GnuCOBOL FAQ

Release 3.0.412

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CHAPTER

ONE

GNUCOBOL FAQ

Status

This is a programming aid and technical reference for the GnuCOBOL COBOL compiler. A work in progress documenting GnuCOBOL Frequently Asked Questions and programming in COBOL with GnuCOBOL.

Along with exploratory mixing of COBOL with Ada, BASIC, C, Datalog, Elixir, Fortran, Go, Haxe, Inform, J, Java, Javascript, Lua, MUMPS, Neko, Python, REXX, SNUSP, Tcl/Tk, Unicon, Vala, Wren, X86, to name a few, while missing some letters. Mostly COBOL, GnuCOBOL.

Sourced at gcfaq.rst. Courtesy of ReStructuredText, Sphinx, Pandoc, and Pygments. PDF format available at GnuCOBOLFAQ.pdf.

GnuCOBOL 3.1.2 is the release version. *GnuCOBOL 4 with XFD, and C++ versions are available for testing*. OpenCOBOL became GNU Cobol on September 27th, 2013, officially dubbed a GNU package. The spelling of GNU Cobol changed to GnuCOBOL on September 20th, 2014. Copyrights were assigned to the Free Software Foundation on June 17th, 2014.

This FAQ is more than a *FAQ* (page 1388) and less than a FAQ. Someday that will change and this document will be split into a GnuCOBOL manual, a cookbook, and a simplified Frequently Asked Questions file. *The mythical, Someday*.

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Comments, corrections, and suggestions regarding this document can be posted to *GnuCOBOL FAQ feedback* (page 1478) hosted in the GnuCOBOL project space.

```
Dedicated to the living memory of Roger While (1950-2015)
```

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Special credits to

Gary Cutler author of the GnuCOBOL Programmers Guide
Joseph James Frantz for hosting and advocacy [aoirthoir]

Version 3.0.412, March 4th, 2020+2

Status never complete; like a limit, $\lim_{aq \to 0} f(aq) = 42$

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ChangeLog *ChangeLog* (page 1481)

Acknowledgment Below is a copy of the long standing acknowledgment request that appears in all versions of the CODASYL COBOL Journal of Development and most ANSI/ISO COBOL standards.

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Many thanks to the original designers, supporting organizations, and individuals of the day.

Note: Regarding COBOL Standards, Official COBOL Standards: There are many references to **standards** in this document. Very few of them are *technically* correct references. Apologies to all the hard working men and women of the technical committees for this unintentional slight. For specific details on what wordings should be used please see *What are the Official COBOL Standards?* (page 55)

1.1 What is GnuCOBOL?

GnuCOBOL is a COBOL compiler. GnuCOBOL is a GNU free software package.

GnuCOBOL implements a substantial part of the COBOL 85, COBOL 2002, COBOL 2014 and upcoming COBOL 202x standards, as well as many extensions from existing COBOL compilers.

GnuCOBOL compiles COBOL into C then compiles the intermediate code with the configured C compiler, usually gcc, into assembler for object code, linked into executable machine code.

COBOL to C to executable on GNU/Linux, Mac OS X, Microsoft Windows, OS/400, z/OS 390 mainframes, smart phones, almost all platforms. *libcob was ported to an 8bit microcontroller with LCD display*.

GnuCOBOL was OpenCOBOL. OpenCOBOL started around 2002, and on September 26th, 2013, GnuCOBOL was accepted and dubbed a GNU package by Dr. Richard Stallman. *One day before the 30th anniversary of the GNU project announcement*.

The official page for GnuCOBOL is:

http://savannah.gnu.org/projects/gnucobol

A valuable reference, the `GnuCOBOL Programmer's Guide` can be found at GnuCOBOL Programmers Guide.

The original `OpenCOBOL Programmer's Guide` can be found at OpenCOBOL Programmers Guide.

In this author's opinion, GnuCOBOL is a world class COBOL compiler, very capable with almost all of the COBOL 85 specifications, plus having some very modern, next generation potentials.

GnuCOBOL REDEFINES programming is the motto.

Coincidentally, that motto is compilable source code.

```
identification division.
program-id. motto.
data division.
working-storage section.

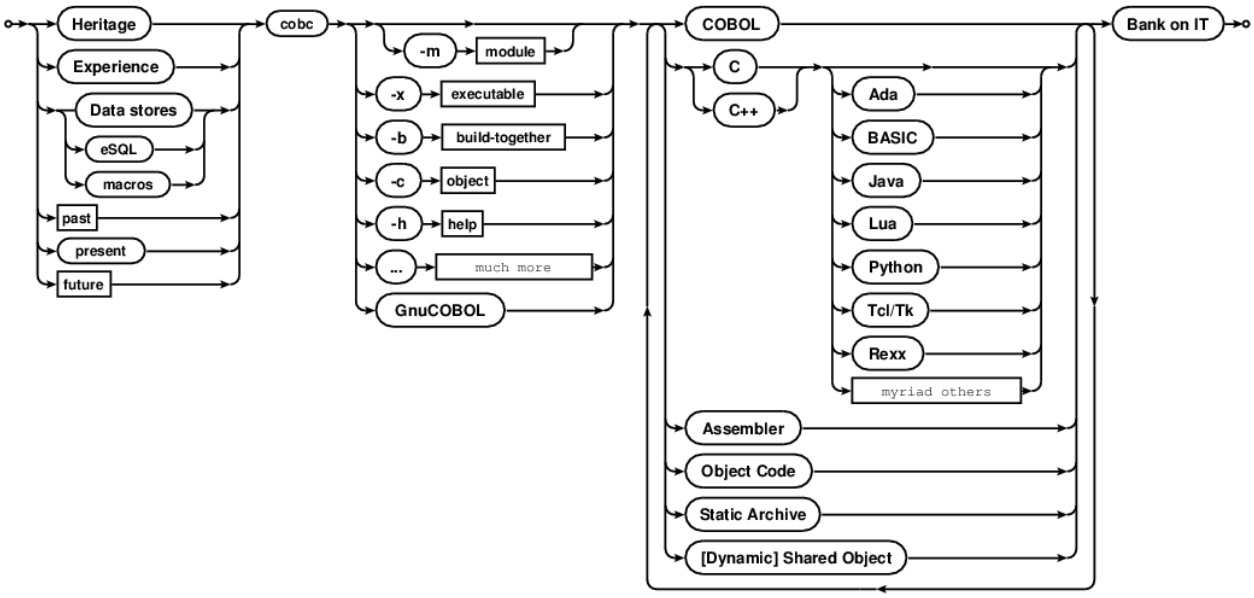
1, computer                                              . 2
   programming value is "Highly rewarding".


2, GnuCOBOL REDEFINES programming                      pic xx.
                                                     procedure
                                                     division.
3. display GnuCOBOL.
```

```
prompt$ cobc -xj -free motto.cob
Hi
```

Ignore the tricky formatting, that was all for looks on a particular forum that only allowed 52 characters with a horizontal scrollbar. GnuCOBOL normally looks far more professional than the odd snippet of fun you may read in this document.

And a little marketing:



1.2 What is COBOL?

COBOL is an acronym for COmmon Business Oriented Language. This author has always thought of it as "Common Business" Oriented more than Common "Business Oriented", but that emphasis is perhaps up to the reader's point of view.

As an aside: I'd like to steal the O in COmmon, and haven't found a suitable word as of yet. Common *Originally* Business Oriented Language, was tried, trying to connote "it's been extended", but it sounds diminishing, like GnuCOBOL can't do Business anymore. Which isn't the case. *So, the quest continues*.

A discussion group posting on LinkedIn tweaked this again, Common Object Business Oriented Language. I like it. And with GnuCOBOL C++, perhaps Sergey can lead the charge/change.

Later... and even better, perhaps:

Common Objective Business Oriented Language.

A stable, business oriented language, that helps people meet the common objectives; across all the computing platforms, around the globe. *That is not an official acronym or anything, just a suggestion*.

1.3 How is GnuCOBOL licensed?

The compiler is licensed under the GNU General Public License.

The run-time library is licensed under GNU Lesser General Public License.

All source codes were copyright by the respective authors. With many thanks to Roger While and Keisuke Nishida for sharing their work with the world.

```
On June 17th, 2015, the legal transfer of all components of the GnuCOBOL
source code tree, from all authors, to the Free Software Foundation, was
announced as official.  The rights to copy the GnuCOBOL project source
codes are now in the care, and capable hands, of the FSF.
```

What this licensing means, roughly, is:

```
You are allowed to write GnuCOBOL programs that use the libcob run time
library however you like.  Closed, proprietary, commercial use is allowed as
part of the LGPL user freedoms.  You can ship GnuCOBOL generated programs in
binary form as you wish, (with exceptions; mentioned below).

Modifications to the compiler itself, if ever distributed, need to
provide access to source code and be licensed under the GNU GPL.

Modifications to the run time library code, if distributed to others,
should also provide access to the source code of the library changes,
and be licensed under the LGPL, but other redistribution models are
allowed.

This ensures that no one is allowed to provide people with access to a
compiler that they can't change, rebuild, and redistribute freely.

If modified sources are personal, or never distributed outside an
organization, there is no burden to release the source of a custom
compiler.  The main intents of the GPL are to ensure end user freedoms.
And the LGPL code to be usable, as given, in closed run-time systems.

I think.  I am not a lawyer.
```

Berkeley Data Base license:

```
Please note: this applies to default GnuCOBOL binary builds.

Any version of the compiler that is configured to use Berkeley DB
beyond version 1.85 must abide by the Oracle license, and sources of the
COBOL programs that use libdb must be shipped with any binaries. There are
alternatives to libdb, but deep down, GnuCOBOL encourages free software.

GnuCOBOL, by default is built with libdb for ISAM operations.  Be aware of
the implications, call Oracle, or build in something like the VBISAM engine.
```

GnuCOBOL is distributed in the hope that it will be useful, but WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE. See the GNU General Public License for more details.

Note: While GnuCOBOL can be held to a high standard of quality and robustness, the authors **do not** claim it to be a "Standard Conforming" implementation of COBOL.

1.4 What platforms are supported by GnuCOBOL?

GnuCOBOL has been built on a lot of operating systems.

OpenCobol 1.0 hosted on SourceForge.net, compiles on:

- All 32-bit MS Windows (95/98/NT/2000/XP)
- All POSIX (Linux/BSD/UNIX-like OSes)
- OS/X

GnuCOBOL 1.1, the first official GNU release version has been built on

- MS Windows native
- MS Windows with Cygwin
- GNU/Linux
- POSIX Systems including OpenSolaris
- OS/X
- AS/400
- HP Integrity HPUX 11.23
- RS600 AIX 5
- 390 Mainframe z/OS OMVS/USS
- others, Raspberry Pi ("$35 for hardware, OS and GnuCOBOL")

GnuCOBOL 2.2, is now making into official repositories. As an example, Ubuntu 18.04, `sudo apt install gnucobol` is release 2.2.

GnuCOBOL 3.1, released in November 2020 will be in some distributions. Along with GnuCOBOL 3.1.1, and GnuCOBOL 3.1.2, released in December 2020. More and more distributions are providing current releases.

With each contribution, GnuCOBOL ends up supported on more and more platforms.

1.5 Are there pre-built GnuCOBOL packages?

Yes.

Note: Windows quick start, February 2020+1

The best option at this time is hosted at https://www.arnoldtrembley.com/GnuCOBOL.htm

Scroll down to **GnuCOBOL Compiler install binaries** and choose from a few configurations. Recommend

- https://www.arnoldtrembley.com/GC312-BDB-rename-7z-to-exe.7z
- https://www.arnoldtrembley.com/GC312-VBI-rename-7z-to-exe.7z

Those builds include Indexed IO, full decimal math support, screens, Report Writer, more. From the soon to be GnuCOBOL 3.1-dev release. G-BDB is built with Berkeley DB, and includes GNU Debugger symbols. VBI is VB-ISAM instead of BDB, without debug symbols in the compiler. Visit the site for the latest, and more configuration choices.

Rename the .7z to .exe, and click for an easy install. Open a console, run `set_env.cmd` in the extract directory, then freely create, compile, and run your COBOL programs.

Debian (page 65) *APT* (page 1323), and RPM packages exist. Packages for NetBSD. Many. Google `opencobol packages` for older builds, and `gnu cobol` for any late breaking news.

A Debian Advanced Package Tool binary package exists for GnuCOBOL 1.1 as `open-cobol` and lists dependencies of

- libc6 (>= 2.7-1),
- libcob1,
- libcob1-dev (= 1.0-1),
- libdb4.5 (>= 4.5.20-3),

- libdb4.5-dev,
- libgmp3-dev,
- libgmp3c2,
- libltdl3-dev,
- libncurses5 (>= 5.6+20071006-3)

Thanks to the gracious efforts of Bart Martens, bartm on Debian's .org domain.

More recently the official repos will have package `gnucobol` and it is usually version 2.2.

Fedora and RedHat `yum` repositories usually have `open-cobol` as a choice for

```
yum install open-cobol
```

GnuCOBOL packages are slowly being introduced, and will likely see a revision from open-cobol-1.1 to GnuCOBOL 3.0 and gnucobol, after some release announcements and posting to GNU servers.

1.5.1 repology

There is a page with just about all details of *official* packaging at

https://repology.org/metapackage/gnucobol/versions

Please note that *none* of these packages are project affiliated, but come to you out of the goodness of the hearts of the volunteers involved.

The **official** project releases are in source form and will be posted to ftp.gnu.org.

1.5.2 kiska.net repository

Also check out kiska.net for binary builds on various platforms. Thanks to Sergey Kashyrin, who is also the author of the version that emits C++ intermediates.

1.5.3 sourceforge

There are GnuCOBOL links at http://cobol.sourceforge.net

In particular, http://sourceforge.net/projects/cobol/files/open-cobol/ can come in handy, with sources and MinGW binaries at a minimum. Maybe more as time goes on.

1.5.4 Windows™ MinGW

Arnold Trembley has been supporting the project with installers for a long time now. His latest is bundled with the OCIDE distribution, or see

This is the link you want to follow first

https://www.arnoldtrembley.com/GnuCOBOL.htm

Then take a look through

https://gnucobol.sourceforge.io/files/

for the latest. Usually in synch with Arnold's releases, but there is usually a few days between Arnold posting a new build and the links being updated.

Older cuts

Arnold put together an INNO installer, based on Gary Cutler's MinGW builds of OpenCOBOL 1.1. Makes it pretty easy to get COBOL running on a PC. You can find it attached to SourceForge discussions, or at Arnold's site:

- https://www.arnoldtrembley.com/OpenCOBOL-MinGw-installer.zip and
- https://www.arnoldtrembley.com/GnuCOBOL-MinGw-Installer.zip with a build guide
- http://opencobol.add1tocobol.com/guides/GnuCOBOL-1.1-MinGW-Build-Guide.pdf

1.5.5 MinGW official

An official GnuCOBOL project MinGW build, put together by Simon Sobisch, is stored on SourceForge, at

http://sourceforge.net/projects/gnucobol/files/gnu-cobol/1.1/ directly downloaded as

```
http://sourceforge.net/projects/gnucobol/files/gnu-cobol/1.1/GnuCOBOL_1.1_MinGW_BDB_PDcurses_MPIR.7z/download
```

As the name implies, this complete compiler build includes Berkeley DB for ISAM, PDCurses for extended screen IO, and MPIR for the decimal arithmetic and other multiprecision math features of GnuCOBOL.

This build is now also included in Colin's *OpenCOBOLIDE* (page 30).

1.5.6 Windows™ Visual Studio vc11 native

Paraphrased from some posts by Simon on the forge:

```
New upload of
http://sourceforge.net/projects/gnucobol/files/gnu-cobol/2.0/gnu-cobol-2.0_nightly_r411_win32_vc11_bin.7z
- works correctly now

http://sourceforge.net/projects/gnucobol/files/gnu-cobol/win_prerequistes/win_prerequistes_vc11.7z
was uploaded, too
```

Keep an eye on http://sourceforge.net/projects/gnucobol/files/gnu-cobol/2.0/ for the latest snapshots.

```
If you don't know already: GC translates COBOL to C and compiles it using a
C compiler. For Win8 I'd use VS2012 or higher (Express Versions work fine).
After installing it go to the downloads area and grab the first "official"
nightly build direct from svn: ... link above

it's quite easy to build GnuCOBOL 2.0 on your own: checkout 2.0-branch,
download the win_prerequisites from sourceforge download area, unpack it to
build_windows, open the VS solution you need (maybe changing defaults.h to
match your path) and click compile.
```

1.5.7 Mario's file pile

Mario Matos is building up a pile of files of GnuCOBOL related archives, in the cloud at

https://meocloud.pt/link/4275816b-59bc-4fe9-96a3-f2c7a24e9246/GnuCOBOL/

There are archives for lots of different cuts of GnuCOBOL for Windows along with a plethora of other tools and utilities, with nuggets of wisdom and how-to information sprinkled throughout.

1.5.8 Online compilers

There are a few sites that provide online compilation for trials and testing.

GnuCOBOL (or an older OpenCOBOL, depending on when the site installed their compilers) can be tried at:

- https://www.tutorialspoint.com/compile_cobol_online.php
- https://ideone.com/l/cobol

There are others. I'll try and keep this list up to date as new sites come to be known.

Please note: These are publicly accessible sites, owned by others.

```
Do NOT post code to a website if you need to keep it private
Do NOT post code to a website if you have no rights to copy
```

Outside that warning, online compiler sites are great for quick trials and showing friends and acquaintances how cool GnuCOBOL is.

1.6 What is the most recent version of GnuCOBOL?

See *What is the current version of GnuCOBOL?* (page 57)

Note: Windows quick start, February 2020+1

The best option at this time is hosted at https://www.arnoldtrembley.com/GnuCOBOL.htm

Scroll down to **GnuCOBOL Compiler install binaries** and choose from a few configurations. Recommend

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Those builds include Indexed IO, full decimal math support, screens, Report Writer, more. From the soon to be GnuCOBOL 3.1-dev release. G-BDB is built with Berkeley DB, and includes GNU Debugger symbols. VBI is VB-ISAM instead of BDB, without debug symbols in the compiler. Visit the site for the latest, and more configuration choices.

Rename the .7z to .exe, and click for an easy install. Open a console, run `set_env.cmd` in the extract directory, then freely create, compile, and run your COBOL programs.

1.7 How complete is GnuCOBOL?

OpenCOBOL 1.0 implements a substantial portion of COBOL 85, supports many of the advances and clarifications of COBOL 2002, and includes many extensions in common use from Micro Focus COBOL, ACUCOBOL and other existent compilers.

GnuCOBOL 2.2 implements a more substantial portion of the COBOL 85 Dialect, COBOL 2002 and a growing number of vendor extensions.

GnuCOBOL 3.1 adds Report Writer and a host of features that have been developed in the reportwriter branch along with even more support for COBOL 2014, COBOL 202x and existent COBOL extensions.

The GnuCOBOL 4 pre-release continues expanding on old and new COBOL features along with Standard syntax and extensions.

Compatibility support includes:

- MF for Micro Focus
- IBM for IBM compatibility
- MVS
- BS2000
- ACU
- RM
- REALIA

GnuCOBOL implements most COBOL technical features and statements (excluding Object COBOL), allowing source code such as

```
CALL "cfunction" USING BY REFERENCE ADDRESS OF VAR-IN-LINKAGE-SECTION.
```

Passing the equivalent of `char**`, pointer to pointer to char. Just as a small example of the level of coverage and flexibility provided by GnuCOBOL.

User Defined Functions can add a level of conciseness to COBOL.

```
MOVE FUNCTION COMPANY-RULE39(SALES-RECORD) TO BONUS
```

GnuCOBOL supports most intrinsic functions, as well as a few extensions.

```
DISPLAY
    FUNCTION UPPER-CASE(
        FUNCTION SUBSTITUTE(
            "This is the orginal string.";
            "original"; "new"; "string"; "text"
        )
    )
```

Allowing for substitution of mixed length strings, something not normally so easy in COBOL. The above will output:

```
THIS IS THE NEW TEXT.
```

Note: While GnuCOBOL can be held to a high standard of quality and robustness, the authors **do not** claim it to be a "Standard Conforming" implementation of COBOL. *Even though it covers a lot of Standard; there is no claim, official and or otherwise*.

1.8 Will I be amazed by GnuCOBOL?

This author believes so. For a free implementation of COBOL, GnuCOBOL may surprise you in the depth and breadth of its COBOL feature support, usability and robustness.

COBOL use has historically been quite secretive and low key. Its domain of use being very secretive and low key. COBOL programmers rarely work on systems that would allow for open internet chat regarding details, let alone *existence* of the programs involved. It is a tribute to the professionalism of these programmers that most people rarely, if ever, hear the name COBOL, a programming language with billions of lines of source code compiled and in production around the world, for over half a century.

GnuCOBOL is poised to change that historic trend, and allow for the long overdue sharing of wisdom that legions of COBOL developers have accumulated over 60 years of success and failure. The GnuCOBOL conversation may be more *POSIX* (page 1361) than mainframe, but there is now room to share, critique and pass on the hard lessons learned from critical systems computing. Given that millions of COBOL programmers kept billions of lines of COBOL source out of the press, surely some of the wisdom can be passed on in a way that keeps all the secrets secret while curious developers are exposed to COBOL outside the vaults.

1.9 Who do I thank for GnuCOBOL?

Many people. In particular **Keisuke Nishida**, **Roger While**, **Simon Sobisch**, **Ron Norman**, **Edward Hard**, **Dave Pitts** and **Sergey Kashyrin**.

See the THANKS file in the source code archive for more names of people that have worked on the OpenCOBOL, now GnuCOBOL, project. Roger points out that the list is woefully incomplete. To quote:

```
The OC project would not have been where it is today without the
significant/enormous help from many-many persons. The THANKS
file does not even do justice to this.
```

1.10 Does GnuCOBOL include a Test Suite?

Why yes it does. 74 syntax tests, 170 coverage tests, and 16 data representation tests in the February 2009 pre-release.

88 syntax, 253 coverage, and 22 data tests in a 2010 cut. 456 tests in the 2014 sources, and growing. (501 tests in early 2015).

2.0-rc3 in early 2017 includes 34 general usage, 203 syntax, 21 listing, 409 coverage, and 26 data representation tests for a total of 693 test areas during build.

2.2 official runs some 700+ internal checks.

3.1 in 2018 was approaching a total of 1,000 `make check` checks.

3.1.2 released in December of 2020 includes 1086 checks.

The 4.0 pre-release has over 1,130 internal integrity checks.

From a development tarball:

```
$ make check
```

will evaluate and report on the test suite. See *make check listing* (page 1340) for a current output listing of a test run.

`make check` is built with Autotools autotest, a Perl based test harness.

It supports a few options, one in particular:

```
$ TESTSUITEFLAGS='--jobs=4' make check
```

will run tests in parallel, pick a number appropriate to the number of cores.

A quad core pass with `--jobs=4`

```
00:24.86 elapsed 300%CPU
```

and without TESTSUITEFLAGS *(some may be pre-cached etc. . .)*

```
01:24.72 elapsed 100%CPU
```

85 seconds down to 25 seconds, when tested in parallel.

1.10.1 Educational benefits of the test suite

The code in *tests/testsuite.dir* is a treasure trove of source code that demonstrates the various features of GnuCOBOL and how to use them.

The code is embedded in Autoconf Autotest macros, in particular `AT_DATA` blocks hold GnuCOBOL sources. With a little bit of practice these distractions can be overlooked, as inside the code is just COBOL.

There are good examples of some of the more technical aspects of COBOL in these tests. Often focused on a single issue, some include a fair amount of COBOL while testing for expected results.

For example, in *testsuite.dir/run_returncode.at*

```
AT_SETUP([RETURN-CODE nested])
AT_KEYWORDS([returncode])

AT_DATA([prog.cob], [
       IDENTIFICATION   DIVISION.
       PROGRAM-ID.      prog.
       PROCEDURE        DIVISION.
           MOVE 1 TO RETURN-CODE.
           IF RETURN-CODE NOT = 1
              DISPLAY RETURN-CODE NO ADVANCING
              END-DISPLAY
           END-IF.
           CALL "mod1"
           END-CALL.
           IF RETURN-CODE NOT = 2
              DISPLAY RETURN-CODE NO ADVANCING
              END-DISPLAY
           END-IF.
           MOVE ZERO TO RETURN-CODE.
           STOP RUN.
       PROGRAM-ID.      mod1.
       PROCEDURE        DIVISION.
           IF RETURN-CODE NOT = 1
              DISPLAY RETURN-CODE NO ADVANCING
              END-DISPLAY
           END-IF.
           MOVE 2 TO RETURN-CODE.
           EXIT PROGRAM.
       END PROGRAM mod1.
       END PROGRAM prog.
])

AT_CHECK([$COMPILE prog.cob], [0], [], [])
AT_CHECK([./prog], [0], [], [])

AT_CLEANUP
```

That code, while testing the `RETURN-CODE` special register, also illustrates how to nest sub-programs in COBOL. There are thousands of feature demonstrations for GnuCOBOL programming in the test suite.

The compiler developers aim to always use warning free COBOL in these tests, in upper case, so they may not have the most modern appearance. This is a testament to the long life of COBOL, and the backward compatible defaults that have carried over in the COBOL Standards from 1960 through modern times. GnuCOBOL supports all the improvements and advancements that COBOL now empowers, but the tests are written in support of the goal for backward compatible long lived source code, for business stability across decades of COBOL evolution.

1.11 Does GnuCOBOL pass the NIST Test Suite?

Mostly. Not all. All attempted tests are passed. Over 9000.

The National Institute of Standards and Technology, NIST, maintained, and now archives a COBOL 85 implementation verification suite of tests. A compressed archive of the tests, last updated in 1993, to include Intrinsic Functions, A copy of the archive has been placed in

https://sourceforge.net/projects/gnucobol/files/nist/

This used to be at: http://www.itl.nist.gov/div897/ctg/cobol_form.htm and redistribution comes with conditions; this is for official purposes of testing a COBOL compiler build. It is not for general redistribution.

GnuCOBOL passes many of the tests included in the NIST sponsored COBOL 85 test suite.

While the system successfully compiles over 400 modules, failing none of the over 9700 tests attempted; GnuCOBOL does **not** claim conformance to any level of COBOL *Standard*.

Instructions for use of the NIST suite is included in the build archive under:

```
tests/cobol85/README
```

Basically, it is a simple `uncompress` and `make` then sit back and relax. The scripts run GnuCOBOL over some 424 programs/modules and includes thousands of different, purposely complicated stress test passes.

It got easier too, just type `make checkall` during a source build to automatically download, extract and run the NIST test suite.

```
Test Modules
------------

Core tests:

  NC - COBOL nucleus tests
  SM - COPY sentence tests
  IC - CALL sentence tests

File I-O tests:

  SQ - Sequential file I-O tests
  RL - Relative file I-O tests
  IX - Indexed file I-O tests
  ST - SORT sentence tests
  SG - Segment tests

Advanced facilities:

  RW - REPORT SECTION tests
  IF - Intrinsic Function tests
  SG - Segment tests
  DB - Debugging facilities tests
  OB - Obsolete facilities tests
```

With the addition of GLOBAL support, the GnuCOBOL-reportwriter pre-release fails none of the attempted tests.

The summary.log from a run in November 2013 with initial Report Writer support:

```
------ Directory Information -------   --- Total Tests Information ---
Module Programs Executed Error Crash   Pass Fail Deleted Inspect Total
------ -------- -------- ----- -----  ----- ---- ------- ------- -----
NC           95       95     0     0   4371    0       4      26  4401
SM           17       17     0     0    293    0       2       1   296
IC           25       25     0     0    247    0       4       0   251
SQ           85       85     0     0    521    0       0      89   610
RL           35       35     0     0   1830    0       5       0  1835
IX           42       42     0     0    510    0       1       0   511
ST           40       40     0     0    289    0       0       0   289
SG           13       13     0     0    313    0       0       0   313
OB            7        7     0     0     34    0       0       0    34
IF           45       45     0     0    735    0       0       0   735
RW            6        6     0     0     42    0       0       0    42
DB           14       14     0     0    404    0       4      27   435
------ -------- -------- ----- -----  ----- ---- ------- ------- -----
Total       424      424     0     0   9589    0      20     143  9752
```

This is up from the 1.1 Feb 2009 release count of 9082.

1.11.1 What's missing?

GnuCOBOL does not yet include support for:

```
Advanced facilities:

  CM - COMMUNICATION SECTION tests
```

and limits tests within the:

```
DB - Debugging facilities tests
OB - Obsolete facilities tests
```

sections.

1.12 What about GnuCOBOL and benchmarks?

COBOL has a legacy dating back to 1959. Many features of the COBOL standard provide defaults more suitable to mainframe architecture than the personal computer a 3rd millennium GnuCOBOL developer will likely be using.

GnuCOBOL, by default, generates code optimized for *big-endian* (page 1318) hardware. Fairly dramatic speed improvements on Intel architecture can come from simple `USAGE IS COMPUTATIONAL-5` clauses in the DATA DIVISION.

1.12.1 telco billing

There is a benchmark posted at http://speleotrove.com/decimal/telco.html and thanks to Bill Klein [wmklein], there is a COBOL entry. From the source code listed below, you should only have to modify

```
Input-Output Section.
 File-Control.
    Select InFile  Assign to
         "C:\expon180.1e6".
    Select OutFile  Assign to
         "C:\TELCO.TXT"
                Line
                Sequential.
```

to point to the correct filename for your local copy of the benchmark million entry file and a suitable OutFile name for a clean compile and run.

Update: There is a version tuned for GnuCOBOL, especially the ROUNDED NEAREST-EVEN support. It gives correct results for what would be common default GnuCOBOL settings and compiler configurations, and Banker's Rounding. *Listed below*.

In summary, the benchmark reads a large input file containing a suitably distributed list of telephone call durations (each in seconds). For each call, a charging rate is chosen and the price calculated and rounded to hundredths. One or two taxes are applied (depending on the type of call) and the total cost is converted to a character string and written to an output file. Running totals of the total cost and taxes are kept; these are displayed at the end of the benchmark for verification.

A run on an older pentium 4 and the million number file gave:

```
$ echo 'N' | time ./telco
Enter 'N' to skip calculations:
0.46user 1.08system 0:01.61elapsed 96%CPU (0avgtext+0avgdata 0maxresident)k
0inputs+134776outputs (0major+345minor)pagefaults 0swaps

$ echo '' | time ./telco
Enter 'N' to skip calculations:
11.37user 1.41system 0:12.95elapsed 98%CPU (0avgtext+0avgdata 0maxresident)k
24inputs+134776outputs (0major+360minor)pagefaults 0swaps

$ tail TELCO.TXT
    35    D  |         0.31         0.02         0.01 |         0.34
   193    D  |         1.73         0.11         0.05 |         1.89
   792    L  |         1.03         0.06              |         1.09
   661    D  |         5.91         0.39         0.20 |         6.50
    44    L  |         0.06         0.00              |         0.06
   262    L  |         0.34         0.02              |         0.36
-------------+-----------------------------------------+-------------
   Totals:   |   922,067.11    57,628.30    25,042.17 | 1,004,737.58
  Start-Time:09:37:23.93
    End-Time:09:37:36.83
```

2 seconds for the short test, 12 for the long, on a fairly small machine.

A more recent 1.1 pre-release, on a dual quad-core Xeon box running Linux SLES 10 64-bit:

```
$ tail TELCO.TXT
     35    D  |         0.31         0.02         0.01 |         0.34
    193    D  |         1.73         0.11         0.05 |         1.89
    792    L  |         1.03         0.06              |         1.09
    661    D  |         5.91         0.39         0.20 |         6.50
     44    L  |         0.06         0.00              |         0.06
    262    L  |         0.34         0.02              |         0.36
 -------------+-----------------------------------------+-------------
```

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```
    Totals:   |   922,067.11    57,628.30    25,042.17 | 1,004,737.58
   Start-Time:21:40:48.52
     End-Time:21:40:51.92
```

3.4 seconds cache-hot, long test. Not bad.

With Bill's permission, the benchmark code is listed here: (with the first few lines added for the benefit of an indent based code highlighter)

```
COBOL
bench
mark
      *>
      *> By William Klein, used with permission
      *>
       Identification Division.
        Program-ID. TELCO.
       Environment Division.
       Input-Output Section.
        File-Control.
           Select InFile  Assign to
                "C:\expon180.1e6".
      *>        "C:\TELCO.TEST".
           Select OutFile  Assign to
                "C:\TELCO.TXT"
                       Line
                       Sequential.
       Data Division.
        File Section.
       FD  InFile.
       01  InRec                Pic S9(15)      Packed-Decimal.
       01  InRec2.
           05                   Pic  X(7).
           05                   Pic S9(1)       Packed-Decimal.
             88  Premimum-Rate                  Value 1 3 5 7 9.
       FD  OutFile.
       01  OutRec               Pic X(70).
       Working-Storage Section.
       01  Misc.
           05                   Pic  X          Value "N".
             88  EOF                           Value "Y".
           05  Do-Calc          Pic  X          Value "Y".
             88  No-Calc                       Value "N".
           05.
               10  Start-Time   Pic X(21).
               10  End-Time     Pic X(21).
       01  Misc-Num.
           05  Price-Dec5       Pic S9(05)V9(06).
           05  Redefines Price-Dec5.
               10               Pic X(3).
               10               Pic S9(05).
                 88  Even-Round
                                 Value 05000 25000 45000 65000 85000.
           05  Running-Totals.
               10  Price-Tot    Pic S9(07)V99    Binary.
               10  BTax-Tot     Pic S9(07)v99    Binary.
               10  DTax-Tot     Pic S9(07)V99    Binary  Value Zero.
```

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```
           10  Output-Tot  Pic S9(07)V99    Binary.
       05  Temp-Num.
           10  Temp-Price   Pic S9(05)V99   Binary.
           10  Temp-Btax    Pic S9(05)V99   Binary.
           10  Temp-DTax    Pic S9(05)V99   Binary.
    01  WS-Output.
       05  Header-1         Pic X(70)       Value
           "  Time  Rate |        Price         Btax         Dtax |
-          "      Output".
       05  Header-2         Pic X(70)       Value
           "-------------+-----------------------------------------+-
-          "-------------".
       05  Detail-Line.
           10               Pic X(01)       Value Space.
           10  Time-Out     Pic zzzz9.
           10               Pic X(04)       Value Space.
           10  Rate-Out     Pic X.
           10               Pic X(04)       Value "  | ".
           10  Price-Out    Pic z,zzz,zz9.99.
           10               Pic X(01)       Value Spaces.
           10  Btax-Out     Pic z,zzz,zZ9.99.
           10               Pic X(01)       Value Spaces.
           10  Dtax-Out     Pic Z,zzz,zz9.99        Blank When Zero.
           10               Pic X(03)       Value " | ".
           10  Output-Out   Pic z,zzz,zZ9.99.
    Procedure Division.
     Mainline.
       Perform Init
       Perform Until EOF
           Read  InFile
               At End
                   Set EOF  to True
               Not At End
                   If No-Calc
                       Continue
                   Else
                       Perform  Calc-Para
                   End-If
                   Write OutRec from Detail-Line
           End-Read
       End-Perform
       Perform WindUp
       Stop Run
            .
    Calc-Para.
       Move InRec   to Time-Out
       If Premimum-Rate
           Move "D"         To Rate-Out
           Compute Temp-Price Rounded Price-Out Rounded Price-Dec5
                    = InRec * +0.00894
           Compute Temp-DTax DTax-Out
                    = Temp-Price * 0.0341
           Add Temp-Dtax to DTax-Tot
       Else
           Move "L"         To Rate-Out
           Compute Temp-Price Rounded Price-Out Rounded Price-Dec5
                    = InRec * +0.00130
```

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```
            Move Zero to DTax-Out Temp-DTax
        End-If
        If Even-Round
            Subtract .01 from Temp-Price
            Move Temp-Price to Price-Out
        End-If
        Compute Temp-Btax BTax-Out
                    = Temp-Price * 0.0675
        Compute Output-Out
                    = Temp-Price + Temp-Btax + Temp-Dtax
        Add Temp-BTax        To Btax-Tot
        Add Temp-Price       to Price-Tot
        Compute Output-Tot
                    = Output-Tot + Function NumVal (Output-Out (1:))
            .
    Init.
        Open Input  InFile
             Output OutFile
        Write OutRec from Header-1
        Write OutRec from Header-2
        Display "Enter 'N' to skip calculations:" Upon Console
        Accept Do-Calc From Console
        Move Function Current-Date   To Start-Time
            .
    WindUp.
        Move Function Current-Date to End-Time
        Write OutRec         from Header-2
        Move Price-Tot       to Price-Out
        Move Btax-Tot        to Btax-Out
        Move Dtax-Tot        to Dtax-Out
        Move Output-Tot      to Output-Out
        Move "   Totals:"    to Detail-Line (1:12)
        Write OutRec         from Detail-Line
        Move Spaces          to OutRec
        String       "  Start-Time:"         Delimited by Size
                     Start-Time (9:2)        Delimited by Size
                     ":"                     Delimited by size
                     Start-Time (11:2)       Delimited by size
                     ":"                     Delimited by size
                     Start-Time (13:2)       Delimited by size
                     "."                     Delimited by size
                     Start-Time (15:2)       Delimited by size
             into OutRec
        Write OutRec
        Move Spaces          to OutRec
        String       "    End-Time:"         Delimited by Size
                     End-Time (9:2)          Delimited by Size
                     ":"                     Delimited by size
                     End-Time (11:2)         Delimited by size
                     ":"                     Delimited by size
                     End-Time (13:2)         Delimited by size
                     "."                     Delimited by size
                     End-Time (15:2)         Delimited by size
             into OutRec
        Write OutRec
        Close InFile
              OutFile
```

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```
                .
```

Data files and other code listings are copyright Mike Cowlishaw and IBM, so go to the speleotrove site, linked above, for all the details.

I'll opine; Bill's and Roger's COBOL is a LOT easier to read than the other entries, being C, C#, Java. (The Turbo Pascal link seems broken, can't speak to the readability), but I'm calling COBOL for the win on this one, wire to wire.

Roger's telco benchmark update

```
Update
      *>
      *> By Roger While, used with permission
      *>
       IDENTIFICATION DIVISION.
       PROGRAM-ID. telco5.
       ENVIRONMENT DIVISION.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
           SELECT INFILE   ASSIGN TO
                "expon180.1e6"
                .
           SELECT OUTFILE  ASSIGN TO
                "TELCO.TXT"
                LINE SEQUENTIAL
                .
       DATA DIVISION.
       FILE SECTION.
       FD  INFILE.
       01  INREC            PIC S9(15)      PACKED-DECIMAL.
       01  INREC2.
           05               PIC  X(7).
           05               PIC  X.
             88  PREMIMUM-RATE
                    VALUES X"1C" X"3C" X"5C" X"7C" X"9C".
       FD  OUTFILE.
       01  OUTREC           PIC X(70).
       WORKING-STORAGE SECTION.
       01  DO-CALC          PIC X            VALUE "Y".
           88  NO-CALC                       VALUE "N".

       01  START-TIME       PIC X(21).
       01  END-TIME         PIC X(21).

       01  PRICE-TOT        PIC S9(07)V99    COMP-5.
       01  BTAX-TOT         PIC S9(07)V99    COMP-5.
       01  DTAX-TOT         PIC S9(07)V99    COMP-5.
       01  OUTPUT-TOT       PIC S9(07)V99    COMP-5.

       01  TEMP-PRICE       PIC S9(07)V99    COMP-5.
       01  TEMP-BTAX        PIC S9(07)V99    COMP-5.
       01  TEMP-DTAX        PIC S9(07)V99    COMP-5.

       01  HEADER-1         PIC X(70)       VALUE
           "  Time  Rate |        Price         Btax         Dtax | "
```

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```
           &    "      Output".
       01  HEADER-2          PIC X(70)       VALUE
           "-------------+---------------------------------------+-"
           &    "------------".
       01  DETAIL-LINE.
           10                 PIC X(01)         VALUE SPACE.
           10  NUMB-OUT       PIC ZZZZ9.
           10                 PIC X(04)         VALUE SPACE.
           10  RATE-OUT       PIC X.
           10                 PIC X(04)         VALUE "  | ".
           10  PRICE-OUT      PIC Z,ZZZ,ZZ9.99.
           10                 PIC X(01)         VALUE SPACES.
           10  BTAX-OUT       PIC Z,ZZZ,ZZ9.99.
           10                 PIC X(01)         VALUE SPACES.
           10  DTAX-OUT       PIC Z,ZZZ,ZZ9.99  BLANK WHEN ZERO.
           10                 PIC X(03)         VALUE " | ".
           10  OUTPUT-OUT     PIC Z,ZZZ,ZZ9.99.
       PROCEDURE DIVISION.
       MAINLINE.
           OPEN INPUT  INFILE
                OUTPUT OUTFILE
           WRITE OUTREC FROM HEADER-1
           END-WRITE
           WRITE OUTREC FROM HEADER-2
           END-WRITE
           DISPLAY "Enter 'N' to skip calculations:" UPON CONSOLE
           END-DISPLAY
           ACCEPT DO-CALC FROM CONSOLE
           END-ACCEPT
       *>  Start timer
           MOVE FUNCTION CURRENT-DATE   TO START-TIME
       *>  Start loop
       *>  PERFORM UNTIL EXIT, changed to 0 = 1 for older compilers
           PERFORM UNTIL 0 = 1
               READ  INFILE AT END
                     EXIT PERFORM
               END-READ
               IF NOT NO-CALC
                   MOVE INREC   TO NUMB-OUT
                   IF PREMIMUM-RATE
                       MOVE "D"         TO RATE-OUT
                       COMPUTE TEMP-PRICE ROUNDED MODE NEAREST-EVEN
                                = INREC * 0.00894
                       END-COMPUTE
                       COMPUTE TEMP-DTAX
                                = TEMP-PRICE * 0.0341
                       END-COMPUTE
                       ADD TEMP-DTAX TO DTAX-TOT
                       END-ADD
                       MOVE TEMP-DTAX TO DTAX-OUT
                   ELSE
                       MOVE "L"         TO RATE-OUT
                       COMPUTE TEMP-PRICE ROUNDED MODE NEAREST-EVEN
                                = INREC * 0.00130
                       END-COMPUTE
                       MOVE ZERO TO TEMP-DTAX
                       MOVE ZERO TO DTAX-OUT
```

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```
                END-IF
                MOVE TEMP-PRICE TO PRICE-OUT
                COMPUTE TEMP-BTAX BTAX-OUT
                            = TEMP-PRICE * 0.0675
                END-COMPUTE
                ADD TEMP-PRICE TEMP-BTAX TEMP-DTAX TO OUTPUT-TOT
                END-ADD
                ADD TEMP-PRICE TEMP-BTAX TEMP-DTAX GIVING OUTPUT-OUT
                END-ADD
                ADD TEMP-BTAX        TO BTAX-TOT
                END-ADD
                ADD TEMP-PRICE       TO PRICE-TOT
                END-ADD
            END-IF
            WRITE OUTREC FROM DETAIL-LINE
            END-WRITE
        END-PERFORM
      *>  End loop
      *>  End timer
        MOVE FUNCTION CURRENT-DATE TO END-TIME
        WRITE OUTREC         FROM HEADER-2
        END-WRITE
        MOVE PRICE-TOT       TO PRICE-OUT
        MOVE BTAX-TOT        TO BTAX-OUT
        MOVE DTAX-TOT        TO DTAX-OUT
        MOVE OUTPUT-TOT      TO OUTPUT-OUT
        MOVE "   Totals:"    TO DETAIL-LINE (1:12)
        WRITE OUTREC         FROM DETAIL-LINE
        END-WRITE
        MOVE SPACES          TO OUTREC
        STRING       "  Start-Time:"         DELIMITED BY SIZE
                     START-TIME (9:2)        DELIMITED BY SIZE
                     ":"                     DELIMITED BY SIZE
                     START-TIME (11:2)       DELIMITED BY SIZE
                     ":"                     DELIMITED BY SIZE
                     START-TIME (13:2)       DELIMITED BY SIZE
                     "."                     DELIMITED BY SIZE
                     START-TIME (15:2)       DELIMITED BY SIZE
             INTO OUTREC
        END-STRING
        WRITE OUTREC
        END-WRITE
        MOVE SPACES          TO OUTREC
        STRING       "    End-Time:"         DELIMITED BY SIZE
                     END-TIME (9:2)          DELIMITED BY SIZE
                     ":"                     DELIMITED BY SIZE
                     END-TIME (11:2)         DELIMITED BY SIZE
                     ":"                     DELIMITED BY SIZE
                     END-TIME (13:2)         DELIMITED BY SIZE
                     "."                     DELIMITED BY SIZE
                     END-TIME (15:2)         DELIMITED BY SIZE
             INTO OUTREC
        END-STRING
        WRITE OUTREC
        END-WRITE
        CLOSE INFILE
              OUTFILE
```

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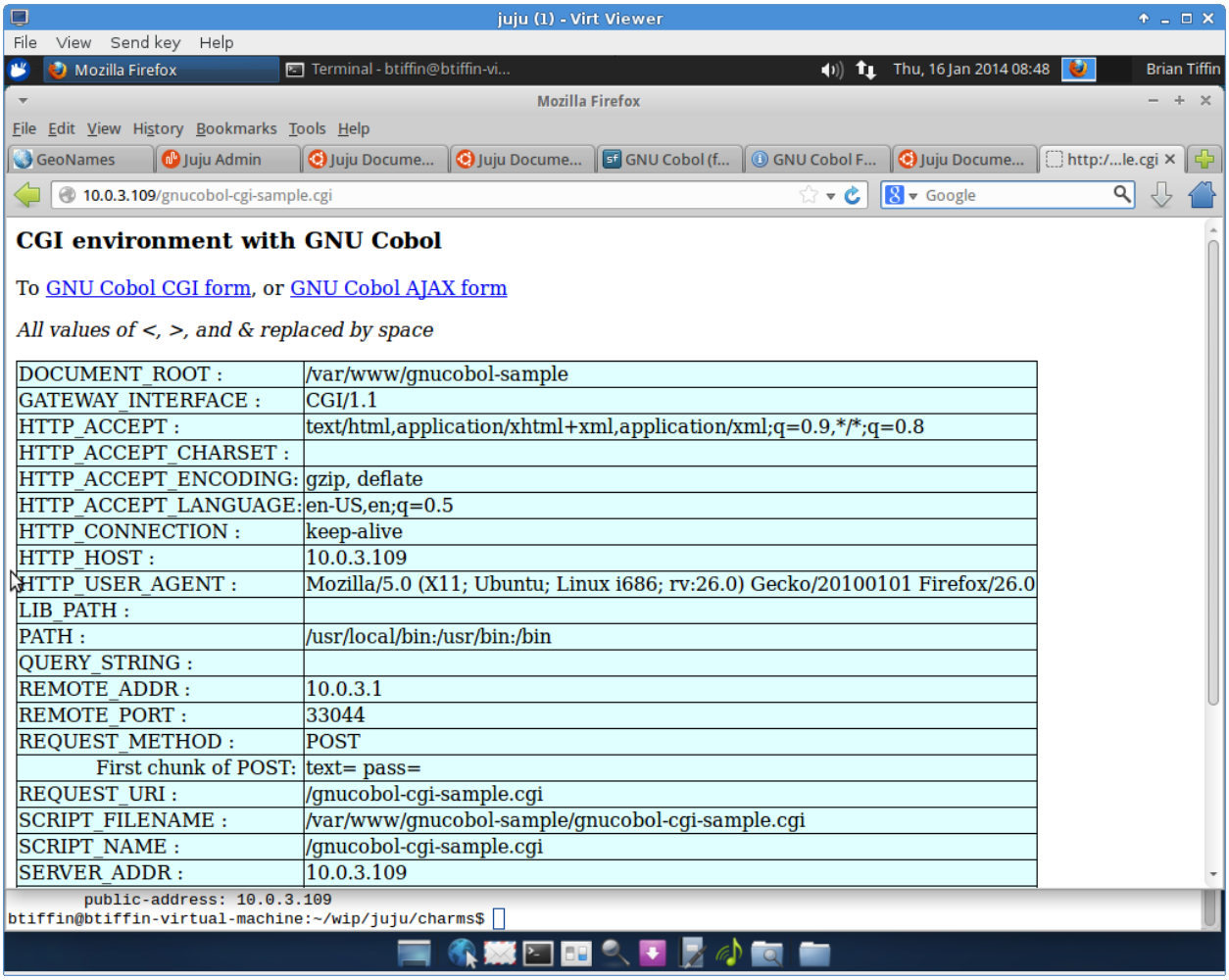
```
            STOP RUN
            .
```

1.13 Can GnuCOBOL be used for CGI?

Yes. Through standard IO redirection and the extended `ACCEPT ... FROM ENVIRONMENT ...` feature, GnuCOBOL is more than capable of supporting advanced Common Gateway Interface programming. See *How do I use GnuCOBOL for CGI?* (page 541) for a sample *Hello Web* program.

Also see *Can GnuCOBOL display the process environment space?* (page 969)

Here's a screenshot of GnuCOBOL running in Apache server CGI, in the Cloud as a Juju Charm.



More specially, this screenshot was taken on a Fedora 19, XFCE desktop with a libvirt VM install of Ubuntu 13.04, running Firefox and browsing a locally spawned cloud instance. The instantiation of the Juju Charm creates another virtual machine, installs a base operating system, compiles and installs GnuCOBOL with Report Writer, builds up a small testsuite of CGI ready COBOL applications, installs everything, starts apache and serves up the pages.

And it all just works

1.13.1 GnuCOBOL with FastCGI

FastCGI can also work with GnuCOBOL. A small wrinkle in the *tectonics* (page 1350) is that the standard IO C header file that is generated by `cobc` needs to be swapped out for `fcgi_stdio.h`. This isn't too bad, as `cobc` can be used to generate intermediate C and after a quick text replacement, can then be called a second time to compile the generated C code into an executable suitable for placing in the web server space.

```
# Sample make rule for using FastCGI with GnuCOBOL
.RECIPEPREFIX = >

program: program.cob
> cobc -x -C program.cob
> sed -i 's/<stdio.h/<fcgi_stdio.h/' program.c
> LD_RUN_PATH=. cobc -x program.c -lfcgi
```

The CGI processing code then needs to add a simple looping structure internally.

```
*> FastCGI from COBOL sample
*>   fastcgi-accept is a binary-long
*>   carriage-return is x"0d" and newline is x"0a"
 procedure division.

 call "FCGI_Accept" returning fastcgi-accept
     on exception
         display
             "FCGI_Accept call error, link with -lfcgi"
         end-display
 end-call

 perform until fastcgi-accept is less than zero

*> Always send out the Content-type before any other IO
     display "Content-type: text/html" carriage-return newline
     end-display

     display "<html><body>" end-display
     display
         "<h3>FastCGI environment with GnuCOBOL</h3>"
     end-display

     ... rest of CGI handling ...

     call "FCGI_Accept" returning fastcgi-accept
         on exception
             move -1 to fastcgi-accept
     end-call

 end-perform
```

Some platforms (ala Cygwin) may need

```
call STATIC "FCGI_Accept" returning fastcgi-accept
```

to get proper linkage with libfcgi.

1.13.2 FastCGI without changing #includes

The makefile steps used above can actually be simplified by passing an `--include` option to the C compiler.

```
cobc -x program.cob -A '--include fcgi_stdio.h' -lfcgi
```

1.13.3 running on hosted services

For those developers looking to serve GnuCOBOL applications on hosted systems without super user privileges, see *How do I use LD_RUN_PATH with GnuCOBOL?* (page 135) for some pointers on getting hosted executables installed properly. `LD_RUN_PATH` can make it easier for CGI programs to find a locally installed `libcob` runtime, something a hosted service may not provide.

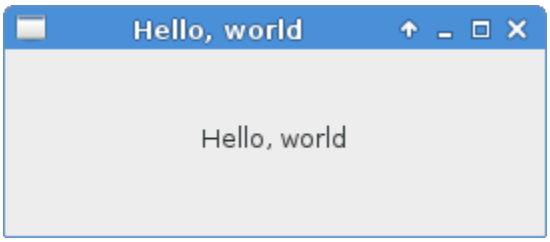
1.14 Does GnuCOBOL support a GUI?

Yes, but not out of the box. There is not currently *(March 2018)* anything that ships with the product.

Third party extensions for Tcl/Tk and linkage to GTK+ and other frameworks do allow for graphical user interfaces. See *Does GnuCOBOL support the GIMP ToolKit, GTK+?* (page 817) and *Can GnuCOBOL interface with Tcl/Tk?* (page 712).

1.14.1 GTK

The expectation is that GTK+ will be completely bound as a callable interface. That is currently *(March 2018)* not the case, with perhaps 2% of the GTK+ functionality wrapped (but with that 2%, fully functional graphical interfaces are possible).



An experimental FUNCTION-ID wrapper is working out well

This procedure division: (part the of the library self-test)

```
cobweb
GTK+
       *> test basic windowing
        procedure division.
        move new-window("cobweb-gtk", width-hint, height-hint)
          to gtk-window-data
        move new-box(gtk-window, HORIZONTAL, spacing, homogeneous)
          to gtk-box-data
        move new-image(gtk-box, "blue66.png") to gtk-image-data
        move new-label(gtk-box, "And? ") to gtk-label-data
        move new-entry(gtk-box, "cobweb-entry-activated")
          to gtk-entry-data
        move new-button(gtk-box, "Expedite", "cobweb-button-clicked")
```

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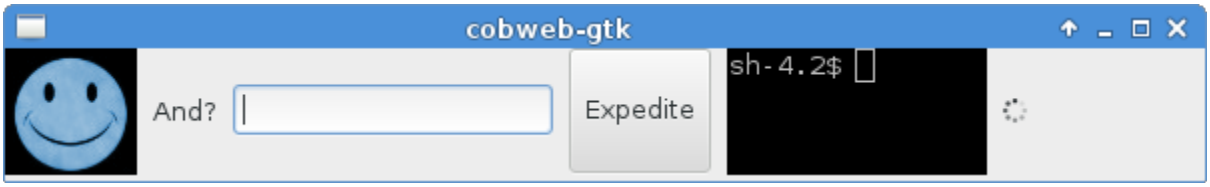
```
          to gtk-button-data
        move new-vte(gtk-box, vte-cols, vte-rows) to gtk-vte-data
        move new-spinner(gtk-box) to gtk-spinner-data

        move gtk-go(gtk-window) to extraneous
        goback.
```

produced



with the shell vte, being a fully functional terminal widget.

9 moves for a gui.

1.14.2 A GTK server

Peter van Eerten, author of *BaCon* (page 988), also develops an interpretive scripting interface to GTK. Commands are passed to the GLib/GTK libraries as text lines. A very COBOL friendly way of programming a Graphical User Interface. No external code is required, just *READ* (page 359) and *WRITE* (page 433) statements.

See *GTK-server* (page 840) for a sample and download links. `GTK-server` can support GTK 1, GTK+ 2 and GTK+ 3 library installs and developers can customize which functions are available (along with sophisticated macros) in a simple and elegant configuration file.

1.14.3 Tcl/Tk

The Tcl/Tk engine by Rildo Pragana is already quite complete but does place most of the burden of GUI development squarely on the Tk side.

Another wrapper for Tcl/Tk is being developed for GnuCOBOL 2 that leverages User Defined Functions, and exposes an event loop to COBOL programmers.

And there is an optional build sequence being built for Tcl as an Intrinsic Function.

```
prompt$ cd gnucobol-source-dir/branches/gnu-cobol-builtin-script
prompt$ ./configure --with-tcl
prompt$ make; make check && sudo make install
```

That option to ./configure when building `cobc` will provide a built in Tcl interpreter that is Tk ready.

```
move function tcl-unrestricted("source tkgui.tcl") to tcl-result
```

That easy. `cobc` will take care of the Tcl integration. To allow the Tcl/Tk event loop to play nice with GnuCOBOL, add

```
tkwait window .
```

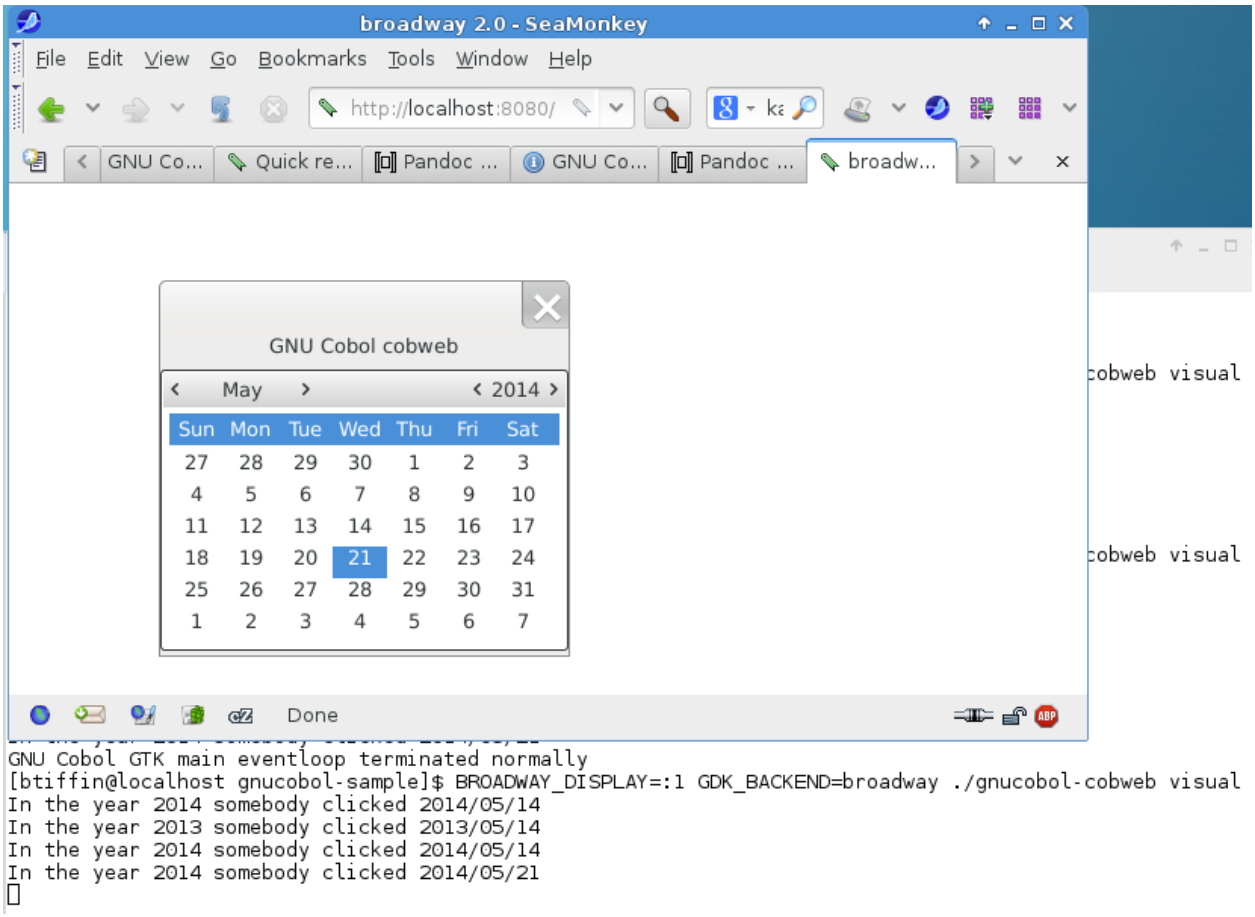
to your Tk script. Where . represents a Tk window (in this case, the top level window).

1.14.4 Vala, WebKit

Vala will also open up a quick path to GUI development with GnuCOBOL. There is already an embedded web browser using the Vala bindings to WebKit. See *Can GnuCOBOL interface with Vala?* (page 735) for a lot more details.

1.14.5 Redirect to browser

GDK 3 supports a backend called Broadway. Transform GTK desktop applications to websockets and HTML5 web guis. Here is a GnuCOBOL sample, written to explore the desktop GTK calendar widget, redirected to a browser using GDK Broadway, *with clicks in the browser window invoking GnuCOBOL graphical event callback handlers, no change to the desktop application source code*.

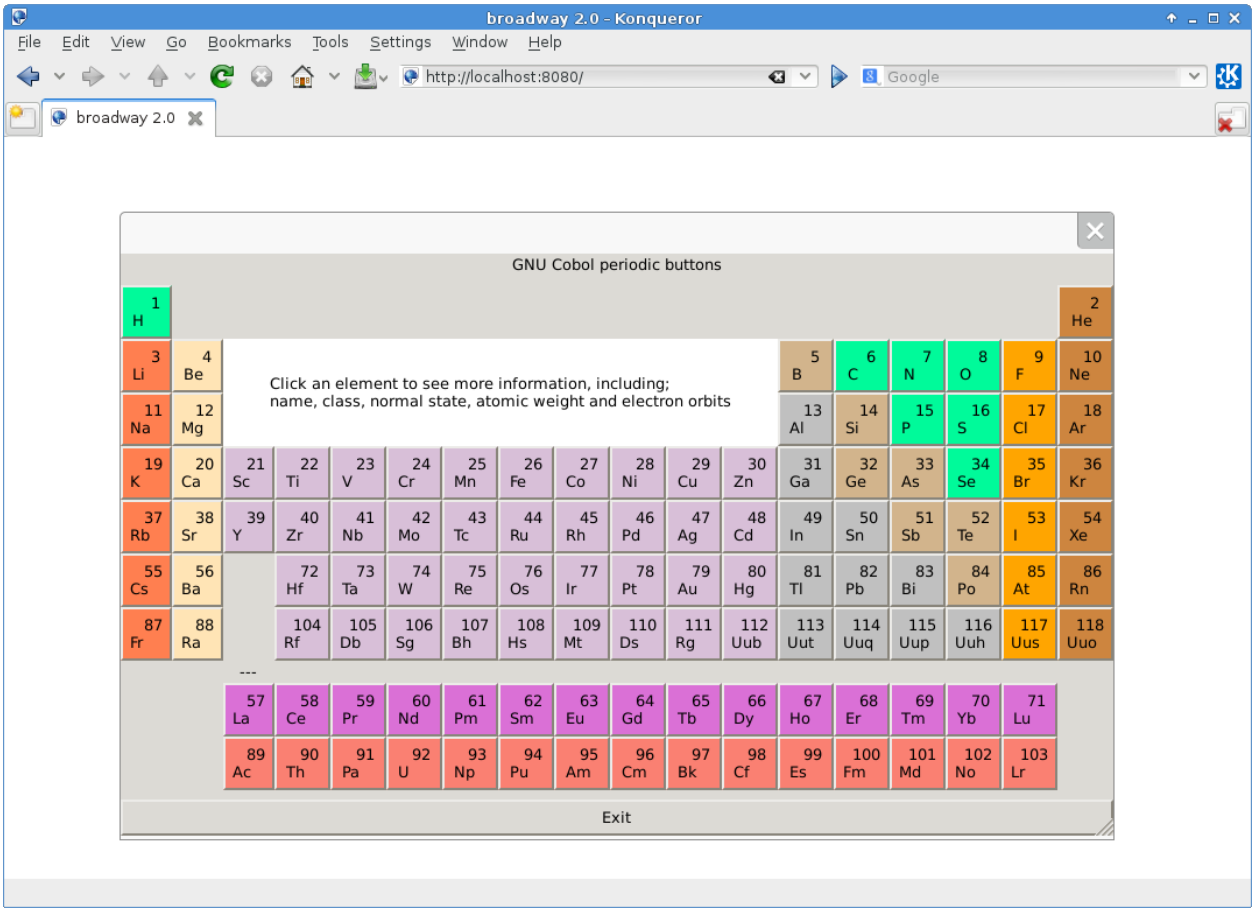


More on this in *A GTK+ calendar* (page 972)

Here is a GTK based interactive periodic table of the elements, written in GNU Cobol (6 lines of C support code), linked to GTK+ 3.0, and running with

```
broadwayd :1 &
BROADWAY_DISPLAY=:1 GDK_BACKEND=broadway ./cobweb-periodic
```

Without recompiling, the events and graphics are handled by the browser.



See *cobweb-periodic listing* (page 1457) for the source code that produced that image. *Please note that with recent changes to GTK+ theming, as of 3.16, the buttons are no longer properly coloured. New code needs to be written to provide CSS property management for GTK+ button colours.*

1.14.6 X11

There are also a few examples of using X11 directly from GnuCOBOL. See *Can GnuCOBOL interface with X11?* (page 1156) for details.

1.14.7 Java AWT

Another very powerful option for graphics programming is available with the COBJAPI user defined function repository. See *What is COBJAPI?* (page 993) for more information.

1.14.8 XForms

One step up from X11, XForms is a framework for building graphical user interfaces on systems that support X11.

See *Can GnuCOBOL interface with XForms?* (page 1265) for details.

1.14.9 Agar

The Agar (libagar) toolkit can also be put to good use with GnuCOBOL. A project has started to bind libagar features in GnuCOBOL user defined functions. Along with a GUI there is also cross-platform support for things like datasources, networking, and system access tools.

See *Can GnuCOBOL interface with Agar?* (page 1273) for details.

1.15 Does GnuCOBOL have an IDE?

IDE Interactive Development Environment

Yes. (And no, there is no IDE that ships with the product but there is a contributor interactive development environment, written explicitly for GnuCOBOL). There are also other IDEs that support COBOL.

The add1tocobol team was working to create extensions for the GNAT Programming Studio. This was working out quite nicely, but more effort would be required to make this a viable alternative for GnuCOBOL developers.

See *Can the GNAT Programming Studio be used with GnuCOBOL?* (page 747) for more information. **Update: this effort is likely abondoned**. See OpenCOBOLIDE, below, for the current leading, and project approved, GnuCOBOL IDE.

There is also the Eclipse IDE and a major project for integrating COBOL but this will not be GnuCOBOL specific.

Many text editors have systems in place for invoking compilers. SciTE, Crimson Editor, Vim and emacs, to name but a few of the dozens of programmer text editors that support edit/compile/test development cycles. See *Kate* (page 1396) for some notes and details on the GnuCOBOL development potentials in the KDE Advanced Text Editor.

See *Is there a good text editor for GnuCOBOL development?* (page 166) for some alternatives to using an Interactive Development Environment.

See *Does GnuCOBOL work with make?* (page 111) for some information on command line compile assistance.

1.15.1 Gix-IDE

Breaking news in February 2020+1 was the announcement from Marco Ridoni of his Gix GnuCOBOL IDE project. Currently for Windows, but GNU/Linux and MacOS build scripts and make files are forth coming.

- IDE, Qt-based, with Scintilla highlighting during edits
- Native debugging, custom module
- ESQL support, rewritten from Sergey's esqlOC codebase
- HTTP REST services, HTTP server provided, JSON input/output
- DB management ala DCLGEN and examining COBOL table/field properties
- Packaged, at least for Visual Studio and MinGW
- Cross-platform. Windows now, GNU/Linux and MacOS need some more work

https://sourceforge.net/p/gnucobol/discussion/cobol/thread/6f9cc8fe2a/#525e

Repository at: https://github.com/mridoni/gix/

1.15.2 OpenCOBOLIDE

There is a GnuCOBOL specific IDE getting good press, posted in PyPi at https://pypi.python.org/pypi/OpenCobolIDE

By Colin Duquesnoy. He just released version 4.7.6 (December 2016), and it now includes a MinGW binary build that Arnold Trembley helped put together for developers running Microsoft Windows. (see *What is the current version of GnuCOBOL?* (page 57))

Older news from Colin:

```
OpenCobolIDE 4.6.2 now includes this new build of GnuCOBOL:
https://launchpad.net/cobcide/4.0/4.6.2
(mirror: https://github.com/OpenCobolIDE/OpenCobolIDE/releases/tag/4.6.2)
```

Nice system. People like it. There have been over 12,000 downloads of the Windows installer. Which turns out to be a very quick and easy way to get up and running with GnuCOBOL in a Windows environment.

From Robert W. Mills, author of `cobolmac`, (See *Does GnuCOBOL support source code macros?* (page 998))

```
For the past week I have been using OpenCobolIDE to do all my GnuCOBOL
development. Being able to see your compile time errors while editing your
source is something I missed after I left the HPe3000 world.

Had a problem after corrupting the recent file list. Think it might have
happened when I deleted a file, outside of OpenCobolIDE, when it was
up-and-running.

I fired off an email to Colin Duquesnoy (the main author) about my problem,
went to bed (it was nearly 1 o'clock in the morning), and found a reply in my
inbox 1st thing the next morning. Was back up and coding by 8 o'clock.

Impressed by the product and the support response (a 7 hour turnaround for
FREE!!).

Would recommend it to anybody.
```

It is best to visit the LaunchPad cobcide parent pages for the latest source code, GNU/Linux packages and Windows installers at

https://launchpad.net/cobcide/+download

1.15.3 Geany

Geany is a light weight GTK based development environment and has surprisingly pleasant COBOL support. http://www.geany.org/

There are other IDEs that support COBOL. Google may respond with a list that suits taste.

1.16 Can GnuCOBOL be used for production applications?

Depends. GnuCOBOL is still in active development. Feature coverage is growing, and while the current implementation offers great coverage, applicability to any given situation would need to be analyzed, and risks evaluated, before commitment to production use.

The licensing allows for commercial use, but GnuCOBOL also ships with notice of indemnity, meaning that there are no guarantees when using GnuCOBOL, directly or indirectly.

And yes, GnuCOBOL is used in production environments.

See the chapter on *GnuCOBOL in production* (page 1285) for a growing list of details regarding GnuCOBOL in production environments.

From [Roger]:

```
Incidentally, OC has been (and still is) used in production
environments since 2005.
(This includes projects that I personally worked on plus other
  projects reported to me; these worldwide)

The OC project would not have been where it is today without the
significant/enormous help from many-many persons. The THANKS
file does not even do justice to this.
```

1.16.1 FAQ author's take on it

If GnuCOBOL is going to break, it's going to break right in front of you, during compiles. If something is not fully supported, GnuCOBOL fails very early on in the trial process. With most COBOL 85 and many nifty COBOL 2014 features, if cobc doesn't complain during compiles, then GnuCOBOL is a very trustworthy and robust COBOL. If you work with newer features, beyond 1989 intrinsics, there may be more reason to keep an eye on things. It would be due diligent to run comprehensive tests before committing to mandatory regulatory reporting systems or other life and core critical deployments. Be prepared to scan emitted C source codes. Know that GnuCOBOL is a free software system. Critical issues can be, are being, and will be addressed. No permission is required to try and make GnuCOBOL a better, more reliable system, and there is a host of very smart people willing to pitch a hand forwarding that goal.

1.16.2 Nagasaki Prefecture

Reported on opencobol.org, The Nagasaki Prefecture, population 1.44 million and 30,000 civil employees is using GnuCOBOL in support of its payroll management system. A team of 3 ported and maintain a suite of 200 COBOL programs, mingled with Perl and specialized reporting modules, running on Nec PX9000 big iron and Xeon servers.

1.16.3 Stories from Currey Adkins

Another post from opencobol.org in April 2009, *reprinted with permission*.

```
GnuCOBOL viability

For those concerned about the viability of OpenCOBOL in a production
environment, I offer our situation as an example.

We started loading OpenCOBOL to a Debian (Etch) Parisc box in mid March. With
some valuable help from this forum we were up and running in a few days.

We then explored the CGI capabilities and moved our home-brewed CGI handler
(written in HP3000 Cobol) over. We ended up changing only a few lines.

As Marcr's post indicates, we found a MySql wrapper and made some minor
changes to it.

Starting the second week in April we were in full development of new systems
for commercial use.
```

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```
Please accept our congratulations to the community and our gratitude for the
help from the forum.

jimc
```

Another reference by Jim, some 6 months later in February 2010, which seems to be enough time for any rose-coloured glass effect to have worn off if it was going to.

```
For our part, the answer is yes.

You may want to read an earlier thread about this. Search on OpenCOBOL
viability.

Having worked with Cobol since the 1960's, my mindset is that no
conversion is automatic.

In our case we are not converting from a specific dialect like MF,
but instead are either writing entirely new systems or are changing
features (making them web based for example) in older systems.

There are some identified failures in OpenCOBOL execution that have
been discussed in this forum. We have found them to be inconsequential
and simply work around them. Then again I do not remember working with
a bug-free compiler.

Our environment is Debian Linux, OpenCOBOL 1.1, MySQL, ISAM (the one
provided with the 1.1 prerelease), HTML (via CGI) and a new PreProcessor
to relieve the tedium of writing SQL statements.

If you have some "nay sayers" in your organization and would like some
support I will be happy to speak with them.

jimc
```

I hope people don't mind a little advertising in this FAQ, but Jim has done a lot for GnuCOBOL, and his company is a community minded company. http://curreyadkins.com/custom-programming-linux-php-apache-open-source/

1.16.4 Public Accounting

Another from opencobol.org

```
As part of an initial study of COBOL compilers for finding an alternative to
that of Micro Focus, OpenCobol was selected to develop a model for the
compilation of a public accounting package (1.5 million lines).

The model had to validate this choice, including with the use of sequential
indexed files, with OpenCobol version 0.33 and small adjustments to the COBOL
code (mainly using reserved keywords and keywords not implemented).

After the functional qualification of this model, the software is in production
since July, 2011 under Linux RedHat Enterprise Linux 4 Advanced Server 32-bit
virtualized environment VMWARE ESX - 4 GB of RAM - processor dual AMD Opteron
6176 (tm).
```

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```
The software package is deployed for 650 users whose 150 connected
simultaneously, at the peaks of activity and in comparison with the previous
platform on AIX 4.3 and Micro Focus, performance gain is in a report, at best,
1-10 (batch of exploitation of entrustment), at worst, 1 to 4 (batch of
recalculation).

With the rise of the package version, a functional validation is in progress
since September 2011 with OpenCobol version 1.1 under Linux RedHat Enterprise
Linux 5 Advanced Server 64-bit and dual Quad-Core AMD Opteron 8356 (tm)
processor. No loss of performance related to the new version of OpenCobol (but
related to the package of 10% to 20% loss) after campaign in the two
environments.
```

1.16.5 ACAS

From Vincent Coen, also author of the CobXRef utility used by `cobc -Xref`.

Applewood Computers Accounting System.

```
If you wish you can also add the fact that the Account package ACAS has
also been migrated over to GOC and is used in productions for various
users. There is at least one more Accounting system called APAC that
has been migrated over from Micro Focus in the last year or so

I have also migrated both Mainframe Cobol applications to GOC running on
Unix, Linux & Sun variants based systems for companies and governments
in the UK and elsewhere including countries where English is not the
spoken language (but luckily the programming is generally in English or
similar) including languages which is written right to left.

Again luckily I did not have to convert/migrate the manuals.

As a guess I would say that over 2 million code lines have been migrated
at this time where the target compiler has been v1.1 and more lately
v2.0/v2.1.
```

1.16.6 A platform port

From SourceForge:

```
It is done. We used open Cobol to migrate old archive-Data from Z/os to
Unix/linux.  At the end of the year we stop working on Z/OS because all our
Data and Software is migrated to SAP and Linux/Unix. But there were many old
archive-Data files wich coudn't migrated to SAP. So our solution was to use
OpenCobol to do the Job. We also could do it with our IBM-Cobol-Compiler but
there is one problem. When the Z/OS is gone, you have no chance to repair any
mistake. So wie transferred all our archive-Data in binary sequential format to
Linux. Then, some open-Cobol-Programs convertet them from EBDCIC to ASCII -
cvs-Format. This was my idear because this is a format that every database and
so on can read and understand. So we use OpenCobol-Programs for converting and
formatting and may be siron, web oracle or what else to bring the data to the
enduser. The old data were sequential tape-files and VSAM-KSDS and the binary
files for trnansfer were createt by the sort-utility. The only thing was, to
remember to use binary mode for then transfer to linux and to keep the
```

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```
record-information (PL/1 Copybooks, Cobol-Copies, SIRON-GENATS) also on the
linux-side. So the big trucks can come at the end of the year and carry away
the about 30 years so loved IBM Mainfraime. But i have my ownd S/370, the
machine i began my IT-Carrier. It is running under Hercules with MVS 3.8 and i
love it. As a hobby i wrote a Fullscreen-controled Horse-Management-System with
ifox00 (assembler) and Cobol68. I wrote some assembler-routines to bring the
dynamic call also to cobol 68 and it works so fine....
Real computing is a IBM Mainfraime. I love the real System-Console and so on...
When you ever worked with such a machine you know what it really means..
Mouting tapes, inserting paper in a line-printer, starting jobs with real
cards, all that i have done and it was the most fun with this old machines and
technics.
```

1.16.7 The COBJAPI angle

With László Erdős's COBJAPI contribution, an entirely new way of programming COBOL has appeared. Rod Gobby was impressed enough to take on the task of porting his company software inventory to this new system.

```
So since 1977 I've gone from FORTRAN, to Assembler, to PL/I, to Business
BASIC, to MS-COBOL, to Power Basic, to GnuCOBOL. At each language change my
code generators have gained more features -- so now my non-OOP Power Basic
is generating OOP GnuCOBOL. The application specs have essentially remained
unchanged for 30 years, but the code looks a lot more sexy, now that I'm
back with COBOL. :-)

By the way, COBJAPI just keeps getting better. A simple event loop
integrates nicely with our GnuCOBOL classes, especially now that we seem to
have overcome some issues with ENTRY and CALL. ;-)

Rod
```

Another quote from Oscar on SourceForge

```
...
this is amazing what you can do with this compiler and now that java GUI
can be invoked using COBJAPI i feel so great.
```

See *What is COBJAPI?* (page 993) for some details on this very powerful sub-system.

1.16.8 A thank-you note

From Gerhard on SourceForge, February 3rd, 2017:

```
I want to thank everyone for your help in getting me started in GnuCOBOL.
I was able to develop my first two COBOL programs from scratch. I used
several FUNCTIONs, built several multidimensional arrays, and called a C
program to return several values back to my program. These were the first
COBOL programs I've developed from scratch. I've done minor COBOL
maintenance in the past. We successfully implemented my two programs for
an ADP to Construction Management System interface at a company with over
20,000 employees. The project was a huge success and my team will use
these two programs as models for future development.

Thank you and Thank you again!!!
```

What more could a volunteer team ask for?

https://sourceforge.net/p/gnucobol/discussion/cobol/thread/dc356ed1/

1.16.9 Commercial Support

Although we'd rather that free COBOL is also fiscally free; anyone needing commercially backed technical support or development assistance can contact Open COBOL by the C Side. OCCSide Corporation.

Full disclosure: This author is a involved in the corporation, and we maintain a contact and project management space at http://occside.peoplecards.ca/

1.17 Where can I get more information about COBOL?

The COBOL FAQ by William M Klein is a great place to start.

A copy of Bill's works were placed on SourceForge, with his permission:

https://sourceforge.net/p/gnucobol/discussion/contrib/thread/e04e33df/

A google of the search words "COBOL" or "GnuCOBOL" or "OpenCOBOL" are bound to lead to enough days worth of reading of in-depth articles, opinions and technical information to satisfy the greatest of curiosities.

Please ignore the "COBOL is dead" tone that many of these articles may be permeated with. COBOL isn't dead, but it is usually used in domains that require the highest level of secrecy, so the billions of lines of production COBOL in use around the globe, rarely, if ever, get mentioned in internet chatter. Hopefully by reading through this document, and keeping an open eye on reality versus trends, you will see the importance that COBOL has held, does hold, *and will* hold in the computing and programming arena.

A new spec for COBOL 2014 was Published in May 2014 by Donald Nelson of ISO/IEC with adoption by ANSI in October 2014. Not dead, or dying or any such thing. With free COBOL, in GnuCOBOL, it's still dancing.

Work on the next COBOL 202x Standard started in 2018.

As a side note, when the original specification was being written, one of the committee members, Howard Bromberg commissioned a tomestone, in 1960. Ignore the trend setter tones and look to the reality. http://www.computerhistory.org/fellowawards/hall/bios/Grace,Hopper/

An archive of a pre-vote draft for the COBOL 2014 spec is stashed at COBOL-2014

along with a copy at open-std.org at

http://www.open-std.org/jtc1/sc22/open/ISO-IECJTC1-SC22_N4561_ISO_IEC_FCD_1989__Information_technol.pdf

Work on the next COBOL 202x Standard started in late 2017.

Note: While GnuCOBOL can be held to a high standard of quality and robustness, the authors **do not** claim it to be a "Standard Conforming" implementation of COBOL.

1.17.1 COBOL programming examples

For COBOL code samples, (aside from the listings included in this document, and with a much wider range of authoring style), the Rosetta Code website is a very good reference. See *Rosetta Code* (page 1457) for more information on this comprehensive programming language resource.

1.17.2 COBOL Programming Course

One of the preeminent COBOL learning resources on the internet, are the tutorials, example programs, COBOL programming exercises, lecture and other notes written for the Department of Computer Science and Information Systems of the University of Limerick, by Michael Coughlan.

http://www.csis.ul.ie/cobol/ for all the links, and

http://www.csis.ul.ie/cobol/course/Default.htm for most of the courseware links, but don't miss out on the other pages linked on the "All Things COBOL" main page. These pages are over a decade old, and like all things COBOL, still very relevant at that young of an age.

1.17.3 Up and Running with COBOL

Hosted by Peggy Fisher, and Lynda.com, there is a very well done set of video tutorials available for getting Up and Running with COBOL. Peggy runs through setting up GnuCOBOL with Windows and Notepad++, and then follows up with

- Describing Data
- Control Structures
- Sequential Files
- Advanced Sequential Files
- Direct Access files
- Tables in COBOL
- String Handling

Well spoken, well paced. About 50 videos, taking a little over 3 hours start to finish.

Recommended for anyone wanted to get setup with GnuCOBOL on Windows, and a recommended share to anyone looking to get into COBOL programming in general.

Peggy touches on mainframe issues when discussing some COBOL issues, so this is a fairly solid start for anyone interested in COBOL programming.

There is a scrolling transcript that keeps pace with the dialogue, and these are professional grade videos.

https://www.lynda.com/COBOL-tutorials/Up-Running-COBOL/411377-2.html

1.17.4 jaymoseley.com

Jay Moseley has written up quite a few COBOL related tutorials, and has added a lot to the world of the Hercules System/390 emulator. He dug in and wrote up bootstrapping instructions for old MVS releases so people can experiment with versions of big iron operating systems on home computers. Including getting a public domain copy of a 1972 version of IBM ANS COBOL up and running.

See *Hercules* (page 1388) for more details.

Jay has also added a GnuCOBOL page to his large mix of information pages.

http://jaymoseley.com/gnucobol/index.html

You'll find sample programs for parsing CSV, displaying the number of days between dates, and lots more.

See *REPORT* (page 369) for a very complete sample and introduction to using the ReportWriter features that are available in the reportwriter branch of the GnuCOBOL source tree.

1.17.5 tutorialspoint.com

There is an online learning centre, tutorialspoint.com *Simply Easy Learning*, and they have posted courseware for COBOL, JCL, and many other topics.

Before reading any further, note this critique, from Bill Woodger (July, 2015):

```
Mmmm... to me the tutuorialspoint stuff is pretty shoddy. To imply that
you need Hercules to run COBOL is... let's say, quaint. On top of that
they seem to imply that a Hercules user would use z/OS. z/OS is a
licensed product, and IBM will not, full-stop and no questions, license
it for Hercules.

I think I've yet to see a page from there that I didn't dislike, because
it will confuse, mislead or plain lie to a new user of COBOL, through
omission and commission.

I think the Cork stuff is orders of magnitude more useful to someone
starting out with COBOL.

I do not think tutorialspoint should be linked-to from the GnuCOBOL
Project.  We can obviously discuss this further, If necessary, I can
come up with an "oh, no, I don't like the look of that" for, say, each
of 20 pages.
```

As you can tell, I disagree with not pointing out the tutorialspoint tutorial, but you will likely be much better off starting with Micheal Coughlan's CSIS tutorials, listed above.

The COBOL course includes source listings with a Try It button, OpenCOBOL used in the background to run compiles and display results to the web forms. (*Once GnuCOBOL 2.0 makes its way into the main free software distribution repositories, they will very likely upgrade to the latest builds*)

They also include instructions for setting up Hercules, a System/370 emulator, and include IBM MVS samples, including *JCL* (page 1393) listings to launch UCOB compiles. The Hercules samples are "at home only" and have not been linked to the web form Try It buttons. Any COBOL tried online will be passed through a GnuCOBOL compiler, and will, by necessity, only work with sources supported by GnuCOBOL (*or more accurately, OpenCOBOL pre-release 1.1*).

http://www.tutorialspoint.com/cobol/index.htm

1.17.6 newcobug.com

After the passing of Thomas Perry in 2014, cobug.com went off the air. It is archived in the Wayback Machine, and those pages became the starting point for Robert Skolnick's new newcobug.com site.

https://web.archive.org/web/20140108215107/http://www.cobug.com/cobol.html

cobug.com was for many years, a go to place for all things COBOL related, in particular a vendor agnostic, but still commercially oriented set of COBOL pages.

Robert will be trying to ensure the continuity of the site, and modernizing it along the way, at http://newcobug.com. He has even gone as far as adding a subdomain, (*which we have not yet taken full advantage of*), for GnuCOBOL related COBOL issues. http://gnucobol.newcobug.com. Robert, being involved with a large internet service provider in Brazil, is well versed in all things internet, and newcobug.com has a very good chance of becoming the new cobug.com.

1.17.7 SimoTime Technologies

Some of the most well written, professional, publicly available COBOL sources can be viewed (not always copied) at http://simotime.com.

SimoTime Technologies has a very comprehensive website that acts as both a COBOL learning centre, and as a template for complete, robust, well disciplined COBOL programming.

The SimoTime COBOL Connection includes a wide range of practical COBOL programming examples, along with full descriptions of why certain things are done the way they are done. http://simotime.com/indexcbl.htm

Highly recommended. A few of the listings are freely available, but most require a licensing agreement with SimoTime Technologies. Take care to read through the licensing terms for each page before copying any sources.

Most listings in the COBOL Connection will compile with GnuCOBOL unaltered, but please abide by the usage terms. Most pages on the site include allowances for personal review and evaluation and count as fair use in that context (at least by Canadian standards), but anything beyond that would require reaching an agreement with SimoTime.

Use the site to see how well disciplined COBOL should look and then hopefully carry that over to your own works.

1.18 Where can I get more information about GnuCOBOL?

Current project activities are at SourceForge.

The discussions on the opencobol.org website *permanently redirected to SourceForge*, have been archived at http://gnucobol.sourceforge.net/files/opencobol.org-archive.tar.gz (2Mb) and as plain text at http://gnucobol.sourceforge.net/files/opencobol.org-archive.txt (8Mb).

add1tocobol.com is a place to find out about a few of the fan initiatives. (An older website is readonly at http://oldsite.add1tocobol.com)

1.18.1 The GnuCOBOL Programmer's Guide

A very well written and masterful OpenCOBOL reference and COBOL development guide. By Gary Cutler, GnuCOBOL Programmers Guide.

1.18.2 The OpenCobol Programmer's Guide

Is still available, at OpenCOBOL Programmers Guide.

1.19 Can I help out with the GnuCOBOL project?

Absolutely. Visit the SourceForge project space and either post a message asking what needs to be done, or perhaps join the development mailing list to find out the current state of development. See *Is there a GnuCOBOL mailing list?* (page 42) for some details. GnuCOBOL is an official GNU, GPL licensed, free software project, with a small team that handles the read/write permissions on SourceForge. The project is very open to code submissions. Having this central point of development allows for the consistency and the very high level of quality control enjoyed by GnuCOBOL users.

1.19.1 Contribution Guidelines

First to clarify a little bit. The GnuCOBOL "project" has two parts. The official GnuCOBOL compiler source tree, and external free software contributions, currently held in a source tree named `contrib`. Ok three parts; from the point of view of the "project", we will gladly reference free software, commentary, and other free resources related to GnuCOBOL and COBOL by simple request or notice from authors. The keyword is free, freedom free. In term of the "project", free COBOL is the main theme. Terminology wise, the "project" encompasses more than *the GnuCOBOL project*, a name normally associated with the official source tree, but being only a small part of the big picture.

Officially, GnuCOBOL is a *GNU* (page 1351) project, so we will abide by the rules and recommendations provided by this very successful free software foundation. Write access to the sources is restricted to those that have signed legal copyright transfer documents, noted below.

GnuCOBOL is also a COBOL project. Not all contributions are part of the legally copyrighted GnuCOBOL sources, owned by the Free Software Foundation, Inc. Be that code, documentation, or other media. Contributions can be made under other forms and licensing, and they are addressed separately. No blocks will be put in place of anyone wanting to help, aside from the overriding concerns that pay homage to the principles of free software.

The GNU recommendations can be found at http://www.gnu.org/prep/standards/standards.html which includes

```
If the program you are working on is copyrighted by the Free Software
Foundation, then when someone else sends you a piece of code to add to the
program, we need legal papers to use it--just as we asked you to sign papers
initially. Each person who makes a nontrivial contribution to a program must
sign some sort of legal papers in order for us to have clear title to the
program; the main author alone is not enough.

So, before adding in any contributions from other people, please tell us, so we
can arrange to get the papers. Then wait until we tell you that we have
received the signed papers, before you actually use the contribution.

This applies both before you release the program and afterward. If you receive
diffs to fix a bug, and they make significant changes, we need legal papers for
that change.

This also applies to comments and documentation files. For copyright law,
comments and code are just text. Copyright applies to all kinds of text, so we
need legal papers for all kinds.
```

There is more commentary on the need for the inconvenience and a lot more in the GNU Coding Standards, , but again, the "project" is more than *the compiler project*.

That's GNU, and contributions to the GnuCOBOL source tree. Contributions outside that tree are also welcome, as long they count as free software.

GnuCOBOL adds, *from the project lead, Simon Sobisch*, *human* (page **??**);

```
Entries MUST be L/GPL. That's Lesser General Public License and/or General
Public Licence.

Authors MUST be willing to hand copyright over to the FSF.

COBOL source modules MUST compile warning/error free, with options

1. -W
2. with any of the standard "-std=" options.
3. with either option -fixed(default) or -free
4. Any/all combination of above
```

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```
Further these COBOL modules MUST execute correctly however they have been
compiled (-std=).
```

The rule for project approved samples can be seen as:

```
Should work. Preferable they compile warning free with -Wall (not have to).
Reference format doesn't matter. If it doesn't work with some configurations
(or better: need a specific configuration) this has to be documented.
```

And that's for code.

Full disclosure: I've been writing samples for this FAQ that usually compile warning free with -W by adding scope terminators with END-DISPLAY, END-ACCEPT, END-COMPUTE etc. I thought approved samples followed the MUST rule.

It has been pointed out that a few of these scope terminators aren't just more typing, they also clutter long understood source code constructs when there are no conditional imperatives such as ON EXCEPTION.

DOH! 2008 through 2015. I don't really want to count how many hours have been spent typing END-DISPLAY into code examples. As of Oct 2015, there will be less of those.

Other contributions include cheerleading, bug reports, discussions, notice of free COBOL that works with the compiler, *or should, but needs porting*, etc.

And a big one, *which will require signatures for reassignment*, internationalization and translations.

1.19.2 Translation Efforts

A new project has started to see native language support in the `cobc` compiler and run-time systems. Skip ahead a little to see the links for the new efforts. What follows in historical information, just for completeness.

From Simon, some many moons ago, when he went by the nickname *human*.

Subject: OC in your native language - translators needed

Hi folks!

We're starting to translate upcoming versions into different languages. The necessary code changes for OC 2.0 were already done. Now we need translators.

Before posting every stuff here I want to gather the translators here. Who is able and willing to translate the strings (currently 724) into what language(s) [or has somebody who does this]?

From the last discussions I remember people wanting to do this for French, Italian, Spanish, German but I don't remember who exactly said that he/she will help. We already have a Japanese translation, but that needs an heavy update.

Later edit

For a new translation create a new catalogue from the pot file. I encourage everybody to use a GUI for that. Some explanations how to do that with my favourite language file editor [url=http://www.poedit.net/]Poedit[/url] and some general instructions:

- File->New catalogue from POT-file (choose latest open-cobol.pot)
- Insert project name: "open-cobol 2.0" and the rest as needed
- Save file with chosen language abbreviation like it is placed in http://www.iana.org/assignments/language-subtag-registry

- Start translation

Some hints for Poedit first-time-users:

- Choose the string you want to translate in the upper pane.
- Translate the text in the lower pane.
- Always keep special characters like %s, %d, n, ... The % are place holders (values will be inserted there by OpenCOBOL). n is a line break, t a tab, etc
- Use [ALT]+[C] often. It copies the original string to the translation field where you can change what's needed. This function can be found in edit menu, too.
- If you're not sure if one of the translations is correct mark it as fuzzy with [ALT]+[U] or via edit menu.

Current assignments of translations: fr: eraso (finished [updates will be needed later]) [earlier: Bear (maybe aouizerate, too)] hi: Yanni de: erstazi es: jcurrey (finished [updates will be needed later]) ja: minemaz (later) it: ?federico?

OK, here is the http://www.filedropper.com/open-cobol{}pot-file from 11-09-06.

human

Update: March 2015

The GnuCOBOL translation effort will be included in an official translation project. Thanks to the many volunteers there. From Simon:

http://translationproject.org/

```
Hi folks!

We're starting to translate upcoming versions into different
languages. The necessary code changes for OC 2.0 were already done.
Now we need translators.

Before posting every stuff here I want to gather the translators
here. Who is able and willing to translate the strings (currently 667)
into what language(s)
[or has somebody who does this]?

From the last discussions I remember people wanting to do this for
French, Italian, Spanish, German but I don't remember who exactly said
that he/she will help. We already have a Japanese translation, but
that needs an heavy update.

...
```

Later:

```
GnuCOBOL 2.0 includes support for English, Spanish and Japanese
messages, errors and warnings.  Source portable object .po files
are nearly complete for Dutch, French and German.  Italian can't
be too far off.
```

Activity will take place on http://translationproject.org

To try Spanish messaging, see *Setting Locale* (page 1350), basically `export LC_MESSAGES=es_ES` before calling the compiler.

And please note that these translations are only the compiler and libcob run-time messages, **not** COBOL syntax or reserved word spellings in source code. COBOL is, by specification, an English programming language.

1.20 Is there a GnuCOBOL mailing list?

Yes.

The GnuCOBOL project mailing lists are graciously hosted on savannah.gnu.org.

http://savannah.gnu.org/mail/?group=gnucobol

There are lists for bugs, messages, users and dev.

An archive of the users list is available for browsing at

http://lists.gnu.org/archive/html/gnucobol-users/

Subscribe to the users list at

https://lists.gnu.org/mailman/listinfo/gnucobol-users

Once you have subscribed, the list will accept messages at gnucobol-users@gnu.org

A private mailing list is managed for developers, and anyone that signs up as a contributor will be provided with access to the (low volume) dev list. Everyone is allowed to view, subscribe and post to the other lists.

The mailing lists were transferred to Savannah in December 2016, replacing the long standing SourceForge list archived at

http://sourceforge.net/p/gnucobol/mailman/open-cobol-list/

1.21 Where can I find more information about COBOL standards?

The COBOL 85 standard is documented in

- ANSI X3.23-1985
- ISO 1989-1985
- ANSI X3.23a-1989
- ANSI X3.23b-1993

This is highly subject to change, but a Draft of COBOL 2014 is/was available at http://www.cobolstandard.info/j4/index.htm and in particular http://www.cobolstandard.info/j4/files/std.zip

In May 2014, the new specification for COBOL 2014 was Published by ISO/IEC. The document was approved in early summer, and adopted by ANSI in October, 2014.

Note: While GnuCOBOL can be held to a high standard of quality and robustness, the authors **do not** claim it to be a "Standard Conforming" implementation of COBOL.

1.22 Can I see the GnuCOBOL source codes?

Absolutely. Being a free software system, all sources that are used to build the compiler are available and free.

Visit http://sourceforge.net/p/gnucobol/code/HEAD/tree/ to browse the current SVN repository.

The SourceForge Files section has links to older release and pre-release archives.

Most distributions of GNU/Linux will also have source code bundles. For example

```
$ apt-get source open-cobol
```

on Debian GNU/Linux will retrieve the most recent released package sources.

1.22.1 A ROBODoc experiment

A ROBODoc experimental project to document the source codes is hosted at ocrobo. See *ROBODoc Support* (page 1323) for a sample configuration file.

The ROBODoc homepage is at http://rfsber.home.xs4all.nl/Robo/robodoc.html.

Frans accepted changes to the main ROBODoc source tree, hosted at https://github.com/gumpu/ROBODoc to be more friendly with COBOL sourcecode, dashes in names being the biggest change.

Downloads of versions beyond 4.99.42 of ROBODoc will be COBOL friendly when passed the `--cobol` command line option. ROBODoc is in the Fedora package repos and work is in progress to have this package re-included in Debian repositories.

1.22.2 A Doxygen pass across the compiler source code

This is mentioned elsewhere, but the GnuCOBOL compiler source code bundle works beautifully with Doxygen. Mix application and compiler sources for overwhelmingly complete call graphs.

Is there GnuCOBOL API documentation? (page 135)

Dimitri van Heesch's 1.7.4 release of Doxygen, http://www.doxygen.org was used to produce http://opencobol.add1tocobol.com/doxy/.

1.22.3 A Doxygen pass, application with compiler suite

Along with Gary's `OCic.cbl` http://opencobol.add1tocobol.com/doxyapp/ to demonstrate how easy it is to generate world class, audit friendly source code documentation, drilled right down to how the COBOL run-time is interacting with the operating system.

1.22.4 What was used to colour the source code listings?

I wrote a Pygments lexer, mushed it into a local copy of Pygments and then call a rst2html-pygments.py program. Requires a fair amount of mucking about. See ReStructuredText and Pygments for some details.

As of January 2013, the COBOL lexer is in mainline Pygments. No more mucking about required. Georg Brandl did a wonderful job of refactoring the COBOL highlighter into his Pygments system. Many thanks to Georg, Tim and team Pocoo.

https://bitbucket.org/birkenfeld/pygments-main/pull-request/72/adding-an-opencobol-lexer

This is now included on SourceForge. In the discussion groups, source code can be highlighted using SourceForge markup. A blank line, a line starting with six tildes, another line starting with two colons, followed by a language tag. Many, available, but for fixed form COBOL use cobol, for less indented, free form COBOL, use cobolfree. Then code, then six closing tildes.

```
As an example; here is a SourceForge message with a code block.  Blank line
before the tildes counts, otherwise it isn't seen as a code block paragraph.
Sadly, spaces in a visually blank line can confuse the start of paragraph
detection.  If it looks like highlighting should be working, and isn't,
```

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```
backspace over the preceding line, just in case.

~~~~~~
::cobol
 SAMPLE
       * Next big thing
        IDENTIFICATION DIVISION.
        PROGRAM-ID. big-thing-42.
        PROCEDURE DIVISION.
        DISPLAY "ok, what now?"
        GOBACK.
~~~~~~
then more message, (and the message part doesn't need the blank line after
the closing tildes, as the closers inform the markup of what's what).

~~~~~~
::cobolfree
    PERFORM 3 TIMES
        DISPLAY "Yeah, that!"
    END-PERFORM
~~~~~~

and more message, which can have a preceding blank line.

Otherwise, to get the forge to highlight code, indent the block by four
spaces.  The tildes can be more convient for COBOL listings though,
as it can save moving text around, inside the browser edit widget.
```

Giving:

```
SAMPLE
      * Next big thing
       IDENTIFICATION DIVISION.
       PROGRAM-ID. big-thing-42.
       PROCEDURE DIVISION.
       DISPLAY "ok, what now?"
       GOBACK.
```

and

```
PERFORM 3 TIMES
    DISPLAY "Yeah, that!"
END-PERFORM
```

This is a context free regular expression colourizer. It gets true COBOL wrong, but mostly right, for the benefit of colour.

Initial indentation counts. Code starting with column 8 followed by a comment in column 7 can confuse the indentation detection. That can be fixed by adding a sequence number tag in columns 1 through 6 to the first line of code in the listing.

1.23 What happened to opencobol.org?

Due to robot spam, new registrations on opencobol.org were disabled in 2012.

The active site is now hosted by SourceForge, at

http://sourceforge.net/projects/gnucobol/

In case anyone is wondering, as of May 2014, 1 (one) entry has shown up in the spam folder and required moderation. Thanks, SourceForge; frees up many hours of volunteer time. Many. There was spam in the reviews, well, hit count hounds, and even those seem to be dealt with, quietly in the background. Nice.

opencobol.org was **redirected to the SourceForge site in October of 2015**.

The Wayback Machine has a fair number of archive snapshots. Most recent copies are simple redirects, but most of the old site materials can be viewed from https://web.archive.org/web/20130901141240/http://www.opencobol.org/

Other snapshots can be chosen from https://web.archive.org/web/20130701000000*/http://opencobol.org

There is also a text archive of the forum posts, and knowledge base, stashed away at

http://gnucobol.sourceforge.net/files/opencobol.org-archive.txt

which is about 8 megabytes of text. Sadly this archive does not include all the metadata (author, and timestamps) that were included with the forum entries, but is still a treasure trove of GnuCOBOL related technical wisdoms.

1.24 What is COBOL in Latin?

I came up with Publicus Negotiatio Cursus Lingua, and then smarter people suggested:

- negotium orientatur lingua plebeius
- generalis negotium pertineo lingua
- de communi codice pro calculorum negotii
- codex communis pro calculorum negotii

I like the last one. ccpcn, pronounce that as kick-pickin'.

Thanks to Ray, Paul, and Daniel on LinkedIn.

1.25 Where can I find open COBOL source code?

Although open source COBOL is still rare, *and free even rarer*, that is slowly changing. This entry will be a perpetually growing list, until the universe is at peace.

$$\lim_{\text{COBOL}\to\infty} f(\text{COBOL}) = 42^{42}$$

Last updated: June 11th, 2013. If you know of a worthy entry, drop me a note.

1.25.1 At GNU

http://savannah.gnu.org/projects/gnucobol

1.25.2 on SourceForge

GnuCOBOL is hosted on SourceForge at http://sourceforge.net/projects/gnucobol/

Other projects include:

- http://sourceforge.net/projects/cobcurses/ A curses screen design utility for OpenCOBOL

- http://sourceforge.net/projects/koopa/ a COBOL parser (generator)
- http://sourceforge.net/projects/cobol/ the open COBOL Utilities Project
- http://sourceforge.net/projects/record-editor/ which accepts COBOL copy books
- http://sourceforge.net/projects/cobol2html/ which auto documents COBOL
- http://sourceforge.net/projects/cobolxmlfilepar/ a one pass XML parser
- http://sourceforge.net/projects/acas/ Applewood Computers Accounting System
- http://sourceforge.net/projects/geekcode21gener/ Geekcode generator, written in COBOL
- http://sourceforge.net/projects/ocic-gui/ Gary Cutler's Compiler assistant, rewritten in a C# gui
- http://sourceforge.net/projects/apac-accounting/ a Business Management system

1.25.3 add1tocobol

The good folk that host this FAQ, also host http://oldsite.add1tocobol.com and http://add1tocobol.com

1.25.4 Stickleback

Wim Niemans' Project Stickleback, http://stickleback.nlbox.com/

1.25.5 other places

- https://sites.google.com/site/cobolunit/ a Unit Testing framework for COBOL, written in COBOL

1.26 What is bubble-generator?

Or, where did the GnuCOBOL syntax diagrams come from?

Dr. Richard Hipp created a small set of Tcl/Tk scripts to assist in drawing syntax diagrams for SQLite. These public domain scripts were modified slightly to create the syntax diagrams used in the GnuCOBOL FAQ, as `bubble-cobol.tcl` and `bubble-cobol-data.tcl`. In keeping with the spirit set by Dr. Hipp, the syntax diagrams in this document are also dedicated to the public domain.

Sourced from the SQLite repository, and discovered at http://wiki.tcl.tk/21708. In this author's opinion, true to Richard's other works, these scripts produce beautiful diagrams. Tcl/Tk is used to produce Postscript outputs, which are then further processed by ImageMagick to produce the final .gif and .png images.

Extra font control was added, and in the GnuCOBOL FAQ version of the syntax diagrams, a non-bold font is used to denote GnuCOBOL extensions that are not part of the COBOL 2014 specification. *Or at least, attempts were made to do so.* GnuCOBOL does not claim any level of conformance to standard, and **the syntax diagrams in this document are not indicative of COBOL syntax as defined by ISO and/or ANSI**.

Although subject to change and correction, the sources used are listed here under *bubble-cobol.tcl* (page 1442).

1.27 Is COBOL dead?

No.

1.28 Do you know any good jokes?

Maybe.

- A computer without COBOL and Fortran is like a piece of chocolate cake without ketchup or mustard.

  John Krueger

- A determined coder can write COBOL programs in any language.

  Author: unknown

- Rumour has it that the object oriented specification for COBOL was code named

  ADD 1 TO COBOL GIVING COBOL.

  Author: unknown

  A less verbose, more concise version; *very unCOBOL that*

  ADD 1 TO COBOL.

  Thanks to aoirthoir

  And, just because;

  ADD 1 TO COBOL GIVING GnuCOBOL

- A common disrespect of COBOL joke is that the acronym stands for:

  Completely Obsolete Business Oriented Language.

  Author unkown

  We know better. The reality is:

  Can't Obsolesce Because Of Legacy. *And why would you want to?*

  Brian Tiffin

- COBOL

  Certainly Old But Often Limber.

  Brian Tiffin

- Ruby on Rails? Don't forget COBOL ON COGS.

  http://www.coboloncogs.org/INDEX.HTM

- Eat COBOL, 200 billion lines can't be wrong.

  Brian Tiffin

- What did COBOL yell to the escaping thief?

  STOP RUN RETURNING NOW.

  Brian Tiffin

- A COBOL programmer's husband asks, "*Honey can you go to the store and get some milk. And if they have eggs, get a dozen*." After twenty minutes she returns and flops 12 bags of milk on the table. He looks at her curiously, "*Honey, why did you do that*?" She responds flatly, "**They had eggs**."

  Author unknown

- What did COBOL reply to the executive? *Yes, I can*

  PERFORM JUMPS THRU HOOPS.

  Brian Tiffin

- What did GnuCOBOL reply to the executive? *Sir, I can*

  PERFORM JUMPS THRU FLAMING-HOOPS UNTIL HELL-FREEZES-OVER.

  And being COBOL, I have to show you how little code it takes:

```
identification division.
program-id. freeze.

data division.
working-storage section.
01 hell                    pic 9.
   88 hell-freezes-over value 1.

procedure division.
perform jumps thru flaming-hoops until hell-freezes-over.
stop run.

jumps.
flaming-hoops.
divide 1 by 0 giving hell.
```

- Wrote COBOL all morning, all afternoon and into the night. *Another carpe*, **diem'ed**.

  Brian Tiffin, ripped from a meme, then farberized

- The lady down the street didn't believe I could build a car out of spaghetti.

  You should have seen the look on her face when I drove pasta.

  Author unknown

- This is your captain speaking.

  THIS IS YOUR CAPTAIN SHOUTING.

  Author unknown

- How many COBOL programmers does it take to change a light bulb?

  One. COBOL programmers understand how the world works, they can change a light bulb. *Which then lets them see their keyboard so they can fill out screen PF103D, submit job LB103R and request approval for a backup T5W-60.*

  Brian Tiffin

1.28.1 Really?

Ok, sorry for the lame.

Here is a link to some actual humour; Bob the Dinosaur, thanks to Scott Adams.

http://dilbert.com/strips/comic/1997-11-04/

And another one; Grace Hopper, by Zach Weinersmith at Saturday Morning Breakfast Cereal.

http://www.smbc-comics.com/?id=2516 (with a small snip from the actual comic, Copyright 2012 Zach Weiner)

Zach also coined the phrase, “off-by-frog”.

http://www.smbc-comics.com/?id=2831

That comic spawned the writing of `frogSort`, officially known as the **Weinersmith Fly By Frog Sort**, or `weiner sort`.

Sorry, back to lame; sweet, sweet, lame.

```
*> ********************************************************
*>  frogSort, called for help with 10-94, request for count
*>  The Weinersmith Fly By Frog Sort, weiner sort for short
*> ********************************************************
 identification division.
 program-id. frogsort.
 data division.
 working-storage section.
 01 opinion          usage binary-long.
 01 shared-value     pic 99.
    88 fair          value 1.
 01 caveman-count    pic x(12) value "[-]+++++++++".
 01 spacer           pic x(10) value spaces.

 linkage section.
 01 jars.
    05 flies        pic 9 occurs 21 times.

*> ********************************************************
 procedure division using jars.
 start-here.
 move function length(jars) to shared-value
 display "Grog sort jars.  frogSort"
 display "http://www.smbc-comics.com/?id=2831"
 .

 forkanother.
     call "fork" returning opinion end-call
     if opinion is zero then
         subtract 1 from shared-value
         if not fair then go forkanother.
 .
```

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```
 call "sleep" using by value flies(shared-value) end-call
 display
     "Jar: " function char(shared-value + 65) " reporting "
     caveman-count(1 : flies(shared-value) + 3) " flies,"
     spacer(1 : 10 - flies(shared-value))
     "that would be " flies(shared-value) " to you, futureman."
 call "wait" using by value 0

 stop run returning 107.
 end program frogsort.
```

Which is an easter egg in the cbrain esoteric programming language, when requesting help for Citizen Band code 10-94, Request for long count. Returns CB code 10-7, Leaving air, radio off.

```
prompt$ ./cbrainrun
10-12 Welcome to cbrain v0.42
cb: 1094
cb: help
Grog sort jars.  frogSort
http://www.smbc-comics.com/?id=2831
Jar: U reporting [-] flies,          that would be 0 to you, futureman.
Jar: K reporting [-] flies,          that would be 0 to you, futureman.
Jar: A reporting [-] flies,          that would be 0 to you, futureman.
Jar: L reporting [-]+ flies,         that would be 1 to you, futureman.
Jar: B reporting [-]+ flies,         that would be 1 to you, futureman.
Jar: M reporting [-]++ flies,        that would be 2 to you, futureman.
Jar: C reporting [-]++ flies,        that would be 2 to you, futureman.
Jar: N reporting [-]+++ flies,       that would be 3 to you, futureman.
Jar: D reporting [-]+++ flies,       that would be 3 to you, futureman.
Jar: O reporting [-]++++ flies,      that would be 4 to you, futureman.
Jar: E reporting [-]++++ flies,      that would be 4 to you, futureman.
Jar: P reporting [-]+++++ flies,     that would be 5 to you, futureman.
Jar: F reporting [-]+++++ flies,     that would be 5 to you, futureman.
Jar: Q reporting [-]++++++ flies,    that would be 6 to you, futureman.
Jar: G reporting [-]++++++ flies,    that would be 6 to you, futureman.
Jar: R reporting [-]+++++++ flies,   that would be 7 to you, futureman.
Jar: H reporting [-]+++++++ flies,   that would be 7 to you, futureman.
Jar: S reporting [-]++++++++ flies,  that would be 8 to you, futureman.
Jar: I reporting [-]++++++++ flies,  that would be 8 to you, futureman.
Jar: T reporting [-]+++++++++ flies, that would be 9 to you, futureman.
Jar: J reporting [-]+++++++++ flies, that would be 9 to you, futureman.
```

1.28.2 A 5-7-5 haiku?

How about a 5-7-5 haiku?

```
 program-id. one.
 procedure division. add
 1 to return-code.

*btiffin*
```

Compiles to a program that returns a failure code when run. Fails as poetry, fails as code. Your welcome.

I wasn't allowed to post that as an actual Haiku on wikipedia. Call it a 5-7-5. Because, it isn't, really, Haiku.

So... ummm, it could be `program-id. sun.` or...

```
springing into life
soaking sun, drinking summer
falling to winter
```

Take that. *I respect the wikipedia discussion decision, but come on,* program one compiles and executes. *Even if it was based on Canadian elementary and high-school, missing the point, 5-7-5 fake haiku.*

1.28.3 One in cbrain

```
0[5-7-5 in cbrain]

 72 . 65
. 73 . 75 .
 85 . 42
```

Displaying HAIKU and returning 42.

CHAPTER

TWO

HISTORY

History

2.1 What is the history of COBOL?

Starting in 1959, a committee was formed under the sponsorship of the United States Department of Defense to recommend a short range option regarding business computing. The Conference on Data System Languages (CODASYL) led by Joe Wegstein of National Bureau of Standards (now National Institute of Standards and Technology) developed a new language, and created the first standardized business computer programming language.

The COmmon Business Oriented Language acronym was announced on September 18th, 1959.

Late in 1960, *essentially* the same COBOL program ran on two different hardware platforms, and stakeholders espied the potential for fulfilling the objective of industry wide, compatible business systems.

Rear Admiral Grace Hopper is affectionately referred to as the *(grand)mother of the COBOL language*, as she and her previous work with FLOW-MATIC, greatly influenced the specifications of the first COBOL. She is said to have argued strongly for words over symbols. So, COBOL has ADD, SUBTRACT, MULTIPLY, and DIVIDE and not just +, -, *, and /.

Grace is often referred to as Admiral Grace Hopper. She was not actually an admiral. She was promoted to captain by the United States Navy in 1973, then, by special Presidential appointment, to commodore in 1983. The rank title of commodore was officially changed by the Navy in 1985, to rear admiral (lower half).

2.1.1 Published Standards

Standards have been published for:

- COBOL-68
- COBOL-74
- COBOL-85

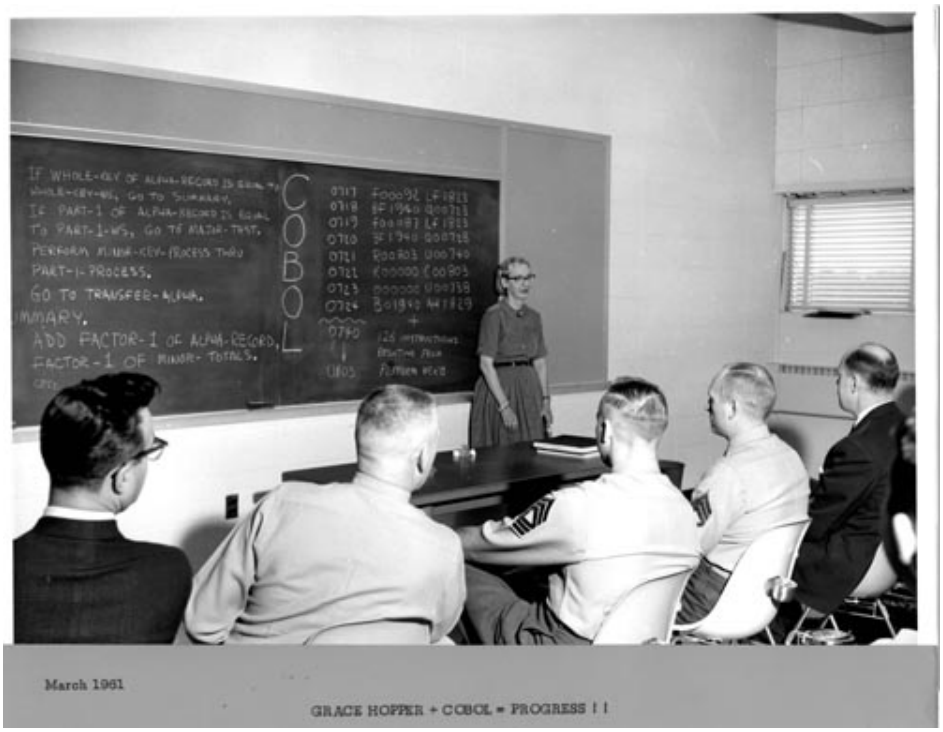

Fig. 1: Grace Hopper discussing COBOL in 1961.
Courtesy of Jeffrey Chuan Chu, and the Computer History Museum.
http://www.computerhistory.org/collections/catalog/102722559

- COBOL-89 Intrinsic Functions
- COBOL-2002
- COBOL-2014

and these roughly correspond to the year they were produced. Note the *y2k* (page 1438) flavour of four digit naming occurred after the millennium change. Again, please note that these are not offical titles. Official titles look more like the newest one (2014), shown here:

ISO/IEC 1989:2014 *Information technology – Programming languages, their environments and system software interfaces – Programming language COBOL*, which was published in May 2014.

See the Wikipedia entry for COBOL which has a lot more details. Including names other than just Grace Hopper, who also deserve to be credited with the initial design and implementation of *what was eventually named* COBOL-60.

2.1.2 The Gartner estimate

Estimates vary, but it is reasonable to believe that of the some 300,000,000,000 (three hundred thousand million, 300 billion) lines of computer source code in production as of 1995, 200,000,000,000 (200 billion) lines were COBOL. A full 2/3rds of the world's source code at the time.

Please note: the above line count estimate is approaching urban legend status and its reutterance is frowned upon now. I looked, and only witnessed a cycle of referenced material, but found no material. Besides, it's an old number.

Even then, there was, is, and will be, a lot of source form COBOL. A lot.

Compiled COBOL literally *(literately?)* dominates in many core critical Business, and perhaps even some Engineering computing areas. When records and fields are being processed, like say financial transactions or inventories, COBOL

shines in legible correctness. Words and not always just code. Good for business. Started that way in 1959, still that way; and more, now and into the unforseeable future.

2.2 What are the Official COBOL Standards?

Many thanks to William Klein, [wmklein] for details on what wordings are to be used when referencing COBOL Standards:

```
There are several references to "COBOL 85" and these are often
distinguished from "Intrinsic Functions".

The official (but really obscure) term that should be used is "Amended
Third Standard COBOL". The "clearer" (and IMHO better) term that should
be used is something like

 - "'85 Standard COBOL with its amendments"

By 1991 (actually 1993 for ISO rather than ANSI) there was no such thing
as "just '85 Standard COBOL". The only recognized Standard was the
"base" document (X3.23-1985) ALONG with its two amendments
 - Intrinsic Functions Module Amendment
 - Corrections Amendment

An interesting related fact is that the "Intrinsic Functions Module" was
OPTIONAL in the ANSI and ISO COBOL Standards but was REQUIRED (at the
HIGH level) for FIPS COBOL. As the "certification tests" were aimed at
getting US government contracts, most vendors (who were still doing
certification) actually treated Intrinsic Functions required not
optional for "High-level" certification. (They were NOT included in the
FIPS intermediate certification process).

Bottom-Line:
 Although some intrinsic functions were added in the '02 Standard (and
more are included in the draft revision), it is not proper (in my
opinion) to distinguish between supporting the '85 Standard and
supporting intrinsic functions.

P.S. The corrections amendment did make some technical changes but all
of these were included in the '02 Standard. Therefore, hopefully, what
it did won't impact OpenCOBOL much.
```

2.2.1 COBOL 2014

ISO/IEC 1989:2014 *Information technology – Programming languages, their environments and system software interfaces – Programming language COBOL*, was published in May 2014.

http://www.iso.org/iso/home/store/catalogue_tc/catalogue_detail.htm?csnumber=51416

There is a pre-vote copy stashed away at open-std.org

```
http://www.open-std.org/jtc1/sc22/open/ISO-IECJTC1-SC22_N4561_ISO_IEC_FCD_1989__Information_technol.pdf
```

Note: While GnuCOBOL can be held to a high standard of quality and robustness, the authors **do not** claim it to be

a “Standard Conforming” implementation of COBOL.

2.3 What is the development history of GnuCOBOL?

OpenCOBOL was initially developed by Keisuke Nishida [Keisuke] from experience working on TinyCOBOL originally developed by Rildo Pragana.

The first public release was version 0.9.0 on January 25th, 2002.

Development continued apace, with version 0.30 released by Keisuke on August 8th, 2004.

Roger While [Roger] then took up the role as lead developer on October 30th, 2004.

Simon Sobisch accepted the role of project lead on August 6th, 2014.

Sergey Kashyrin [Sergey] posted the C++ emitter, GnuCOBOL 2.0 CPP on September 27th, 2013. The same day Richard Stallman dubbed OpenCOBOL an official GNU project, as GNU Cobol. Sergey followed along with the rename. **September 21st, 2014, the spelling change to GnuCOBOL.**

Ron Norman [Ron] had code posted for Report Writer, which became GnuCOBOL with Report Writer on November 23rd, 2013.

Version 0.9 Keisuke publicly announced OpenCOBOL on January 25th, 2002.

Version 0.30 was released on August 8th, 2004.

Version 0.31 was released February 1st, 2005.

Version 0.32 was released May 12th, 2005.

Version 0.33 started on May 13th, 2005.

Version 1.0 was released on December 27th, 2007.

Version 1.1 was released on SourceForge on May 4th, 2012.

Version 1.1CE went into active development on May 4th, 2012.

Version 2.0 was released in September 2013.

Version 2.0 CPP, C++ was released in September 2013.

Version 2.0rc-1 was released on SourceForge on August 13th, 2016.

Version 2.0rc-2 was released on SourceForge on November 6th, 2016.

Version 2.2 was officially release on GNU FTP on September 6th, 2017.

Report Writer Version was posted to SourceForge for trial in November 2013.

GNU OpenCOBOL was accepted as an official GNU project on September 27th, 2013 and was rebranded as GNU Cobol.

GNU Cobol version 1.1 was posted with a digital signature to ftp.gnu.org/gnu/gnucobol on January 18th, 2014. Due to a mismatch caused during build testing, the first cut source kit was replaced, January 20th, 2014.

GnuCOBOL GnuCOBOL became the preferred spelling on September 21st, 2014.

FSF Copyright ownership for the entire OpenCOBOL (now GnuCOBOL) source tree by the Free Software Foundation become legally binding on June 17th, 2015. This copyright reassignment covers all releases of the source code, dating back to Keisuke’s original 0.9 public announcement in 2002.

2.4 What is the current version of GnuCOBOL?

ftp://ftp.gnu.org/gnu/gnucobol/

GnuCOBOL 3.1.2, released on December 23rd, 2020.

- https://ftp.gnu.org/gnu/gnucobol/gnucobol-3.1.2.tar.gz
- ftp://ftp.gnu.org/gnu/gnucobol/gnucobol-3.1.2.tar.gz

Signed via GNU Privacy Guard,

- https://ftp.gnu.org/gnu/gnucobol/gnucobol-3.1.2.tar.gz.sig
- ftp://ftp.gnu.org/gnu/gnucobol/gnucobol-3.1.2.tar.gz.sig

GnuCOBOL 3.1 was released on November 11th, 2020.

ftp://ftp.gnu.org/gnu/gnucobol/gnucobol-3.1.tar.gz

GnuCOBOL 2.2 was released on September 6th, 2017.

ftp://ftp.gnu.org/gnu/gnucobol/gnucobol-2.2.tar.gz

Previous release was GnuCOBOL 1.1, shortly after rebranding from OpenCOBOL.

ftp://ftp.gnu.org/gnu/gnucobol/gnu-cobol-1.1.tar.gz

GnuCOBOL is also hosted on SourceForge, release files kept in the download section at

https://sourceforge.net/projects/gnucobol/files

Many GNU/Linux distributions have an open-cobol package, ready to install. Packages named gnucobol will be more current, based on the version 2 or later sources.

Note: Windows quick start, February 2020+1

The best option at this time is hosted at https://www.arnoldtrembley.com/GnuCOBOL.htm

Scroll down to **GnuCOBOL Compiler install binaries** and choose from a few configurations. Recommend

- https://www.arnoldtrembley.com/GC312-BDB-rename-7z-to-exe.7z
- https://www.arnoldtrembley.com/GC312-VBI-rename-7z-to-exe.7z

Those builds include Indexed IO, full decimal math support, screens, Report Writer, more. From the soon to be GnuCOBOL 3.1-dev release. G-BDB is built with Berkeley DB, and includes GNU Debugger symbols. VBI is VB-ISAM instead of BDB, without debug symbols in the compiler. Visit the site for the latest, and more configuration choices.

Rename the .7z to .exe, and click for an easy install. Open a console, run `set_env.cmd` in the extract directory, then freely create, compile, and run your COBOL programs.

Older releases

Simon Sobisch has put together a MinGW binary build of GnuCOBOL 1.1 for use with Windows(tm), hosted at http://sourceforge.net/projects/gnucobol/files/gnu-cobol/1.1/ file name is GnuCOBOL_1.1_MinGW_BDB_PDcurses_MPIR.7z

Other versions include:

- 1.1 Stable by Keisuke Nishada and Roger While
- 2.0 Pre-release with FUNCTION-ID support by Roger While.

- 2.0 C++ emitter by Sergey Kashryin

These are all on SourceForge at http://sourceforge.net/p/gnucobol/code/

http://sourceforge.net/p/gnucobol/code/HEAD/tree/branches/gnu-cobol-2.0/ is the main branch.

A pre-release, with Report Writer module by Ron Norman is the feature leading development source.

The next official releases will be from the GnuCOBOL 2.0 branch. *This is the branch that has the most complete continuity of Roger While's compiler developments.*

Making the choice:

These are all good compilers. Until you are preparing for production rollouts, don't worry too much about which version of the sources you use to build up applications. GnuCOBOL COBOL is pretty much COBOL, and these versions vary more in implementation details than anything else. Porting between versions will likely be zero effort, beyond verification.

For COBOL 85 with a little 2002, GnuCOBOL 1.1 is still a very valid choice.

For User Defined Functions, Report Writer, C++ emitter, IEEE FLOAT, then 2.0 is the better starting point. Slightly more risk, worthy of extra testing and analysis before committing to production use, *until such time that there is a release announcement*.

Even older versions:

OpenCOBOL 1.0 was released December 27th, 2007 by Roger While [Roger].

The decision to go 1.0 from the 0.33 version followed many incremental enhancements from 2005 through till late in 2007.

OpenCOBOL 1.1 pre-release became active on December 27th, 2007 and major developments occurred publicly until February, 2009. The pre-release source tar can be found at GnuCOBOL 1.1 with installer instructions at GnuCOBOL Install and in the INSTALLING text file of the sources.

The 1.1 pre-release of February 2009 was tagged as release on SourceForge in May of 2012. The 1.1 community edition is now in development as the 2.0 branch at http://sourceforge.net/projects/gnucobol

Newer versions:

GnuCOBOL with Report Writer will merged into mainline trunk and after a 2.3 fix up pass, will finally end the split between the 2.0 branch and the reportwriter branch. Feature packed, Ron is doing world class work with the reportwriter branch which also includes a large number of practical COBOL updates.*

2.3 is the trunk branch at this point. It'll be released to fix any reported bugs in 2.2, as preparations are made for the Report Writer merge.

2.4.1 Building the 2.2 stable release

```
$ tar xvf gnucobol-2.2tar.gz
$ cd gnucobol-2.2
$ ./configure
$ make
$ make check
$ sudo make install
$ sudo ldconfig
```

Default configuration places the newly created binaries in `/usr/local`. `cobc`, in `/usr/local/bin` and other files in `/usr/local/share/gnucobol`.

2.4.2 Building from trunk

Get the source

```
$ svn checkout svn://svn.code.sf.net/p/gnucobol/code/trunk gnucobol
$ cd gnucobol/
```

The SVN tree assumes a development setup that includes GNU autotools.

```
$ build_aux/bootstrap
```

Will build the initial `./configure` script. `bootstrap` does some low level work to create this file.

Set up for an out of tree build. *Not necessary, but cleaner.*

```
$ mkdir build
$ cd build
$ ../configure --help   # to see any options you may want to tweak
$ ../configure          # note the .. up directory, while in build/
```

Then make, and test

```
$ make
$ make check
```

For more validation, the NIST COBOL 85 test suite can be used with

```
$ make check-all
```

Then install and refresh the linker cache

```
$ sudo make install
$ sudo ldconfig
```

Ensure things are setup in the proper prefix location with

```
$ type cobc
$ cobc --version
```

2.4.3 Building the 2.2 stable version

After a download and extract from http://sourceforge.net/projects/gnucobol/files/latest/download?source=files

```
$ tar xvf gnucobol-2.2.tar.gz
$ cd gnucobol-2.2
$ ./configure
$ make
$ make check     # (or make checkall)
$ sudo make install
$ sudo ldconfig
```

will place a new set of binaries in `/usr/local`, ready to roll.

The `ldconfig` after `make install` is important, GnuCOBOL installs shared libraries, and the link loader cache needs to be informed.

Be sure to see *What are the configure options available for building GnuCOBOL?* (page 72) for all the available options for building from sources.

The above instructions also apply to the GnuCOBOL 2.0 releases.

2.4.4 Building GnuCOBOL 3.0 release candidates

Get a copy of the latest source kit from SourceForge

https://sourceforge.net/projects/gnucobol/files/gnu-cobol/3.0/gnucobol-3.0-rc1.tar.gz

or

https://sourceforge.net/projects/gnucobol/files/gnu-cobol/3.0/gnucobol-3.0-rc-1_win.zip

Prerequisites include GMP, ncurses, Berkeley DB (or VB-ISAM) and the GNU build tools (gcc and friends), or other C compiler suite.

```
$ tar xvf gnu-cobol-3.0-rc-1.tar.gz
$ cd gnucobol-3.0
$ ./configure
$ make
$ make check
$ make test
$ sudo make install
$ sudo ldconfig
```

Use `./configure --help` to list all of the available build configuration options.

`make check` does almost 700 internal tests, and `make test` runs a freshly built compiler with the NIST COBOL-85 test suite. These are important steps (`make check` in particular) and should pass before any `make install`.

If there are problems, visit the SourceForge Help getting started forum and experts will help you work out any local installation issues.

https://sourceforge.net/p/gnucobol/discussion/help/

2.4.5 occurlrefresh

If you build of OpenCOBOL 1.1 or GnuCOBOL (any) and have libcurl, you will be able to compile the `occurlrefresh.cbl` (with `occurlsym.cpy`) application and an early `occurl.c` libCURL wrapper that allows file transfers off the internet. `occurlrefresh` includes default filenames for retrieving the most recent pre-release source archive and only updates the local copy if there has been a newer upstream release as determined by timestamp.

Thanks to [aoirthoir] for hosting these; currently *(March 2018)* at

- occurlrefresh.cbl
- occurlsym.cpy
- occurl.c

and then simply

```
$ ./occurlrefresh
```

to download any new development archives. libCURL tests the modification timestamps, so this procedure is very resource efficient, only pulling from the server if there is something new. A `-b` option is accepted that will spawn off `tar`, `configure` and the `make` pass to compile a fresh copy. `-b` does not do an install, you'll still have to do that manually after verifying that everything is ok.

2.4.6 Building the reportwriter version

Get the source

```
$ svn checkout svn://svn.code.sf.net/p/gnucobol/code/branches/reportwriter \
  gnu-cobol-rw
$ cd gnu-cobol-rw/
```

or with wget, *thanks to Simon for the snippet*.

```
$ mkdir reportwriter
$ wget -N -e robots=off -r -np -nH --cut-dirs =5 \
  http://svn.code.sf.net/p/gnucobol/code/branches/reportwriter
$ chmod 775 configure tests/testsuite
$ touch cobc/*pars*.c* cobc/pplex.c* cobc/scanner.c* cobc/*.hpp tests/testsuite
```

GnuCOBOL has removed pre configured scripts, and now uses a bootstrap method to create the `configure` script.

```
$ build_aux/bootstrap
```

Set up for an out of tree build. *Not necessary, but cleaner.*

```
$ mkdir build
$ cd build
$ ../configure --help   # to see any options you may want to tweak
$ ../configure          # note the .. up directory, while in build/
```

and the make, test, and install

```
$ make
$ make check
$ sudo make install
$ sudo ldconfig
```

and for more validation, the NIST COBOL 85 test suite

```
$ cd tests/cobol85
$ wget http://www.itl.nist.gov/div897/ctg/suites/newcob.val.Z
$ uncompress newcob.val.Z
$ make test
```

Party, big party. Dancing, and woo hoos, like it's 1985. *Actually, the last test suite update was in 1993, shortly after Intrinsic Functions*.

While the test is running, take a look at *REPORT* (page 369).

Or, read through some of the NIST test code, perhaps SM/SM101A.CBL, a program that puts `COPY` *through its paces.* Please note that **newcob.val is not for redistribution**. Get it from the source, and share the link, not the file.

While Ron still works in the reportwriter branch, GnuCOBOL 3.0+ has the Report Writer module and many of Ron's other enhancements to the compiler included now. *After many years of split, GnuCOBOL has merged in the Report Writer*.

2.5 What is the future of COBOL?

That is a good question. *What follows is strictly opinion, and readers are encouraged to make the future and not wait for it to just happen.*

COBOL is still very much in use with large systems, and big iron COBOL is a big business, all on its own. Millions are spent setting up and maintaining COBOL development systems. Many millions. That can be seen as a good thing, a bad thing, or a neutral thing. Some people are deeply invested in COBOL and see change as anathema. Some people are itching to get away from what they see as a money pit, stagnant as the world progresses. Some may be suffering internal conflict, split by both those extreme views.

Reality is likely somewhere in the middle. *And part of the opinion, this author leans to staying with COBOL unless there are some serious reasons not to. User interface, interoperability and networking portions of hertitage applications come to mind.* With GnuCOBOL, staying with COBOL may be a more attractive option. Source codes may need only minimal change, the money pit shrinks considerably, or disappears, and at the same time interoperability potentials increase, considerably. Keep all the heritage COBOL, extend into the future and build up and out, not sideways.

COBOL 2014 has some very nice features. Not all the features a modern development team may want or need, *networking and user interface come to mind again*, but a very solid core for problem solving. GnuCOBOL being a compiler heavily rooted in C (or C++, thanks to Sergey), bridges the business computing model enshrined in COBOL, with the computer sciences enshrined in just about all the other programming development systems in use today. There are C implementations of nearly all mainstream programming languages. Java is actually based on a C implementation, as is Python, Perl, Ruby, PHP, to name but a few. There are C implementations of Ada, Fortran, BASIC, Lisp, Prolog, Javascript, a very long list. COBOL is a first class citizen in all of these environments with GnuCOBOL. GnuCOBOL bridges the gap between Business and Science, and can take on either role, fully, or in a mixed paradigm.

Need a network module? CALL it, or use `cobc` to link object code directly into a master program. Need a slicker user interface, use cobweb-gtk or cobweb-tk and offer up modern screens. CALL a few other modules and have a browser ready interface. Need the flexibility of some advanced data structure or multiprocessing system? Link it in. Need the Cloud? Put an instance of GnuCOBOL on your Cloud. Need a DevOps strategy, well, build that layer around heritage and let your GnuCOBOL developers talk with your GnuCOBOL operations teams. Need to interoperate with some monster third party system? Dig in, knowing full well that it'll all work at the common layer of the C application binary interface.

The future of COBOL is what we will make of it. High costs no longer needs to be the primary area of modernization discussions surrounding heritage COBOL systems. They can be, for those that feel the need to spend; and there will be vendors willing to sign you up, for decades to come. Or, for those willing, GnuCOBOL will be waiting to ease some of the financial burdens, and open up the future to the opportunities that await.

CHAPTER

THREE

USING GNUCOBOL

Using GnuCOBOL

3.1 How do I install GnuCOBOL?

Installation instructions can be found at GnuCOBOL Install, but there are now a few ways to install GnuCOBOL.

Note: Windows quick start, February 2020+1

The best option at this time is hosted at https://www.arnoldtrembley.com/GnuCOBOL.htm

Scroll down to **GnuCOBOL Compiler install binaries** and choose from a few configurations. Recommend

- https://www.arnoldtrembley.com/GC312-BDB-rename-7z-to-exe.7z
- https://www.arnoldtrembley.com/GC312-VBI-rename-7z-to-exe.7z

Those builds include Indexed IO, full decimal math support, screens, Report Writer, more. From the soon to be GnuCOBOL 3.1-dev release. G-BDB is built with Berkeley DB, and includes GNU Debugger symbols. VBI is VB-ISAM instead of BDB, without debug symbols in the compiler. Visit the site for the latest, and more configuration choices.

Rename the .7z to .exe, and click for an easy install. Open a console, run `set_env.cmd` in the extract directory, then freely create, compile, and run your COBOL programs.

3.1.1 From source with GNU/Linux

```
$ wget http://sourceforge.net/projects/gnucobol/files/gnu-cobol/3.0/gnucobol-3.0-rc1.
↪tar.gz
$ tar xvf gnucobol-3.0.tar.gz
$ cd gnu-cobol-3.0
$ ./configure
$ make
$ make check
$ sudo make install
$ sudo ldconfig
```

January 2015:

A note on versions. OpenCOBOL 1.1 Feb 2009 was the last public pre-release of what is now GnuCOBOL.

There were two rebranding passes. OpenCOBOL to GNU Cobol then to GnuCOBOL. GNU Cobol 1.1 is the package listed here. It is OpenCOBOL 1.1 with rebranding, and a fair number of bug fixes and improvements.

Alternatively, for later, more feature rich, but less tested GnuCOBOL 2, change the wget to:

```
wget -N -e robots=off -r -np -nH --cut-dirs =5 \
    http://svn.code.sf.net/p/gnucobol/code/branches/gnu-cobol-2.0
```

for the master development branch. Or, Report Writer. Close to 2.0, but diverged earlier, now merged into GnuCOBOL 3.0 pre-releases.

```
wget -N -e robots=off -r -np -nH --cut-dirs =5 \
    http://svn.code.sf.net/p/gnucobol/code/branches/reportwriter
```

or for a C++ version, again, an earlier 2.0 branch point:

```
wget -N -e robots=off -r -np -nH --cut-dirs =5 \
    http://svn.code.sf.net/p/gnucobol/code/branches/gnu-cobol-cpp
```

or, to experiment with FLI COBOL, (FUNCTION PYTHON, JVM, LUA, TCL, REXX):

```
wget -N -e robots=off -r -np -nH --cut-dirs =5 \
    http://svn.code.sf.net/p/gnucobol/code/branches/gnu-cobol-builtin-script
```

The backslashes represent an ignored newline. If you combine the lines, drop the backslash. It is only there for width control in this document, the wget command is all one line.

Reportwriter has been folded into trunk now. The C++ version is close to baseline 2.1. gnu-cobol-cpp will remain a separate branch for the forseeable future.

FLI COBOL is Foreign Language Intrinsic COBOL, embedded scripting with

- FUNCTION PYTHON(text, args...)
- FUNCTION REXX(text, args...)
- FUNCTION TCL(text, args...)
- FUNCTION JVM(class, method, jni-spec, args...)
- FUNCTION LUA(text, args...)
- plans for FUNCTION qjs, mruby, nekovm, jsi, ...

If you are reading this for the first time, and looking for a COBOL 85 compiler, go with the gnu-cobol-2.1 instructions. All these compilers are valid, working COBOL compilers. gnu-cobol-1.1 (which is very close to open-cobol-1.1, the version in most major distros) is very likely the most common installation type, by far. Years and years of accumulated installs.

GnuCOBOL 2.1 is making headway.

GnuCOBOL 3.0 is close to ready, but not stamped for production by the development team quite yet. It too is a valid COBOL compiler, passing over 9700 NIST tests, but, production use would come with warnings to include an extra round of verification and site suitability testing.

Please see *What are the differences between OpenCOBOL 1.1 and GnuCOBOL 1.1?* (page 144)

For anyone that needs to care, 1.1 is GPL (and LGPL) 2+. All newer cuts are GPL (and LGPL) 3+.

All sources, in all branched, back to the initial 0.9 public release by Keisuke Nishida have had copyrights reassigned to the Free Software Foundation.

3.1.2 Debian

The Debian binary package makes installing GnuCOBOL 1.0 a snap. From **root** or using sudo

```
$ apt-get install open-cobol (old version now)

$ apt install gnucobol
```

3.1.3 Ubuntu

The Ubuntu repositories are very similar to Debian, using the same *APT* (page 1323) tool set.

Note on linking: Please be aware that Ubuntu has made a change to default link optimization that currently REQUIRE an external setting for the proper use of GnuCOBOL (and the older named OpenCOBOL) with dynamic libraries.

```
export COB_LD_FLAGS+='-Wl, --no-as-needed'
```

before any compiles that use `-l` (minus ell) options to include named libraries.

This can also be accomplished without the exported environment variable during compiles by asking `cobc` to pass arguments through the C compiler to the link phase.

```
cobc -Q "-Wl, --no-as-needed"
```

See *Why can't libcob find my link modules at run-time?* (page 154) for further details.

3.1.4 Fedora

From the main Fedora repositories

```
$ yum install open-cobol (old version)

$ sudo dnf install gnucobol
```

3.1.5 Windows

And then we get to Windows™. A lot of people seem to have trouble with getting GnuCOBOL up and running with Windows. This situation has steadily improved since 2009, and continues to improve as of 2020.

Note: Windows quick start, February 2020+1

The best option at this time is hosted at https://www.arnoldtrembley.com/GnuCOBOL.htm

Scroll down to **GnuCOBOL Compiler install binaries** and choose from a few configurations. Recommend

- https://www.arnoldtrembley.com/GC312-BDB-rename-7z-to-exe.7z
- https://www.arnoldtrembley.com/GC312-VBI-rename-7z-to-exe.7z

Those builds include Indexed IO, full decimal math support, screens, Report Writer, more. From the soon to be GnuCOBOL 3.1-dev release. G-BDB is built with Berkeley DB, and includes GNU Debugger symbols. VBI is VB-ISAM instead of BDB, without debug symbols in the compiler. Visit the site for the latest, and more configuration choices.

Rename the .7z to .exe, and click for an easy install. Open a console, run `set_env.cmd` in the extract directory, then freely create, compile, and run your COBOL programs.

Older news, pre 2020

The fastest method to get GnuCOBOL running on Windows is likely via the OpenCobolIDE by Colin Duquesnoy with the MinGW GnuCOBOL package by Arnold Trembley.

A Windows installer is hosted at

https://launchpad.net/cobcide/+download

For ease of use with Windows and GnuCOBOL, start there.

That will install the IDE, and MinGW build of GnuCOBOL (at time of writing 2.0-rc2), from early 2017. A click and go Setup.exe file.

Next, builds can be from sources using Cygwin or MinGW. These two extensions to Windows provide a necessary layer of POSIX features that GnuCOBOL was created with (and for).

With Cygwin, you can simply follow the instructions listed above for building on GNU/Linux. Cygwin provides almost all of the same tools.

For MinGW, read the OC_GettingStarted_Windows document by [wmklein] available online at

- http://opencobol.add1tocobol.com/oc_gettingstarted_windows.html
- http://gnucobol.sourceforge.net/guides/OC_GettingStarted_Windows.pdf

Also see *What is the current version of GnuCOBOL?* (page 57) and *visual studio* (page 9).

One recent addition for easing the burden with Windows installs came from Arnold Trembley. He put together an amalgam of instructions and code to create a bundle that when extracted should have you up and running with a MinGW GnuCOBOL system in a very short period of time.

From Arnold:

```
I worked with Realia COBOL 4.2 for OS/2 and DOS back in the early 1990's.
It was an excellent compiler, but too expensive for me to buy for personal
use.  Unlike Microfocus COBOL, there were no license fees for executables
you created using Realia COBOL. CA (formerly Computer Associates) bought
Realia, and I don't think CA-Realia COBOL is available any more.

Two days was just for me to fumble around with building the GnuCOBOL 2.0
from source, while writing a manual (still unfinished) on how to do it. My
end goal is to create an installer for the GnuCOBOL 2.0 (like I did for
GnuCOBOL 1.1) so you can run a setup.exe for it like any other windows
application. But if GC 2.0 will be included in a future release of
OpenCOBOLIDE that would be even better.

I have a working version of GnuCOBOL 2.0 (r624 from 10JUL2015) built with
MinGW, if you would like to try it, but it's a 52 megabyte zip file with
no documentation or installer. You can download it from here:

http://www.arnoldtrembley.com/GC20base.zip

Create a folder named something like c:\GnuCOBOL or C:\GC20 and unzip the
contents into it while preserving the directory structure. Read the CMD
files for an idea of how to setup the environment variables. Several
months ago I tested it with OpenCOBOLIDE, and I was able to compile a
small COBOL program.
```

And from a happy customer (Eugenio Di Lorenzo) that just wanted to get GnuCOBOL installed with a minimum of fuss:

```
Good Job Arnold. This is what I need.

Just downloaded, unpacked and it works out of the box !  1 minute for
installation.  After that I configured preferences in OCIDE and all works
fine.  Thanks a lot.

I suggest to store this zip file or something similar into the sourceforge
site.
```

Following Eugenio's advice, a home for Arnold's works will be in the GnuCOBOL project space at:

http://gnucobol.sourceforge.net/files/index.html

3.1.6 Macintosh

From Ganymede on opencobol.org

HOWTO: Installling OpenCOBOL 1.0.0 (with BerkeleyDB) under Mac OS 10.5.x-10.6.x

```
On Mac OS X 10.5.x/10.6.x, I have successfully managed to compile and install
OpenCOBOL 1.0.0 (including libdb linking), and am now happily compiling
production systems with it. It's not *entirely* straightforward, as it involves
installing GMP via MacPorts -- the *only way* that GMP will install properly
because of some eccentricities in Apple's Xcode development tools (particularly
with relation to c99 in gcc), unless you are willing to patch things by hand.
In addition, the earlier BerkeleyDB versions (the 4.x.x ones available via
MacPorts) cause some strange ioctl errors at runtime under Mac OS X Leopard and
Snow Leopard when attempting certain types of ORGANIZATION IS INDEXED
operations; precisely what conditions causes this I am yet to fully ascertain.
The upshot of it is that in order to compile and run a complete OpenCOBOL 1.0.0
installation on Leopard and Snow Leopard, one has to 1) install GMP via
MacPorts; but 2) compile and install a recent version of BerkeleyDB natively.

Probably at some point, I'm going to package this into a pretty-pretty
precompiled .app and .dmg along with a rudimentary Cocoa compiler interface.
Until then, however -- my COBOL on Mac comrades! -- please do the following:

-- INSTALLATION STEPS (Tested on both 10.5.x and 10.6.x) --
1) Download an appropriate MacPorts distribution for your OS:
<http://distfiles.macports.org/MacPorts/>
If you want to use the installer:
* For 10.5.x: MacPorts-1.8.0-10.5-Leopard.dmg
* For 10.6.x: MacPorts-1.8.0-10.6-SnowLeopard.dmg
From source, MacPorts-1.8.0.tar.gz is confirmed to work on both versions.
NB: Make sure PATH is properly set by install in your active user's ~/.profile.
2) Update MacPorts: sudo port -d selfupdate
3) Install GMP with MacPorts: sudo port install gmp
4) Download the Oracle Berkeley DB 5.0.21 (or later) .tar.gz source:
<http://www.oracle.com/technology/products/berkeley-db/db/index.html>
5) Untar, cd to the Berkeley DB source folder, then:
cd /build_unix
6) Do the following to configure, make and install Berkeley DB:
../dist/configure
make
sudo make install
7) Download and untar OpenCOBOL 1.0.0, cd to directory
8) Run ./configure, setting CPPFLAGS and LDFLAGS as below (CHANGING ANY
VERSION-SPECIFIC PATHS TO WHAT YOU JUST INSTALLED) as follows:

./configure
CPPFLAGS="-I/opt/local/var/macports/software/gmp/5.0.1_0/opt/local/include/
-I/usr/local/BerkeleyDB.5.0/include/"
LDFLAGS="-L/opt/local/var/macports/software/gmp/5.0.1_0/opt/local/lib
-L/usr/local/BerkeleyDB.5.0/lib/"

9) Make and install:
make
sudo make install
10) Et voila! Try exiting the directory and invoking cobc.

-- YOU SHOULD THEN BE ABLE TO DO SOMETHING LIKE THIS: --
```

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```
phrygia.ganymede-labs.com:bottles ganymede$ sw_vers
ProductName: Mac OS X
ProductVersion: 10.5.6
BuildVersion: 9G55
phrygia.ganymede-labs.com:bottles ganymede$ cobc -V
cobc (OpenCOBOL) 1.0.0
Copyright (C) 2001-2007 Keisuke Nishida
Copyright (C) 2007 Roger While
phrygia.ganymede-labs.com:bottles ganymede$ cobc -v -x bottles.cbl
preprocessing bottles.cbl into
/var/folders/KI/KI15WC0KGMmvvO980RztgU+++TI/-Tmp-//cob75450_0.cob translating
/var/folders/KI/KI15WC0KGMmvvO980RztgU+++TI/-Tmp-//cob75450_0.cob into
/var/folders/KI/KI15WC0KGMmvvO980RztgU+++TI/-Tmp-//cob75450_0.c
  gcc -pipe -c -I/usr/local/include
-I/opt/local/var/macports/software/gmp/5.0.1_0/opt/local/include/
-I/usr/local/BerkeleyDB.5.0/include/ -I/usr/local/include -O2 -Wno-unused
-fsigned-char -Wno-pointer-sign -o
/var/folders/KI/KI15WC0KGMmvvO980RztgU+++TI/-Tmp-//cob75450_0.o
/var/folders/KI/KI15WC0KGMmvvO980RztgU+++TI/-Tmp-//cob75450_0.c gcc -pipe
-L/opt/local/var/macports/software/gmp/5.0.1_0/opt/local/lib
-L/usr/local/BerkeleyDB.5.0/lib/ -o bottles
/var/folders/KI/KI15WC0KGMmvvO980RztgU+++TI/-Tmp-//cob75450_0.o
-L/opt/local/var/macports/software/gmp/5.0.1_0/opt/local/lib
-L/usr/local/BerkeleyDB.5.0/lib/ -L/usr/local/lib -lcob -lm -lgmp
-L/usr/local/lib -lintl -liconv -lc -R/usr/local/lib -lncurses -ldb


With lots of sloppy LINKAGE SECTION kisses,
-- Ganymede
```

homebrew

And an update from Martin Ward. This is likely how GnuCOBOL 2 compile from source efforts should be approached in 2015 and beyond. Martin needed 32 bit pointers, and struggled through to come up with a `homebrew` solution to his GnuCOBOL build.

```
I tried brew install gnu-cobol --universal but that just installs the
64 bit version. I would prefer to compile from source: which means
installing 32 bit versions of libdb and gmp.  brew install gmp --32-bit
will install a 32 bit version of gmp, but this option does not affect the
installation of libdb.

I compiled db-6.1.26 with CFLAGS=-m32 and installed it, and then built
GnuCOBOL with: ./configure CFLAGS=-m32
CPPFLAGS=-I/usr/local/BerkeleyDB.6.1/include/
LDFLAGS=-L/usr/local/BerkeleyDB.6.1/lib/

This works!
```

And a follow up update posted to the SourceForge forums

```
1) brew install gmp@4
2) export LDFLAGS='-L/usr/local/opt/gmp@4/lib'
3) export CPPFLAGS='-I/usr/local/opt/gmp@4/include'
```

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```
4) ./configure

One update:

export LDFLAGS='-L/usr/local/opt/gmp@4/lib -L/usr/local/opt/berkeley-db/lib'
export CPPFLAGS='-I/usr/local/opt/gmp@4/include -I/usr/local/opt/berkeley-db/include'
./configure
```

3.1.7 CentOS

From the discussion forum on SourceForge, by Stuart Bishop.

```
Just to document this a little further as I've got this install down pat and
repeated many times - to do an install of Opencobol-1.1 on a newly installed
Centos-6.6:

After installing a "Basic Server" Centos-6.6 from CD 1 of 2...

Login to your CentOS Box, and su to root

install dependencies 1 of 2
yum install gmp gmp-devel libtool ncurses ncurses-devel ncurses-libs make

install dependencies 2 of 2
yum install libdbi libdbi-devel libtool-ltdl libtool-ltdl-devel db4 db4-devel

Obtain gmp-5.1.3.tar; ./configure; make; make check; make install

Download open-cobol 1.1.tar.gz; you can use wget
yum install wget
wget http://downloads.sourceforge.net/project/open-cobol/
Copy to say /usr/local and decompress and extract

cd /usr/local/open-cobol-1.1

Build and install with ./configure; make; make check; make install
```

But, GnuCOBOL has some nice fixes, as it was being rebranded from OpenCOBOL.

The wget might be better as

```
$ wget http://sourceforge.net/projects/gnucobol/files/gnu-cobol/1.1/gnu-cobol-1.1.tar.
↪gz
 ...
$ cd ...gnu-cobol-1.1
 ...
```

or one of the others, listed above; reportwriter, C++, fileio rewrite, 2.0; Go with the 2.0 pre-releases, it's the master branch, and reportwriter, for very well done REPORT SECTION support. Passes NIST suport tests, and most report code thrown at it, say back to 68. Almost 50 years of backwards compatibility and a chance to revitalize COBOL assets, perhaps thought lost to price / value ratios for run-time fees versus perceived value for some older report layouts.

3.1.8 MINIX

MINIX From "mini-Unix", a POSIX compliant Unix-like operating system based on a microkernel architecture. By Andrew S. Tanenbaum.

From Pat McCavery, on installing with MINIX 3.

```
Hi Guys

I have installed GnuCOBOL on Minix 3. I just wanted to report about it and
leave a some instructions if someone is interested later.

I think that these instructions will help with BSD installs as Minix heavily
borrows from NetBSD.

But first off, why Minix?

Minix was just a toy when Linus studied it but it has gone through revisions.
Minix 3 aims to be a high reliability embedded OS.

It is highly compartmentalized and a failure in a driver should not bring it
down. Also there is a reincarnation server that will try to revive drivers
that have failed.

Drivers are in userland.

It's much smaller then Linux.

However it has a very small user base. You can't just assume that things have
been tested, there isn't enough of a community to get the coverage and things
need to be well tested without relying on the herd for protection.

Here is how things went:

I installed gmp 5.1.3 and VBISAM both with configure prefix="/usr"

vbisam needed chmod +x install-sh

I renamed doc/cbrunt.tex to hide it and I touched to create an empty
cbrunt.tex file

I installed texi2html 1.82 I am not sure it helped with anything

I installed help2man-1.44.1

I installed bison and flex Fromm the minix repo(which is really mostly
untested NetBSD packages)

I installed autoconf 2.69 and automake 1.15 both with prefix="/usr"

autoconf failed at test 503 with make check but I installed it anyways.

I installed GnuCOBOL with configure --with-vbisam

692 test ran, 4 failed, 2 were expected fails.

The two unexpected fails were:
COB_PRE_LOAD with entry points
```

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```
First read on empty sequential file.

I don't think Minix has shared objects and I didn't need libtool

the compiler was clang.
```

Another OS that supports GnuCOBOL. Thanks to Pat for the info.

3.2 What are the configure options available for building GnuCOBOL?

configure is a de facto standard development tool for *POSIX* (page 1361) compliant operating systems, in particular GNU/Linux. It examines the current environment and creates a Makefile suitable for the target computer and the package being built.

For GnuCOBOL, the `./configure` script accepts `--help` as a command line option to display all of the available configuration choices.

```
`configure' configures GnuCOBOL 1.1 to adapt to many kinds of systems.

Usage: ./configure [OPTION]... [VAR=VALUE]...

To assign environment variables (e.g., CC, CFLAGS...), specify them as
VAR=VALUE.  See below for descriptions of some of the useful variables.

Defaults for the options are specified in brackets.

Configuration:
  -h, --help              display this help and exit
      --help=short        display options specific to this package
      --help=recursive    display the short help of all the included packages
  -V, --version           display version information and exit
  ---quiet, --silent   do not print `checking...' messages
      --cache-file=FILE   cache test results in FILE [disabled]
  -C, --config-cache      alias for `--cache-file=config.cache'
  -n, --no-create         do not create output files
      --srcdir=DIR        find the sources in DIR [configure dir or `..']

Installation directories:
  --prefix=PREFIX         install architecture-independent files in PREFIX
                          [/usr/local]
  --exec-prefix=EPREFIX   install architecture-dependent files in EPREFIX
                          [PREFIX]

By default, `make install' will install all the files in
`/usr/local/bin', `/usr/local/lib' etc.  You can specify
an installation prefix other than `/usr/local' using `--prefix',
for instance `--prefix=$HOME'.

For better control, use the options below.

Fine tuning of the installation directories:
  --bindir=DIR           user executables [EPREFIX/bin]
  --sbindir=DIR          system admin executables [EPREFIX/sbin]
```

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```
  --libexecdir=DIR       program executables [EPREFIX/libexec]
  --datadir=DIR          read-only architecture-independent data [PREFIX/share]
  --sysconfdir=DIR       read-only single-machine data [PREFIX/etc]
  --sharedstatedir=DIR   modifiable architecture-independent data [PREFIX/com]
  --localstatedir=DIR    modifiable single-machine data [PREFIX/var]
  --libdir=DIR           object code libraries [EPREFIX/lib]
  --includedir=DIR       C header files [PREFIX/include]
  --oldincludedir=DIR    C header files for non-gcc [/usr/include]
  --infodir=DIR          info documentation [PREFIX/info]
  --mandir=DIR           man documentation [PREFIX/man]

Program names:
  --program-prefix=PREFIX            prepend PREFIX to installed program names
  --program-suffix=SUFFIX            append SUFFIX to installed program names
  --program-transform-name=PROGRAM   run sed PROGRAM on installed program names

System types:
  --build=BUILD     configure for building on BUILD [guessed]
  --host=HOST       cross-compile to build programs to run on HOST [BUILD]

Optional Features:
  --disable-FEATURE       do not include FEATURE (same as --enable-FEATURE=no)
  --enable-FEATURE[=ARG]  include FEATURE [ARG=yes]
  --enable-maintainer-mode  enable make rules and dependencies not useful
                          (and sometimes confusing) to the casual installer
  --disable-dependency-tracking  speeds up one-time build
  --enable-dependency-tracking   do not reject slow dependency extractors
  --enable-experimental   (GnuCOBOL) enable experimental code (Developers only!)
  --enable-param-check    (GnuCOBOL) enable CALL parameter checking
  --enable-shared[=PKGS]
                          build shared libraries [default=yes]
  --enable-static[=PKGS]
                          build static libraries [default=yes]
  --enable-fast-install[=PKGS]
                          optimize for fast installation [default=yes]
  --disable-libtool-lock  avoid locking (might break parallel builds)
  --disable-rpath         do not hardcode runtime library paths
  --disable-nls           do not use Native Language Support

Optional Packages:
  --with-PACKAGE[=ARG]    use PACKAGE [ARG=yes]
  --without-PACKAGE       do not use PACKAGE (same as --with-PACKAGE=no)
  --with-cc=<cc>          (GnuCOBOL) specify the C compiler used by cobc
  --with-seqra-extfh      (GnuCOBOL) Use external SEQ/RAN file handler
  --with-cisam            (GnuCOBOL) Use CISAM for ISAM I/O
  --with-disam            (GnuCOBOL) Use DISAM for ISAM I/O
  --with-vbisam           (GnuCOBOL) Use VBISAM for ISAM I/O
  --with-index-extfh      (GnuCOBOL) Use external ISAM file handler
  --with-db1              (GnuCOBOL) use Berkeley DB 1.85 (libdb-1.85)
  --with-db               (GnuCOBOL) use Berkeley DB 3.0 or later (libdb)(default)
  --with-lfs64            (GnuCOBOL) use large file system for file I/O (default)
  --with-dl               (GnuCOBOL) use system dynamic loader (default)
  --with-patch-level      (GnuCOBOL) define a patch level (default 0)
  --with-varse         (GnuCOBOL) define variable sequential format (default 0)
  --with-gnu-ld           assume the C compiler uses GNU ld [default=no]
  --with-pic              try to use only PIC/non-PIC objects [default=use
                          both]
```

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```
  --with-tags[=TAGS]
                          include additional configurations [automatic]
  --with-gnu-ld           assume the C compiler uses GNU ld default=no
  --with-libiconv-prefix[=DIR]  search for libiconv in DIR/include and DIR/lib
  --without-libiconv-prefix     don't search for libiconv in includedir and libdir
  --with-libintl-prefix[=DIR]  search for libintl in DIR/include and DIR/lib
  --without-libintl-prefix     don't search for libintl in includedir and libdir

Some influential environment variables:
  CC          C compiler command
  CFLAGS      C compiler flags
  LDFLAGS     linker flags, e.g. -L<lib dir> if you have libraries in a
              nonstandard directory <lib dir>
  CPPFLAGS    C/C++ preprocessor flags, e.g. -I<include dir> if you have
              headers in a nonstandard directory <include dir>
  CPP         C preprocessor
  CXXCPP      C++ preprocessor

Use these variables to override the choices made by 'configure' or to help
it to find libraries and programs with nonstandard names/locations.

Report bugs to <open-cobol-list@lists.sourceforge.net>.
```

3.2.1 GnuCOBOL build time environment variables

LD_RUN_PATH Embeds build time library paths in the compiler. Handy when on hosts without root access. Point cobc at user built libcob and dependency libraries when needed. If set while compiling as well, CGI binaries will know where to find libcob and any other custom DSO files.

LD_LIBRARY_PATH Run time shared library path, can effect lookup order during `./configure, make`, but mentioned here as an alternative to LD_RUN_PATH. Complicating factor when running GnuCOBOL CGI on shared hosts. An intermediate script is needed to set LD_LIBRARY_PATH to point to local user account libcob. (Or hint to staff to install GnuCOBOL, very likely (as of 2014) in repositories as `open-cobol`. Some package maintainers have separated the GPL compiler and LGPL run-time support into `open-cobol` and `libcob1` (along with -dev header packages for both).

COB_CC The C compiler invoked during the cobc build chain.

COB_CFLAGS The flags passed to the C compiler during the build chain.

COB_LDFLAGS The link flags pass to the C compiler.

COB_LIBS The default -l libraries used during the C compiler phase. -lm -lcob etcetera. These commands and options are displayed with cobc -v.

COB_CONFIG_DIR Hmm, news says this was dropped, but it'll effect where .conf dialect support files are found.

COB_COPY_DIR Path to COPY books.

COBCPY Path to COPY books. Knowing Roger these are cumulative.

COB_LIBRARY_PATH Sets a default.

COB_VARSEQ_FORMAT Determines a few code paths during make.

COB_UNIX_LF Sets a default.

3.3 Does GnuCOBOL have any other dependencies?

GnuCOBOL relies on a native C compiler with *POSIX* (page 1361) compatibility. GCC being a freely available compiler collection supported by most operating systems currently *(March 2018)* in use.

GnuCOBOL requires the following external libraries to be installed:

GNU MP (libgmp) 4.1.2 or later libgmp is used to implement decimal arithmetic. GNU MP is licensed under GNU Lesser General Public License.

GNU Libtool (libltdl) libltdl is used to implement dynamic CALL statements. GNU Libtool is licensed under GNU Lesser General Public License.

NOTE - Libtool is not required for Linux and Windows (including MinGW and Cygwin)

The following libraries are optional:

Berkeley DB (libdb) 1.85 or later libdb can be used to implement indexed file I/O and SORT/MERGE. Berkeley DB is licensed under the original BSD License (1.85) or their own open-source license (2.x or later). Note that, as of 2.x, if you linked your software with Berkeley DB, you must distribute the source code of your software along with your software, or you have to strike a deal with Oracle Corporation.

For more information about Oracle Berkeley DB dual licensing see:

http://www.oracle.com/technetwork/database/berkeleydb/downloads/licensing-098979.html

Ncurses (libncurses) 5.2 or later libncurses can be used to implement SCREEN SECTION. Ncurses is licensed under a BSD-style license.

3.4 How does the GnuCOBOL compiler work?

GnuCOBOL is a multi-stage command line driven compiler. Command line options control what stages are performed during processing.

1. Preprocess
2. Translate
3. Compile
4. Assemble
5. Link
6. Build
7. Job run

GnuCOBOL produces intermediate C source code that is then passed to a configured C compiler and other tools. the GNU C compiler, `gcc` being a standard.

The main tool, `cobc`, by default, produces modules, linkable shared object files. Use `cobc -x` to produce executables (with a main).

3.4.1 Example of GnuCOBOL stages

Documenting the output of the various stages of GnuCOBOL compilation.

3.4.2 Original source code

hello.cob

```
000100* HELLO.COB GnuCOBOL FAQ example
000200 IDENTIFICATION DIVISION.
000300 PROGRAM-ID. hello.
000400 PROCEDURE DIVISION.
000500     DISPLAY "Hello, world".
000600     STOP RUN.
```

3.4.3 Preprocess

```
$ cobc -E hello.cob
```

Preprocess only pass. One operation of the preprocessor is to convert FIXED format to FREE format. *COPY* (page 237) includes are also read in along with *REPLACE* (page 368) substitution. The above command displayed:

```
# 1 "hello.cob"

IDENTIFICATION DIVISION.
PROGRAM-ID. hello.
PROCEDURE DIVISION.
 DISPLAY "Hello, world".
 STOP RUN.
```

3.4.4 Translate

```
$ cobc -C hello.cob
```

Translate only; preprocesses and then translates the COBOL sources into C. You can examine these files to get a good sense of how the GnuCOBOL environment interacts with the native C facilities. GnuCOBOL 1.1 produced `hello.c.h` and `hello.c`.

3.4.5 hello.c.h

```
/* Generated by            cobc 1.1.0 */
/* Generated from          hello.cob */
/* Generated at            Oct 04 2008 00:19:36 EDT */
/* GnuCOBOL build date     Oct 01 2008 22:15:19 */
/* GnuCOBOL package date   Oct 01 2008 16:31:26 CEST */
/* Compile command         cobc -C hello.cob */

/* PROGRAM-ID : hello */

static unsigned char b_5[4] __attribute__((aligned));        /* COB-CRT-STATUS */
static unsigned char b_1[4] __attribute__((aligned));        /* RETURN-CODE */
static unsigned char b_2[4] __attribute__((aligned));        /* SORT-RETURN */
static unsigned char b_3[4] __attribute__((aligned));        /* NUMBER-OF-CALL-
↪PARAMETERS */

/* attributes */
```

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```
static cob_field_attr a_1        = {16, 4, 0, 0, NULL};
static cob_field_attr a_2        = {33, 0, 0, 0, NULL};

/* fields */
static cob_field f_5        = {4, b_5, &a_1};        /* COB-CRT-STATUS */

/* constants */
static cob_field c_1        = {12, (unsigned char *)"Hello, world", &a_2};

/* ---------------------------------------------- */
```

3.4.6 hello.c

```
/* Generated by            cobc 1.1.0 */
/* Generated from          hello.cob */
/* Generated at            Oct 04 2008 00:19:36 EDT */
/* GnuCOBOL build date    Oct 01 2008 22:15:19 */
/* GnuCOBOL package date  Oct 01 2008 16:31:26 CEST */
/* Compile command         cobc -C hello.cob */

#define  __USE_STRING_INLINES 1
#include <stdio.h>
#include <stdlib.h>
#include <string.h>
#include <math.h>
#include <libcob.h>

#define COB_SOURCE_FILE               "hello.cob"
#define COB_PACKAGE_VERSION        "1.1"
#define COB_PATCH_LEVEL               0

/* function prototypes */
static int hello_ (const int);

int hello (void);


/* functions */

int
hello ()
{
  return hello_ (0);
}

/* end functions */

static int
hello_ (const int entry)
{

#include "hello.c.h"  /* local variables */

  static int initialized = 0;
  static cob_field *cob_user_parameters[COB_MAX_FIELD_PARAMS];
```

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```
static cob_module module = { NULL, NULL, &f_5, NULL, cob_user_parameters, 0, '.',
                             '$', ',', 1, 1, 1, 0};


/* perform frame stack */
int frame_index;
struct frame {
  int  perform_through;
  void *return_address;
} frame_stack[255];

/* Start of function code */

if (unlikely(entry < 0)) {
  if (!initialized) {
      return 0;
  }
  initialized = 0;
  return 0;
}

module.next = cob_current_module;
cob_current_module = &module;

if (unlikely(initialized == 0))
  {
    if (!cob_initialized) {
      cob_fatal_error (COB_FERROR_INITIALIZED);
    }
    cob_check_version (COB_SOURCE_FILE, COB_PACKAGE_VERSION, COB_PATCH_LEVEL);
    if (module.next)
      cob_set_cancel ((const char *)"hello", (void *)hello, (void *)hello_);
    (*(int *) (b_1)) = 0;
    (*(int *) (b_2)) = 0;
    (*(int *) (b_3)) = 0;
    memset (b_5, 48, 4);


    initialized = 1;
  }

/* initialize frame stack */
frame_index = 0;
frame_stack[0].perform_through = -1;

/* initialize number of call params */
(*(int *) (b_3))   = cob_call_params;
cob_save_call_params = cob_call_params;

goto l_2;

/* PROCEDURE DIVISION */


/* hello: */

l_2:;
```

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```
  /* MAIN SECTION: */

  /* MAIN PARAGRAPH: */

  /* hello.cob:5: DISPLAY */
  {
    cob_new_display (0, 1, 1, &c_1);
  }
  /* hello.cob:6: STOP */
  {
    cob_stop_run ((*(int *) (b_1)));
  }

  cob_current_module = cob_current_module->next;
  return (*(int *) (b_1));

}

/* end function stuff */
```

3.4.7 Generate assembler

Using the -S switch asks `cobc` to ask the C compiler tool chain to not process farther than the assembler code generation phase.

```
$ cobc -S hello.cob
```

3.4.8 hello.s

```
    .file        "cob9141_0.c"
    .text
.globl hello
    .type        hello, @function
hello:
    pushl        %ebp
    movl        %esp, %ebp
    subl        $8, %esp
    movl        $0, (%esp)
    call        hello_
    leave
    ret
    .size        hello, .-hello
    .data
    .align 4
    .type        module.5786, @object
    .size        module.5786, 28
module.5786:
    .long        0
    .long        0
    .long        f_5.5782
    .long        0
    .long        cob_user_parameters.5785
```

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```
    .byte        0
    .byte        46
    .byte        36
    .byte        44
    .byte        1
    .byte        1
    .byte        1
    .byte        0
    .local        cob_user_parameters.5785
    .comm        cob_user_parameters.5785,256,32
    .local        initialized.5784
    .comm        initialized.5784,4,4
    .section        .rodata
.LC0:
    .string        "Hello, world"
    .data
    .align 4
    .type        c_1.5783, @object
    .size        c_1.5783, 12
c_1.5783:
    .long        12
    .long        .LC0
    .long        a_2.5781
    .align 4
    .type        f_5.5782, @object
    .size        f_5.5782, 12
f_5.5782:
    .long        4
    .long        b_5.5776
    .long        a_1.5780
    .align 4
    .type        a_2.5781, @object
    .size        a_2.5781, 8
a_2.5781:
    .byte        33
    .byte        0
    .byte        0
    .byte        0
    .long        0
    .align 4
    .type        a_1.5780, @object
    .size        a_1.5780, 8
a_1.5780:
    .byte        16
    .byte        4
    .byte        0
    .byte        0
    .long        0
    .local        b_3.5779
    .comm        b_3.5779,4,16
    .local        b_2.5778
    .comm        b_2.5778,4,16
    .local        b_1.5777
    .comm        b_1.5777,4,16
    .local        b_5.5776
    .comm        b_5.5776,4,16
    .section        .rodata
```

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```
.LC1:
    .string         "1.1"
.LC2:
    .string         "hello.cob"
.LC3:
    .string         "hello"
    .text
    .type         hello_, @function
hello_:
    pushl          %ebp
    movl          %esp, %ebp
    subl          $2072, %esp
    movl          8(%ebp), %eax
    shrl          $31, %eax
    testl          %eax, %eax
    je          .L4
    movl          initialized.5784, %eax
    testl          %eax, %eax
    jne          .L5
    movl          $0, -2052(%ebp)
    jmp          .L6
.L5:
    movl          $0, initialized.5784
    movl          $0, -2052(%ebp)
    jmp          .L6
.L4:
    movl          cob_current_module, %eax
    movl          %eax, module.5786
    movl          $module.5786, cob_current_module
    movl          initialized.5784, %eax
    testl          %eax, %eax
    sete          %al
    movzbl          %al, %eax
    testl          %eax, %eax
    je          .L7
    movl          cob_initialized, %eax
    testl          %eax, %eax
    jne          .L8
    movl          $0, (%esp)
    call          cob_fatal_error
.L8:
    movl          $0, 8(%esp)
    movl          $.LC1, 4(%esp)
    movl          $.LC2, (%esp)
    call          cob_check_version
    movl          module.5786, %eax
    testl          %eax, %eax
    je          .L9
    movl          $hello_, 8(%esp)
    movl          $hello, 4(%esp)
    movl          $.LC3, (%esp)
    call          cob_set_cancel
.L9:
    movl          $b_1.5777, %eax
    movl          $0, (%eax)
    movl          $b_2.5778, %eax
    movl          $0, (%eax)
```

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```
    movl        $b_3.5779, %eax
    movl        $0, (%eax)
    movl        $4, 8(%esp)
    movl        $48, 4(%esp)
    movl        $b_5.5776, (%esp)
    call        memset
    movl        $1, initialized.5784
.L7:
    movl        $0, -4(%ebp)
    movl        $-1, -2044(%ebp)
    movl        $b_3.5779, %edx
    movl        cob_call_params, %eax
    movl        %eax, (%edx)
    movl        cob_call_params, %eax
    movl        %eax, cob_save_call_params
.L10:
    movl        $c_1.5783, 12(%esp)
    movl        $1, 8(%esp)
    movl        $1, 4(%esp)
    movl        $0, (%esp)
    call        cob_new_display
    movl        $b_1.5777, %eax
    movl        (%eax), %eax
    movl        %eax, (%esp)
    call        cob_stop_run
.L6:
    movl        -2052(%ebp), %eax
    leave
    ret
    .size        hello_, .-hello_
    .ident        "GCC: (Debian 4.3.1-9) 4.3.1"
    .section        .note.GNU-stack,"",@progbits
```

Produces `hello.s`.

3.4.9 Produce object code

```
$ cobc -c hello.cob
```

Compile and assemble, do not link. Produces `hello.o`.

3.4.10 Build modules

```
$ cobc -m hello.cob
$ cobc hello.cob
```

Build dynamically loadable module. This is the *default behaviour*. Either example produces `hello.so` or `hello.dll`.

```
$ cobc -b hello.cob
```

`-b` also creates a *DSO* (page 1319). In this simple case, the extended Build is the same as the single Module build with `-m`. `-b` will build a dynamically loadable module that includes all the entry points from all of the files included

on a command line. It's fun; you can mix .cob, .c, , .s, .o, and -l libs and GnuCOBOL does the right thing glueing it all together. `-b Build together` is eminently suited to Programming In The Large and using `cobcrun`.

```
$ cobc -b hello.cob support.c
```

will put together a single *DSO* (page 1319) that includes all the functions from `support.c`, as well as the entry points defined in `hello.cob`.

```
$ cobc -m hello.cob support.c
```

will create two separate *DSO* (page 1319) files, one for `hello` and one for `support`.

3.4.11 Module run

```
$ cobcrun hello
Hello, world
```

Will scan for the *DSO* (page 1319) *hello.so*, and then load, link, and execute the **hello** function name. Note: the DSO extension is not given to cobcrun. It is specific to the platform in use. It might be .so, or .dll, or .dylib, or, . . . ; GnuCOBOL will do the right thing, no extension is given to `cobcrun`.

3.4.12 Create executable

```
$ cobc -x hello.cob
```

Create an executable program. This examples produces `hello` or `hello.exe`.

Important:. *cobc* produces a *Dynamic Shared Object* by default. To create executables that include a *main* entry point, you need to use `-x`.

```
$ ./hello
Hello, world
```

GnuCOBOL also supports features for multiple source, multiple language programming, detailed in the FAQ at *Does GnuCOBOL support modules?* (page 670).

3.4.13 Run job

There is an additional `cobc` switch in GnuCOBOL 2.0, `-j` that asks the compiler to execute the program (or module) after compilation.

```
$ cobc -xj hello.cob
Hello, world
```

The job switch allows GnuCOBOL programmers to follow a Compile, Link and Go development paradigm. `-j` will invoke `cobcrun` when `-m` or `-b` builds are requested.

3.4.14 Interpreter directive

It even goes one step further, using the power of *hash-bang* POSIX style shell interpreter directives. GnuCOBOL programs can be treated as scripts.

For example, given the text file, `hello-cobol.sh`

```
#!/usr/local/bin/cobc -xj
000100* HELLO.COB GnuCOBOL FAQ example
000200 IDENTIFICATION DIVISION.
000300 PROGRAM-ID. hello.
000400 PROCEDURE DIVISION.
000500     DISPLAY "Hello, world".
000600     STOP RUN.
```

with `chmod +x hello-cobol.sh` you get

```
$ ./hello-cobol.sh
Hello, world
```

Scripted COBOL. (Or at least it feels like it; the text passed to the interpreter, which is effectively `cobc`, is compiled (and executed) due to the `-xj` compiler switches).

3.4.15 sizes for hello on Fedora 16

The directory listing after using the various cobc options:

```
-rwxrwxr-x. 1 btiffin btiffin  9730 Apr 22 00:25 hello
-rw-rw-r--. 1 btiffin btiffin  2253 Apr 22 00:26 hello.c
-rw-rw-r--. 1 btiffin btiffin   835 Apr 22 00:26 hello.c.h
-rw-rw-r--. 1 btiffin btiffin   391 Apr 22 00:26 hello.c.l.h
-rw-rw-r--. 1 btiffin btiffin   181 Apr 22 00:24 hello.cob
-rw-rw-r--. 1 btiffin btiffin  3288 Apr 22 00:24 hello.o
-rw-rw-r--. 1 btiffin btiffin  2577 Apr 22 00:26 hello.s
-rwxrwxr-x. 1 btiffin btiffin  9334 Apr 22 00:27 hello.so
```

Not bad. Small programs, small native binaries. As things should be.

3.5 What is cobc?

`cobc` is the GnuCOBOL compiler. It processes source code into object, library or executable code. `cobc` can also produce listings, and/or cross-reference files. You can also ask `cobc` to leave intermediate generated C sources on disk for perusal or further processing.

See *What compiler options are supported?* (page 86) for more information.

With most installations, `man cobc` and `info cobc` will be available anytime you need a little assistance when working with the compiler.

`cobc --help` is always available, and will display the many compile time options.

`cobc --version` will display build date and release version.

`cobc --info` will display various platform and configuration information.

To get a complete picture of your compile and runtime environments:

- `cobc --version`
- `cobc --info`
- `cobc --list-reserved`
- `cobc --std=cobol2002 --list-reserved`, shows word list for a given conf

- `cobc --list-intrinsics`
- `cobc --list-mnemonics`
- `cobc --list-system`
- `cobcrun --version`, (libcob and cobcrun versions)
- `cobcrun --info`, (build info for libcob)
- `cobcrun --runtime-conf`, will take into account any active overrides

3.6 What is cobcrun?

`cobcrun` is the GnuCOBOL driver program that allows the execution of programs stored in GnuCOBOL modules.

The `cobc` compiler, by default, produces modules (the `-m` option). These modules are linkable dynamic shared objects (DSO). Using GNU/Linux for example

```
$ cobc -x hello.cob
$ ./hello
Hello, world

$ cobc hello.cob
$ cobcrun hello
Hello, world
```

The `cobc -x hello.cob` built an executable binary called `hello`. The `cobc hello.cob` produced a *DSO* (page 1319) `hello.so`, and `cobcrun` resolves the entry point and executes the code, right from the *DSO* (page 1319).

`cobcrun` *is the compiler author's preferred way to manage GnuCOBOL development.* It alleviates knowing which source file needs `-x` while encouraging proper modular programming, a mainstay of GnuCOBOL.

3.6.1 path and module

There is a `cobcrun` command line switch, `-M` in GnuCOBOL 2.0 that offers even more flexibility when running modules. Without `-M`, the entry symbol needs to match the external *DSO_* name. The module path modifier allows separate names for the library and the entry point (any entry point within the DSO).

It will preset `COB_LIBRARY_PATH` with any optional path and `COB_PRE_LOAD` with an optional module basename. Ending slash only sets path. `-M` will accept path/file, path/, or file.

```
# build up a library, lots of subprograms in a single DSO
cobc -b multiprog.cob program??.cob

# run program06 in library multiprog, with a single argc/argv string
cobcrun -M multiprog program06 "command line argument"

# equivalent to cobcrun multiprog, without -M, if CWD is ~/cobol/multiprog
cobcrun -M /home/me/cobol/multiprog multiprog

# sample in a job control scenario
# exit code 0 is ok, 1 to 9 and the catch-all are problems,
#     30 thru 89 are special case codes that start program30, ..., program89
cobcrun -M /home/me/cobol/multiprog program27 "program27-inputfilename.dat" \
"program27-outputfilename.rpt"
```

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```
case $? in
            0) echo "program27 complete" ;;
        [1-9]) echo "program27 fell over with status $?" ;;
   [3-8][0-9]) cobcrun -M /home/me/cobol/multiprog program$? "for say, state taxes"
            *) echo "batch job fell over with status $?" ;;
esac
```

3.7 What is cob-config?

`cob-config` is a small program that can be used to display the C compiler flags and libraries required for compiling. Using GNU/Linux for example

```
$ cob-config
Usage: cob-config [OPTIONS]
Options:
        [--prefix[=DIR]]
        [--exec-prefix[=DIR]]
        [--version]
        [--libs]
        [--cflags]
$ cob-config --libs
-L/usr/local/lib -lcob -lm -lgmp -lncurses -ldb
$ cob-config --cflags
-I/usr/local/include
```

You may need to use these features during mixed source language development, usually by back-ticking the command output inline with other `gcc` commands.

3.8 What compiler options are supported?

The GnuCOBOL system strives to follow standards, yet also remain a viable compiler option for the many billions of existing lines of COBOL sources, by supporting many existing extensions to the COBOL language. Many details of the compile can be controlled with command line options. Please also see *What are the GnuCOBOL compile time configuration files?* (page 105) for more details on this finely tuned control.

```
$ cobc -V
cobc (GnuCOBOL) 1.1.0
Copyright (C) 2001-2008 Keisuke Nishida / Roger While
Built    Oct 29 2008 16:32:02
Packaged Oct 28 2008 19:05:45 CET

$ cobc --help
Usage: cobc [options] file...

Options:
  --help                Display this message
  --version, -V         Display compiler version
  -v                    Display the programs invoked by the compiler
  -x                    Build an executable program
  -m                    Build a dynamically loadable module (default)
  -std=<dialect>        Compile for a specific dialect :
```

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```
                          cobol2002   Cobol 2002
                          cobol85     Cobol 85
                          ibm         IBM Compatible
                          mvs         MVS Compatible
                          bs2000      BS2000 Compatible
                          mf          Micro Focus Compatible
                          default     When not specified
                        See config/default.conf and config/*.conf
  -free                 Use free source format
  -fixed                Use fixed source format (default)
  -O, -O2, -Os          Enable optimization
  -g                    Produce debugging information in the output
  -debug                Enable all run-time error checking
  -o <file>             Place the output into <file>
  -b                    Combine all input files into a single
                        dynamically loadable module
  -E                    Preprocess only; do not compile, assemble or link
  -C                    Translation only; convert COBOL to C
  -S                    Compile only; output assembly file
  -c                    Compile and assemble, but do not link
  -t <file>             Generate and place a program listing into <file>
  -I <directory>        Add <directory> to copy/include search path
  -L <directory>        Add <directory> to library search path
  -l <lib>              Link the library <lib>
  -D <define>           Pass <define> to the C compiler
  -conf=<file>          User defined dialect configuration - See -std=
  --list-reserved       Display reserved words
  --list-intrinsics     Display intrinsic functions
  --list-mnemonics      Display mnemonic names
  -save-temps(=<dir>)   Save intermediate files (default current directory)
  -MT <target>          Set target file used in dependency list
  -MF <file>            Place dependency list into <file>
  -ext <extension>      Add default file extension

  -W                    Enable ALL warnings
  -Wall                 Enable all warnings except as noted below
  -Wobsolete            Warn if obsolete features are used
  -Warchaic             Warn if archaic features are used
  -Wredefinition        Warn incompatible redefinition of data items
  -Wconstant            Warn inconsistent constant
  -Wparentheses         Warn lack of parentheses around AND within OR
  -Wstrict-typing       Warn type mismatch strictly
  -Wimplicit-define     Warn implicitly defined data items
  -Wcall-params         Warn non 01/77 items for CALL params (NOT set with -Wall)
  -Wcolumn-overflow     Warn text after column 72, FIXED format (NOT set with -Wall)
  -Wterminator          Warn lack of scope terminator END-XXX (NOT set with -Wall)
  -Wtruncate            Warn possible field truncation (NOT set with -Wall)
  -Wlinkage             Warn dangling LINKAGE items (NOT set with -Wall)
  -Wunreachable         Warn unreachable statements (NOT set with -Wall)

  -ftrace               Generate trace code (Executed SECTION/PARAGRAPH)
  -ftraceall            Generate trace code (Executed SECTION/PARAGRAPH/STATEMENTS)
  -fsyntax-only         Syntax error checking only; don't emit any output
  -fdebugging-line      Enable debugging lines ('D' in indicator column)
  -fsource-location     Generate source location code (Turned on by -debug or -g)
  -fimplicit-init       Do automatic initialization of the Cobol runtime system
  -fsign-ascii          Numeric display sign ASCII (Default on ASCII machines)
```

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```
  -fsign-ebcdic         Numeric display sign EBCDIC (Default on EBCDIC machines)
  -fstack-check         PERFORM stack checking (Turned on by -debug or -g)
  -ffold-copy-lower     Fold COPY subject to lower case (Default no transformation)
  -ffold-copy-upper     Fold COPY subject to upper case (Default no transformation)
  -fnotrunc             Do not truncate binary fields according to PICTURE
  -ffunctions-all       Allow use of intrinsic functions without FUNCTION keyword
  -fmfcomment           '*' or '/' in column 1 treated as comment (FIXED only)
  -fnull-param          Pass extra NULL terminating pointers on CALL statements
```

3.8.1 For 2.0 that becomes

```
GnuCOBOL compiler for most COBOL dialects with lots of extensions

Usage: cobc [options]... file...

Options:
  -h, -help             display this help and exit
  -V, -version          display compiler version and exit
  -i, -info             display compiler information (build/environment)
  -v, -verbose          display compiler version and the commands
                        invoked by the compiler
  -vv, -verbose=2       like -v but additional pass verbose option
                        to assembler/compiler
  -vvv, -verbose=3      like -vv but additional pass verbose option
                        to linker
  -q, -brief            reduced displays, commands invoked not shown
  -###                 like -v but commands not executed
  -x                    build an executable program
  -m                    build a dynamically loadable module (default)
  -j [<args>], -job[=<args>]    run program after build, passing <args>
  -std=<dialect>        warnings/features for a specific dialect
                        <dialect> can be one of:
                        cobol2014, cobol2002, cobol85, default,
                        ibm, mvs, bs2000, mf, acu;
                        see configuration files in directory config
  -F, -free             use free source format
  -fixed                use fixed source format (default)
  -O, -O2, -Os          enable optimization
  -g                    enable C compiler debug / stack check / trace
  -d, -debug            enable all run-time error checking
  -o <file>             place the output into <file>
  -b                    combine all input files into a single
                        dynamically loadable module
  -E                    preprocess only; do not compile or link
  -C                    translation only; convert COBOL to C
  -S                    compile only; output assembly file
  -c                    compile and assemble, but do not link
  -T <file>             generate and place a wide program listing
  into <file>
  -t <file>             generate and place a program listing into <file>
  --tlines=<lines>      specify lines per page in listing, default = 55
  --no-symbols          specify no symbols in listing
  -P[=<dir or file>]    generate preprocessed program listing (.lst)
  -Xref                 generate cross reference through 'cobxref'
                        (V. Coen's 'cobxref' must be in path)
```

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```
  -I <directory>          add <directory> to copy/include search path
  -L <directory>          add <directory> to library search path
  -l <lib>                link the library <lib>
  -A <options>            add <options> to the C compile phase
  -Q <options>            add <options> to the C link phase
  -D <define>             define <define> for COBOL compilation
  -K <entry>              generate CALL to <entry> as static
  -conf=<file>            user-defined dialect configuration; see -std
  -list-reserved          display reserved words
  -list-intrinsics        display intrinsic functions
  -list-mnemonics         display mnemonic names
  -list-system            display system routines
  -save-temps[=<dir>]     save intermediate files
                          - default: current directory
  -ext <extension>        add file extension for resolving COPY

  -W                      enable all warnings
  -Wall                   enable most warnings (all except as noted below)
  -Wno-<warning>          disable warning enabled by -W or -Wall
  -Wno-unfinished         don't warn if unfinished features are used
                          - ALWAYS active
  -Wobsolete              warn if obsolete features are used
  -Warchaic               warn if archaic features are used
  -Wredefinition          warn incompatible redefinition of data items
  -Wconstant              warn inconsistent constant
  -Woverlap               warn overlapping MOVE items
  -Wpossible-overlap      warn MOVE items that may overlap depending on variables
                          - NOT set with -Wall
  -Wparentheses           warn lack of parentheses around AND within OR
  -Wstrict-typing         warn type mismatch strictly
  -Wimplicit-define       warn implicitly defined data items
  -Wcorresponding         warn CORRESPONDING with no matching items
  -Winitial-value         warn Initial VALUE clause ignored
  -Wprototypes            warn missing FUNCTION prototypes/definitions
  -Wcall-params           warn non 01/77 items for CALL params
                          - NOT set with -Wall
  -Wcolumn-overflow       warn text after program-text area, FIXED format
                          - NOT set with -Wall
  -Wterminator            warn lack of scope terminator END-XXX
                          - NOT set with -Wall
  -Wtruncate              warn possible field truncation
                          - NOT set with -Wall
  -Wlinkage               warn dangling LINKAGE items
                          - NOT set with -Wall
  -Wunreachable           warn unreachable statements
                          - NOT set with -Wall

  -fsign=[ASCII|EBCDIC] define display sign representation
                          - default: machine native
  -ffold-copy=[UPPER|LOWER]     fold COPY subject to value
                          - default: no transformation
  -ffold-call=[UPPER|LOWER]     fold PROGRAM-ID, CALL, CANCEL subject to value
                          - default: no transformation
  -fdefaultbyte=0..255  initialize fields without VALUE to decimal value
                          - default: initialize to picture
  -fintrinsics=[ALL|intrinsic function name(,name,...)] intrinsics to be used without␣
↪FUNCTION keyword
```

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```
  -ftrace               generate trace code
                        - executed SECTION/PARAGRAPH
  -ftraceall            generate trace code
                        - executed SECTION/PARAGRAPH/STATEMENTS
                        - turned on by -debug
  -fsyntax-only         syntax error checking only; don't emit any output
  -fdebugging-line      enable debugging lines
                        - 'D' in indicator column or floating >>D
  -fsource-location     generate source location code
                        - turned on by -debug/-g/-ftraceall
  -fimplicit-init       automatic initialization of the COBOL runtime system
  -fstack-check         PERFORM stack checking
                        - turned on by -debug or -g
  -fsyntax-extension    allow syntax extensions
                        - e.g. switch name SW1, etc.
  -fwrite-after         use AFTER 1 for WRITE of LINE SEQUENTIAL
                        - default: BEFORE 1
  -fmfcomment           '*' or '/' in column 1 treated as comment
                        - FIXED format only
  -facucomment          '$' in indicator area treated as '*',
                        '|' treated as floating comment
  -fnotrunc             allow numeric field overflow
                        - non-ANSI behaviour
  -fodoslide            adjust items following OCCURS DEPENDING
                        - requires implicit/explicit relaxed syntax
  -fsingle-quote        use a single quote (apostrophe) for QUOTE
                        - default: double quote
  -frecursive-check     check recursive program call
  -foptional-file       treat all files as OPTIONAL
                        - unless NOT OPTIONAL specified

  -ftab-width=1..12     set number of spaces that are asumed for tabs
  -ftext-column=72..255 set right margin for source (fixed format only)
  -fpic-length=<number> maximum number of characters allowed in the character-string
  -fword-length=1..61   maximum word-length for COBOL words / Programmer defined words
  -fliteral-length=<number>     maximum literal size in general
  -fnumeric-literal-length=1..38        maximum numeric literal size
  -fassign-clause=<value>       set way of interpreting ASSIGN
  -fbinary-size=<value> binary byte size - defines the allocated bytes according to␣
↪PIC
  -fbinary-byteorder=<value>    binary byte order
  -ffilename-mapping    resolve file names at run time using environment variables.
  -fpretty-display      alternate formatting of numeric fields
  -fbinary-truncate     numeric truncation according to ANSI
  -fcomplex-odo         allow complex OCCURS DEPENDING ON
  -findirect-redefines  allow REDEFINES to other than last equal level number
  -flarger-redefines-ok allow larger REDEFINES items
  -frelax-syntax-checks allow certain syntax variations (e.g. REDEFINES position)
  -fperform-osvs        exit point of any currently executing perform is recognized␣
↪if reached
  -fsticky-linkage      linkage-section items remain allocated between invocations
  -frelax-level-hierarchy       allow non-matching level numbers
  -fhostsign            allow hexadecimal value 'F' for NUMERIC test of signed PACKED␣
↪DECIMAL field
  -faccept-update       set WITH UPDATE clause as default for ACCEPT dest-item,␣
↪instead of WITH NO UPDATE
  -faccept-auto         set WITH AUTO clause as default for ACCEPT dest-item, instead␣
↪of WITH TAB
```

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```
  -fconsole-is-crt      assume CONSOLE IS CRT if not set otherwise
  -fprogram-name-redefinition   program names don't lead to a reserved identifier
  -fno-echo-means-secure        NO-ECHO hides input with asterisks like SECURE
  -fcomment-paragraphs=<support>        comment paragraphs in IDENTIFICATION DIVISION␣
↪(AUTHOR, DATE-WRITTEN, ...)
  -fmemory-size-clause=<support>        MEMORY-SIZE clause
  -fmultiple-file-tape-clause=<support> MULTIPLE-FILE-TAPE clause
  -flabel-records-clause=<support>      LABEL-RECORDS clause
  -fvalue-of-clause=<support>   VALUE-OF clause
  -fdata-records-clause=<support>       DATA-RECORDS clause
  -ftop-level-occurs-clause=<support>   OCCURS clause on top-level
  -fsynchronized-clause=<support>       SYNCHRONIZED clause
  -fgoto-statement-without-name=<support>       GOTO statement without name
  -fstop-literal-statement=<support>    STOP-LITERAL statement
  -fdebugging-line=<support>    DEBUGGING MODE and indicator 'D'
  -fuse-for-debugging=<support> USE FOR DEBUGGING
  -fpadding-character-clause=<support>  PADDING CHARACTER clause
  -fnext-sentence-phrase=<support>      NEXT SENTENCE phrase
  -feject-statement=<support>   EJECT statement
  -fentry-statement=<support>   ENTRY statement
  -fmove-noninteger-to-alphanumeric=<support>   move noninteger to alphanumeric
  -fodo-without-to=<support>    OCCURS DEPENDING ON without to
  -fsection-segments=<support>  section segments
  -falter-statement=<support>   ALTER statement
  -fcall-overflow=<support>     OVERFLOW clause for CALL
  -fnumeric-boolean=<support>   boolean literals (B'1010')
  -fhexadecimal-boolean=<support>       hexadecimal-boolean literals (BX'A')
  -fnational-literals=<support> national literals (N'UTF-16 string')
  -fhexadecimal-national-literals=<support>     hexadecimal-national literals (NX'265E
↪')
  -facucobol-literals=<support> ACUCOBOL-GT literals (#B #O #H #X)
  -fword-continuation=<support> continuation of COBOL words
  -fnot-exception-before-exception=<support>    NOT ON EXCEPTION before ON EXCEPTION
  -faccept-display-extensions=<support> extensions to ACCEPT and DISPLAY
  -frenames-uncommon-levels=<support>   RENAMES of 01-, 66- and 77-level items
  -fprogram-prototypes=<support>        CALL/CANCEL with program-prototype-name
  -freference-out-of-declaratives=<support>     references to sections not in␣
↪DECLARATIVES from within DECLARATIVES
        where <support> is one of the following:
        'ok', 'warning', 'archaic', 'obsolete', 'skip', 'ignore', 'error',
        'unconformable'
  -fnot-reserved=<word> word to be taken out of the reserved words list
  -freserved=<word>     word to be added to reserved words list
  -freserved=<word>:<alias>     word to be added to reserved words list as alias


Report bugs to: bug-gnucobol@gnu.org
or (preferably) use the issue tracker via the home page.
GnuCOBOL home page: <http://www.gnu.org/software/gnucobol/>
General help using GNU software: <http://www.gnu.org/gethelp/>
```

3.8.2 For reportwriter that becomes

```
prompt$ cobc --info
cobc (GnuCOBOL) 2.0.0
```

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```
Copyright (C) 2016 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
Written by Keisuke Nishida, Roger While, Ron Norman, Simon Sobisch, Edward
Hart
Built     Jun 15 2016 07:38:33
Packaged  Oct 25 2015 21:40:28 UTC
C version "5.2.1 20151010"

build information
build environment        : x86_64-pc-linux-gnu
CC                       : gcc
CPPFLAGS                 :
CFLAGS                   : -g -O0 -pipe -fsigned-char -Wall
                           -Wwrite-strings -Wmissing-prototypes
                           -Wno-format-y2k
LD                       : /usr/bin/ld -m elf_x86_64
LDFLAGS                  : -Wl,-z,relro,-z,now,-O1

GnuCOBOL information
COB_CC                   : gcc
COB_CFLAGS               : -I/usr/local/include -pipe
COB_LDFLAGS              :
  env: COB_LDFLAGS       : -Wl,--no-as-needed
COB_LIBS                 : -L/usr/local/lib -lcob -lm -lvbisam -lgmp
                           -lncurses -ldl
COB_CONFIG_DIR           : /usr/local/share/gnu-cobol/config
COB_COPY_DIR             : /usr/local/share/gnu-cobol/copy
COB_MSG_FORMAT           : GCC
COB_MODULE_EXT           : so
COB_EXEEXT               :
64bit-mode               : yes
BINARY-C-LONG            : 8 bytes
Extended screen I/O      : ncurses
Variable format          : 0
Sequential handler       : Internal
ISAM handler             : VBISAM

prompt$ cobc --help
GnuCOBOL compiler for most COBOL dialects with lots of extensions

usage: cobc [options]... file...

options:
  -h, -help             display this help and exit
  -V, -version          display compiler version and exit
  -i, -info             display compiler information (build/environment)
  -v, -verbose          display the commands invoked by the compiler
  -vv                   display compiler version and the commands
                        invoked by the compiler
  -x                    build an executable program
  -m                    build a dynamically loadable module (default)
  -j(=<args>), -job(=<args>) run job, with optional arguments passed to program/module
  -std=<dialect>        warnings/features for a specific dialect
                        <dialect> can be one of:
                        cobol2014, cobol2002, cobol85, default,
```

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```
                        ibm, mvs, bs2000, mf, acu;
                        see configuration files in directory config
  -F, -free             use free source format
  -fixed                use fixed source format (default)
  -O, -O2, -Os          enable optimization
  -g                    enable C compiler debug / stack check / trace
  -d, -debug            enable all run-time error checking
  -o <file>             place the output into <file>
  -b                    combine all input files into a single
                        dynamically loadable module
  -E                    preprocess only; do not compile or link
  -C                    translation only; convert COBOL to C
  -S                    compile only; output assembly file
  -c                    compile and assemble, but do not link
  -P(=<dir or file>)    generate preprocessed program listing (.lst)
  -Xref                 generate cross reference through 'cobxref'
                        (V. Coen's 'cobxref' must be in path)
  -I <directory>        add <directory> to copy/include search path
  -L <directory>        add <directory> to library search path
  -l <lib>              link the library <lib>
  -A <options>          add <options> to the C compile phase
  -Q <options>          add <options> to the C link phase
  -D <define>           define <define> for COBOL compilation
  -K <entry>            generate CALL to <entry> as static
  -conf=<file>          user defined dialect configuration - See -std=
  -cb_conf=<tag:value>  override configuration entry
  -list-reserved        display reserved words
  -list-intrinsics      display intrinsic functions
  -list-mnemonics       display mnemonic names
  -list-system          display system routines
  -save-temps(=<dir>)   save intermediate files
                        - default: current directory
  -ext <extension>      add default file extension

  -W                    enable ALL warnings
  -Wall                 enable all warnings except as noted below
  -Wno-<feature>        disable warning enabled by -W or -Wall
  -Wobsolete            warn if obsolete features are used
  -Warchaic             warn if archaic features are used
  -Wredefinition        warn incompatible redefinition of data items
  -Wconstant            warn inconsistent constant
  -Woverlap             warn overlapping MOVE items
  -Wparentheses         warn lack of parentheses around AND within OR
  -Wstrict-typing       warn type mismatch strictly
  -Wimplicit-define     warn implicitly defined data items
  -Wcorresponding       warn CORRESPONDING with no matching items
  -Wexternal-value      warn EXTERNAL item with VALUE clause
  -Wprototypes          warn missing FUNCTION prototypes/definitions
  -Wcall-params         warn non 01/77 items for CALL params
                        - NOT set with -Wall
  -Wcolumn-overflow     warn text after program-text area, FIXED format
                        - NOT set with -Wall
  -Wterminator          warn lack of scope terminator END-XXX
                        - NOT set with -Wall
  -Wtruncate            warn possible field truncation
                        - NOT set with -Wall
  -Wlinkage             warn dangling LINKAGE items
```

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```
                        - NOT set with -Wall
  -Wunreachable         warn unreachable statements
                        - NOT set with -Wall

  -fsign=<value>        define display sign representation
                        - ASCII or EBCDIC (default: machine native)
  -ffold-copy=<value>   fold COPY subject to value
                        - UPPER or LOWER (default: no transformation)
  -ffold-call=<value>   fold PROGRAM-ID, CALL, CANCEL subject to value
                        - UPPER or LOWER (default: no transformation)
  -fdefaultbyte=<value> initialize fields without VALUE to decimal value
                        - 0 to 255 (default: initialize to picture)
  -fintrinsics=<value>  intrinsics to be used without FUNCTION keyword
                        - ALL or intrinsic function name(,name,...)
  -ftrace               generate trace code
                        - executed SECTION/PARAGRAPH
  -ftraceall            generate trace code
                        - executed SECTION/PARAGRAPH/STATEMENTS
                        - turned on by -debug
  -fsyntax-only         syntax error checking only; don't emit any output
  -fdebugging-line      enable debugging lines
                        - 'D' in indicator column or floating >>D
  -fsource-location     generate source location code
                        - turned on by -debug/-g/-ftraceall
  -fimplicit-init       automatic initialization of the COBOL runtime system
  -fstack-check         PERFORM stack checking
                        - turned on by -debug or -g
  -fsyntax-extension    allow syntax extensions
                        - eg. switch name SW1, etc.
  -fwrite-after         use AFTER 1 for WRITE of LINE SEQUENTIAL
                        - default: BEFORE 1
  -fmfcomment           '*' or '/' in column 1 treated as comment
                        - FIXED format only
  -facucomment          '$' in indicator area treated as '*',
                        '|' treated as floating comment
  -fnotrunc             allow numeric field overflow
                        - non-ANSI behaviour
  -fodoslide            adjust items following OCCURS DEPENDING
                        - requires implicit/explicit relaxed syntax
  -fsingle-quote        use a single quote (apostrophe) for QUOTE
                        - default: double quote
  -frecursive-check     check recursive program call
  -frelax-syntax        relax syntax checking
                        - eg. REDEFINES position
  -foptional-file       treat all files as OPTIONAL
                        - unless NOT OPTIONAL specified


Report bugs to: bug-gnucobol@gnu.org or
use the preferred issue tracker via home page.
GnuCOBOL home page: <http://www.gnu.org/software/gnucobol/>
General help using GNU software: <http://www.gnu.org/gethelp/>
```

3.8.3 And with 3.0-rc

```
prompt$ cobc --info
cobc (GnuCOBOL) 3.0-dev.0
Copyright (C) 2018 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
Written by Keisuke Nishida, Roger While,
           Ron Norman, Simon Sobisch, Edward Hart
Built     Jun 14 2018 03:13:41
Packaged  Sep 30 2017 10:21:38 UTC
C version "6.3.1 20161221 (Red Hat 6.3.1-1)"

build information
build environment        : x86_64-pc-linux-gnu
CC                       : gcc
C version                : "6.3.1 20161221 (Red Hat 6.3.1-1)"
CPPFLAGS                 :
CFLAGS                   : -O2 -pipe -finline-functions -fsigned-char
                           -Wall -Wwrite-strings -Wmissing-prototypes
                           -Wno-format-y2k -U_FORTIFY_SOURCE
LD                       : /usr/bin/ld -m elf_x86_64
LDFLAGS                  : -Wl,-z,relro,-z,now,-O1

GnuCOBOL information
COB_CC                   : gcc
COB_CFLAGS               : -I/usr/local/include -Wno-unused
                           -fsigned-char -Wno-pointer-sign -pipe
  env: COB_CFLAGS        : -I/home/btiffin/clean/trunk
                           -I/home/btiffin/clean/trunk/libcob
                           -I/usr/local/include -Wno-unused
                           -fsigned-char -Wno-pointer-sign -pipe
COB_LDFLAGS              :
  env: COB_LDFLAGS       : -L/home/btiffin/clean/trunk/libcob/.libs
COB_LIBS                 : -L/usr/local/lib -lcob -lm -lvbisam -lgmp
                           -lncursesw -ldl
  env: COB_LIBS          : -L/home/btiffin/clean/trunk/libcob/.libs
                           -lcob -lm -lvbisam -lgmp -lncursesw -ldl
COB_CONFIG_DIR           : /usr/local/share/gnucobol/config
  env: COB_CONFIG_DIR    : /home/btiffin/clean/trunk/config
COB_COPY_DIR             : /usr/local/share/gnucobol/copy
  env: COB_COPY_DIR      : /home/btiffin/clean/trunk/copy
COB_MSG_FORMAT           : GCC
COB_OBJECT_EXT           : o
COB_MODULE_EXT           : so
COB_EXE_EXT              :
64bit-mode               : yes
BINARY-C-LONG            : 8 bytes
extended screen I/O      : ncursesw
variable format          : 0
sequential handler       : built-in
ISAM handler             : VBISAM
mathematical library     : GMP

prompt$ cobc --help
GnuCOBOL compiler for most COBOL dialects with lots of extensions
```

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```
Usage: cobc [options]... file...

Options:
  -h, -help             display this help and exit
  -V, -version          display compiler version and exit
  -i, -info             display compiler information (build/environment)
                        and exit
  -v, -verbose          display compiler version and the commands
                        invoked by the compiler
  -vv, -verbose=2       like -v but additional pass verbose option
                        to assembler/compiler
  -vvv, -verbose=3      like -vv but additional pass verbose option
                        to linker
  -q, -brief            reduced displays, commands invoked not shown
  -###                  like -v but commands not executed
  -x                    build an executable program
  -m                    build a dynamically loadable module (default)
  -j [<args>], -job[=<args>]    run program after build, passing <args>
  -std=<dialect>        warnings/features for a specific dialect
                        <dialect> can be one of:
                        default, cobol2014, cobol2002, cobol85, xopen,
                        ibm-strict, ibm, mvs-strict, mvs,
                        mf-strict, mf, bs2000-strict, bs2000,
                        acu-strict, acu, rm-strict, rm;
                        see configuration files in directory config
  -F, -free             use free source format
  -fixed                use fixed source format (default)
  -O, -O2, -O3, -Os     enable optimization
  -O0                   disable optimization
  -g                    enable C compiler debug / stack check / trace
  -d, -debug            enable all run-time error checking
  -o <file>             place the output into <file>
  -b                    combine all input files into a single
                        dynamically loadable module
  -E                    preprocess only; do not compile or link
  -C                    translation only; convert COBOL to C
  -S                    compile only; output assembly file
  -c                    compile and assemble, but do not link
  -T <file>             generate and place a wide program listing into <file>
  -t <file>             generate and place a program listing into <file>
  --tlines=<lines>      specify lines per page in listing, default = 55
  -P[=<dir or file>]    generate preprocessed program listing (.lst)
  -Xref                 specify cross reference in listing
  -I <directory>        add <directory> to copy/include search path
  -L <directory>        add <directory> to library search path
  -l <lib>              link the library <lib>
  -A <options>          add <options> to the C compile phase
  -Q <options>          add <options> to the C link phase
  -D <define>           define <define> for COBOL compilation
  -K <entry>            generate CALL to <entry> as static
  -conf=<file>          user-defined dialect configuration; see -std
  -list-reserved        display reserved words
  -list-intrinsics      display intrinsic functions
  -list-mnemonics       display mnemonic names
  -list-system          display system routines
  -save-temps[=<dir>]   save intermediate files
```

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```
                        * default: current directory
  -ext <extension>      add file extension for resolving COPY

Warning options:
  -W                    enable all warnings
  -Wall                 enable most warnings (all except as noted below)
  -Wno-<warning>        disable warning enabled by -W or -Wall
  -Wno-unfinished       do not warn if unfinished features are used
                        * ALWAYS active
  -Wno-pending          do not warn if pending features are mentioned
                        * ALWAYS active
  -Wobsolete            warn if obsolete features are used
  -Warchaic             warn if archaic features are used
  -Wredefinition        warn about incompatible redefinition of data items
  -Wtruncate            warn about field truncation from constant assignments
  -Wpossible-truncate   warn about possible field truncation
                        * NOT set with -Wall
  -Woverlap             warn about overlapping MOVE of items
  -Wpossible-overlap    warn about MOVE of items that may overlap depending on␣
↪variables
                        * NOT set with -Wall
  -Wparentheses         warn about lack of parentheses around AND within OR
  -Wstrict-typing       warn strictly about type mismatch
  -Wimplicit-define     warn about implicitly defined data items
  -Wcorresponding       warn about CORRESPONDING with no matching items
  -Winitial-value       warn if initial VALUE clause is ignored
  -Wprototypes          warn about missing FUNCTION prototypes/definitions
  -Warithmetic-osvs     warn if arithmetic expression precision has changed
  -Wcall-params         warn about non 01/77 items for CALL parameters
                        * NOT set with -Wall
  -Wconstant-expression  warn about expressions that always resolve to true/false
  -Wcolumn-overflow     warn about text after program-text area, FIXED format
                        * NOT set with -Wall
  -Wterminator          warn about lack of scope terminator END-XXX
                        * NOT set with -Wall
  -Wlinkage             warn about dangling LINKAGE items
                        * NOT set with -Wall
  -Wunreachable         warn about likely unreachable statements
                        * NOT set with -Wall
  -Wno-dialect          do not warn about dialect specific issues
                        * ALWAYS active
  -Wothers              do not warn about different issues
                        * ALWAYS active
  -Werror               treat all warnings as errors
  -Werror=<warning>     treat specified <warning> as error

Compiler options:
  -fsign=[ASCII|EBCDIC] define display sign representation
                        * default: machine native
  -ffold-copy=[UPPER|LOWER]     fold COPY subject to value
                        * default: no transformation
  -ffold-call=[UPPER|LOWER]     fold PROGRAM-ID, CALL, CANCEL subject to value
                        * default: no transformation
  -fdefaultbyte=<value> initialize fields without VALUE to value
                        * decimal 0..255 or any quoted character
                        * default: initialize to picture
  -fmax-errors=<number> maximum number of errors to report before
```

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```
                        compilation is aborted
                        * default: 100
  -fdump=<scope>        dump data fields on abort, <scope> may be
                        a combination of: ALL, WS, LS, RD, FD, SC
  -fintrinsics=[ALL|intrinsic function name(,name,...)]
                        intrinsics to be used without FUNCTION keyword

  -fno-recursive_check  disable check of recursive program call;
                        effectively compiling as RECURSIVE program
  -ftrace               generate trace code
                        * scope: executed SECTION/PARAGRAPH
  -ftraceall            generate trace code
                        * scope: executed SECTION/PARAGRAPH/STATEMENTS
                        * turned on by -debug
  -fsyntax-only         syntax error checking only; don't emit any output
  -fdebugging-line      enable debugging lines
                        * 'D' in indicator column or floating >>D
  -fsource-location     generate source location code
                        * turned on by -debug/-g/-ftraceall
  -fimplicit-init       automatic initialization of the COBOL runtime system
  -fstack-check         PERFORM stack checking
                        * turned on by -debug or -g
  -fwrite-after         use AFTER 1 for WRITE of LINE SEQUENTIAL
                        * default: BEFORE 1
  -fmfcomment           '*' or '/' in column 1 treated as comment
                        * FIXED format only
  -facucomment          '$' in indicator area treated as '*',
                        '|' treated as floating comment
  -fnotrunc             allow numeric field overflow
                        * non-ANSI behaviour
  -fodoslide            adjust items following OCCURS DEPENDING
                        * implies -fcomplex-odo
  -fsingle-quote        use a single quote (apostrophe) for QUOTE
                        * default: double quote
  -foptional-file       treat all files as OPTIONAL
                        * unless NOT OPTIONAL specified
  -fno-theader           suppress all headers and output of compilation
                         options from listing while keeping page breaks
  -fno-tsource           suppress source from listing
  -fno-tmessages         suppress warning and error summary from listing
  -ftsymbols             specify symbols in listing

Compiler dialect configuration options:
  -freserved-words=<value>      use of complete/fixed reserved words
  -ftab-width=1..12      set number of spaces that are asumed for tabs
  -ftext-column=72..255  set right margin for source (fixed format only)
  -fpic-length=<number>  maximum number of characters allowed in the PICTURE␣
↪character-string
  -fword-length=1..61    maximum word-length for COBOL (= programmer defined) words
  -fliteral-length=<number>     maximum literal size in general
  -fnumeric-literal-length=1..38        maximum numeric literal size
  -fassign-clause=<value>       set way of interpreting ASSIGN
  -fbinary-size=<value>  binary byte size - defines the allocated bytes according to␣
↪PIC
  -fbinary-byteorder=<value>    binary byte order
  -fscreen-section-rules=<value>        which compiler's rules to apply to SCREEN␣
↪SECTION item clauses
```

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```
  -ffilename-mapping     resolve file names at run time using environment variables.
  -fpretty-display       alternate formatting of numeric fields
  -fbinary-truncate      numeric truncation according to ANSI
  -fcomplex-odo          allow complex OCCURS DEPENDING ON
  -findirect-redefines   allow REDEFINES to other than last equal level number
  -flarger-redefines-ok  allow larger REDEFINES items
  -frelax-syntax-checks  allow certain syntax variations (e.g. REDEFINES position)
  -frelax-level-hierarchy       allow non-matching level numbers
  -fselect-working       require ASSIGN USING items to be in WORKING-STORAGE
  -fsticky-linkage       LINKAGE-SECTION items remain allocated between invocations
  -fmove-ibm             MOVE operates as on IBM (left to right, byte by byte)
  -fperform-osvs         exit point of any currently executing perform is recognized␣
↪if reached
  -farithmetic-osvs      limit precision in intermediate results to precision of␣
↪final result (less accurate)
  -fconstant-folding     evaluate constant expressions at compile time
  -fhostsign             allow hexadecimal value 'F' for NUMERIC test of signed␣
↪PACKED DECIMAL field
  -fprogram-name-redefinition   program names don't lead to a reserved identifier
  -faccept-update        set WITH UPDATE clause as default for ACCEPT dest-item,␣
↪instead of WITH NO UPDATE
  -faccept-auto          set WITH AUTO clause as default for ACCEPT dest-item,␣
↪instead of WITH TAB
  -fconsole-is-crt       assume CONSOLE IS CRT if not set otherwise
  -fno-echo-means-secure        NO-ECHO hides input with asterisks like SECURE
  -fline-col-zero-default       assume the first item in a field DISPLAY goes at LINE␣
↪0 COL 0, not LINE 1 COL 1
  -fdisplay-special-fig-consts  special behaviour of DISPLAY SPACE/ALL X'01'/ALL X'02
↪'/ALL X'07'
  -fbinary-comp-1        COMP-1 is a 16-bit signed integer
  -fmove-non-numeric-lit-to-numeric-is-zero     imply zero in move of non-numeric␣
↪literal to numeric items
  -fcomment-paragraphs=<support>        comment paragraphs in IDENTIFICATION DIVISION␣
↪(AUTHOR, DATE-WRITTEN, ...)
  -fmemory-size-clause=<support>        MEMORY-SIZE clause
  -fmultiple-file-tape-clause=<support> MULTIPLE-FILE-TAPE clause
  -flabel-records-clause=<support>      LABEL-RECORDS clause
  -fvalue-of-clause=<support>   VALUE-OF clause
  -fdata-records-clause=<support>       DATA-RECORDS clause
  -ftop-level-occurs-clause=<support>   OCCURS clause on top-level
  -fsynchronized-clause=<support>       SYNCHRONIZED clause
  -fgoto-statement-without-name=<support>       GOTO statement without name
  -fstop-literal-statement=<support>    STOP-literal statement
  -fstop-identifier-statement=<support> STOP-identifier statement
  -fdebugging-mode=<support>    DEBUGGING MODE and debugging indicator
  -fuse-for-debugging=<support> USE FOR DEBUGGING
  -fpadding-character-clause=<support>  PADDING CHARACTER clause
  -fnext-sentence-phrase=<support>      NEXT SENTENCE phrase
  -flisting-statements=<support>        listing-directive statements EJECT, SKIP1,␣
↪SKIP2, SKIP3
  -ftitle-statement=<support>   listing-directive statement TITLE
  -fentry-statement=<support>   ENTRY statement
  -fmove-noninteger-to-alphanumeric=<support>   move noninteger to alphanumeric
  -fmove-figurative-constant-to-numeric=<support>       move figurative constants to␣
↪numeric
  -fmove-figurative-space-to-numeric=<support>  move figurative constant SPACE to␣
↪numeric
```

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```
  -fmove-figurative-quote-to-numeric=<support>  move figurative constant QUOTE to␣
↪numeric
  -fodo-without-to=<support>    OCCURS DEPENDING ON without to
  -fsection-segments=<support>  section segments
  -falter-statement=<support>   ALTER statement
  -fcall-overflow=<support>     OVERFLOW clause for CALL
  -fnumeric-boolean=<support>   boolean literals (B'1010')
  -fhexadecimal-boolean=<support>       hexadecimal-boolean literals (BX'A')
  -fnational-literals=<support> national literals (N'UTF-16 string')
  -fhexadecimal-national-literals=<support>     hexadecimal-national literals (NX'265E
↪')
  -facu-literals=<support>      ACUCOBOL-GT literals (#B #O #H #X)
  -fword-continuation=<support> continuation of COBOL words
  -fnot-exception-before-exception=<support>    NOT ON EXCEPTION before ON EXCEPTION
  -faccept-display-extensions=<support> extensions to ACCEPT and DISPLAY
  -frenames-uncommon-levels=<support>   RENAMES of 01-, 66- and 77-level items
  -fsymbolic-constant=<support> constants defined in SPECIAL-NAMES
  -fconstant-78=<support>       constant with level 78 item (note: has left to right␣
↪precedence in expressions)
  -fconstant-01=<support>       constant with level 01 CONSTANT AS/FROM item
  -fperform-varying-without-by=<support>        PERFORM VARYING without BY phrase␣
↪(implies BY 1)
  -fprogram-prototypes=<support>        CALL/CANCEL with program-prototype-name
  -freference-out-of-declaratives=<support>     references to sections not in␣
↪DECLARATIVES from within DECLARATIVES
  -fnumeric-value-for-edited-item=<support>     numeric literals in VALUE clause of␣
↪numeric-edited items
  -fincorrect-conf-sec-order=<support>  incorrect order of CONFIGURATION SECTION␣
↪paragraphs
  -fdefine-constant-directive=<support> allow >> DEFINE CONSTANT var AS literal
  -ffree-redefines-position=<support>   REDEFINES clause not following entry-name in␣
↪definition
  -frecord-delimiter=<support>  RECORD DELIMITER clause
  -fsequential-delimiters=<support>     BINARY-SEQUENTIAL and LINE-SEQUENTIAL phrases␣
↪in RECORD DELIMITER
  -frecord-delim-with-fixed-recs=<support>      RECORD DELIMITER clause on file with␣
↪fixed-length records
  -fmissing-statement=<support> missing statement (e.g. empty IF / PERFORM)
  -fzero-length-literals=<support>      zero-length literals, e.g. '' and ""
        where <support> is one of the following:
        'ok', 'warning', 'archaic', 'obsolete', 'skip', 'ignore', 'error',
↪'unconformable'
  -fnot-reserved=<word>  word to be taken out of the reserved words list
  -freserved=<word>      word to be added to reserved words list
  -freserved=<word>:<alias>     word to be added to reserved words list as alias
  -fnot-register=<word>  special register to disable
  -fregister=<word>      special register to enable


Report bugs to: bug-gnucobol@gnu.org
or (preferably) use the issue tracker via the home page.
GnuCOBOL home page: <http://www.gnu.org/software/gnucobol/>
General help using GNU software: <http://www.gnu.org/gethelp/>
```

3.8.4 A note on -A and -Q

The -A and -Q switches can get a bit tricky. These pass options on to the C compiler and some escaping is sometimes necessary.

For example: To pass a defined symbol all the way through to the Assembly layer you could use:

```
cobc -xjgv -debug -A '-Wa\,--defsym,DEBUG=1' cpuid.cob vendor.s brand.s negate.s
```

to inform the compiler toolchain to pass the DEBUG=1 option to `gcc`, which would then pass the option to `as`, as in:

```
Command line:   cobc -xjgv -debug -A -Wa\,--defsym,DEBUG=1 cpuid.cob vendor.s brand.s␣
↪negate.s
Preprocessing:  cpuid.cob -> cpuid.i
Return status:  0
Parsing:        cpuid.i (cpuid.cob)
Return status:  0
Translating:    cpuid.i -> cpuid.c (cpuid.cob)
Executing:      gcc -std=gnu99 -c -I/usr/local/include -pipe -Wno-unused
                -fsigned-char -Wno-pointer-sign -g -Wa\,--defsym,DEBUG=1 -o
                "/tmp/cob8643_0.o" "cpuid.c"
Return status:  0
Executing:      gcc -std=gnu99 -c -I/usr/local/include -pipe -Wno-unused
                -fsigned-char -Wno-pointer-sign -g -Wa\,--defsym,DEBUG=1 -fPIC
                -DPIC -o "/tmp/cob8643_1.o" "vendor.s"
Return status:  0
Executing:      gcc -std=gnu99 -c -I/usr/local/include -pipe -Wno-unused
                -fsigned-char -Wno-pointer-sign -g -Wa\,--defsym,DEBUG=1 -fPIC
                -DPIC -o "brand.o" "brand.s"
Return status:  0
Executing:      gcc -std=gnu99 -c -I/usr/local/include -pipe -Wno-unused
                -fsigned-char -Wno-pointer-sign -g -Wa\,--defsym,DEBUG=1 -fPIC
                -DPIC -o "negate.o" "negate.s"
Return status:  0
Executing:      gcc -std=gnu99 -Wl,--export-dynamic -o "cpuid"
                "/tmp/cob8643_0.o" "/tmp/cob8643_1.o" "brand.o" "negate.o"
                -L/usr/local/lib -lcob -lm -lvbisam -lgmp -lncursesw -ldl
Return status:  0

Executing:      ./cpuid
Vendor: AuthenticAMD, with highest CPUID function: 13
CPUID normal maximum  : 0000000000000000013
Processor Brand string: AMD A10-5700 APU with Radeon(tm) HD Graphics
Number: 7fffffe2, Address: 0x6031e0
Number: 8000001e, Address: 0x6031e0
CPUID extended maximum: 0000000002147483678, 0x8000001E
Return status:  0
```

In this case the assembler support files included these lines

```
.ifdef DEBUG
# prep the printf call, args are rdi, rsi, rdx and rax
    movq    $msg, %rdi
    movl    %edx, %esi
    movq    8(%rsp), %rdx
    xorb    %al,%al
    call    printf
.endif
```

with conditional assembly directives that produced the:

```
Number: 7fffffe2, Address: 0x6031e0
Number: 8000001e, Address: 0x6031e0
```

output lines during the execution of cpuid, by assembling in calls to `printf`. In this case ALL the assembled files are getting the DEBUG=1 definition, and finer control would mean splitting up the `cobc` command into separate steps, if that was not wanted in some of the other assembler files.

3.9 What dialects are supported by GnuCOBOL?

Using the `std=<dialect>` compiler option, GnuCOBOL can be configured to compile using specific historical COBOL compiler features and quirks.

Supported dialects include:

- default
- acu
- cobol85
- cobol2002
- cobol2014
- ibm
- mvs
- mf
- bs2000

In 3.0-rc:

- acu
- acu-strict
- bs2000
- bs2000-strict
- cobol2002
- cobol2014
- cobol85
- default
- ibm
- ibm-strict
- mf
- mf-strict
- mvs
- mvs-strict
- rm

- rm-strict
- xopen

For details on what options and switches are used to support these dialect compiles, see the `config/` directory of your GnuCOBOL installation. For Debian GNU/Linux, that will be `/usr/share/open-cobol/config/` if you used APT to install a GnuCOBOL package or `/usr/local/share/open-cobol/config/` after a build from the source archive. Or, `/usr/share/gnucobol/config` for packages from the GnuCOBOL versions of the source tree, as they become available.

For example: the *bs2000.conf* file restricts data representations to 2, 4 or 8 byte binary while *mf.conf* allows data representations from 1 thru 8 bytes. *cobol85.conf* allows debugging lines, *cobol2002.conf* configures the compiler to warn that this feature is obsolete.

The *-strict* dialect options are configured to be restrictive on supported reserved word use. Use these options to help ensure your source code will compile with other compilers. Use the non strict versions to assist in porting code from other compilers and have them work as expected in terms of data layouts but still allow GnuCOBOL features and reserved word use that may not be part of the actual dialect.

3.9.1 Supported Literal values

GnuCOBOL strives to be a useful COBOL compiler. By supporting features provided by other compilers, there are some extensions in GnuCOBOL that will not be in the COBOL standards document. GnuCOBOL does not claim any level of conformance with any official COBOL specifications, but does strive to be useful.

The `cobc` compiler supports:

```
DISPLAY B#101                          *> base 2 numeric literal
DISPLAY O#17777777777777777777        *> base 8 numeric literal
DISPLAY X#ffffffffffffffff             *> base 16 numeric literal
DISPLAY H#ffffffffffffffff             *> base 16 numeric literal


DISPLAY B"000001010"                   *> numeric as base 2
DISPLAY BX"00001010"                   *> string literal in base 2
DISPLAY H"DECAFBAD"                    *> numeric as base 16

DISPLAY N"ABCDE"                       *> 16bit character National
DISPLAY NX"20304050"                   *> 16bit National in base 16

DISPLAY L"ABCDE"                       *> L String literal??

DISPLAY "ABC" & "DEF"                  *> string literal concatenation
DISPLAY X"0a00"                        *> string as base 16 pairs
   MOVE Z"C-string" TO add-zero-byte *> nul byte suffix literal
```

3.10 What extensions are used if cobc is called with/without "-ext" for COPY?

From Roger on opencobol.org

```
In the following order -
CPY, CBL, COB, cpy, cbl, cob and finally with no extension.
```

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```
User specified extensions (in the order as per command line) are inspected
PRIOR to the above defaults.

ie. They take precedence.
```

From Simon on SourceForge

```
The standard extensions for copybooks are (in the given order):

    no extension
    CPY
    CBL
    COB
    cpy
    cbl
    cob

Given

    COBCPY=/globdir1:../globdir2

and a command line with

    "-I/mydir1 -I ../mydir2 -e myext"

and the standard installation path for COB_COPY_DIR

    /usr/local/share/gnu-cobol/config

with the statement "COPY mybook." The following files are checked, in the
following order (relative to current file)

    mybook
    mybook.myext
    mybook.CPY
    mybook.CBL
    mybook.COB
    mybook with lowercase standard extensions (cpy, cbl, cob)
    /mydir1/mybook
    /mydir1/mybook.myext
    /mydir1/mybook.CPY
    /mydir1/mybook.CBL
    /mydir1/mybook with other standard extensions
    ../mydir2/mybook
    ../mydir2/mybook.myext
    ../mydir2/mybook.CPY
    ../mydir2/mybook.CBL
    ../mydir2/mybook with other standard extensions
    /globdir1/mybook
    /globdir1/mybook.myext
    /globdir1/mybook.CPY
    /globdir1/mybook.CBL
    /globdir1/mybook with other standard extensions
    ../globdir2/mybook
    ../globdir2/mybook.myext
    ../globdir2/mybook.CPY
    ../globdir2/mybook.CBL
```

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```
    ../globdir2/mybook with other standard extensions
    /usr/local/share/gnu-cobol/copy/mybook
    /usr/local/share/gnu-cobol/copy/mybook.myext
    /usr/local/share/gnu-cobol/copy/mybook.CPY
    /usr/local/share/gnu-cobol/copy/mybook.CBL
    /usr/local/share/gnu-cobol/copy/mybook with other standard extensions

If all these 64 files are not found you'll see

    myprog.cob:line: Error: mybook: file not found
```

The `/usr/local/share/gnu-cobol` is relative to the installation prefix. It might be `/usr/share/gnu-cobol` or other system directory, and can be set during `./configure` when building GnuCOBOL from source.

3.11 What are the GnuCOBOL compile time configuration files?

To assist in the support of the various existent COBOL compilers, GnuCOBOL reads configuration files controlling various aspects of a compile pass.

Each supported dialect will also have a *.conf* file in the `config/` sub-directory of its installation. For Debian GNU/Linux, these will be in `/usr/share/open-cobol/config/` or `/usr/local/share/open-cobol/config` under default package and default *make* conditions.

For example, the default configuration, *default.conf* is:

```
# COBOL compiler configuration                                    -*- sh -*-

# Value: any string
name: "GnuCOBOL"

# Value: int
tab-width: 8
text-column: 72

# Value: `cobol2002', `mf', `ibm'
#
assign-clause: mf

# If yes, file names are resolved at run time using environment variables.
# For example, given ASSIGN TO "DATAFILE", the actual file name will be
#  1. the value of environment variable `DD_DATAFILE' or
#  2. the value of environment variable `dd_DATAFILE' or
#  3. the value of environment variable `DATAFILE' or
#  4. the literal "DATAFILE"
# If no, the value of the assign clause is the file name.
#
# Value: `yes', `no'
filename-mapping: yes

# Value: `yes', `no'
pretty-display: yes

# Value: `yes', `no'
auto-initialize: yes
```

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```
# Value: `yes', `no'
complex-odo: no

# Value: `yes', `no'
indirect-redefines: no

# Value:         signed  unsigned  bytes
#                ------  --------  -----
# `2-4-8'        1 -  4                2
#                5 -  9                4
#               10 - 18                8
#
# `1-2-4-8'      1 -  2                1
#                3 -  4                2
#                5 -  9                4
#               10 - 18                8
#
# `1--8'         1 -  2    1 -  2      1
#                3 -  4    3 -  4      2
#                5 -  6    5 -  7      3
#                7 -  9    8 -  9      4
#               10 - 11   10 - 12      5
#               12 - 14   13 - 14      6
#               15 - 16   15 - 16      7
#               17 - 18   17 - 18      8
binary-size: 1-2-4-8

# Value: `yes', `no'
binary-truncate: yes

# Value: `native', `big-endian'
binary-byteorder: big-endian

# Value: `yes', `no'
larger-redefines-ok: no

# Value: `yes', `no'
relaxed-syntax-check: no

# Perform type OSVS - If yes, the exit point of any currently executing perform
# is recognized if reached.
# Value: `yes', `no'
perform-osvs: no

# If yes, non-parameter linkage-section items remain allocated
# between invocations.
# Value: `yes', `no'
sticky-linkage: no

# If yes, allow non-matching level numbers
# Value: `yes', `no'
relax-level-hierarchy: no

# not-reserved:
# Value: Word to be taken out of the reserved words list
# (case independent)
```

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```
# Dialect features
# Value: `ok', `archaic', `obsolete', `skip', `ignore', `unconformable'
author-paragraph:                       obsolete
memory-size-clause:                       obsolete
multiple-file-tape-clause:                obsolete
label-records-clause:                obsolete
value-of-clause:                        obsolete
data-records-clause:                obsolete
top-level-occurs-clause:                skip
synchronized-clause:                ok
goto-statement-without-name:        obsolete
stop-literal-statement:                obsolete
debugging-line:                        obsolete
padding-character-clause:                obsolete
next-sentence-phrase:                archaic
eject-statement:                        skip
entry-statement:                        obsolete
move-noninteger-to-alphanumeric:    error
odo-without-to:                        ok
```

3.11.1 reportwriter default.conf

```
# GnuCOBOL compiler configuration
#
# Copyright (C) 2001,2002,2003,2004,2005,2006,2007 Keisuke Nishida
# Copyright (C) 2007-2012 Roger While
#
# This file is part of GnuCOBOL.
#
# The GnuCOBOL compiler is free software: you can redistribute it
# and/or modify it under the terms of the GNU General Public License
# as published by the Free Software Foundation, either version 3 of the
# License, or (at your option) any later version.
#
# GnuCOBOL is distributed in the hope that it will be useful,
# but WITHOUT ANY WARRANTY; without even the implied warranty of
# MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
# GNU General Public License for more details.
#
# You should have received a copy of the GNU General Public License
# along with GnuCOBOL.  If not, see <http://www.gnu.org/licenses/>.


# Value: any string
name: "GnuCOBOL"

# Value: enum
standard-define                 0
#        CB_STD_OC = 0,
#        CB_STD_MF,
#        CB_STD_IBM,
#        CB_STD_MVS,
#        CB_STD_BS2000,
#        CB_STD_85,
```

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```
#        CB_STD_2002

# Value: int
tab-width:                      8
text-column:                    72

# Value: 'mf', 'ibm'
#
assign-clause:                  mf

# If yes, file names are resolved at run time using
# environment variables.
# For example, given ASSIGN TO "DATAFILE", the file name will be
#  1. the value of environment variable 'DD_DATAFILE' or
#  2. the value of environment variable 'dd_DATAFILE' or
#  3. the value of environment variable 'DATAFILE' or
#  4. the literal "DATAFILE"
# If no, the value of the assign clause is the file name.
#
filename-mapping:               yes

# Alternate formatting of numeric fields
pretty-display:                 yes

# Allow complex OCCURS DEPENDING ON
complex-odo:                    no

# Allow REDEFINES to other than last equal level number
indirect-redefines:             no

# Binary byte size - defines the allocated bytes according to PIC
# Value:         signed  unsigned  bytes
#                ------  --------  -----
# '2-4-8'         1 -  4    same        2
#                 5 -  9    same        4
#                10 - 18    same        8
#
# '1-2-4-8'       1 -  2    same        1
#                 3 -  4    same        2
#                 5 -  9    same        4
#                10 - 18    same        8
#
# '1--8'          1 -  2    1 -  2      1
#                 3 -  4    3 -  4      2
#                 5 -  6    5 -  7      3
#                 7 -  9    8 -  9      4
#                10 - 11   10 - 12      5
#                12 - 14   13 - 14      6
#                15 - 16   15 - 16      7
#                17 - 18   17 - 18      8
#
binary-size:                    1-2-4-8

# Numeric truncation according to ANSI
binary-truncate:                yes

# Binary byte order
```

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```
# Value: 'native', 'big-endian'
binary-byteorder:               big-endian

# Allow larger REDEFINES items
larger-redefines-ok:            no

# Allow certain syntax variations (eg. REDEFINES position)
relaxed-syntax-check:           no

# Perform type OSVS - If yes, the exit point of any currently
# executing perform is recognized if reached.
perform-osvs:                   no

# If yes, linkage-section items remain allocated
# between invocations.
sticky-linkage:                 no

# If yes, allow non-matching level numbers
relax-level-hierarchy:          no

# If yes, allow reserved words from the 85 standard
cobol85-reserved:               no

# Allow Hex 'F' for NUMERIC test of signed PACKED DECIMAL field
hostsign:                       no

# not-reserved:
# Value: Word to be taken out of the reserved words list
# (case independent)
# Words that are in the (proposed) standard but may conflict

# Dialect features
# Value: 'ok', 'archaic', 'obsolete', 'skip', 'ignore', 'unconformable'

alter-statement:                        obsolete
author-paragraph:                       obsolete
data-records-clause:                    obsolete
debugging-line:                         obsolete
eject-statement:                        skip
entry-statement:                        obsolete
goto-statement-without-name:            obsolete
label-records-clause:                   obsolete
memory-size-clause:                     obsolete
move-noninteger-to-alphanumeric:        error
multiple-file-tape-clause:              obsolete
next-sentence-phrase:                   archaic
odo-without-to:                         ok
padding-character-clause:               obsolete
section-segments:                       ignore
stop-literal-statement:                 obsolete
synchronized-clause:                    ok
top-level-occurs-clause:                ok
value-of-clause:                        obsolete
```

3.11.2 differences with ibm.conf

```
$ diff -u config/default.conf config/ibm.conf
--- config/default.conf 2014-02-21 14:29:56.154806798 -0500
+++ config/ibm.conf     2014-02-21 14:29:56.159806822 -0500
@@ -20,10 +20,10 @@


 # Value: any string
-name: "GnuCOBOL"
+name: "IBM COBOL"

 # Value: enum
-standard-define                        0
+standard-define                        2
 #        CB_STD_OC = 0,
 #        CB_STD_MF,
 #        CB_STD_IBM,
@@ -38,7 +38,7 @@

 # Value: 'mf', 'ibm'
 #
-assign-clause:                 mf
+assign-clause:                 ibm

 # If yes, file names are resolved at run time using
 # environment variables.
@@ -52,13 +52,13 @@
 filename-mapping:              yes

 # Alternate formatting of numeric fields
-pretty-display:                        yes
+pretty-display:                        no

 # Allow complex OCCURS DEPENDING ON
-complex-odo:                   no
+complex-odo:                   yes

 # Allow REDEFINES to other than last equal level number
-indirect-redefines:            no
+indirect-redefines:            yes

 # Binary byte size - defines the allocated bytes according to PIC
 # Value:         signed  unsigned  bytes
@@ -81,10 +81,10 @@
 #               15 - 16   15 - 16      7
 #               17 - 18   17 - 18      8
 #
-binary-size:                   1-2-4-8
+binary-size:                   2-4-8

 # Numeric truncation according to ANSI
-binary-truncate:               yes
+binary-truncate:               no

 # Binary byte order
 # Value: 'native', 'big-endian'
```

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```
@@ -98,20 +98,20 @@

 # Perform type OSVS - If yes, the exit point of any currently
 # executing perform is recognized if reached.
-perform-osvs:                 no
+perform-osvs:                 yes

 # If yes, linkage-section items remain allocated
 # between invocations.
-sticky-linkage:                       no
+sticky-linkage:                       yes

 # If yes, allow non-matching level numbers
-relax-level-hierarchy:        no
+relax-level-hierarchy:        yes

 # If yes, allow reserved words from the 85 standard
 cobol85-reserved:             no

 # Allow Hex 'F' for NUMERIC test of signed PACKED DECIMAL field
-hostsign:                     no
+hostsign:                     yes

 # not-reserved:
 # Value: Word to be taken out of the reserved words list
@@ -125,8 +125,8 @@
 author-paragraph:                     obsolete
 data-records-clause:                  obsolete
 debugging-line:                               obsolete
-eject-statement:                      skip
-entry-statement:                      obsolete
+eject-statement:                      ok
+entry-statement:                      ok
 goto-statement-without-name:          obsolete
 label-records-clause:                 obsolete
 memory-size-clause:                   obsolete
@@ -138,5 +138,5 @@
 stop-literal-statement:                       obsolete
 synchronized-clause:                  ok
-top-level-occurs-clause:              ok
+top-level-occurs-clause:              skip
 value-of-clause:                      obsolete
```

3.12 Does GnuCOBOL work with make?

Absolutely. Very well, but no built in rules for GNU `make` *yet*.

Makefile command entries, (after the rule, **commands are normally preceded by TAB, not spaces**, but for the sake of this FAQ, a different RECIPEPREFIX is used to allow easier copy'n'paste from the web browser).

A sample (*unsophisticated*) `makefile`

```
# Makefile for the GnuCOBOL FAQ
# Brian Tiffin, Modified: 2015-11-14/06:58-0500
```

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```
# Dedicated to the public domain, all rights waived
.RECIPEPREFIX = >

# default options, note that -g will leave intermediate files
COBCOPTS = -W -g -debug

# filenames to cleanup
COBCCLEAN = $*.c $*.s $*.i $*.c.h $*.c.l* $*.so $*.html $*

# Simple GnuCOBOL rules.  Customize to taste,
# create an executable
%: %.cob
> cobc $(COBCOPTS) -x $^ -o $@

# create an executable, and run it
%.run: %.cob
> cobc $(COBCOPTS) -xj $^ -o $@

# create an executable, and mark date-compiled
#%.mark: %.cob
#> sed -i 's#date-compiled\..*$$#date-compiled\. '\
#"$$(date +%Y-%m-%d/%H:%M%z)"'\.#' $^
#> cobc $(COBCOPTS) -x $^ -o $@

# create a dynamic module
%.so: %.cob
> cobc $(COBCOPTS) -m $^ -o $@

# create a linkable object
%.o: %.cob
> cobc $(COBCOPTS) -c $^ -o $@

# generate C code
%.c: %.cob
> cobc $(COBCOPTS) -C $^

# generate assembly
%.s: %.cob
> cobc $(COBCOPTS) -S $^

# generate intermediates in tmps
%.i: %.cob
> [ -d tmps ] || mkdir tmps
> cobc $(COBCOPTS) --save-temps=tmps -c $^

# create an executable; if errors, call vim in quickfix
%.q: %.cob
> cobc $(COBCOPTS) -x $^ 2>errors.err || vi -q

# make binary; capture warnings, call vim quickfix
%.qw: %.cob
> cobc $(COBCOPTS) -x $^ 2>errors.err ; vi -q

# run ocdoc to get documentation
%.ocdoc: %.cob
> ./ocdoc $^ $*.rst $*.html $*.css
```

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```
# run rst2html
%.html: %.cob
> sed ':loop;/!rst.marker!/{d};N;b loop' $^ | sed '$$d' \
    | sed 's/:SAMPLE:/$*/' | rst2html >$*.html

# run cobxref
%.lst: %.cob
> cobc $(COBCOPTS) -Xref $^

# run cobolmac, .cbl to .cob
%.mac: %.cbl
> cobolmac <$^ >$*.cob

# clean up -g files, with interactive prompting, just in case
%.clean: %.cob
> @echo "Remove: " $(COBCCLEAN)
> @(read -p "Are you sure? " -r; \
    if [[ $$REPLY =~ ^[Yy]$$ ]]; then rm $(COBCCLEAN) ; fi)

# tectonics for occurlrefresh
occurlrefresh: occurl.c occurlsym.cpy occurlrefresh.cbl
> cobc -x $(COBCOPTS) occurlrefresh.cbl occurl.c -lcurl
```

And now to work with a small program called `program.cob`, use

```
prompt$ make program       # for executables
prompt$ make program.run   # compile and run
prompt$ make program.mark  # change date-compiled and compile
prompt$ make program.o     # for object files
prompt$ make program.so    # for shared library
prompt$ make program.q     # compile and call vi in quickfix mode
prompt$ make program.clean # clean up cobc generated files
prompt$ make program.html  # generate documentation
```

The last rule, *occurlrefresh* is an example of how a multi-part project can be supported. Simply type

```
$ make occurlrefresh
```

and make will check the timestamps for occurl.c, occurlsym.cpy and occurlrefresh.cbl and then build up the executable if any of those files have changed compared to the timestamp of the binary.

The `program.mark` rule is a little dangerous, it modifies the source before continuing on to `cobc -x`. *Probably not overly wise in a production environment.*

See *Tectonics* (page 1350) for another word to describe building code.

3.13 Do you have a reasonable source code skeleton for GnuCOBOL?

Maybe. Style is a very personal developer choice. GnuCOBOL pays homage to this freedom of choice.

Below is a template that can be loaded into Vim when editing new files of type `.cob` or `.cbl`.

```
" Auto load COBOL template
autocmd BufNewFile  *.cob      0r ~/lang/cobol/header.cob
autocmd BufNewFile  *.cbl      0r ~/lang/cobol/header.cob
```

The filename is installation specific, and would need to change in any given `~/.vimrc` config file. But in the local case, it loads from `$HOME/lang/cobol/header.cob` and looks like:

```
GCobol >>SOURCE FORMAT IS FREE
REPLACE ==:SAMPLE:== BY ==program-name==.
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****J* project/:SAMPLE:
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20150405  Modified:
      *> LICENSE
      *>   Copyright 2015 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or greater)
      *> PURPOSE
      *>   :SAMPLE: program.
      *> TECTONICS
      *>   cobc -x -g -debug :SAMPLE:.cob
      *> ***************************************************************
       identification division.
       program-id. :SAMPLE:.
       author.
       date-compiled.
       date-written.
       installation.
       remarks.
       security.

       environment division.
       configuration section.
       source-computer.
       object-computer.
       special-names.
       repository.
           function all intrinsic.

       input-output section.
       file-control.
       i-o-control.

       data division.
       file section.

       working-storage section.

       local-storage section.
       linkage section.
       report section.
       screen section.

      *> ***************************************************************
       procedure division.
```

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```
       goback.
      *> ****************************************************************

      *> informational warnings and abends
       soft-exception.
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .

       end program :SAMPLE:.
      *> ****************************************************************
      *>*****
>>ELSE
```

```
!rst-marker!
========
:SAMPLE:
========

.. contents::

Introduction
------------

Usage
-----

    prompt$ ./:SAMPLE:

Source
------

.. include::  :SAMPLE:.cob
   :code: cobolfree
   :end-before: !rst-marker
>>END-IF
```

It includes empty versions (that still compile) of most sections, in the right order. Deleting the unnecessary lines is pretty easy, and act as handy reminders.

This skeleton also includes starter lines for in source documentation. The only rule for those documentation lines is that no line can start with > or $ (as that would trigger the GnuCOBOL preprocessor as it scans through the text looking for >>END-IF, or >>ELSE, or other compiler directives). These lines can be processed with `rst2html` and there is a sample make rule listed under, *Does GnuCOBOL work with make?* (page 111) as `make program.html` that includes the simple steps for extracting and processing the documentation.

A few other `./vimrc` settings allow for automatically filling in the `author` and `date-written` paragraphs, as well as setting the `Modified:` timestamp when writing out the buffer. Customize with your own name and timestamp preferences.

```
" Auto update modified time stamp
"    Modified: must occur in the first 32 lines,
"    32 chars of data before Modified: tag remembered
"    modify strftime to suit
function! LastModified()
    if &modified
        let save_cursor = getpos(".")
        let n = min([32, line("$")])
        keepjumps exe '1,' . n . 's#^\(.\{,32}Modified:\).*#\1'
            \ . strftime(" %Y-%m-%d/%H:%M%z") . '#e'
        keepjumps exe '1,' . n . 's#^\(.\{,32}@modified \).*#\1'
            \ . strftime("%Y-%m-%d/%H:%M%z") . '#e'
        keepjumps exe '1,' . n . 's#^\(.\{,32}author.\)$#\1'
            \ . ' YOUR NAME HERE.' . '#e'
        keepjumps exe '1,' . n . 's#^\(.\{,32}date-written.\).*#\1'
            \ . strftime(" %Y-%m-%d/%H:%M%z") . '.' . '#e'
        call histdel('search', -1)
        call setpos('.', save_cursor)
    endif
endfunction
au BufWritePre * call LastModified()
```

Here is a FIXED form header that this author used to use. It includes `ocdoc` lines.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *><* ===========
      *><*
      *><* ===========
      *><* :Author:
      *><* :Date:
      *><* :Purpose:
      *><* :Tectonics: cobc
      *> ***************************************************************
       identification division.
       program-id. .

       environment division.
       configuration section.
       source-computer. posix.
       object-computer.

       special-names.

       repository.
           function all intrinsic.

       input-output section.
       file-control.
      *>   select
      *>   assign to
      *>   organization is
      *>   .
```

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```
       data division.
       file section.
      *>fd .
      *>    01 .

       working-storage section.
       local-storage section.
       linkage section.
       screen section.

      *> ****************************************************************
       procedure division.

       goback.
       end program .
      *><*
      *><* Last Update: dd-Mmm-yyyy
```

Fill in the *program-id* and *end program* to compile. Fill in the ocdoc title for generating documentation. See *What is ocdoc?* (page 588) for more information on *(one method of)* inline documentation.

Here are some other templates that can be cut and pasted.

Fixed form, in lowercase, *with some starter lines thrown in as reminders*.

```
GNU    >>SOURCE FORMAT IS FIXED
Cobol *> ****************************************************************
      *> Author:
      *> Date:
      *> Purpose:
      *> Tectonics: cobc -x -g head-full.cob
      *>            COB_SET_DEBUG=Y ./head-full
      *> ****************************************************************
  id   identification division.
       program-id. sample.

 site  environment division.
       configuration section.
       source-computer. posix with debugging mode.
       object-computer. posix.

       special-names.

       repository.
           function all intrinsic.

       input-output section.
       file-control.
           select standard-in
           assign to keyboard
           organization is line sequential
           status is stdin-file-status
           .

           select standard-out
           assign to display
           organization is line sequential
```

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```
           status is stdout-file-status
           .

 data  data division.
 file  file section.
       fd standard-in.
           01 stdin-line       pic x(32768).
       fd standard-out.
           01 stdout-line      pic x(32768).

store  working-storage section.
       01 stdin-file-status.
          05 stdin-status      pic 99.
          05 stdin-substatus   pic 99.

       01 stdout-file-status.
          05 stdout-status     pic 99.
          05 stdout-substatus  pic 99.

       01 countdown            pic 99.
       01 display-count        pic z9.
       01 joke-limiter         pic x     value low-value.
          88 refrain                     value high-value.

       local-storage section.
       linkage section.
       report section.
       screen section.

      *> ****************************************************************
 code  procedure division.
 decl  declaratives.

       helpful-debug section.
           use for debugging on cleanse.
       cleanse-debug.
           display
               "DEBUG: cleansing input: " trim(stdin-line trailing)
               upon syserr
       .

       bark-on-stdin-errors section.
           use after standard error on standard-in.
       bark-stdin.
           display
               "Something bad happened on KEYBOARD" upon syserr
       .

       bark-on-stdout-errors section.
           use after standard error on standard-out.
       bark-stdout.
           display
               "Something bad happened on DISPLAY" upon syserr
       .

       end declaratives.
```

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```
main  mainline section.

     *> Turn on statement tracer lines <*
      ready trace

      open input standard-in
      if stdin-status greater than 10
          perform soft-exception
      end-if

      open output standard-out
      if stdout-status greater than 10
          perform soft-exception
      end-if

     *> Turn off statement tracer lines <*
      reset trace

      perform until stdin-status greater than 9
          move "What is your command? " to stdout-line
          write stdout-line end-write
          if stdout-status greater than 10
              perform soft-exception
          end-if

          read standard-in
              at end
                  exit perform
          end-read
          if stdin-status greater than 10
              perform soft-exception
          end-if

          perform cleanse

          evaluate stdin-line also true
              when "help"         also any
                  display "We all want a little help"
                  display "help, quit or exit exit"
              when "quit"         also any
                  display
                      "I know you want to quit, but I'm being"
                      " unfriendly; type 'exit', you user you"
              when "exit"         also refrain
                  display "fine, leaving now"
                  exit perform
              when "exit"         also any
                  display "Ha!  No quit for you"
                  display
                      "Wasting your time for "
                  end-display
                  perform varying countdown from 10 by -1
                      until countdown equal zero
                      move countdown to display-count
                      display
                          display-count "... " with no advancing
                      call
```

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```
                           "fflush" using NULL
                           on exception continue
                       end-call
                       call "C$SLEEP" using 1 end-call
                   end-perform
                   display "keep trying"
                   set refrain to true
               when other
                   display "try 'help'"
           end-evaluate
       end-perform

done   goback.

      *> ****************************************************************
aide   helper section.

      *> rudimentary changes to stdin, show off a few functions <*
       cleanse.
           move trim(substitute(lower-case(stdin-line),
               "'", space, '"', space))
             to stdin-line
       .

warn   soft-exception.
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

fail   hard-exception.
         perform soft-exception
         stop run returning 127
       .

unit   end program sample.
```

Fixed form in UPPERCASE

```
GCobol >>SOURCE FORMAT IS FIXED
      ************************************************************************
      * Author:
      * Date:
      * Purpose:
      * Tectonics: cobc
      ************************************************************************
       IDENTIFICATION DIVISION.
       PROGRAM-ID. .

       ENVIRONMENT DIVISION.
       CONFIGURATION SECTION.

       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
           SELECT
           ASSIGN TO
```

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```
           ORGANIZATION IS
           .

       DATA DIVISION.
       FILE SECTION.
       FD .
           01 .

       WORKING-STORAGE SECTION.

       LOCAL-STORAGE SECTION.

       LINKAGE SECTION.

       SCREEN SECTION.

      ******************************************************************
       PROCEDURE DIVISION.

       GOBACK.
       END PROGRAM .
```

The GCobol "sequence number" can safely be removed. It is there to ensure proper alignment in the browser, solely for the ReStructuredText markup used for the GnuCOBOL FAQ documentation.

FREE FORM can be compiled with `cobc -free` or use the supported compiler directive:

```
>>SOURCE FORMAT IS FREE
```

The above line must start in column 7 unless `cobc -free` is used.

```
*> **  >>SOURCE FORMAT IS FREE
*> ******************************************************************
*> Author:
*> Date:
*> Purpose:
*> Tectonics: cobc -free
*> ******************************************************************
identification division.
program-id. .

environment division.
configuration section.

input-output section.
file-control.
    select
        assign to
        organization is
    .

data division.
file section.
fd .
    01 .

working-storage section.
```

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```
local-storage section.

linkage section.

screen section.

procedure division.

goback.
end program .
```

These files can be downloaded from

- headfix.cob
- headfixuppper.cob
- headfree.cob
- head-full.cob

As listed above, `head-full.cob` has a lot of gunk in it, and is more useful as a reminder than a day to day default. See *autoload a skeleton* (page 865).

Please excuse the small sample command interpreter, it's my homage to Python and:

```
$ python
Python 2.7.5 (default, Nov 12 2013, 16:18:42)
[GCC 4.8.2 20131017 (Red Hat 4.8.2-1)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> exit
Use exit() or Ctrl-D (i.e. EOF) to exit
>>>
```

If you know I want to exit, just exit, don't tell me I did it wrong. Having said that, this reminder source plays out ala:

```
$ cobc -x -g head-full.cob
$ COB_SET_DEBUG=Y ./head-full
Source :    'head-full.cob'
Program-Id: sample          Statement: OPEN                 Line: 93
Program-Id: sample          Statement: IF                   Line: 94
Program-Id: sample          Statement: OPEN                 Line: 98
Program-Id: sample          Statement: IF                   Line: 99
Program-Id: sample          Statement: RESET TRACE          Line: 103
What is your command?
```

quit

```
DEBUG: cleansing input: quit
I know you want to quit, but I'm being unfriendly; type 'exit', you user you
What is your command?
```

'exit'

```
DEBUG: cleansing input: 'exit'
Ha!  No quit for you
Wasting your time for
```

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```
10...  9...  8...  7...  6...  5...  4...  3...  2...  1... keep trying
What is your command?
```

"EXIT"

```
DEBUG: cleansing input: "EXIT"
fine, leaving now
```

Note: There are tricks to ensure that `FIXED FORMAT` source code can be compiled in a both a `FIXED` and `FREE FORMAT` mode. That includes:

- using free form end of line comments, `*>` in column 7 and 8, or later
- no sequence numbers or notes in column 1-6, *the saddest concession*
- write DEBUG line compiler directives with the `>>D` starting in column 5 (so the `D` ends up in column 7)
- avoid – continuation lines, `&` being a handy replacement that may well enhance readability when literals are involved
- judicious use of the `>>SOURCE FORMAT IS ...` directive, placed at column 8 or later, to toggle around tricky bits of comment and code sections

---

3.14 Can GnuCOBOL be used to write command line stdin, stdout filters?

Absolutely. It comes down to `SELECT name ASSIGN TO KEYBOARD` for standard input, and `SELECT name ASSIGN TO DISPLAY` for standard out.

Below is a skeleton that can be used to write various filters. These programs can be used as command line pipes, or with redirections.

```
$ cat datafile | filter
$ filter <inputfile >outputfile
```

`filter.cob`. You'll want to change the 01-transform paragraph to do all the processing of each record. This skeleton simply copies stdin to stdout, *with a limit of 32K records* so that may need to be changed as well or tests made to ensure the default LINE SEQUENTIAL mode of KEYBOARD and DISPLAY are appropriate for the task at hand.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *><* ===========
      *><* filter
      *><* ===========
      *><* :Author:    Brian Tiffin
      *><* :Date:      20090207
      *><* :Purpose:   Standard IO filters
      *><* :Tectonics: cobc -x filter.cob
      *> ************************************************************
       identification division.
       program-id. filter.

       environment division.
```

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```
       configuration section.

       input-output section.
       file-control.
           select standard-input assign to keyboard.
           select standard-output assign to display.

       data division.
       file section.
       fd standard-input.
           01 stdin-record     pic x(32768).
       fd standard-output.
           01 stdout-record    pic x(32768).

       working-storage section.
       01  file-status         pic x  value space.
           88 end-of-file             value high-value
              when set to false is         low-value.

      *> ************************************************************
       procedure division.
       main section.
       00-main.

       perform 01-open

       perform 01-read

       perform
            until end-of-file
                perform 01-transform
                perform 01-write
                perform 01-read
       end-perform
       .

       00-leave.
       perform 01-close
       .

       goback.
      *> end main

       support section.
       01-open.
       open input standard-input
       open output standard-output
       .

       01-read.
       read standard-input
            at end set end-of-file to true
       end-read
       .

      *> All changes here
       01-transform.
```

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```
       move stdin-record to stdout-record
       .
      *>

       01-write.
       write stdout-record end-write
       .

       01-close.
           close standard-input
           close standard-output
       .

       end program filter.
      *><*
      *><* Last Update: dd-Mmm-yyyy
```

3.14.1 CBL_GC_HOSTED

A recent entry in the GnuCOBOL system call library allows for quick access to some of the common variables hosted by the C run-time system.

`CBL_GC_HOSTED` provides access to

- stdin sets pointer to stream
- stdout sets pointer to stream
- stderr sets pointer to stream
- argc sets binary-long
- argv sets pointer to char pointer pointer
- errno sets pointer with address of errno

If GnuCOBOL is built with HAVE_TIMEZONE defined, CBL_GC_HOSTED can also return

- tzname sets pointer to pointer to two element char pointer array
- timezone sets binary-c-long, number of seconds West of UTC.
- daylight sets binary-long, 0/1 flag for daylight savings time

Treat all returned values as read only, except for errno which is a reference to the actual field and can be read and modified through a BASED integer.

```
*> POSIX stream IO mix and match with GnuCOBOL
 01 result           usage binary-long.

 01 stdin            usage pointer.
 01 errno-address    usage pointer.
 01 errno            usage binary-long based.

 01 buffer           pic x(80).
 01 got              usage pointer.

*> POSIX timezone information
 01 tzname           usage pointer.
```

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```
01 tznames          usage pointer based.
   05 tzs           usage pointer occurs 2 times.
01 timezone         usage binary-c-long.
01 daylight         usage binary-long.


call "CBL_GC_HOSTED" stdin "stdin"
call "CBL_GC_HOSTED" errno-address "errno"
set address of errno to errno-address

call "fgets" using buffer by value 80 stdin returning got
if got equal null then
    display "stdin error: " errno upon syserr
    move 0 to err
end-if

set environment "TZ" to "PST8PDT"
call "tzset" returning omitted
call "CBL_GC_HOSTED" tzname "tzname" returning result
if result equal zero and tzname not equal null then
    set address of tznames to tzname
    if tzs(1) not equal null then
        call "printf" using
            by content "first tzname: %s" & x"0a00"
            by value tzs(1)
    end-if
end-if
```

The `CBL_GC_HOSTED` system call makes it just a little bit easier to interact with POSIX and C from GnuCOBOL.

3.15 How do you print to printers with GnuCOBOL?

GnuCOBOL and COBOL in general does not directly support printers. That role is delegated to the operating system. Having said that, there are a few ways to get data to a printer.

3.15.1 printing with standard out

Writing directly to standard out, as explained in *Can GnuCOBOL be used to write command line stdin, stdout filters?* (page 123) and then simply piping to `lpd` should usually suffice to get text to your printer.

```
$ ./cobprog | lp
$ ./yearend | lp -d $PRESIDENTSPRINTER
```

Don't try the above with the DISPLAY verb; use WRITE TO stdout, with stdout selected and assigned to the `DISPLAY` name.

3.15.2 calling the system print

Files can be routed to the printer from a running program with sequences such as

```
CALL "SYSTEM"
    USING "lp os-specific-path-to-file"
    RETURNING status
END-CALL
```

3.15.3 print control library calls

And then we open up the field of callable libraries for print support. Below is some template code for sending files to a local CUPS install.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian
      *> Date:      10-Aug-2009
      *> Purpose:   CUPS quick print
      *> Tectonics: cobc -lcups -x cupscob.cob
      *> ************************************************************
       identification division.
       program-id. cupscob.

       data division.
       working-storage section.
       01 result      usage binary-long.
       01 cupsError   usage binary-long.
       01 msgPointer  usage pointer.
       01 msgBuffer   pic   x(1024) based.
       01 msgDisplay  pic   x(132).

      *> ************************************************************
       procedure division.
       call "cupsPrintFile"
         using
           "cupsQueue" & x"00"
           "filename.prn" & x"00"
           "GnuCOBOL CUPS interface" & x"00"
           by value 0
           by reference NULL
         returning result
       end-call

       if result equals zero
           call "cupsLastError" returning cupsError
           display "Err: " cupsError

           call "cupsLastErrorString" returning msgPointer
           set address of msgBuffer to msgPointer
           string
               msgBuffer delimited by x"00"
             into msgDisplay
           end-string
           display function trim(msgDisplay)
       else
           display "Job: " result
       end-if
```

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```
       goback.
       end program cupscob.
```

3.15.4 print to PDF with CUPS

As it turns out, the above code snippet can be used to print directly to a PDF defined cups-pdf printer. By

```
$ apt-get install cups cups-pdf
```

Under Debian, you can then

```
call "cupsPrintFile"
    using
        "PDFer"       & x"00"
        "cupscob.cob" & x"00"
        "cupscob.pdf" & x"00"
        by value 0
        by reference NULL
    returning result
end-call
```

Assuming `PDFer` is a Class or printer with a PDF member. A PDF version of the text in `cupscob.cob` will be placed in `~/PDF/` as `cupscob.pdf`.

Roger While added this wisdom:

```
Check if your particular distro has cups-pdf in
its repository. (eg. Using Yast with Suse).
If yes, install from there.
If no, use one of the RPM finders on the web to find
a version for your distro.
eg. www.rpmfind.com

The installation of cups-pdf should automatically set
up a dummy printer with the name "cups-pdf".
So you do not actually need to define a class.
You can print directly to "cups-pdf".
(Check defined printers with eg. "lpstat -t")

The output file location is dependent on the cups-pdf
configuration file normally located at /etc/cups/cups-pdf.conf.
So, eg. on my box the location is defined thus -
Out ${HOME}/Documents/PDFs
```

The code with a little more documentation, in case it turns out to be useful.

```
call "cupsPrintFile"              *> requires -lcups
    using
        "cups-pdf"    & x"00"         *> printer class
        "cupscob.cob" & x"00"         *> input filename
        "cupscob.pdf" & x"00"         *> title
        by value 0                    *> num_options
        by reference NULL             *> options struct <*
    returning result
    on exception
```

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```
        display "hint: use -lcups for cupsPrintFile"
end-call
```

3.15.5 Jim Currey's prtcbl

Jim kindly donated this snippet. One of his earliest efforts establishing a base of GnuCOBOL resources. prtcbl produces source code listing with results piped to a printer.

A few customizations. This version requires a change to a filename for printer control, location of copybooks, and possible changes to the system lp command line.

Stash a print setup string in the file so named. The program prompts for input, output and printer.

Jim pointed out that this was early attempts with OpenCOBOL as a tool to support better in house development, *and was nice enough to let me reprint it.*

```
GCobol IDENTIFICATION DIVISION.
       PROGRAM-ID. PRTCBL.
      *AUTHOR. J C CURREY.
      ************************************************************
      *      PRINTS A COBOL SOURCE FILE WITH IT'S COPY BOOKS     *
      *                                                          *
      *   VERSION 001--ORIGINAL VERSION                          *
      *                3/26/2009--J C CURREY                     *
      *                                                          *
      *           002--ADDS .CPY (CAPS) IF .cpy FAILS TO FIND    *
      *                 FILE AND EXPANDS INPUT TO 132 CHARACTERS*
      *                4/09/2009--J C CURREY                     *
      *                                                          *
      *           003--ADDS NOLIST AND LIST SUPPORT (NOTE NOT    *
      *                 SUPPORTED BY OPENCOBOL COMPILER)         *
      *                 **NOLIST IN COL 7-14 TURNS OFF LISTING   *
      *                 **LIST IN COL 7-12 TURNS ON LISTING      *
      *                4/22/2009--J C CURREY                     *
      *                                                          *
      *           004--ADDS SUPPORT FOR /testing-set-1/copybooks *
      *                Copybooks are searched for first in the   *
      *                local directory and if not found, then in *
      *                /testing-set-1/copybooks                  *
      *                 5/7/2009--J C CURREY                     *
      *                                                          *
      *           005--CORRECTS MISSING LINE ISSUE ON PAGE BREAKS*
      *                IN THE COPY FILE PRINTING SECTION.        *
      *                1285451--SANDY DOSS                       *
      *                06/19/2009--JEREMY MONTOYA                *
      *                                                          *
      *           006--USES EXTERNAL PCL CODE FILE TO INSERT PCL *
      *                CODE INTO PRINT FILE FOR FORMATTING.      *
      *                1330505--JIM CURREY                       *
      *                12/14/2009--PETE MCTHOMPSON               *
      ************************************************************
       ENVIRONMENT DIVISION.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
121409     SELECT FORMAT-FILE ASSIGN TO WS-NAME-FORMAT-FILE
121409       ORGANIZATION IS LINE SEQUENTIAL.
```

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```
           SELECT PRINT-FILE ASSIGN TO WS-NAME-PRINT-FILE
             ORGANIZATION IS LINE SEQUENTIAL.
           SELECT INPUT-FILE ASSIGN TO WS-NAME-INPUT-FILE
             ORGANIZATION IS LINE SEQUENTIAL
             FILE STATUS IS WS-INPUT-FILE-STATUS.
           SELECT COPY-FILE ASSIGN TO WS-NAME-COPY-FILE
             ORGANIZATION IS LINE SEQUENTIAL
             FILE STATUS IS WS-COPY-FILE-STATUS.
       DATA DIVISION.
       FILE SECTION.
      *
       FD  PRINT-FILE.
121409 01  FORMAT-LINE                         PIC X(140).
       01  PRINT-LINE.
           05  OR-LINE-NUMBER                  PIC Z(6).
           05  OR-FILLER-1                     PIC XX.
           05  OR-TEXT                         PIC X(132).
121409*
121409 FD  FORMAT-FILE.
121409 01  FORMAT-RECORD                       PIC X(140).
      *
       FD  INPUT-FILE.
       01  INPUT-RECORD.
           05  IR-BUFFER                       PIC X(132).

       FD  COPY-FILE.
       01  COPY-RECORD.
           05  CR-BUFFER                       PIC X(132).
      **NOLIST
      * THIS IS ANOTHER LINE
      **LIST
      *
       WORKING-STORAGE SECTION.
      ************************************************
      *   CONSTANTS, COUNTERS AND WORK AREAS         *
      ************************************************
       01  WS-NAME-PROGRAM                     PIC X(12) VALUE
121409                                            "prtcbl   006".
       01  WS-NO-PARAGRAPH                     PIC S9(4) COMP.
       01  WS-I                                PIC S9(4) COMP.
       01  WS-J                                PIC S9(4) COMP.
       01  WS-K                                PIC S9(4) COMP.
       01  WS-NAME-PRINT-FILE                  PIC X(64) VALUE SPACES.
       01  WS-NAME-INPUT-FILE                  PIC X(64) VALUE SPACES.
       01  WS-INPUT-FILE-STATUS                PIC XX VALUE "00".
050709 01  WS-NAME-COPY-FILE                   PIC X(128) VALUE SPACES.
050709 01  WS-HOLD-NAME-COPY-FILE              PIC X(128) VALUE SPACES.
121409 01  WS-NAME-FORMAT-FILE                 PIC X(128) VALUE SPACES.
       01  WS-COPY-FILE-STATUS                 PIC XX VALUE "00".
       01  WS-LINE-PRINTER-NAME                PIC X(16) VALUE SPACES.
       01  WS-LINE-NUMBER                      PIC S9(6) COMP
                                                    VALUE ZERO.
       01  WS-PAGE-LINE-COUNTER                PIC S9(4) COMP
                                                    VALUE 999.
       01  WS-PAGE-NUMBER                      PIC S9(4) COMP
                                                    VALUE ZERO.
       01  WS-PRINT-COMMAND                    PIC X(128).
```

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```
      *
       01  WS-ESCAPE-CHARACTER                 PIC X VALUE X"1B".
      *
       01  WS-HEADING-LINE                     PIC X(132).
       01  WS-CURRENT-DATE                     PIC X(21).
       01  WS-ED4S                             PIC ZZZZ-.
042209 01  WS-SWITCH-PRINT                     PIC X VALUE SPACE.
      ****************************************************************
      *                PROCEDURE DIVISION                            *
      ****************************************************************
       PROCEDURE DIVISION.
       0000-MAIN SECTION.
           PERFORM 1000-INITIALIZATION THRU 1990-EXIT.
           PERFORM 2000-PROCESS THRU 2990-EXIT.
           PERFORM 9000-END-OF-PROGRAM THRU 9990-EXIT.
           STOP RUN.
      ****************************************************************
      *               INITIALIZATION                                 *
      ****************************************************************
       1000-INITIALIZATION.
           MOVE 1000 TO WS-NO-PARAGRAPH.
           DISPLAY "I) ", WS-NAME-PROGRAM, " BEGINNING AT--"
             FUNCTION CURRENT-DATE.
       1002-GET-INPUT-FILE.
           DISPLAY "A) ENTER INPUT-FILE NAME " WITH NO ADVANCING.
           ACCEPT WS-NAME-INPUT-FILE.
           OPEN INPUT INPUT-FILE.
           IF WS-INPUT-FILE-STATUS IS EQUAL TO 35
             DISPLAY "W) INPUT FILE NOT FOUND"
             GO TO 1002-GET-INPUT-FILE.
           DISPLAY "A) ENTER PRINT-FILE (WORK FILE) NAME "
             WITH NO ADVANCING.
           ACCEPT WS-NAME-PRINT-FILE.
           DISPLAY "A) ENTER PRINTER NAME " WITH NO ADVANCING.
           ACCEPT WS-LINE-PRINTER-NAME.
           OPEN OUTPUT PRINT-FILE.
121409     MOVE "laserjet_113D.txt" TO WS-NAME-FORMAT-FILE.
121409     OPEN INPUT FORMAT-FILE.
121409 1010-OUTPUT-PCL-CODES.
121409     READ FORMAT-FILE NEXT RECORD AT END GO TO 1020-FORMAT-EOF.
121409     MOVE FORMAT-RECORD TO FORMAT-LINE.
121409     WRITE FORMAT-LINE.
121409     GO TO 1010-OUTPUT-PCL-CODES.
121409 1020-FORMAT-EOF.
121409     CLOSE FORMAT-FILE.
       1990-EXIT.
           EXIT.
      ****************************************************************
      *                DETAIL SECTION                                *
      ****************************************************************
       2000-PROCESS.
           MOVE 2000 TO WS-NO-PARAGRAPH.
           READ INPUT-FILE NEXT RECORD AT END GO TO 2990-EXIT.
           ADD 1 TO WS-LINE-NUMBER.
           IF WS-PAGE-LINE-COUNTER IS GREATER THAN 112
             PERFORM 2800-HEADINGS THRU 2890-EXIT.
           MOVE WS-LINE-NUMBER TO OR-LINE-NUMBER.
```

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```
           MOVE SPACES TO OR-FILLER-1.
           MOVE INPUT-RECORD TO OR-TEXT.
042209     IF IR-BUFFER (7:6) IS EQUAL TO "**LIST"
042209       MOVE "Y" TO WS-SWITCH-PRINT.
042209     IF WS-SWITCH-PRINT IS EQUAL TO "N"
042209       THEN NEXT SENTENCE
042209       ELSE WRITE PRINT-LINE
042209            ADD 1 TO WS-PAGE-LINE-COUNTER.
042209      IF IR-BUFFER (7:8) IS EQUAL TO "**NOLIST"
042209       MOVE "N" TO WS-SWITCH-PRINT.
           IF IR-BUFFER (7:1) IS EQUAL TO "*" GO TO 2000-PROCESS.
           MOVE 1 TO WS-I.
       2010-COMPARE-LOOP.
           IF IR-BUFFER (WS-I:2) IS EQUAL TO "*>" GO TO 2090-ENDER.
           IF IR-BUFFER (WS-I:6) IS EQUAL TO " COPY " GO TO 2020-COPY.
           ADD 1 TO WS-I.
           IF WS-I IS LESS THAN 73 GO TO 2010-COMPARE-LOOP.
           GO TO 2000-PROCESS.
       2020-COPY.
           SUBTRACT 1 FROM WS-LINE-NUMBER.
           ADD 6 TO WS-I.
           MOVE 1 TO WS-J.
           MOVE SPACES TO WS-NAME-COPY-FILE.
       2022-MOVE-LOOP.
           IF IR-BUFFER (WS-I:1) IS EQUAL TO SPACE
             GO TO 2030-OPEN-COPYFILE.
           IF IR-BUFFER (WS-I:1) IS EQUAL TO "."
             MOVE ".cpy" to WS-NAME-COPY-FILE (WS-J:4)
               GO TO 2030-OPEN-COPYFILE.
           MOVE IR-BUFFER (WS-I:1) TO WS-NAME-COPY-FILE (WS-J:1).
           ADD 1 TO WS-I, WS-J.
           IF WS-I IS GREATER THAN 73
             OR WS-J IS GREATER THAN 64
               THEN MOVE "**PROBLEM WITH.COPY STATEMENT ABOVE**"
                      TO OR-TEXT
                    WRITE PRINT-LINE
                    ADD 1 TO WS-PAGE-LINE-COUNTER
                    GO TO 2000-PROCESS.
           GO TO 2022-MOVE-LOOP.
       2030-OPEN-COPYFILE.
           OPEN INPUT COPY-FILE.
           IF WS-COPY-FILE-STATUS IS NOT EQUAL TO "00"
040909       MOVE ".CPY" TO WS-NAME-COPY-FILE (WS-J:4)
040909       OPEN INPUT COPY-FILE
040909       IF WS-COPY-FILE-STATUS IS NOT EQUAL TO "00"
050709         MOVE WS-NAME-COPY-FILE TO WS-HOLD-NAME-COPY-FILE
050709         STRING "/testing-set-1/copybooks/"
050709           WS-HOLD-NAME-COPY-FILE
050709             INTO WS-NAME-COPY-FILE
      *     DISPLAY "D) AT.COPY FILE OPEN NAME=\", WS-NAME-COPY-FILE, "\"
050709         OPEN INPUT COPY-FILE
050709           IF WS-COPY-FILE-STATUS IS NOT EQUAL TO "00"
050709             ADD 25 TO WS-J
050709             MOVE ".cpy" TO WS-NAME-COPY-FILE (WS-J:4)
      *     DISPLAY "D) AT.COPY FILE OPEN NAME=\", WS-NAME-COPY-FILE, "\"
050709             OPEN INPUT COPY-FILE
050709             IF WS-COPY-FILE-STATUS IS NOT EQUAL TO "00"
```

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```
050709               MOVE "***COPY FILE ABOVE NOT FOUND***" TO OR-TEXT
050709               WRITE PRINT-LINE
050709               ADD 1 TO WS-LINE-NUMBER
050709               ADD 1 TO WS-PAGE-LINE-COUNTER
050709               GO TO 2000-PROCESS
050709             END-IF
050709           END-IF
040909       END-IF
040909     END-IF.
       2032-PRINT-LOOP.
           READ COPY-FILE NEXT RECORD AT END GO TO 2039-EOF.
           ADD 1 TO WS-LINE-NUMBER.
061909*    MOVE WS-LINE-NUMBER TO OR-LINE-NUMBER.
061909*    MOVE SPACES TO OR-FILLER-1.
061909*    MOVE COPY-RECORD TO OR-TEXT.
           IF WS-PAGE-LINE-COUNTER IS GREATER THAN 112
             PERFORM 2800-HEADINGS THRU 2890-EXIT.
061909     MOVE WS-LINE-NUMBER TO OR-LINE-NUMBER.
061909     MOVE SPACES TO OR-FILLER-1.
061909     MOVE COPY-RECORD TO OR-TEXT.
042209     IF CR-BUFFER (7:6) IS EQUAL TO "**LIST"
042209       MOVE "Y" TO WS-SWITCH-PRINT.
042209     IF WS-SWITCH-PRINT IS EQUAL TO "N"
042209       THEN NEXT SENTENCE
042209       ELSE WRITE PRINT-LINE
042209            ADD 1 TO WS-PAGE-LINE-COUNTER.
042209      IF CR-BUFFER (7:8) IS EQUAL TO "**NOLIST"
042209       MOVE "N" TO WS-SWITCH-PRINT.
           GO TO 2032-PRINT-LOOP.
       2039-EOF.
           CLOSE COPY-FILE.
042209     MOVE "Y" TO WS-SWITCH-PRINT.
       2090-ENDER.
           GO TO 2000-PROCESS.
      *
      *    PAGE HEADINGS
      *
       2800-HEADINGS.
           INITIALIZE PRINT-LINE.
           ADD 1 TO WS-PAGE-NUMBER.
           MOVE FUNCTION CURRENT-DATE TO WS-CURRENT-DATE.
           MOVE WS-NAME-INPUT-FILE TO PRINT-LINE.
           MOVE WS-PAGE-NUMBER TO WS-ED4S.
           MOVE "PAGE" TO PRINT-LINE (66:4).
           MOVE WS-ED4S TO PRINT-LINE (71:4).
           MOVE WS-CURRENT-DATE (5:2) TO PRINT-LINE (80:2).
           MOVE "/" TO PRINT-LINE (82:1).
           MOVE WS-CURRENT-DATE (7:2) TO PRINT-LINE (83:2).
           MOVE "/" TO PRINT-LINE (85:1).
           MOVE WS-CURRENT-DATE (1:4) TO PRINT-LINE (86:4).
           MOVE WS-CURRENT-DATE (9:2) TO PRINT-LINE (92:2).
           MOVE ":" TO PRINT-LINE (94:1).
           MOVE WS-CURRENT-DATE (11:2) TO PRINT-LINE (95:2).
           MOVE ":" TO PRINT-LINE (97:1).
           MOVE WS-CURRENT-DATE (13:2) TO PRINT-LINE (98:2).
           IF WS-PAGE-NUMBER IS EQUAL TO 1
             THEN WRITE PRINT-LINE
```

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```
             ELSE WRITE PRINT-LINE AFTER ADVANCING PAGE.
           INITIALIZE PRINT-LINE.
           WRITE PRINT-LINE.
           MOVE 4 TO WS-PAGE-LINE-COUNTER.
       2890-EXIT.
           EXIT.
      *
      *    END OF JOB
      *
       2990-EXIT.
           EXIT.
      ****************************************************************
      *             TERMINATION                                      *
      ****************************************************************
       9000-END-OF-PROGRAM.
           MOVE 9000 TO WS-NO-PARAGRAPH.
           CLOSE INPUT-FILE.
           CLOSE PRINT-FILE.
121409*    STRING "lp -d " DELIMITED BY SIZE,
121409*      WS-LINE-PRINTER-NAME DELIMITED BY SIZE,
121409*      "-o sides=two-sided-long-edge " DELIMITED BY SIZE,
121409*      "-o lpi=11 -o cpi=18 -o page-left=34 " DELIMITED BY SIZE,
121409*      WS-NAME-PRINT-FILE DELIMITED BY SIZE
121409*        INTO WS-PRINT-COMMAND.
           STRING "lp -d " DELIMITED BY SIZE,
             WS-LINE-PRINTER-NAME DELIMITED BY SIZE,
             "-o raw " DELIMITED BY SIZE,
             WS-NAME-PRINT-FILE DELIMITED BY SIZE
               INTO WS-PRINT-COMMAND.
           CALL "SYSTEM" USING WS-PRINT-COMMAND.
           DISPLAY "I) " WS-NAME-PROGRAM " COMPLETED NORMALLY AT--"
               FUNCTION CURRENT-DATE.
       9990-EXIT.
           EXIT.
```

3.16 Can I run background processes using GnuCOBOL?

Absolutely. Using the `CALL "SYSTEM"` service. Some care must be shown to properly detach the input output handles, and to instruct the processes to ignore hangup signals along with the "run in a background subshell" control.

```
CALL "SYSTEM"
    USING
        "nohup whatever 0</dev/null 1>mystdout 2>mystderr &"
    RETURNING result
END-CALL
```

That runs `whatever` in the background, detaches stdin, sends standard output to the file `mystdout` and standard error to `mystderr`.

The above example is for POSIX_ shell operating systems. As always, the commands sent through SYSTEM are VERY operating system dependent.

3.17 Is there GnuCOBOL API documentation?

Absolutely. Sort of. And it's beautiful, complete and awe inspiring.

Dimitri van Heesch's 1.7.4 release of Doxygen, http://www.doxygen.org was used to produce http://opencobol.add1tocobol.com/doxy/ and along with Gary's OCic.cbl http://opencobol.add1tocobol.com/doxyapp/ to highlight the absolutely beautiful compiler and application documentation available for GnuCOBOL now. These pages were produced with very little effort with only a few small tweaks to the Doxygen generated Doxyfile (to turn on all files, and to generate call graphs). The sample pass produces a 1400 page beauty of a reference manual in PDF generated from the Doxygen LaTex output. *2950 pages for the sample application run.*

GnuCOBOL ships as a developer tarball and Doxygen was let loose on the source tree after a ./configure and make pass. When the -C output of Gary Cutler's OCic.cbl was placed into the tree, the output includes the call graphs that exercise some of the GnuCOBOL run-time library. This application level documentation is world class.

Regarding the above "sort of". This was a near effortless use of Doxygen. GnuCOBOL was not touched and the sources have no explicit Doxygen tags. It also excludes many of the automake, libtool, bison and flex source files. Even still, beautiful. The compiler API is now an easy grok, and application level documentation (doxyapp using OCic.cbl as a sample) should satisfy the world's most ruthless code auditor and meticulous development team lead.

See http://opencobol.add1tocobol.com/doxy/d2/dd4/structcb__field.html for a tantalizing sample of cb_field collaboration diagram and completeness of source code coverage. See http://opencobol.add1tocobol.com/doxyapp/d4/da8/OCic_8c.html for a view of how Doxygen handles the application level documentation. All for free.

3.18 How do I use LD_RUN_PATH with GnuCOBOL?

`LD_RUN_PATH` can be a saving grace for developers that want to build GnuCOBOL on hosted environments. `LD_RUN_PATH` is similar to `LD_LIBRARY_PATH` but builds the shared library path into `cobc` and then all of the binaries *compiled* with cobc. That means you can cherry pick the link loader paths when you build GnuCOBOL in a way that can add support for unsupported host features.

If you want a recent version of ncurses on your hosting service, but don't have root permissions, you can build it into one of your own directories then

```
EXPORT LD_RUN_PATH=mylibdir
./configure ; make ; make install
```

to build your GnuCOBOL. All compiles with `cobc` will now include mylibdir during compiles, and better yet, the binaries produced will also include mylibdir in the search path at run-time.

If you don't have *RECORD_PATH* in your `cobc` then you can simply compile with

```
LD_RUN_PATH=mylibdir cobc -x nextbigthing.cob
```

to achieve similar results.

With the CGI interface, see *How do I use GnuCOBOL for CGI?* (page 541), you can now build up a complete web side solution using GnuCOBOL with little worry about being stuck on link library dependencies or running scripts to setup any path variables before safely using your cgi-bin binaries.

`LD_RUN_PATH` is magical when root permissions are unavailable or undesired when installing local built libraries. It can also avoid some security problems that can occur when you rely on `LD_LIBRARY_PATH` user environment settings. Outputs from `cobc` will have **your** search path and not some `/home/badusers` trickery settings, as `LD_RUN_PATH` searches come *before* `LD_LIBRARY_PATH`. Relying on `LD_LIBRARY_PATH` is deemed a **Don't do** by some experts. `LD_RUN_PATH` is a much safer bet. Downside; susceptible to files being moved on disk to new

pathnames, which can require a re-compile. For production installs, `LD_RUN_PATH` and setting rpath in an executable is a worthy consideration.

3.19 What GNU build tool options are available when building GnuCOBOL?

The sources for the GnuCOBOL compiler follows *GNU* (page 1351) standards whenever possible. This includes being built around the GNU build system.

3.19.1 Basics

From an end-user perspective, what this means is that the source code distributions follow these basic steps:

```
tar xvf open-cobol-1.1.tar.gz
cd open-cobol-1.1
./configure
make
make check
sudo make install
sudo ldconfig
```

But that is just scratching the surface of the possibilities. See *What are the configure options available for building GnuCOBOL?* (page 72) for the first steps with `./configure`.

3.19.2 Out of tree builds

Next up, GnuCOBOL fully supports out-of-source-tree builds.

From Roger:

```
I mentioned in the past the preferred way of doing
a configure/build ie. Out-of-source-tree build.

eg.
We have OC 2.0 in /home/open-cobol-2.0

We want to test -
OC with BDB
OC with vbisam
OC without db (ISAM)

mkdir /home/oc20110710bdb
cd /home/oc20110710bdb
/home/open-cobol-2.0/configure --enable-debug
make
make check
cd tests
cd cobol85
# <Get newcob.val - per README>
make test

mkdir /home/oc20110710vbisam
cd /home/oc20110710vbisam
```

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```
/home/open-cobol-2.0/configure --enable-debug --with-vbisam
make
make check
cd tests
cd cobol85
# <Get newcob.val - per README>
make test

mkdir /home/oc20110710nodb
cd /home/oc20110710nodb
/home/open-cobol-2.0/configure --enable-debug --without-db
make
make check
cd tests
cd cobol85
# <Get newcob.val - per README>
make test

For the last example both the OC and ANSI85 tests have been adjusted
to cater for lack of ISAM functionality.

To set your current environment to compile/execute from any of the above
(ie. without doing a "make install" from any directory), then
either "source" or execute as part of current environment
(with . ) the following files from the build directory -
tests/atconfig
tests/atlocal

(Note in that order)

So eg.
. /home/oc20110710vbisam/tests/atconfig
. /home/oc20110710vbisam/tests/atlocal

will set compiler/runtime to this environment in the current shell.

Note that both the OC tests and the ANSI85 tests do this internally
(Fairly obvious otherwise we would not be testing the right thing).

Of course, from any of the above example directories you can do
a final "make install".
```

This can be made a lot easier to remember by using a shell function.

Add the following to `$HOME/.bashrc` (and **edit the path names**).

```
# multiple versions of GnuCOBOL, when built from source
# ### UPDATE source PATHNAMES to match local installation ###
use-cobol () {
    local ROOTPATH="$HOME"/builds
    case "$1" in
    2\.0 | 2)
         source "$ROOTPATH"/branches/gnu-cobol-2.0/tests/atconfig
         source "$ROOTPATH"/branches/gnu-cobol-2.0/tests/atlocal
         ;;
    reportwriter | rw)
         source "$ROOTPATH"/branches/reportwriter/tests/atconfig
```

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```
        source "$ROOTPATH"/branches/reportwriter/tests/atlocal
        ;;
    cpp | c\+\+)
        source "$ROOTPATH"/branches/gnu-cobol-cpp/tests/atconfig
        source "$ROOTPATH"/branches/gnu-cobol-cpp/tests/atlocal
        ;;
    fileiorewrite )
        source "$ROOTPATH"/branches/fileiorewrite/tests/atconfig
        source "$ROOTPATH"/branches/fileiorewrite/tests/atlocal
        ;;
    release | gnucobol)
        source "$ROOTPATH"/trunk/gnu-cobol/tests/atconfig
        source "$ROOTPATH"/trunk/gnu-cobol/tests/atlocal
        ;;
    *)
        echo "Use use-cobol 2 rw cpp fileiorewrite or release"
        ;;
    esac
}
```

And now, it is a simpler:

```
prompt$ use-cobol 2.0
prompt$ use-cobol reportwriter
prompt$ use-cobol c++
```

You could also add strings to the case statement patterns to match personal taste, as in `2\.0 | 2 | simon)` and use:

```
prompt$ use-cobol simon
prompt$ use-cobol ron
prompt$ use-cobol sergey
prompt$ use-cobol joe
prompt$ use-cobol experiment
```

if that is easier to remember. And use what ever name for the `use-cobol` function that you please.

Please note that because of the way shell scripts work, those `atconfig` and `atlocal` lines don't work from an external script. You have to invoke the `source` shell command from the current shell, and shell functions do that.

If you like to keep your ~/.bashrc clean, then source in the definition of the function. As long as the function runs from the current shell and not a sub-shell it will work, otherwise all the environment settings are forgotten, as the environment is never passed up to a parent process, only down to children.

3.19.3 Autotest options

By developing the GnuCOBOL system around the GNU build tools, developers receive a great many options *for free*.

`make check` can include TESTSUITEFLAGS.

The TESTSUITEFLAGS allows for options that include:

- `make check TESTSUITEFLAGS="--list"` to list the available tests and descriptions
- `"--verbose"` to show a little more information during the tests

- `"--jobs=n"` to run n tests in parallel. On multi core systems, the speed up is fairly dramatic. For 425 tests, normally 1 minute 22 seconds, `--jobs=4` ran in 36 seconds (on a small little AMD Athlon(tm) II X2 215 Processor). The more cores, the more dramatic the improvement.

3.20 Why don't I see any output from my GnuCOBOL program?

This is *actually* a frequently asked question, and it usually has the same answer.

Or, it used to. There has been a change to core libcob that should alleviate this problem for most programs. The explanation below will only pertain to people running a version of the compiler dated before January 2017. More recent builds will have COB_EXIT_WAIT.

GnuCOBOL uses the Curses and NCurses packages for advanced terminal features and SCREEN SECTION handling. This uses `stdscr` for input and output, and not the standard CONSOLE, SYSIN, SYSOUT character interface modes. One feature of the Curses handler is the concept of a secondary screen buffer, which is erased during initialization and then disappears at rundown. This can happen so fast on short display programs that it looks like nothing happens.

```
program-id. helloat.
DISPLAY "Hello, world" LINE 5 COLUMN 5
goback.
```

Running that code will cause the Curses package to initialize a secondary buffer, display the Hello string, then immediately restore the original screen buffer during `goback`. It will look like nothing is output when ./helloat is run. There are a few fixes for this.

- delay rundown with a `CALL "C$SLEEP" USING 5 END-CALL`
- `ACCEPT OMITTED` which will wait for a carriage return (GnuCOBOL 2.0)
- `ACCEPT unused-variable` can also be used to pause a program before exit
- or even better, dump the secondary buffer from all Curses screen handling

(ACCEPT OMITTED actually waits for any "terminating" keyboard input, carriage return, function keys, and some others).

The last option from the above list, removing the secondary buffer, is discussed below under RMCUP, SMCUP.

3.20.1 COB_EXIT_WAIT

GnuCOBOL now includes a test at rundown and can pause a program exit to allow the last display to stay on screen. Two configuration settings, **COB_EXIT_WAIT** (default true) and **COB_EXIT_MSG** (default 'end of program, please press a key to exit') are now available.

`COB_EXIT_WAIT` true will pause a program during rundown if extended screen IO was activated and display the message defined in `COB_EXIT_MSG`. By default, the problem of fast display followed by restoration of the shadow display buffer should no longer be an issue for developers using SCREEN IO in GnuCOBOL. Set `COB_EXIT_WAIT` to false to let programs finish without the key press.

This setting is part of the GnuCOBOL run time configuration, `config/runtime.cfg` and be set there. See *What is runtime.cfg?* (page 146) for more details.

Even with this enhancement to GnuCOBOL, this author still recommends turning off RMCUP/SMCUP as detailed below.

3.20.2 SMCUP and RMCUP

https://blogs.oracle.com/samf/entry/smcup_rmcup_hate is a great article that discusses, and sledgehammer fixes, the curses init screen clearing issue, leaving output on the stdout terminal, not an alternate screen.

First to find out the actual terminal capabilities, (and what control file is going to change):

```
$ infocmp | head -2
```

shows:

```
# Reconstructed via infocmp from file: /home/btiffin/.terminfo/x/xterm-256color
xterm-256color|xterm with 256 colors,
```

There is some voodoo with `infocmp` (and `tic`, the terminal information compiler), to worry about. By default, infocmp reads local user files, but this change can also effect the entire system, if run as root.

Using a super user context:

```
[btiffin@localhost junk]$ sudo infocmp | head -2
# Reconstructed via infocmp from file: /usr/share/terminfo/x/xterm-256color
xterm-256color|xterm with 256 colors,
```

gives us the system file.

After creating a *just in case* copy of `/usr/share/terminfo/x/xterm-256color` it is time to get rid of the alternate stdscr.

```
$ infocmp >xterm.terminfo
$ vi xterm.terminfo
$ # get rid of smcup= and rmcup= upto and including the comma
$ tic xterm.terminfo
```

in my case, the temporary *xterm.terminfo* looked like:

```
...
rin=\E[%p1%dT, rmacs=\E(B, rmam=\E[?7l, rmcup=\E[?1049l,
rmir=\E[4l, rmkx=\E[?1l\E>, rmm=\E[?1034l, rmso=\E[27m,
rmul=\E[24m, rs1=\Ec, rs2=\E[!p\E[?3;4l\E[4l\E>, sc=\E7,
setab=\E[4%p1%dm, setaf=\E[3%p1%dm,
setb=\E[4%?%p1%{1}%=%t4%e%p1%{3}%=%t6%e%p1%{4}%=%t1%e%p1%{6}%=%t3%e%p1%d%;m,
setf=\E[3%?%p1%{1}%=%t4%e%p1%{3}%=%t6%e%p1%{4}%=%t1%e%p1%{6}%=%t3%e%p1%d%;m,
sgr=%?%p9%t\E(0%e\E(B%;\E[0%?%p6%t;1%;%?%p2%t;4%;%?%p1%p3%|%t;7%;%?%p4%t;5%;%?%p7%t;8
↪%;m,
sgr0=\E(B\E[m, smacs=\E(0, smam=\E[?7h, smcup=\E[?1049h,
...
```

and becomes:

```
...
rin=\E[%p1%dT, rmacs=\E(B, rmam=\E[?7l,
rmir=\E[4l, rmkx=\E[?1l\E>, rmm=\E[?1034l, rmso=\E[27m,
rmul=\E[24m, rs1=\Ec, rs2=\E[!p\E[?3;4l\E[4l\E>, sc=\E7,
setab=\E[4%p1%dm, setaf=\E[3%p1%dm,
setb=\E[4%?%p1%{1}%=%t4%e%p1%{3}%=%t6%e%p1%{4}%=%t1%e%p1%{6}%=%t3%e%p1%d%;m,
setf=\E[3%?%p1%{1}%=%t4%e%p1%{3}%=%t6%e%p1%{4}%=%t1%e%p1%{6}%=%t3%e%p1%d%;m,
sgr=%?%p9%t\E(0%e\E(B%;\E[0%?%p6%t;1%;%?%p2%t;4%;%?%p1%p3%|%t;7%;%?%p4%t;5%;%?%p7%t;8
↪%;m,
```

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```
sgr0=\E(B\E[m, smacs=\E(0, smam=\E[?7h,
...
```

`rmcup` and `smcup` edited out. (*The end bits of the first and last lines of the listing.*)

After the tic command completes, there is a shiny new local `/home/btiffin/.terminfo/x/xterm-256color` compiled terminfo file that has no alternate terminal screen capabilities. All output will happen in the primary screen buffer. I see no downside to this.

As long as you don't run the *terminal info compiler*, `tic`, as *root*, the files in `/usr/share/terminfo/...` will still be the originals, and a new local copy is made. `tic` will overwrite the system file if it can, but will move on and create a local compiled file, if it cannot write to the system. Until you are sure, best to run this locally and not as the superuser.

The script in Sam's blog, mentioned above, will alleviate doing this manually every time the system updates the terminfo database.

So now, code like the following that displays data on line 2, column 12 and line 3, column 13

```
identification division.
program-id. helloscreen.
procedure division.
display "Hello, world" at 0212
display "Goodbye, smcup/rmcup" at 0313
goback.
end program helloscreen.
```

and then the command below; *which still blanks the screen, but now leaves output on the terminal after goback.*

```
[btiffin@home forum]$ ./helloscreen

       Hello, world
        Goodbye, smcup/rmcup
[btiffin@home forum]$
```

GnuCOBOL displays things using advanced terminal capabilities, but leaves the data on screen after image exit.

Never worry about smcup/rmcup hate on curses init again. Not just GnuCOBOL and curses, but `vi`, `less`, `man` and any other alternate screen application. For the win. This change effects old school TE TI termcap calls too.

Curses will still play havoc with screen section programs in pipes; as stdin, stdout are a little special with curses involved. This is a minor annoyance that won't come up as often and piping screen interactive programs has always been laden in voodoo anyway.

3.21 What are the GnuCOBOL compiler run-time limits?

This may well be a long term entry, updated as facts come in

Some limits are only found by careful examination of code.

For instance, field names are limited to 31 characters, unless `-frelax-syntax` is used in which case the maximum is 61.

Some limits are enumerated.

3.21.1 libcob/common.h

From `libcob/common.h` May 2014

```
/* Buffer size definitions */

#define COB_MINI_BUFF           256
#define COB_SMALL_BUFF          1024
#define COB_NORMAL_BUFF         2048
#define COB_FILE_BUFF           4096
#define COB_MEDIUM_BUFF         8192
#define COB_LARGE_BUFF          16384
#define COB_MINI_MAX            (COB_MINI_BUFF - 1)
#define COB_SMALL_MAX           (COB_SMALL_BUFF - 1)
#define COB_NORMAL_MAX          (COB_NORMAL_BUFF - 1)
#define COB_FILE_MAX            (COB_FILE_BUFF - 1)
#define COB_MEDIUM_MAX          (COB_MEDIUM_BUFF - 1)
#define COB_LARGE_MAX           (COB_LARGE_BUFF - 1)

/* Perform stack size */
#define COB_STACK_SIZE          255

/* Maximum size of file records */
#define MAX_FD_RECORD           65535

/* Maximum number of parameters */
#define COB_MAX_FIELD_PARAMS    36

/* Maximum number of field digits */
#define COB_MAX_DIGITS          38

/* Max digits in binary field */
#define COB_MAX_BINARY          39

/* Maximum number of cob_decimal structures */
#define COB_MAX_DEC_STRUCT      32

/* Maximum group and single field size */
#define COB_MAX_FIELD_SIZE      268435456

...
```

How configurable are these, when needs press? Change developer would need to comb over the run-time, to make sure there aren't hidden assumptions.

For instance, MAX_FIELD_PARAMS, is included in a field by field copy in `libcob/call.c` indexed by number. Change to that value would need other source changes in support.

Umm, start mucking around with MAX_DIGITS, and expect to comb over a LOT of GNU Cobol source. The first 500 lines of `libcob/common.h` is optimization macros, let alone the hooks in numeric.c, move, and on and on into the big blue. Or, read this, go, "oh yeah? I can write that." and show me up *while enhancing the world*.

COBOL fields (and group total) can be 258 megabytes, COB_MAX_FIELD_SIZE.

MAX_FD_RECORD limits are likely entangled by external forces, and again, more reading if you want to change this.

Terminal buffer is MEDIUM_BUFF, 8K, as is the free form line limit.

Environment variable lookup space is LARGE_BUFF, so 16K.

Details are usually gleaned with a `grep` across the source tree.

3.22 What are the GnuCOBOL run-time environment variables?

COB_LEGACY Effect screen attributes for non input fields when set to Y.

COB_LIBRARY_PATH Augments the run time DSO search path.

COB_LS_NULLS Inserts a 0 byte before any x value less than x'20' when set to Y. From asking around, this is very likely related to legacy print file support. *I may be rumour mongering, but I trust the sources*.

COB_LS_FIXED Writes to LINE SEQUENTIAL files will be padded with spaces to the FD length when set to Y.

COB_PRE_LOAD A colon separated list of DSO names. This comes in very handy when coming to grips with both foreign libraries and GnuCOBOL dynamic shared object files.

COB_SET_DEBUG Turns on >>D lines when set to Y.

COB_SYNC Explicit flush after writes when set.

GnuCOBOL 1.1 COB_SYNC values:

```
    none of the values below: don't do extra synch - the system (and
additional for indexed files the library used) decide when the buffer
should be written to the file (in general keys are stored more often and
if locking is active more is done) - it is guaranteed to be done on
CLOSE... --> this is the standard and is normally completely fine.

    Y or y: after all file-changes (WRITE, REWRITE, DELETE) do an extra
synch of the indexed files via the library, all other files will receive
an fflush()/)

    P or p: additional send fsync() to all files to be physically written
to disk and wait until this is finished (real slow)
```

GnuCOBOL 2.0 settings

```
    false values: don't do extra synch - the system (and additional for
indexed files the library used) decide when the buffer should be written
to the file (in general keys are stored more often and if locking is
active more is done) - it is guaranteed to be done on CLOSE... --> this is
the standard and is normally completely fine.

    true values or P: after all sucessful file commands nearly identical
to the P option of GnuCOBOL 1.1: if fdatasync() is available use this
(force data write and wait for it but don't force writing of metadata like
last access/write stamps), otherwise use fsync
```

There is an *extreme performance penalty* with `COB_SYNC` set. Be warned.

The setting was added for systems that need files to be immediately written because of likely power outages without UPS, or similar concerns, not for file sharing issues.

For the GnuCOBOL-reportwriter branch, Ron has added code to allow `COB_SYNC` settings on a per-file basis, but until those changes are merged into GnuCOBOL 2.0, the `COB_SYNC` setting is global, and effects all file write operations during a run.

DB_HOME Used by Berkeley DB for file sharing, pointing to file directory.

ESC_DELAY For ncurses, SCREEN SECTION, detection of the ESC key is delayed, allowing for detection of extended keyboard keys, ala Function and cursor keys. Historically, on slow serial lines of old, this delay was set to a noticable value, approaching one second. Now, the delay can be safely set to less than 100 milliseconds, roughly the threshold of human noticeability. export ESC_DELAY=25 being a sane choice.

OCREPORTDEBUG *This is Ron's, it may go away*

- COB_BELL
- COB_DISABLE_WARNINGS
- COB_ENV_MANGLE
- COB_FILE_PATH
- COB_LS_USES_CR
- COB_REDIRECT_DISPLAY
- COB_SCREEN_EXCEPTIONS
- COB_SCREEN_ESC
- COB_SET_TRACE
- COB_SORT_CHUNK
- COB_SORT_MEMORY
- COB_TIMEOUT_SCALE
- COB_TRACE_FILE
- COB_UNIX_LF
- COB_VARSEQ_FORMAT
- LOGNAME
- TEMP
- TMP
- TMPDIR
- USERNAME

3.23 What are the differences between OpenCOBOL 1.1 and GnuCOBOL 1.1?

Thanks to Simon Sobisch, for putting these back port ChangeLog notes together. *Nice*

> the differences of OpenCOBOL 1.1 and GnuCOBOL 1.1 (this release had the temporary name GNU Cobol, but I'll stick to the newer one when referencing it

3.23.1 General:

- test suite and ANSI 85 tests will pass if no ISAM is configured, too (ISAM tests are skipped in this case)
- configure: Added check for using GMP library, better checks for BDB
- included CBL_OC_DUMP for hex-dumping

- security issue: following CVE-2009-4029 distribution tarballs are created with mode 755, not 777
- tarstamp.h includes a printable definition for COB_NUM_TAR_DATE & COB_NUM_TAR_TIME
- name change shows it's really free, not only open-source (like others) and it shows it has a quality that's worth to be GNU
- credits to more of the people involved
- minor fixes of typing errors
- support for icc, better support for IBM390, MSC, BORLANDC, WATCOMC
- remove extraneous include files (most stuff was integrated in libcob.h)
- fix warnings from C compiler when building GnuCOBOL
- compiler configuration files are complete (include every option)

3.23.2 libcob:

- FUNCTIONs: correctly compute RANDOM number [bugs:#72], don't crash on large-scale numbers with INTEGER and MOD, don't loose precision with MOD and REM [bugs:#37]
- ACCEPT DAY OF WEEK fixed
- new system routine C$GETPID
- fix INSPECT converting for SPACE[S] / ZERO[ES] ...
- fixes for UNSTRING: delimited by all delimiter size > 1, see [bugs:#54]; UNSTRING INTO; UNSTRING with multiple variable length fields
- ACCEPT SCREEN: Changed insert key default to off, added environment variable COB_INSERT_MODE, Y or y to get old behaviour (insert default becomes on)
- ACCEPT: fix for PDCurses and numpad in general; new return values Tab = 2007, Back tab = 2008; end key positions to end of data (was end of field), backspace key moves remainder left (inserts space at end or 0 for numerics)
- fix for PDCurses with COLOR_PAIRS
- fixing results for SUBTRACT int FROM PIC S9(n)V9(m) COMP-3, ADD 1 TO PIC S9(n)V9(m) VALUE -0.1, ADD with binary-truncate:no (for example with -std=ibm or std=mf)
- fileio: lineseq_write adds 'n' in some cases (compatibility to MF) - be aware that this changes current behaviour (when WRITE AFTER/BEFORE are mixed)
- fileio: Fix problem to rewrite INDEXED (VBISAM) record with alternate key
- fileio: Prevent runtime crash when ASSIGN is missing in SELECT FILE

3.23.3 cobc:

- new options –info (output of most important configuration/environment details); –list-system (displaying all registered system routines), -A and -Q (add options to C compile / link phase)
- Warn if -Debug is used (because likely -debug was intended)
- support for spaces in path names passed to cobc
- enable linking of already assembled modules for different UNIXes
- FREE: Remove of exception for NULL address (as this is explicit allowed)

- fix incorrect counting of number of digits for "$", "+", and "-" [bugs:#39]
- Lexer was missing comment lines in FREE format, i.e. trying to process "* COPY 12345." and look for "12345" file as a copybook :-)
- Added check for maximum size of group items
- new compiler configuration default-organization: set to either record-sequential (default=old behaviour) or line-sequential
- better warning/error messages

3.23.4 Related

- (closed) Bugs: #37 http://sourceforge.net/p/gnucobol/bugs/37/
- (closed) Bugs: #39 http://sourceforge.net/p/gnucobol/bugs/39/
- (closed) Bugs: #54 http://sourceforge.net/p/gnucobol/bugs/54/
- (closed) Bugs: #72 http://sourceforge.net/p/gnucobol/bugs/72/

3.24 What is runtime.cfg?

`runtime.cfg` is an assistive file the allows control over the run time environment for GnuCOBOL.

Placed in the same directory as the configuration files, `config/runtime.cfg` supports a small domain specific language, for setting and resetting various environment variables that influence a lot of GnuCOBOL features.

You can also include other configuration files, specific for the job at hand.

Valid keywords include:

- setenv
- unsetenv
- include
- includeif
- reset

The settings that will be used during a program run can be seen by using

```
prompt$ cobcrun -r
```

For example:

```
GnuCOBOL 2.0-rc3.0 runtime configuration
 via  /usr/local/share/gnucobol/config/runtime.cfg

 CALL configuration
    : COB_LOAD_CASE         : not set
    : COB_PHYSICAL_CANCEL   : false (default)
    : COB_PRE_LOAD          : not set
    : COB_LIBRARY_PATH      : not set

 File I/O configuration
    : COB_FILE_PATH         : not set
```

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```
    : COB_VARSEQ_FORMAT     : 0 (default)
    : COB_LS_FIXED          : false (default)
    : COB_LS_NULLS          : false (default)
    : COB_SORT_CHUNK        : 256 KB (default)
    : COB_SORT_MEMORY       : 128 MB (default)
    : COB_SYNC              : false (default)

 Screen I/O configuration
    : COB_BELL              : BEEP (default)
    : COB_REDIRECT_DISPLAY  : false (default)
    : COB_SCREEN_ESC        : false (default)
    : COB_SCREEN_EXCEPTIONS : false (default)
    : COB_INSERT_MODE       : false (default)
    : COB_TIMEOUT_SCALE     : 0 (1000) (default)
    : COB_LEGACY            : false (default)
    : COB_EXIT_WAIT         : true (default)
    : COB_EXIT_MSG          : 'end of program, please press a key to exit'
(default)

 Miscellaneous
    : COB_DISABLE_WARNINGS  : false (default)
    : COB_ENV_MANGLE        : false (default)
    : COB_SET_TRACE         : false (default)
    : COB_TRACE_FILE        : not set

 System configuration
 env: USERNAME              : 'btiffin' (set by LOGNAME)
 env: LANG                  : 'en_CA.UTF-8'
    : OSTYPE                : not set
 env: TERM                  : 'xterm'
    : LC_CTYPE              : C
    : LC_NUMERIC            : C
    : LC_COLLATE            : en_CA.UTF-8
    : LC_MESSAGES           : en_CA.UTF-8
    : LC_MONETARY           : en_CA.UTF-8
    : LC_TIME               : en_CA.UTF-8
```

The default `config/runtime.cfg` includes documentation on how each setting works and what environment variable can be used to influence each runtime option.

The filename used is `config/runtime.cfg` or a name set in the environment variable `COB_RUNTIME_CONFIG`.

Please note that these are NOT compile time options, but are set during program initialization. Each run of a program can be different, depending on these settings.

An example from March of 2017. Please see your local copy of `config/runtime.cfg` for specifics, as this file can change from release to release of the GnuCOBOL compiler.

```
# GnuCOBOL runtime configuration
#
# Copyright (C) 2015, 2016 Free Software Foundation, Inc.
# Written by Simon Sobisch, Ron Norman
#
# This file is part of the GnuCOBOL runtime.
#
# The GnuCOBOL runtime is free software: you can redistribute it
# and/or modify it under the terms of the GNU Lesser General Public License
```

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```
# as published by the Free Software Foundation, either version 3 of the
# License, or (at your option) any later version.
#
# GnuCOBOL is distributed in the hope that it will be useful,
# but WITHOUT ANY WARRANTY; without even the implied warranty of
# MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.  See the
# GNU General Public License for more details.
#
# You should have received a copy of the GNU Lesser General Public License
# along with GnuCOBOL.  If not, see <http://www.gnu.org/licenses/>.


#
## General instructions
#

# The initial runtime.cfg file is found in the  $COB_CONFIG_DIR/config
# (  COB_CONFIG_DIR  defaults to  installdir/gnucobol  ).
# The environment variable  COB_RUNTIME_CONFIG  may define a different runtime
# configuration file to read.

# If settings are included in the runtime environment file multiple times
# then the last setting value is used, no warning occurs.

# Settings via environment variables always take precedence over settings
# that are given in runtime configuration files. And the environment is
# checked after completing processing of the runtime configuration file(s)

# All values set to string variables or environment variables are checked
# for  ${envvar}  and replacement is done at the time of the setting.

# Any environment variable may be set with the directive  setenv  .
# Example:  setenv COB_LIBARAY_PATH ${LD_LIBRARY_PATH}

# Any environment variable may be unset with the directive  unsetenv
# (one var per line).
# Example:  unsetenv COB_LIBRARY_PATH

# Runtime configuration files can include other files with the directive
# include.
# Example:  include my-runtime-configuration-file

# To include another configuration file only if it is present use the directive
# includeif.
# You can also use  ${envvar}  inside this.
# Example:  includeif ${HOME}/mygc.cfg

# If you want to reset a parameter to its default value use:
#    reset parametername

# Most runtime variables have boolean values, some are switches, some have
# string values, integer values and some are size values.
# The boolean values will be evaluated as following:
#   to true:          1, Y, ON, YES, TRUE  (no matter of case)
#   to false:         0, N, OFF
# A 'size' value is an integer optionally followed by K, M, or G for kilo, mega
# or giga.
```

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```
# For convenience a parameter in the runtime.cfg file may be defined by using
# either the environment variable name or the parameter name.
# In most cases the environment variable name is the parameter name (in upper
# case) with the prefix  COB_  .

#
## General environment
#

# Environment name:  COB_DISABLE_WARNINGS
#   Parameter name:  disable_warnings
#          Purpose:  turn off runtime warning messages
#             Type:  boolean
#          Default:  false
#          Example:  DISABLE_WARNINGS  TRUE

# Environment name:  COB_ENV_MANGLE
#   Parameter name:  env_mangle
#          Purpose:  names checked in the environment would get non alphanumeric
#                    change to '_'
#             Type:  boolean
#          Default:  false
#          Example:  ENV_MANGLE  TRUE

# Environment name:  COB_SET_TRACE
#   Parameter name:  set_trace
#          Purpose:  to enable to COBOL trace feature
#             Type:  boolean
#          Default:  false
#          Example:  SET_TRACE  TRUE

# Environment name:  COB_TRACE_FILE
#   Parameter name:  trace_file
#          Purpose:  to define where COBOL trace output should go
#             Type:  string
#          Default:  stderr
#          Example:  TRACE_FILE  ${HOME}/mytrace.log

#
## Call environment
#

# Environment name:  COB_LIBRARY_PATH
#   Parameter name:  library_path
#          Purpose:  paths for dynamically-loadable modules
#             Type:  string
#             Note:  the default paths .:/installpath/extras are always
#                    added to the given paths
#          Example:  LIBRARY_PATH    /opt/myapp/test:/opt/myapp/production

# Environment name:  COB_PRE_LOAD
#   Parameter name:  pre_load
#          Purpose:  modules that are loaded during startup, can be used
#                    to CALL COBOL programs or C functions that are part
#                    of a module library
#             Type:  string
```

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```
#             Note:  the modules listed should NOT include extensions, the
#                    runtime will use the right ones on the various platforms,
#                    COB_LIBRARY_PATH is used to locate the modules
#          Example:  PRE_LOAD      COBOL_function_library:external_c_library

# Environment name:  COB_LOAD_CASE
#   Parameter name:  load_case
#          Purpose:  resolve ALL called program names to UPPER or LOWER case
#             Type:  Only use  UPPER  or  LOWER
#          Default:  if not set program names in CALL are case sensitive
#          Example:  LOAD_CASE  UPPER

# Environment name:  COB_PHYSICAL_CANCEL
#   Parameter name:  physical_cancel
#          Purpose:  physically unload a dynamically-loadable module on CANCEL,
#                    this frees some RAM and allows the change of modules during
#                    run-time but needs more time to resolve CALLs (both to
#                    active and not-active programs)
#            Alias:  default_cancel_mode, LOGICAL_CANCELS (0 = yes)
#             Type:  boolean (evaluated for true only)
#          Default:  false
#          Example:  PHYSICAL_CANCEL  TRUE

#
## File I/O
#

# Environment name:  COB_VARSEQ_FORMAT
#   Parameter name:  varseq_format
#          Purpose:  declare format used for variable length sequential files
#                    - different types and lengths precede each record
#                    - 'length' is the data length & does not include the prefix
#             Type:  0   means 2 byte record length (big-endian) + 2 NULs
#                    1   means 4 byte record length (big-endian)
#                    2   means 4 byte record length (local machine int)
#                    3   means 2 byte record length (big-endian)
#          Default:  0
#          Example:  VARSEQ_FORMAT 1

# Environment name:  COB_FILE_PATH
#   Parameter name:  file_path
#          Purpose:  define default location where data files are stored
#             Type:  file path directory
#          Default:  .  (current directory)
#          Example:  FILE_PATH ${HOME}/mydata

# Environment name:  COB_LS_FIXED
#   Parameter name:  ls_fixed
#          Purpose:  Defines if LINE SEQUENTIAL files should be fixed length
#                    (or variable, by removing trailing spaces)
#            Alias:  STRIP_TRAILING_SPACES  (0 = yes)
#             Type:  boolean
#          Default:  false
#          Example:  LS_FIXED TRUE

# Environment name:  COB_LS_NULLS
#   Parameter name:  ls_nulls
```

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```
#          Purpose:  Defines for LINE SEQUENTIAL files what to do with data
#                    which is not DISPLAY type.  This could happen if a LINE
#                    SEQUENTIAL record has COMP data fields in it.
#             Type:  boolean
#          Default:  false
#             Note:  The TRUE setting will handle files that contain COMP data
#                    in a similar manner to the method used by Micro Focus COBOL
#          Example:  LS_NULL = TRUE

# Environment name:  COB_SYNC
#   Parameter name:  sync
#          Purpose:  Should the file be synced to disk after each write/update
#             Type:  boolean
#          Default:  false
#          Example:  SYNC: TRUE

# Environment name:  COB_SORT_MEMORY
#   Parameter name:  sort_memory
#          Purpose:  Defines how much RAM to assign for sorting data
#             Type:  size  but must be more than 1M
#          Default:  128M
#          Example:  SORT_MEMORY 64M

# Environment name:  COB_SORT_CHUNK
#   Parameter name:  sort_chunk
#          Purpose:  Defines how much RAM to assign for sorting data in chunks
#             Type:  size  but must be within 128K and 16M
#          Default:  256K
#          Example:  SORT_CHUNK 1M

#
## Screen I/O
#

# Environment name:  COB_BELL
#   Parameter name:  bell
#          Purpose:  Defines how a request for the screen to beep is handled
#             Type:  FLASH, SPEAKER, FALSE, BEEP
#          Default:  BEEP
#          Example:  BELL SPEAKER

# Environment name:  COB_REDIRECT_DISPLAY
#   Parameter name:  redirect_display
#          Purpose:  Defines if DISPLAY output should be sent to 'stderr'
#             Type:  boolean
#          Default:  false
#          Example:  redirect_display Yes

# Environment name:  COB_SCREEN_ESC
#   Parameter name:  screen_esc
#          Purpose:  Enable handling of ESC key during ACCEPT
#             Type:  boolean
#          Default:  false
#             Note:  is only evaluated if COB_SCREEN_EXCEPTIONS is active
#          Example:  screen_esc Yes

# Environment name:  COB_SCREEN_EXCEPTIONS
```

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```
#   Parameter name:  screen_exceptions
#           Purpose:  enable exceptions for function keys during ACCEPT
#              Type:  boolean
#           Default:  false
#           Example:  screen_exceptions Yes

# Environment name:  COB_TIMEOUT_SCALE
#   Parameter name:  timeout_scale
#           Purpose:  specify translation in milliseconds for ACCEPT clauses
#                     BEFORE TIME value / AFTER TIMEOUT
#              Type:  integer
#                     0 means 1000 (Micro Focus COBOL compatible), 1 means 100
#                     (ACUCOBOL compatible), 2 means 10, 3 means 1
#           Default:  0
#           Example:  timeout_scale 3

# Environment name:  COB_INSERT_MODE
#   Parameter name:  insert_mode
#           Purpose:  specify default insert mode for ACCEPT; 0=off, 1=on
#              Type:  boolean
#           Default:  false
#           Example:  insert_mode Y

# Environment name:  COB_LEGACY
#   Parameter name:  legacy
#           Purpose:  keep behaviour of former runtime versions, currently only
#                     for setting screen attributes for non input fields
#              Type:  boolean
#           Default:  not set
#           Example:  legacy true

# Environment name:  COB_EXIT_WAIT
#   Parameter name:  exit_wait
#           Purpose:  to wait on main program exit if an extended screenio
#                     DISPLAY was issued without an ACCEPT following
#              Type:  boolean
#           Default:  true
#           Example:  COB_EXIT_WAIT off

# Environment name:  COB_EXIT_MSG
#   Parameter name:  exit_msg
#           Purpose:  string to display if COB_EXIT_WAIT is processed, set to ''
#                     if no actual display but an ACCEPT should be done
#              Type:  string
#           Default:  'end of program, please press a key to exit' (localized)
#           Example:  COB_EXIT_MSG ''

# Note: If you want to slightly speed up a program's startup time, remove all
#       of the comments from the actual real file that is processed
```

And the delta between current GnuCOBOL 2.0 and ReportWriter as of January 2017:

```
105a106,114
> # Environment name:  COB_CURRENT_DATE
> #   Parameter name:  current_date
> #           Purpose:  specify an alternate Date/Time to be returned to ACCEPT
clauses
```

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```
> #                     This is used for testing purposes
> #             Alias:  COB_DATE
> #              Type:  Numeric string in format YYYYDDMMHH24MISS
> #           Default:  The operating system date is use
> #           Example:  COB_CURRENT_DATE "2016/03/16 16:40:52"
>
159a169,171
> #                     b32 means 4 byte record length (big-endian)
> #                     l32 means 4 byte record length (little-endian)
> #                     mf  means Micro Focus default
162a175,201
> # Environment name:  COB_VARREL_FORMAT
> #   Parameter name:  varrel_format
> #           Purpose:  declare format to be used for variable length relative
> #                     files (different types and lengths preceding each
record)
> #              Type:  0   means local machine 'size_t'
> #                     b32 means 4 byte record length (big-endian)
> #                     l32 means 4 byte record length (little-endian)
> #                     b64 means 8 byte record length (big-endian)
> #                     l64 means 8 byte record length (little-endian)
> #                     mf  means Micro Focus default
> #                     gc  means GnuCOBOL default (local 'size_t')
> #           Default:  0
> #           Example:  VARREL_FORMAT B32
>
> # Environment name:  COB_FIXREL_FORMAT
> #   Parameter name:  fixrel_format
> #           Purpose:  declare format to be used for fixed length relative
> #                     files (different types and lengths preceding each
record)
> #              Type:  b32 means 4 byte record length (big-endian)
> #                     l32 means 4 byte record length (little-endian)
> #                     b64 means 8 byte record length (big-endian)
> #                     l64 means 8 byte record length (little-endian)
> #                     mf  means Micro Focus default
> #                     gc  means GnuCOBOL default (local 'size_t')
> #           Default:  gc  fixed size with no record length prefix
> #           Example:  FIXREL_FORMAT B32
>
188c227,247
< #           Example:  LS_NULL = TRUE
---
> #           Example:  LS_NULLS = TRUE
>
> # Environment name:  COB_LS_VALIDATE
> #   Parameter name:  ls_validate
> #           Purpose:  Defines for LINE SEQUENTIAL files that the data should
be
> #                     validated. If any record has non-DISPLAY characters
then
> #                     an error status of 30 is returned
> #              Type:  boolean
> #           Default:  true
> #              Note:  The TRUE setting does data validation
> #                     The FALSE setting lets non-DISPLAY characters be
written
```

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```
> #                     If LS_NULLS is set, then LS_VALIDATE is not checked
> #          Example:   LS_VALIDATE = FALSE
>
> # Environment name:   COB_MF_FILES
> #   Parameter name:   mf_files
> #          Purpose:   Declares that all files in the program should follow
> #                     Micro Focus format
> #             Type:   boolean
> #          Default:   false
> #          Example:   MF_FILES = TRUE
253,259d311
<
< # Environment name:   COB_INSERT_MODE
< #   Parameter name:   insert_mode
< #          Purpose:   specify default insert mode for ACCEPT; 0=off, 1=on
< #             Type:   boolean
< #          Default:   false
< #          Example:   insert_mode Y
```

3.25 How do I get the length of a LINE SEQUENTIAL read?

When using `ACCESS MODE IS LINE SEQUENTIAL` the number of bytes read for the current record will be set in an identifier by using an *FD* (page 260) *VARYING* (page 431) `DEPENDING ON` clause.

For example,

```
FD infile
    RECORD IS VARYING IN SIZE FROM 1 TO 65535 CHARACTERS
    DEPENDING ON infile-record-length.
01 infile-record.
   05 infile-data      PIC X OCCURS FROM 1 TO 65535 TIMES
                       DEPENDING ON infile-record-length.
```

That can be shortened to

```
FD infile RECORD VARYING DEPENDING ON infile-record-length.
```

Implicitly set on READ, and controls lengths of *WRITE* (page 433) when explicitly set before a WRITE or *REWRITE* (page 382) operation.

This FD VARYING clause can also be specified with normal SEQUENTIAL (BINARY SEQUENTIAL) access mode, but that mode is more generally used with already known values and fixed length records.

The identifier can be pretty much any *NUMERIC* (page 328) type, but is limited to PIC 9(9) in size, just shy of one billion for record lengths.

3.26 Why can't libcob find my link modules at run-time?

Under normal circumstances, this is not a problem. But, Windows™, GNU/Linux and other operating systems can suffer from a layer of complexity that needs to be overcome for smooth use of dynamic link libraries.

One important issue regarding Ubuntu based distributions of GNU/Linux: A change was made by Canonical™ regarding the link load optimizer, that breaks GnuCOBOL's ability to find dynamic shared objects, by not including hints as to what libraries are required in executables.

Setting

```
export COB_LDFLAGS='-Wl, --no-as-needed'
```

before running `cobc` will work around the problem until new versions of GnuCOBOL 2.0 (or later) make their way into the Ubuntu repositories.

And now for some of the more common complexities that developers face.

Most advanced operating systems include a cache of, and/or, a search path to loadable link modules. This may need to be managed by GnuCOBOL application developers to play well with the operating system at hand.

GNU/Linux uses a fair number of environment variables for controlling the search path and a fairly sophisticated system that manages the *DSO* (page 1319) ecosystem. For historic reasons, almost all the variables and utilities start with LD, as *ld* is the "link LoaDer".

`LD_LIBRARY_PATH` is likely the most commonly used way to manage the search path for loading dynamic shared objects. `LD_RUN_PATH` can also be used, and it hard codes some of the search path in the native executable.

GnuCOBOL adds a layer to the run-time search path with `COB_LIBRARY_PATH` and can pre load libraries through the used of `COB_PRE_LOAD`.

Compile time options can be specified in `COB_LDFLAGS` and the C compiler's `LDFLAGS`.

GnuCOBOL version 2 includes `cobc` command line options that allow custom options to be passed to the underlying C compiler during compilation, which can be used to solve most, if not all, technical challenges.

```
-I <directory>          Add <directory> to copy/include search path
-L <directory>          Add <directory> to library search path
-l <lib>                Link the library <lib>
-A <options>            Add <options> to the C compile phase
-Q <options>            Add <options> to the C link phase
-K <entry>              Generate CALL to <entry> as static
```

For more information see:

- *What is COB_PRE_LOAD?* (page 671)
- *How do I use LD_RUN_PATH with GnuCOBOL?* (page 135)
- *What is COB_LIBRARY_PATH?* (page 867)
- *CALL* (page 219)

More information can be found in some of the more complex example build rules used with things like the SWIG entry at

- *Does GnuCOBOL work with SWIG?* (page 1046)

3.26.1 colons and semi-colons

Here is a note from massimo and Ivan on a SourceForge thread as they were coming to grips with linkage issues on Windows.

The problem:

```
libcob: Cannot find module 'gtk_init'
```

The trial:

```
here following my env variables:

set path=..\bin\;..\runtime_acu;%path%;

:: needed at compile time (serve OLDNAMES.LIB prelevata da
s:\std\wip\generator\include e messa in
s:\std\wip\maw\gnu\gnu_cobol_2.0\mylib\
include=..\include
LIB=..\lib;
PKG_CONFIG_PATH=..\lib\pkgconfig
set COB_LDFLAGS=-Wl,--no-as-needed
(I find out similar issue on linux solved with this)
set COB_LIBS= ..\lib\gtk\*.lib
set COB_LIBRARY_PATH=..\bin;..\runtime_acu;..\lib;.
set COB_CONFIG_DIR=..\config
set COB_PRE_LOAD=..\bin\libgtk-3-0.dll;..\bin\libgdk-3-0.dll;
..\bin\libgobject-2.0-0.dll;
..\bin\libpango-1.0-0.dll;..\bin\libglib-2.0-0.dll;
..\bin\libgdk_pixbuf-2.0-0.dll; acu_io_bridge.dll;..\runtime_acu\wrun32.dll
```

And a little later, a solution:

```
Finally I found out the issue!!!!!

All the values in my set script were separated by ;(semi colon standard
windows) , but mingw want them separated by : (colon standard linux).  I
changed all the ; to : (specially in cob_preload and cob_library_path)
and it worked.

Hope this can be usefull for somenone else.

cheers
Ivan
```

3.27 How do I measure GnuCOBOL performance?

With great care and attention to detail.

Measuring performance is a rather tricky business. There are many pitfalls in gleaning accurate performance information. But for day to day ballpark estimates there are a variety of tools to sate curiousity, from simple to outright complex.

3.27.1 Benchmarks

There are not a lot of publicly available COBOL benchmark programs. This is partly due to the historically closed nature of big business COBOL and partly due to the lack of a free COBOL compiler of GnuCOBOL quality during the long history of COBOL development. That status should change now that GnuCOBOL is more widely available.

One benchmark used with GnuCOBOL is the Telco billing program, listed in the FAQ at *What about GnuCOBOL and benchmarks?* (page 15) from code written by Bill Klein and modified by Roger While. More benchmarking suites will be added to this FAQ as they become known and available.

3.27.2 GNU/Linux

For most of the examples listed below, `anagrams.cob` *was used. Sources for this word sorting application can be found on Rosetta Code at:*

http://rosettacode.org/wiki/Anagrams#COBOL

There are some very easy ways to get a rough measure of GnuCOBOL program performance when running GNU/Linux.

The `time` command is one of the first level entries.

```
prompt$ time cobc -x anagrams.cob

real    0m0.115s
user    0m0.088s
sys     0m0.020s
```

Compiling the code took just over 1/10th of a second from a human perspective with about 2/100ths of a second of measurable time in the Linux kernel, and another 8/100ths of a second in GNU userland. CPU values, I/O and especially I/O waits can influence the `real` value considerably.

```
prompt$ time ./anagrams
2016-04-28T05:16:17.999194355, 000018977 seconds past midnight
25104 words, most anagrams: 05
abel      [abel, able, bale, bela, elba]
acert     [caret, carte, cater, crate, trace]
aegln     [angel, angle, galen, glean, lange]
aeglr     [alger, glare, lager, large, regal]
aeln      [elan, lane, lean, lena, neal]
eilv      [evil, levi, live, veil, vile]
2016-04-28T05:16:18.034565633, 000018978 seconds past midnight

real    0m0.042s
user    0m0.032s
sys     0m0.008s
```

These are very rough estimates, and very dependent on current system activity and a host of other factors. Rough estimates, also limited by available resolution of measurable time slices.

The timestamps displayed by GnuCOBOL started at 17.999 and ended at 18.034, so just over 3/10ths of a second for the run, including all the I/O to disk and screen. Which is pretty close to the 4/10ths reported by `time` for the `real` field. As shown, the code scanned for anagrams from a list of 25104 words, read in from a text file with one word per line.

The `gprof` command is another entry level tool. These profiling feature are added by passing the `-pg` option to the `gcc` compile step when building a GnuCOBOL executable (or object code).

```
prompt$ cobc -x -Q '-pg' anagrams.cob
prompt$ ./anagrams
2016-04-28T05:13:01.894518641, 000018781 seconds past midnight
25104 words, most anagrams: 05
abel      [abel, able, bale, bela, elba]
acert     [caret, carte, cater, crate, trace]
aegln     [angel, angle, galen, glean, lange]
aeglr     [alger, glare, lager, large, regal]
aeln      [elan, lane, lean, lena, neal]
eilv      [evil, levi, live, veil, vile]
2016-04-28T05:13:01.933875670, 000018781 seconds past midnight
```

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```
prompt$ ls -larct
-rwxrwxr-x  1 username groupname  20024 Apr 28 05:05 anagrams
-rw-rw-r--  1 username groupname   2797 Apr 28 05:05 gmon.out

prompt$ gprof anagrams
Flat profile:

Each sample counts as 0.01 seconds.
 no time accumulated

  %   cumulative   self              self     total
 time   seconds   seconds    calls  Ts/call  Ts/call  name
  0.00      0.00     0.00        1     0.00     0.00  anagrams
  0.00      0.00     0.00        1     0.00     0.00  anagrams_
```

The `gcc -pg` compile and link option inserts code to allow for simple function call profiling. This data is captured to `gmon.out` during a run. Turns out the anagram sample ran too fast for `gprof` to pick out much data.

A second level tool is the Linux kernel `perf` tool. It goes much deeper in analysis.

`perf` creates a `perf.data` during recording and pumps out a wide variety of information during reporting. This is a kernel tool as of Linux 2.6.31 (released in 2009), and is still deemed a lightweight performance measurement tool advertised as "*more than just counters*".

Recording a run:

```
prompt$ perf record ./anagrams
2016-04-28T05:23:07.574207248, 000019387 seconds past midnight
25104 words, most anagrams: 05
abel      [abel, able, bale, bela, elba]
acert     [caret, carte, cater, crate, trace]
aegln     [angel, angle, galen, glean, lange]
aeglr     [alger, glare, lager, large, regal]
aeln      [elan, lane, lean, lena, neal]
eilv      [evil, levi, live, veil, vile]
2016-04-28T05:23:07.610477929, 000019387 seconds past midnight
[ perf record: Woken up 1 times to write data ]
[ perf record: Captured and wrote 0.008 MB perf.data (176 samples) ]
```

And then reporting details from the generated `perf.data`:

```
prompt$ perf report --stdio | cat
Warning:
Kernel address maps (/proc/{kallsyms,modules}) were restricted.

# Total Lost Samples: 0
#
# Samples: 176  of event 'cycles'
# Event count (approx.): 127807808
#
# Overhead  Command   Shared Object     Symbol
# ........  ........  ................  ................................
#
    33.08%  anagrams  libcob.so.4.0.0   [.] sort_compare
    14.03%  anagrams  libc-2.21.so      [.] msort_with_tmp.part.0
     7.27%  anagrams  libc-2.21.so      [.] _IO_getc
```

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```
    6.57%  anagrams  libc-2.21.so      [.] __memcpy_sse2
    5.31%  anagrams  libc-2.21.so      [.] __GI___mempcpy
    4.79%  anagrams  anagrams          [.] anagrams_
    2.30%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    2.25%  anagrams  libcob.so.4.0.0   [.] cob_move
    1.99%  anagrams  libc-2.21.so      [.] __GI___qsort_r
    1.99%  anagrams  libc-2.21.so      [.] _int_free
    1.95%  anagrams  libc-2.21.so      [.] __memcmp_sse4_1
    1.32%  anagrams  libcob.so.4.0.0   [.] cob_decimal_get_field
    1.14%  anagrams  libc-2.21.so      [.] __libc_calloc
    1.13%  anagrams  libcob.so.4.0.0   [.] cob_read_next
    1.10%  anagrams  libc-2.21.so      [.] __memmove_ssse3
    0.66%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.66%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.66%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.66%  anagrams  libcob.so.4.0.0   [.] cob_set_exception
    0.66%  anagrams  libgmp.so.10.2.0  [.] __gmpn_add_n
    0.66%  anagrams  libcob.so.4.0.0   [.] _IO_getc@plt
    0.66%  anagrams  libcob.so.4.0.0   [.] __gmpz_set_ui@plt
    0.66%  anagrams  libgmp.so.10.2.0  [.] __gmpz_sizeinbase
    0.66%  anagrams  libcob.so.4.0.0   [.] cob_intr_formatted_current_date
    0.64%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.64%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.54%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.52%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.51%  anagrams  ld-2.21.so        [.] _dl_map_object
    0.50%  anagrams  libcob.so.4.0.0   [.] lineseq_read
    0.50%  anagrams  ld-2.21.so        [.] strcmp
    0.49%  anagrams  libcob.so.4.0.0   [.] cob_malloc
    0.49%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.48%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.48%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.45%  anagrams  libc-2.21.so      [.] __memset_sse2
    0.43%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.42%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.41%  anagrams  libc-2.21.so      [.] memchr
    0.27%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.05%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
    0.01%  anagrams  [unknown]         [k] 0xffffffffxxxxxxxx
```

Showing where the anagram program spent most of its time. `perf` is a kernel tool, and normally needs root access to get at some of the details. Those details are not included in this GNU userspace run and `perf` gave a warning pointing that out.

3.27.3 Other measurement tools

There are a lot of performance measurment tools, but for anything beyond very rough estimates, there needs to be a fair investment in time and attention to detail as each sample is analysed.

For Microsoft Windows, a few searches of MSDN will lead to list of official performance analysis tools that are available to developers on that platform.

For Apple, looking at XCode tools such as `Instruments` will provide a good start at measuring performance of GnuCOBOL executables.

3.27.4 -debug performance implications

Adding `-debug` to a `cobc` command line has very negligible impact on run-time of GnuCOBOL programs. There are quite a few extra C code lines generated, mostly to track section, paragraph and source line number for exception reporting, and there are also boundary checks added and a few other safey measures, but overall they don't add much burden to executables. These C source lines usually compile down to a few small tests or variable settings, and will have little overall impact on performance, except in the most extreme cases of number crunching applications.

The anagrams.cob timing measurments with and without -debug ended up within the margin of error for the values. There was a wider range of timing values between various runs, then was detected by adding -debug, or not.

The GnuCOBOL project recommends compiling programs with -debug, even for production installs. Unless there are mitigating circumstances, the extra protections and ability for GnuCOBOL to report exact line numbers during exceptions are well worth it, and the -debug option is recommended by the project contributors. It's optional and needs to be explicitly requested, but even for production builds, this setting is a recommended practice.

3.28 Are there bugs in GnuCOBOL?

Yes, some.

Not to put GnuCOBOL in the wrong light. It's a capable compiler, but it's not perfect, considering the nearly infinite permutations allowed in COBOL software development. Complexities can sometimes lead to compilation problems. But, in terms of trust, if the compilation succeeds, odds are strongly in favour of the runtime code doing the right thing. GnuCOBOL bugs are most often triggered at compile time, *and there are usually work arounds*. If there are problems with generated code, the problem will usually be immediately evident on initial tests.

If the compilation succeeds, and initial tests succeed, you can place as much faith in GnuCOBOL as any other complex compiler. When more faith is required, the generated C source codes can be passed through a myriad of static analysis and validation programs that are available for free and for fee. Beyond that, the generated assembler listings can be examined, and beyond that, runtime debuggers are always available.

To increase peace of mind, `valgrind` is a very capable tool. *With point releases, the core GnuCOBOL test suite passes without leak, both in compiler and compiled code, or it doesn't ship.*

Almost done with the reputation disclaimers and marketing speak, but two more things needs to be addressed, *and this is not unique to GnuCOBOL.*

```
  15. Disclaimer of Warranty.

  THERE IS NO WARRANTY FOR THE PROGRAM, TO THE EXTENT PERMITTED BY
APPLICABLE LAW.  EXCEPT WHEN OTHERWISE STATED IN WRITING THE COPYRIGHT
HOLDERS AND/OR OTHER PARTIES PROVIDE THE PROGRAM "AS IS" WITHOUT WARRANTY
OF ANY KIND, EITHER EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO,
THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR
PURPOSE.  THE ENTIRE RISK AS TO THE QUALITY AND PERFORMANCE OF THE PROGRAM
IS WITH YOU.  SHOULD THE PROGRAM PROVE DEFECTIVE, YOU ASSUME THE COST OF
ALL NECESSARY SERVICING, REPAIR OR CORRECTION.

  16. Limitation of Liability.

  IN NO EVENT UNLESS REQUIRED BY APPLICABLE LAW OR AGREED TO IN WRITING
WILL ANY COPYRIGHT HOLDER, OR ANY OTHER PARTY WHO MODIFIES AND/OR CONVEYS
THE PROGRAM AS PERMITTED ABOVE, BE LIABLE TO YOU FOR DAMAGES, INCLUDING ANY
GENERAL, SPECIAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF THE
USE OR INABILITY TO USE THE PROGRAM (INCLUDING BUT NOT LIMITED TO LOSS OF
DATA OR DATA BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY YOU OR THIRD
```

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```
PARTIES OR A FAILURE OF THE PROGRAM TO OPERATE WITH ANY OTHER PROGRAMS),
EVEN IF SUCH HOLDER OR OTHER PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF
SUCH DAMAGES.
```

And now on to the realities of some known problems.

Of special note are the edge cases surrounding foreign function interfacing and BY VALUE parameter handling with CALL and PROCEDURE DIVISION USING. COBOL has a very specific, and rigid, view of data types, and it is sometimes tricky mapping that to non-COBOL programs with different features allowed in call frame setup.

`CALL BY VALUE` and `PROCEDURE DIVISION USING BY VALUE` need special care and attention.

When calling `FUNCTION-ID` numeric literals can cause problems, the data is currently passed to the function as a string form. `PIC 9 ANY LENGTH` in the `LINKAGE SECTION` may work, but the best work around is to use intermediate working storage and `MOVE`, as then GnuCOBOL will have explicit data types to work with. Numerical literals currently have no default type with GnuCOBOL User Defined Functions. This will be fixed, but for now, the intermediate working storage method works the best.

User Defined Functions cannot return `POINTER` data, but can return a record that has a `POINTER` as the first field.

```
01 user-pointer USAGE POINTER.

MOVE user-function(user-data) TO user-pointer
```

Will not properly compile. It's a bug, and it will be fixed.

```
01 user-record.
   05 user-pointer USAGE POINTER.

MOVE user-function(user-data) to user-record
```

Will properly compile and execute. Functions are great for returning group items, so the above `RETURNING` block can add all sorts of other fields to the return values for user functions.

In terms of core COBOL, there are still a few bugs that need to be found and fixed, but not many. The NIST testsuite passes with flying colours, the internal integrity checks during compiler builds are extensive and growing.

3.29 How do C data types map to GnuCOBOL data definitions?

Very carefully. The C standard is somewhat ambiguous about data types, with a few specific exceptions.

For the most part, the C standard (and GnuCOBOL is best when used with C99 expectations), defines data types using *at least* qualifiers. A `short` is at least as large as a `char`, possibly larger. An `int` is at least as big as a `short`, and a `long` is at least at big as an `int`. And one of the few exceptions, by standard `sizeof(char)` is 1, by definition. That means a `char` is an 8 bit byte, but the signed/unsigned default is still implementation defined.

Sadly, by C standard `char`, `signed char`, and `unsigned char` are three distinct types. Many people may assume unsigned, and that a C compiler will allow 0 thru 255, and not -128 through 127, but you need to look at the implementation details. This author is a *gcc* user, and GNU C implements `char` as `signed char`.

```
#include <stdio.h>

int
main(int argc, char** argv)
{
    char c;
```

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```
    c = 127;
    printf("%d\n", c);
    c += 1;
    printf("%d\n", c);
    c += 1;
    printf("%d\n", c);
    return 0;
}
```

Which produces:

```
prompt$ gcc chars.c
prompt$ ./a.out
127
-128
-127
```

Yayy, C standard.

COBOL is rarely ambiguous. A `BINARY-CHAR` is an 8 bit byte, defaulting to `SIGNED` unless otherwise specified with an `UNSIGNED` qualifier. By spec.

A `BINARY-SHORT` is 16 bits, again `SIGNED` unless otherwise specified.

A `BINARY-LONG` is 32 bits, `SIGNED`.

A `BINARY-DOUBLE` is 64 bits, `SIGNED` by default.

So, when coding to a *C* `long`, the native system may compile 16 bits, 32 bits, or 64 bits `signed` by default. Only `char` suffers from no specified `signed` or `unsigned` default. (In extreme cases you might even get an 8 bit `long` quantity, but by then you are likely programming embedded chips and probably know more about what you are doing than most developers). What this all means is that mapping from COBOL to C is a little bit hit or miss and hard to get completely cross platform results without building in a knowledge base of target systems (or writing a support tool that compiles native C and then modifies compiler directives to pass in COBOL preprocessor defines, or some such).

By and large we get away with

8 bit char, 16 bit short, 32 bit int, and 64 bit long. For robust software, that doesn't really cut it, and for interfacing to C it becomes a bit of a shell game. One of the more notorious culprits is Microsoft C Win64. A pointer is 64 bits, a `long int` is 32 bits and a `long long int` is 64 bits. By that convention I guess a 128 bit integral value will be `long long long long int`, and the kids will really be up against it. 96 bits being a `long long long int`. Current standards are leaving the ambiguous definitions and adding more sane type names. C99 defines explicit `uint8_t`, `uint_16`, etcetera. The future may not be as bleak as `long long long long int`. But C99 also adds `uint_fast8_t` and `int_least64_t` style unfixed width types, so perhaps the games get to continue. Who wouldn't want to use `..fast..`, sounds fast.

GnuCOBOL has an extension `BINARY-C-LONG`, that compiles the right size for a *C* `long`, (by knowing what the target C compiler is and, well, just knowing, by rote built in knowledge base).

More fortunately, the floating point types are little more sane, COBOL `FLOAT-SHORT` is a *C* `float` and a `FLOAT-LONG` is a *C* `double`. Then again, COBOL isn't really a friend of binary floating point, built instead for robust support of decimal arithmetic.

3.29.1 Structures

C usually pads structures for optimal CPU performance. An 8 bit field followed by a 32 bit field will usually leave 3 bytes of padding to align the 32 field on a mod 4 base address. COBOL is not defined that way, record groups are contiguous, normally. GnuCOBOL supports the *SYNCHRONIZED* (page 417) data attribute clause, or `SYNCH`

for short. The compiler will pad grouped fields that are marked as `SYNCH` to match the assumptions of the native C compiler.

3.30 Is it possible to create statically linked GnuCOBOL executables?

Yes, with a little effort in terms of the *tectonics* (page 1350).

Note: This was only tested with Xubuntu 16.04 GNU/Linux, on a 64bit machine with GCC 5.4 and GnuCOBOL 2.0-rc3 configured with –with-vbisam.

And a reminder from Simon about the differences between static and dynamic linking in terms of licensing:

Attention: For static linking make sure to get the license dependencies right - they often differ when you want to statically link a library. See COPYING.LESSER or the nice summary at https://www.gnu.org/licenses/gpl-faq.html#LGPLStaticVsDynamic

And this is only the part for libcob, libvbisam, libc, libgmp (all licensed as LGPL) - you'd have to recheck the other dependencies.

In short: if you want to ship the executable as one file you will also have to provide all *object files* of your generated COBOL source (or the source, whatever you like more) as this would allow the user to relink it with a modified version. This is not necessary if you let GnuCOBOL be installed on the system beforehand and just use this version for dynamic library loading.

Simon

Because GnuCOBOL is built using autotools and integrated libtool, there is a static version of libcob.a created during source builds. With a small change to the tool chain calls, the generated C files can be used to build a statically linked executable.

It comes down to using `-Wl,-Bstatic` and `-Wl,-Bdynamic` wrapped around the `-lcob` portion of the final compile pass.

This is fairly easy to get at when using `-v -save-temp` options on an initial `cobc` compile and then capturing the steps for use in a second pass.

For instance, using the following simple COBOL program:

```
*>GCOB
       identification division.
       program-id. statically.

       procedure division.
       display "statically linked"

       goback.
       end program statically.
```

statically.cob

And then an initial pass to get at the tool chain steps:

```
prompt$ cobc -x -v -save-temp statically.cob
cobc (GnuCOBOL) 2.0-rc3.0
```

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```
Built     Feb 24 2017 13:48:33  Packaged  Nov 05 2016 15:27:33 UTC
C version "5.4.0 20160609"
loading standard configuration file 'default.conf'
command line:   cobc -x -v -save-temp statically.cob
preprocessing:  statically.cob -> statically.i
return status:  0
parsing:        statically.i (statically.cob)
return status:  0
translating:    statically.i -> statically.c (statically.cob)
executing:      gcc -c -I/usr/local/include -Wno-unused -fsigned-char
                -Wno-pointer-sign -pipe -o "statically.o" "statically.c"
return status:  0
executing:      gcc -Wl,--export-dynamic -o "statically" "statically.o"
                -Wl,--no-as-needed -L/usr/local/lib -lcob -lm
                -lvbisam -lgmp -lncurses -ldl
return status:  0
```

Capturing the critical lines in a Makefile (to avoid a little typing):

```
# Creating a static libcob executable
.RECIPEPREFIX = >

statically: statically.cob
> cobc -save-temp -x statically.cob
> gcc -c -I/usr/local/include -Wno-unused -fsigned-char \
      -Wno-pointer-sign -pipe -g -o "statically.o" "statically.c"
> gcc -o "statically" "statically.o" -Wl,--no-as-needed \
      -L/usr/local/lib -Wl,-Bstatic -lcob -lvbisam \
      -Wl,-Bdynamic -lm -lgmp -lncurses -ldl
```

This version wraps the -lcob (and -lvbisam) for a static link. All the other dependencies are left as dynamic.

Now, a second pass:

```
prompt$ make -B statically
cobc -save-temp -x statically.cob
gcc -c -I/usr/local/include -Wno-unused -fsigned-char \
    -Wno-pointer-sign -pipe -g -o "statically.o" "statically.c"
gcc -o "statically" "statically.o" -Wl,--no-as-needed \
    -L/usr/local/lib -Wl,-Bstatic -lcob -lvbisam \
    -Wl,-Bdynamic -lm -lgmp -lncurses -ldl
```

The source is still passed to `cobc` (to ensure a proper preprocessor pass and C intermediate code generation) and then a second set of `gcc` commands is used to tweak the outcome. The result is a much larger binary with `libcob.a` and `libvbisam.a` built in.

```
prompt$ ls -go statically
-rwxrwxr-x 1 969264 Feb 24 17:50 statically

prompt$ ldd statically
        linux-vdso.so.1 =>  (0x00obfuscated)
        libm.so.6 => /lib/x86_64-linux-gnu/libm.so.6 (0x00obfuscated)
        libgmp.so.16 => /usr/local/lib/libgmp.so.16 (0x00obfuscated)
        libncurses.so.5 => /lib/x86_64-linux-gnu/libncurses.so.5 (0x00obfuscated)
        libtinfo.so.5 => /lib/x86_64-linux-gnu/libtinfo.so.5 (0x00obfuscated)
        libdl.so.2 => /lib/x86_64-linux-gnu/libdl.so.2 (0x00obfuscated)
```

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```
        libc.so.6 => /lib/x86_64-linux-gnu/libc.so.6 (0x00obfuscated)
        /lib64/ld-linux-x86-64.so.2 (0x00obfuscated)
```

`libcob` and `libvbisam` are not listed. This is compared to a normal compile of:

```
prompt$ cobc -x statically.cob
prompt$ ls -go statically
-rwxrwxr-x 1 13408 Feb 24 17:52 statically

prompt$ ldd statically
        linux-vdso.so.1 =>  (0x00obfuscated)
        libcob.so.4 => /usr/local/lib/libcob.so.4 (0x00obfuscated)
        libm.so.6 => /lib/x86_64-linux-gnu/libm.so.6 (0x00obfuscated)
        libvbisam.so.1 => /usr/local/lib/libvbisam.so.1 (0x00obfuscated)
        libgmp.so.16 => /usr/local/lib/libgmp.so.16 (0x00obfuscated)
        libncurses.so.5 => /lib/x86_64-linux-gnu/libncurses.so.5 (0x00obfuscated)
        libtinfo.so.5 => /lib/x86_64-linux-gnu/libtinfo.so.5 (0x00obfuscated)
        libdl.so.2 => /lib/x86_64-linux-gnu/libdl.so.2 (0x00obfuscated)
        libc.so.6 => /lib/x86_64-linux-gnu/libc.so.6 (0x00obfuscated)
        /lib64/ld-linux-x86-64.so.2 (0x00obfuscated)
```

Both copies have the same result (although the first copy is actually a normal dynamically linked binary and the display message isn't very truthful):

```
prompt$ cobc -x statically.cob
prompt$ ./statically
statically linked

prompt$ make -B statically
prompt$ ./statically
statically linked
```

To show that the new Makefile rule can be used after source code changes, let's create a more informative program.

```
*>GCOB
       identification division.
       program-id. statically.

       procedure division.
       display "static linking of libcob"
       call "SYSTEM" using "ls -go statically"
       goback.
       end program statically.
```

And (without changing the Makefile, as the modified commands follow an initial `cobc` pass, which will generate new intermediates before invoking the second phase):

```
prompt$ make -B statically
cobc -save-temp -x statically.cob
gcc -c -I/usr/local/include -Wno-unused -fsigned-char \
    -Wno-pointer-sign -pipe -g -o "statically.o" "statically.c"
gcc -o "statically" "statically.o" -Wl,--no-as-needed \
    -L/usr/local/lib -Wl,-Bstatic -lcob -lvbisam \
    -Wl,-Bdynamic -lm -lgmp -lncurses -ldl

prompt$ ./statically
```

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```
static linking of libcob
-rwxrwxr-x 1 969312 Feb 24 18:05 statically
```

Followed by a normal dynamic compile, and a much smaller executable:

```
prompt$ cobc -xj statically.cob
static linking of libcob
-rwxrwxr-x 1 13480 Feb 24 18:06 statically
```

With a little bit of prep work, GnuCOBOL can be used to produce native executables that do not depend on a GnuCOBOL installation on the target machine. (Assuming a compatible platform, 64bit/32bit, similar operating system, etc).

Attention: Even though this process can create shippable binaries, be wary of any and all component licensing when distributing code. Almost all default components of GnuCOBOL are GPL/LGPL but other external dependencies may include other licensing and distribution responsibilities. Static and dynamic linking are usually treated differently when it comes to licensing obligations.

3.31 Is there a good text editor for GnuCOBOL development?

Yes, many. This answer will be woefully incomplete given the amount of choice available.

3.31.1 Vim

Author's choice. Very good support for GnuCOBOL syntax highlighting, loading new file templates, and just all round great text editing. See *Does Vim support GnuCOBOL?* (page 865) for a lot more details.

3.31.2 Emacs

The world's other best text editor. Especially when used with the Emacs VIm Layer.

3.31.3 THE

The Hessling Editor. This one should make anyone coming from the mainframe environment feel right at home. Supports look and feel modes for XEDIT/KEDIT/ISPF and a few other specialties. A command based terminal user interface editor packed with power. Handles fixed length text (no new line), knows about EBCDIC and ASCII, supports REXX scripting and includes COBOL highlighting.

See http://hessling-editor.sourceforge.net/ for downloads and documentation.

Some quick hints for highlighting:

- `'set parser cobol cobol'` to load a COBOL highlighter
- `'set autocolour *.cob cobol'` to automatically highlight .cob files.

THE ships with a COBOL token highlighter, but it is not loaded by default. The default `cobol.tld` is best used with `FORMAT FIXED` source code.

3.31.4 KDE Advanced Text Editor

Kate. Supports COBOL quite well, and recently gained Vim modal editing powers. A GUI editor with pseudo console features. See *Kate* (page 1396) for a more detailed write up.

3.31.5 Notepad++

Developers on Windows might want to take a look at Notepad++, a well received text editor on that platform.

3.31.6 Others

There are many. The editors mentioned above is just scratching the surface.

Also see *Does GnuCOBOL have an IDE?* (page 29) for alternatives to using a simple text editor for GnuCOBOL development.

3.32 How can I properly manage numeric fields with extended screen IO?

This covers both SCREEN SECTION and extended ACCEPT and DISPLAY.

It turns out to be a little bit technical. There is a difference in the way that the runtime engine handles data accepted from screens and console mode.

Extended IO requires USAGE DISPLAY, and is not yet capable of editing "by PICTURE". There is an extra step (or two) required to get numeric data from screens into properly aligned working storage. For instance, decimal point handling needs a little bit of extra code.

Eugenio Di Lorenzo has written up an example to demonstrate:

```
       >>SOURCE FORMAT IS FREE
IDENTIFICATION DIVISION.
program-id. GCACCEPT9.
*>
*****************************************************************************
*> GnuCOBOL
*> Purpose:    SHOWS HOW TO ACCEPT & CHECK A NUMBER WITH DCIMALS & SIGN FROM A
FILED ON SCREEN
*> Tectonics:  cobc -x GCACCEPT.COB  (use GnuCOBOL 2.0 or greater)
*> Usage:      GCACCEPT
*> Author:     Eugenio Di Lorenzo - Italia (DILO)
*> License:    Copyright 2017 E.Di Lorenzo - GNU Lesser General Public License, LGPL,␣
↪3.0 (or greater)
*> Version:    1.0 2017.03.01
*> Changelog:  1.0 first release.
*>
*****************************************************************************
ENVIRONMENT DIVISION.
Configuration Section.
 SPECIAL-NAMES.
   CRT STATUS IS wKeyPressed
   Decimal-Point is Comma.
```

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```
DATA DIVISION.
WORKING-STORAGE SECTION.
78  K-ESCAPE      VALUE 2005.

01 black   constant as 0.
01 blue    constant as 1.
01 green   constant as 2.
01 cyan    constant as 3.
01 red     constant as 4.
01 magenta constant as 5.
01 yellow  constant as 6.
01 white   constant as 7.
01 pro         pic X value  '_'.
01 wKeyPressed pic 9999.

01 wRetCode    PIC 9999.

*>
*****************************************************************************
*> HOW IT WORKS:
*>
*****************************************************************************
*> Field9 is your numeric field you have to accept and next you can store for example␣
↪in a file
*> in this example it is PIC S9(7)V99 = 9 bytes, 7 integers & 2 decimals signed
*> FieldX is the field you have to use in the ACCEPT statement
*> in this example it is 11 bytes = 9 digits + the sign (+ or -) + the comma
*> FieldZ is a working filed to display the number on screen after the ACCEPT (11␣
↪bytes)
*> it is same length than FieldX but it is edited

01 Field9   PIC S9(7)V99. *> this is the numeric field (example to be stored in a␣
↪file)
01 FieldX   PIC X(11).
01 FieldZ   PIC -(7)9,99. *> max edited number is -9999999,99 (11 chars)


*> ************************************************************
*>          P R O C E D U R E   D I V I S I O N
*> ************************************************************
PROCEDURE DIVISION.
  *> sets in order to detect the PgUp, PgDn, PrtSc(screen print), Esc keys,
  set environment 'COB_SCREEN_EXCEPTIONS' TO 'Y'.
  set environment 'COB_SCREEN_ESC'        TO 'Y'.

  display 'GnuCOBOL - HOW TO MANAGE NUMERIC DATA ON SCREEN'
                                    at 0205 with  Background-Color white Foreground-
↪Color blue reverse-video
  display '-------------------------------------------'
                                    at 0305 with  Background-Color white Foreground-
↪Color blue reverse-video
  display 'Type an amount .....:'   at 0505 with  Background-Color white Foreground-
↪Color blue reverse-video
  display 'signed with 2 decimals'  at 0540 with  Background-Color white Foreground-
↪Color blue reverse-video
  display '12345678901'             at 0627 with  Background-Color white Foreground-
↪Color blue reverse-video
```

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```
  display '(decimal point is comma)' at 0640 with  Background-Color white Foreground-
↪Color blue reverse-video
  display 'ESC = EXIT'               at 2305 with  Background-Color white Foreground-
↪Color blue reverse-video
  .
Accept-Field.
  accept FieldX at 0527 with  Background-Color blue Foreground-Color cyan
         update prompt character is pro auto-skip reverse-video

  if wKeyPressed = K-ESCAPE go to End-Program end-if

*> INTRINSIC FUNCTION: TEST-NUMVAL(STRING)
*> ---------------------------------------
*> tests the given string for conformance to the rules used by intrinsic FUNCTION␣
↪NUMVAL.
*> Returns 0 if the value conforms, a character position of the first non conforming␣
↪character,
*> or the length of the field plus one for other cases such as all spaces.
*> example: you can type +123,44 (is ok) ; -145,,23 (is ko) ; 123- (is ok) etc
  move function test-numval(FieldX) to wRetCode
  display  'RetCode.............:' at 1305 with  Background-Color white Foreground-
↪Color blue reverse-video
  display  wRetCode   at 1334 with  Background-Color white Foreground-Color blue␣
↪reverse-video

  display ' '
        at 1505 with  Background-Color white Foreground-Color black reverse-video

  if wRetCode > length of FieldX
     *> the field is empty ! program move zero to the field
     move zero to FieldX

     move function numval(FieldX) to Field9 FieldZ
     *> following statement is used to display the amount on screen after the ACCEPT
     move FieldZ to FieldX
     display FieldX                              at 0527 with  Background-Color white␣
↪Foreground-Color blue reverse-video

     display 'correct format number '            at 1505 with  Background-Color white␣
↪Foreground-Color green reverse-video
     display '=> empty field ! forced to ZERO.' at 1520 with  Background-Color red  ␣
↪Foreground-Color green reverse-video
     display 'Edited Number.......:'                 at 0905 with Background-Color␣
↪white Foreground-Color blue reverse-video
     display  FieldZ                                 at 0927 with Background-Color␣
↪white Foreground-Color blue reverse-video
     display 'Number in memory....:'                 at 1105 with Background-Color␣
↪white Foreground-Color blue reverse-video
     display  Field9                                 at 1129 with Background-Color␣
↪white Foreground-Color blue reverse-video
     display 'PIC S9(7)V99 = 9 bytes, 7 int & 2 dec.' at 1140 with Background-Color␣
↪white Foreground-Color blue reverse-video
  else
     *> field is not empty
     if wRetCode not = ZERO
        *> field is not correct
        display 'incorrect format number '           at 1505 with Background-Color␣
↪white Foreground-Color red reverse-video
```

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```
        display '- 1st wrong character at position: ' at 1529 with Background-Color␣
↪white Foreground-Color red reverse-video
        display wRetCode                              at 1564 with Background-Color␣
↪white Foreground-Color red reverse-video
     else
        *> field is correct

        move function numval(FieldX) to Field9 FieldZ
        *> following statement is used to display the amount on screen after the␣
↪ACCEPT
        move FieldZ to FieldX
        display FieldX                              at 0527 with Background-Color␣
↪white Foreground-Color blue reverse-video

        display 'correct format number '                at 1505 with Background-
↪Color white Foreground-Color green reverse-video
        display 'Edited Number.......:'                 at 0905 with Background-
↪Color white Foreground-Color blue reverse-video
        display  FieldZ                                 at 0927 with Background-
↪Color white Foreground-Color blue reverse-video
        display 'Number in memory....:'                 at 1105 with Background-
↪Color white Foreground-Color blue reverse-video
        display  Field9                                 at 1129 with Background-
↪Color white Foreground-Color blue reverse-video
        display 'PIC S9(7)V99 = 9 bytes, 7 int & 2 dec.' at 1140 with Background-
↪Color white Foreground-Color blue reverse-video

      end-if
  end-if

 go Accept-Field
 .
End-Program.
 goback.

*>
*****************************************************************************************
*> HOW TO MANAGE A SIGE NUMERIC FIELD ON SCREEN (short form whitout demo statements)
*>
*****************************************************************************************
*>  display 'Type an amount .....:'  at 0505 with  Background-Color white Foreground-
↪Color blue reverse-video
*>  .
*>Accept-Field.
*>  accept FieldX at 0527 with  Background-Color blue Foreground-Color cyan
*>         update prompt character is pro auto-skip reverse-video
*>  if function test-numval(FieldX) > length of FieldX
*>     move zero to FieldX
*>     move function numval(FieldX) to Field9 FieldZ
*>     move FieldZ to FieldX
*>     display FieldX  at 0527 with Background-Color white Foreground-Color blue␣
↪reverse-video
*>  else
*>     if function test-numval(FieldX) not = ZERO
*>        display 'incorrect format number ' at 1505 with  Background-Color white␣
↪Foreground-Color red reverse-video
*>        go to Accept-Field
```

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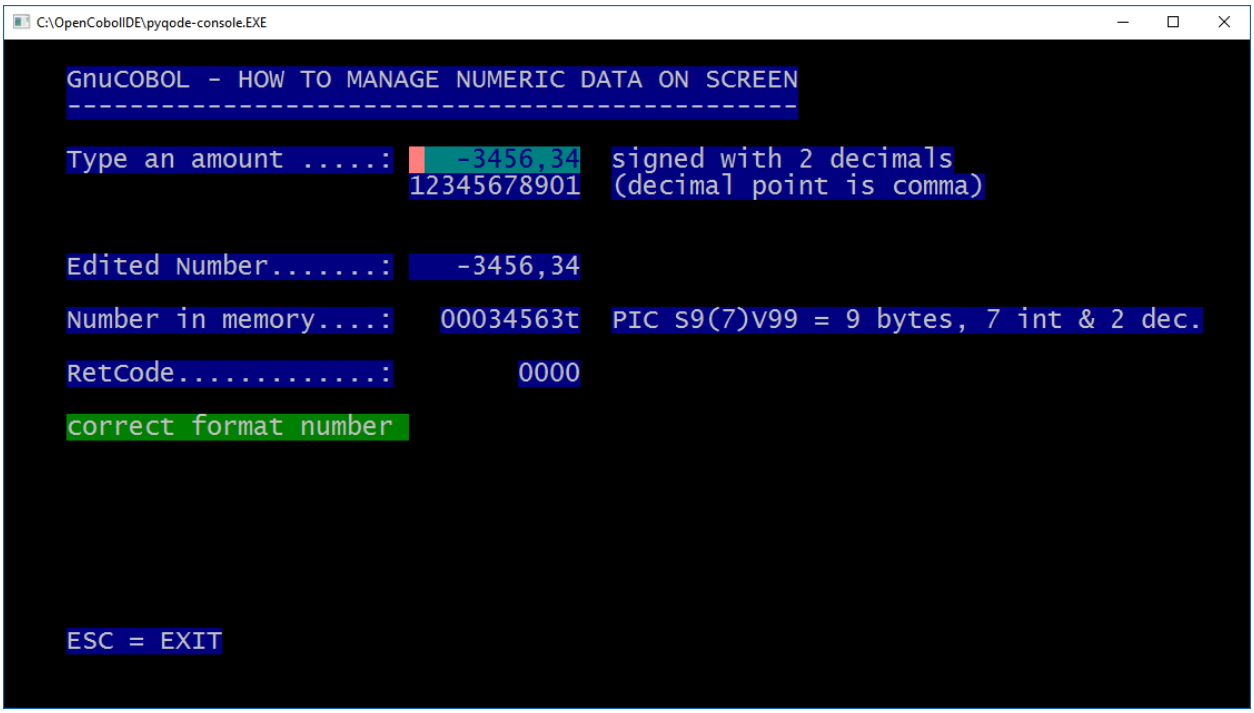
```
*>       else
*>        move function numval(FieldX) to Field9 FieldZ
*>        move FieldZ to FieldX
*>        display FieldX at 0527 with Background-Color white Foreground-Color blue␣
↪reverse-video
*>      end-if
*>  end-if
```

With a screen shot of the code in action:



3.33 Does GnuCOBOL support reference modification?

Yes. Usually referred to as “refmod”.

Reference modification is a field access modifier added in COBOL-85.

```
field(offset : length)
```

Only a segment of the field is returned, starting at *offset* for the given *length*.

```
01 some-field PIC x(10) VALUE "abcdefghij".

...

DISPLAY some-field
DISPLAY some-field(1:5)
DISPLAY some-field(6:5)
DISPLAY some-field(8:)
```

Shows:

```
abcdefghij
abcde
fghij
hij
```

The last code line shows that the default width, if left blank, is "the rest of the field".

That refmode syntax can also be used in combination with subscripts:

```
table-field(current-index)(offset : length)
```

And with other name qualifiers:

```
table-field OF account-group(current-index)(offset IN accounts : len)
```

Note that it is offset : length, *not* start : end.

And don't use "length" in actual code as *LENGTH* (page 313) is a reserved word.

OF (page 331) and *IN* (page 297) are interchangeable aliases.

Offset is standard COBOL 1 relative ordinal numbering, the first position is 1.

The width, if left blank is computed to be the rest of the field given the starting offset and current field size (with *OCCURS* (page 331) *DEPENDING* (page 247) *ON* (page 333) taken into consideration, if applicable).

See below under *debug mode bounds checking* (page 173) for the impact of values that are outside the bounds of the current field size; either by starting at an invalid offset, or for a width that exceeds the size of the field.

3.33.1 reference modification expressions

refmod is one of the few places (outside of *COMPUTE* (page 233)) that COBOL syntax allows compile time/run time arithmetic expressions. The offset and length can be arbitrarily complex computations (upto a compiler limit; at time of writing, 32 stacked (nested) operations per expression).

```
DISPLAY some-field( 1 + 2 + 3 : 4 + 5 * 6 / 4 )
```

COBOL order of precedence rules apply and parenthesis can be used to group and control the order of operations.

```
DISPLAY some-field( (1 + 2) * 3 : 4 + 5 * 6 / 4 )
```

Recent versions of GnuCOBOL 2.0 will compute the result of any literal expressions during compile time. Older OpenCOBOL versions did not. All parts of the computation that can be pre-calculated will be compiled in as simple literals.

Variables can also be used.

```
DISPLAY some-field(
           base-offset + current-offset : function length(subject-field))
```

As with any expression, the minus sign dash leads to a need to use proper spacing.

```
DISPLAY some-field(1:a-3)
DISPLAY some-fielf(1:a - 3)
```

Parse as two different things. The first is a reference to identifier **a-3** and the second is identifier **a** minus 3.

Recommendation is to always use full spacing with COBOL expressions.

```
DISPLAY some-field(1 : a-3 + 4 + b - 3)
```

`a-3` and `b` being identifiers in that example.

Spacing around parenthesis is usually a matter of personal taste, or shop standard.

A compiler expression optimization will actually generate code as `a-3 + b -1` for that simple example above, reducing the literal math at compile time.

3.33.2 debug mode bounds checking

One thing to watch for with reference modification is bounds checking.

As with table subscripting, COBOL defaults to no check. That means code can access data outside the actual field storage area when using reference modification.

```
01 some-field PIC x(8).
01 mod-len USAGE BINARY-LONG value 10.

...
DISPLAY some-field(1 : mod-len)
```

That code will display the field data plus 2 character worth of whatever happens to be in memory beyond the end of the field.

With `cobc -debug` that will cause a runtime abend:

```
libcob: refmod.cob: 33: length of 'some-field' out of bounds: 10
```

Literals can be checked at compile time:

```
DISPLAY some-field(1 : 10)

prompt$ cobc -x refmod.cob
refmod.cob: in paragraph 'sample-main':
refmod.cob: 33: error: length of 'some-field' out of bounds: 10
```

That compile time test is defeated when the offset and/or length is in a variable. Invalid access will need to rely of -debug bounds checking in that case. But who wants runtime abends? Show proper care and attention when using refmod features.

If code relies on reference modification to access data outside the space defined for a field, you can't use *-debug* runtime checks available in the `cobc` compiler. So keep those types of routines to a minimum. Compile those segments separately and link the object code, if the source actually requires out of bounds refmod to function properly. *-debug* actually emits extra code for the checks, so you can get away with separately compiled segments and still benefit from all the other runtime check features in most of an application.

Don't write new code that relies on out of bounds refmod. The excuse for that type of code has been superseded by ANY LENGTH qualifiers in the LINKAGE SECTION.

3.34 Does GnuCOBOL support using a mouse?

Yes.

See *How do I enable mouse support in GnuCOBOL programs?* (page 1282) for details.

3.35 What is the GnuCOBOL Enhanced Debugger?

Symas and Camelian are hosting a download of cbl-gdb. Includes a `cobcd` compile wrapper, extensions in GDB for COBOL data access and tracking, and a (not tested here) VSCodium debugger module with vsix technology.

The link as of May 2020 is a personal server; obfuscating the address.

```
http colon slash slash
www dot dubner dot com slash symas slash repos slash cblgdb-2.3.tar.gz
```

Licensed as 3 clause BSD.

3.35.1 Install

After you have done the `tar xvf` of *cblgdb-2.3.tar.gz*, you'll have a `cblgdb-2.3` subdirectory.

The README.md file is short. Requires GnuCOBOL-3.1-dev or later. There are some `cobc` command options added that are required by `cobcd`.

The `./configure` file is not a normal GNU autoconf configure. This is a custom setup script that will do its best to ensure dependencies are in place.

After system setup, type `make`. When that looks good, then `sudo make install`.

3.35.2 Sample

This is from an introductory run (sight as yet unseen).

Using one of the samples in, *samples/ref_test_1/*

```
prompt$ make -B
COBCDEVEL=1 COBCDNOCLEAN=2 COBCDFLAGS=--free COBCDXM=-x ../../cobcd rtest.cbl

prompt$ ./rtest
entering: rtest
Addition result: (should be 4.44): +04.44
Subtraction result: (should be 1.23) +01.23
ABCDEFGHIJKLMNOPQRSTUVWXYZ
```

Normal run. Now for some debug. (gdb -q quiets the banner)

```
prompt$ gdb -q rtest
Reading symbols from rtest...done.
registering CPrint (Usage is "print  <COBOL identifier>") [Version 2.3]
registering CWatch (Usage is "cwatch <COBOL identifier>")
```

Note the COBOL.

```
(gdb) start
Temporary breakpoint 1 at 0x40111b: file rtest.cbl, line 3.
Starting program: /home/btiffin/inst/cblgdb-2.3/samples/ref_test_1/rtest

[Thread debugging using libthread_db enabled]
Using host libthread_db library "/lib64/libthread_db.so.1".

```

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```
Temporary breakpoint 1, 0x000000000040111b in main (argc=0, argv=0x7fffffffdc50) at␣
↪rtest.cbl:3
3       PROCEDURE DIVISION.
```

Note the rtest.cbl:3, and PROCEDURE DIVISION on start.

When following along; GDB displays the source line of the next instruction/source line, not what just happened. The what just happened part is now sitting waiting for print and explore. The next source line is what you are getting ready for at the gdb prompt, I'm mentioning this as the commentary is usually one line behind what the current step line displays. GDB also remembers the last command, and ENTER repeats. All the empty (gdb) prompts are step commands.

```
(gdb) step
0x00007ffff7b8a4d0 in cob_module_global_enter () from /usr/local/lib/libcob.so.4

(gdb)
Single stepping until exit from function cob_module_global_enter,
which has no line number information.
RTEST_ (entry=0) at rtest.cbl:4
4       DISPLAY "entering: rtest".

(gdb)
entering: rtest
5       CALL 'ADD-SUB'.

(gdb)
0x000000000040159b in ADD__SUB () at rtest.cbl:32
32      ADDITION.

(gdb)
0x00007ffff7b8a4d0 in cob_module_global_enter () from /usr/local/lib/libcob.so.4

(gdb)
Single stepping until exit from function cob_module_global_enter,
which has no line number information.
0x00007ffff74f3a70 in memset_ifunc () from /lib64/libc.so.6

(gdb)
Single stepping until exit from function memset_ifunc,
which has no line number information.
0x00007ffff750ccb0 in __memset_sse2_unaligned () from /lib64/libc.so.6

(gdb)
Single stepping until exit from function __memset_sse2_unaligned,
which has no line number information.
ADD__SUB_ (entry=0) at rtest.cbl:33
33      MOVE 1.23 TO WS-ADDEND-1.
```

There is still intermixing of a little libc, I don't mind that. *It turns out there are different ways of interacting with cobcd, and debugging while in GDB can be made a "COBOL only" experience.* GDB allows a lot of customizations and can get set up to meet personal preferences, with personal shortcuts.

```
(gdb) print ws-addend-1
"0000"
```

This prints the value of ws-addend-1, COBOL variable name, in gdb, *before the MOVE*. The source displayed will be the next step in gdb. That print command was done after the source listing, but before the actual step into the `MOVE`

`1.23 TO WS-ADDEND-1` statement.

```
(gdb) step
34      MOVE 3.21 TO WS-ADDEND-2.

(gdb) print ws-addend-1
"0123"
```

The new value, from move to ws-addend-1, next step will be the move to ws-addend-2

```
(gdb) step
35      CALL 'ADD-THEM' USING WS-FOR-ADD.

(gdb) print ws-addend-2
"0321"
```

The value printed, S99V99. And next step will be the sub-program call; followed by a bunch more steps, with the blank "just hit enter to do last command" gdb mode.

```
(gdb) step
0x0000000000401ed0 in ADD__THEM (b_41=0x7fffffffdc50 "\001") at rtest.cbl:65
65      DoTheAddition.

(gdb)
0x00007ffff7b8a4d0 in cob_module_global_enter () from /usr/local/lib/libcob.so.4

(gdb)
Single stepping until exit from function cob_module_global_enter,
which has no line number information.
ADD__THEM_ (entry=0, b_41=0x606160 <b_16> "000001230321") at rtest.cbl:66
66          MOVE LK-PARAM-1 TO LS-Accumulator.

(gdb)
67          ADD  LK-PARAM-2 TO LS-Accumulator.
(gdb)
68          MOVE LS-Accumulator TO LK-RESULT.
(gdb)
69          GOBACK.
(gdb)
ADD__SUB_ (entry=0) at rtest.cbl:36
36      DISPLAY 'Addition result: (should be 4.44): ' WITH NO ADVANCING.
```

More C mixin, but still only a couple of steps worth. This could continue, but it's already a tl;dr. End with a `print *` to see working store.

```
(gdb) print *
  1 : 01 WS-FOR-ADD/ADD-SUB [W-S] : "044401230321"
  2 : 02 WS-SUM/WS-FOR-ADD/ADD-SUB [W-S] : +04.44
  3 : 02 WS-ADDEND-1/WS-FOR-ADD/ADD-SUB [W-S] : "0123"
  4 : 02 WS-ADDEND-2/WS-FOR-ADD/ADD-SUB [W-S] : "0321"
  5 : 01 WS-FOR-SUBTRACT/ADD-SUB [W-S] : "000000000000"
  6 : 02 WS-DIFFERENCE/WS-FOR-SUBTRACT/ADD-SUB [W-S] : +00.00
  7 : 02 WS-MINUEND/WS-FOR-SUBTRACT/ADD-SUB [W-S] : "0000"
  8 : 02 WS-SUBTRAHEND/WS-FOR-SUBTRACT/ADD-SUB [W-S] : "0000"
  9 : 01 TESTER/ADD-SUB [W-S] : "000000000000000000"
 10 : 02 TESTER-02/TESTER/ADD-SUB [W-S] : "000000000000000000"
 11 : 10 TEST-1/TESTER-02/TESTER/ADD-SUB [W-S] : "000000000"
 12 : 20 BOB/TEST-1/TESTER-02/TESTER/ADD-SUB [W-S] : "000000000"
```

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```
 13 : 20 BOB/TEST-2/TESTER-02/TESTER/ADD-SUB [W-S] : "000000000"
 14 : 10 TEST-2/TESTER-02/TESTER/ADD-SUB [W-S] : "000000000"
 15 : 66 BILL/ADD-SUB [W-S] : "000000000"
 16 : 01 LS-ALPHABET/ADD-SUB [L-S] : "                          "
```

Nice.

```
(gdb) cont
Continuing.
Addition result: (should be 4.44): +04.44
Subtraction result: (should be 1.23) +01.23
ABCDEFGHIJKLMNOPQRSTUVWXYZ
[Inferior 1 (process 2683) exited normally]
(gdb)
```

And let it finish up, `cont` being continue.

Didn't exercise the WATCH potential or show off any of the other goodies in this short intro. This, will be a handy tool.

3.36 How do I write a user defined function?

GnuCOBOL supports FUNCTION-ID.

The Standard uses the acronym UDF, User Defined Functions.

To *use* a User defined functions it needs to be explicitly mentioned in the REPOSITORY paragraph of the CONFIGURATION SECTION of any callers.

A user defined function is treated as a separate sub-program, with all four divisions. Starting with IDENTIFICATION DIVISION, but instead of PROGRAM-ID., use FUNCTION-ID..

Functions are not allowed to modify the ENVIRONMENT assumptions of a caller, and many ENVIRONMENT DIVISION paragraphs are disallowed (things like DECIMAL POINT IS, etc).

Data is passed in the LINKAGE SECTION of the DATA DIVISION, including the return value. GnuCOBOL will generate code to allocate memory for the return value inside the function. Memory is not allocated for the input parameters, as is true for most LINKAGE SECTION data references. Even though the return value is mentioned in the LINKAGE SECTION, a programmer does not need to explicitly allocate any memory when setting the return.

User defined functions *must* provide an explicit returning field; COBOL does not provide for void returns in user defined functions. Invoking user defined functions is *always* in the context of a sending field data reference being used by the current COBOL statement. Function return values are never receiving fields. You don't move data *to* the result of a COBOL function, you retrieve data *from* a function.

The PROCEDURE DIVISION header will include USING and RETURNING phrases.

A FUNCTION-ID program scope is terminated with an END FUNCTION [name] clause.

In a quirk with GnuCOBOL, return values are somewhat limited in type. POINTER is not a supported return value in GnuCOBOL for instance (at time of writing, May 2020). A group item *is* allowed as a return. *If the first (and possibly only) item in the group is a POINTER, then the caller can act as if a POINTER was returned.* This is used to great effect with some of the cobweb repositories.

When the FUNCTION-ID PROCEDURE DIVISION ends, usually with GOBACK, the return value will be released to the enclosing COBOL statement that invoked the function. Common statements that use functions are MOVE, COMPUTE, DISPLAY and just about any other COBOL statement where a sending field is mentioned.

Another quirk in the GnuCOBOL implementation is that numeric literals are passed to functions as USAGE DISPLAY items. This differs from normal CALL assumptions that convert USAGE DISPLAY numeric items to integer in a call frame. *For literal values, 1234 in source, functions get a character field view of the data, not an integer as may be assumed*. It is common to see FUNCTION NUMVAL(1234) used to force a numeric parameter to be passed to the function and any binary numeric linkage field items. This only applies to **numeric literals** in source code. Any BINARY-LONG data items (for instance) referenced via working storage identifier will have the proper type passed to linkage. In the case of seeing

```
MOVE FUNCTION NEW-WINDOW(640, 480) TO window-structure
```

The 640 and 480 will be passed as PIC 999 data items, not USAGE BINARY.

You will commonly see

```
01 window-width USAGE BINARY-LONG.

MOVE 640 to window-width
MOVE FUNCTION NEW-WINDOW(window-width...
```

Or

```
MOVE FUNCTION NEW-WINDOW(FUNCTION NUMVAL(640), FUNCTION NUMVAL(480))
  TO window-structure
```

With FUNCTION ALL INTRINSIC in the caller ENVIRONMENT, that shortens to

```
MOVE NEW-WINDOW(NUMVAL(640), NUMVAL(480)) TO window-structure
```

As of May 2020, even if you don't need any actual result value, in a function meant more for effect, like FUNCTION DRAW-CIRCLE, you still need to invoke the function from a COBOL statement that uses a sending field context. It is common to see values discarded using an extraneous data value.

```
01 extraneous pic x.
MOVE cool-effect("fireworks") TO extraneous
```

GnuCOBOL only supports BY REFERENCE for function parameters, BY VALUE or BY CONTENT clauses are not yet supported (as of May 2020).

This has the implication that parameters to user defined functions cannot be constants. `01 identifier CONSTANT AS value` cannot be passed by reference, as that would potentially allow modification. Constants can't be passed to user defined functions. Even though it may be read only usage, the compiler still needs to pass by reference, and needs a slot in working store to do so.

And finally an example.

```
IDENTIFICATION DIVISION.
FUNCTION-ID. udf-sample.

DATA DIVISION.
LINKAGE SECTION.
01 data-value   PIC S9(9).
01 data-binary  USAGE BINARY-LONG.
01 data-decimal PIC 9 ANY NUMERIC.    *> caller sets width
01 data-fixed   PIC X(16).
01 data-buffer  PIC X ANY LENGTH.     *> caller sets width
01 return-value.
   05 binary-result USAGE BINARY-LONG.
   05 decimal-result PIC S9(9).
```

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```
PROCEDURE DIVISION USING
    data-value data-binary data-decimal data-fixed data-buffer
    RETURNING return-value.

DISPLAY "value: " data-value " binary: " data-binary
        " decimal: " data-decimal
DISPLAY "fixed: " data-fixed
DISPLAY "buffer length: " FUNCTION LENGTH(data-buffer)
DISPLAY "buffer: "  FUNCTION TRIM(data-buffer)

MOVE FUNCTION LENGTH TO binary-result decimal-result
GOBACK.
END FUNCTION udf-sample.
```

That could be called from

```
IDENTIFICATION DIVISION.
PROGRAM-ID. use-udf.

ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
REPOSITORY.
    FUNCTION udf-sample
    FUNCTION ALL INTRINSIC.

DATA DIVISION.
WORKING-STORAGE SECTION.
01 udf-value   PIC S9(9).
01 udf-binary  USAGE BINARY-LONG.
01 udf-decimal PIC 9(9).
01 udf-fixed   PIC X(16).
01 udf-buffer  PIC X(80).
01 udf-return.
   05 binary-result USAGE BINARY-LONG.
   05 decimal-result PIC S9(9).

PROCEDURE DIVISION USING
    udf-value udf-binary udf-decimal udf-fixed udf-buffer
    RETURNING udf-return.

MOVE FUNCTION udf-sample TO udf-return

GOBACK.
END PROGRAM use-udf.
```

```
prompt$ cobc -xj use-udf.cob udf-sample.cob
```

3.37 What is cobfile?

A `cobfile` utility has been added to the GnuCOBOL source tree, in the *bin/* support source sub-directory. Used to create/execute file copy/convert programs. Generates COBOL programs and copybooks from skeletons contained in *cobfile.c*. Ron wrote this utility as a command line interpreter with a small set of commands. It can use `readline` for advanced terminal input if available during `./configure`, and can also run in a batch mode.

`cobfile` will scan and process a *cobfile.conf* file is found within the GnuCOBOL config search path.

Invocation options include:

```
Options:
  -i  cmdfile    Read commands from this file
  -p  progid     Define PROGRAM-ID
  -k, -keep      Keep the generated COBOL code
  -D  env=val    Define environment variable
  -h, -help      display this help and exit
  -V, -version   display version and exit
```

Commands (terminated by semi-colons) include:

```
INPUT
OUTPUT
SKIP=
COPY=
GEN
RUN
SKIPIF[condition]
COBC[opts]
PROGRAMID=name
QUIT / EXIT
HELP
```

Line comments can start in column 1, as * or #.

3.38 What is gcdiff?

There is now a `gcdiff` utility included in the *bin/* source tree. This routine is for `make check` testing where some outputs are not fixed. Dates, times, page numbers and the like. Specially marked reference text will allow these fields to vary when comparing test program outputs.

Invocation options:

```
Options:
  -C x           character 'x' indicates ignore
  -e STR         string STR is ignored
  -n STR         string STR is ignored; alpha chars are DIGITS in testfile
  -f STR         STR is date/time pattern; date/time in testfile must be
                     close to modification time of testfile
  -T STR         STR is date/time pattern; date/time in testfile must be
                     close to current time of day
  -v STR         STR is date/time pattern; verify date/time in testfile
  -I STR         if STR is on line of referencefile, ignore complete line
  -x secs        seconds of difference allowed in time compare; default: 300
  -w             ignore all spaces
  -U             Keep trailing spaces (remove underscore)
  -h, -help      display this help and exit
  -V, -version   display version and exit
  referencefile  base text file (reference case) to compare with
        -T,current time
        -v,verify time
        -f,'testfile' time
        -e,just ignore
  testfile       text file created by the test case to be compared
```

Patterns include:

```
    DDD MMM dd HH:MM:SS YYYY
    MMM DD YYYY HH:MI:SS
    MMM DD YYYY HH-MI-SS
    MMM DD YYYY HH:MM:SS
    YYYY/MM/DD HH:MI:SS
    YYYY/MM/DD
    HH:MM:SS
    HH:MI:SS
    YY/MM/DD
     V.R.P
    HH:MM
    HH:MI
    YYYY
     dd
    MMM
    DDD
along with day and month names (in English)

Strings can be set with ``-I``, that if found will cause the line to
be ignored for comparison.
```

`gcdiff` will return a 0 status if the test output only differs from the reference text within the specially marked fields as long as those fields match the pattern.

CHAPTER

FOUR

RESERVED WORDS

4.1 What are the GnuCOBOL RESERVED words?

COBOL is a reserved word rich language. The GnuCOBOL compiler recognizes:

Only supported words are listed below, all known words have entries:

Reserved Word List		
ACCEPT (page 187)	*ACCESS* (page 192)	*ADDRESS* (page 194)
ADD (page 192)	*ADVANCING* (page 195)	*AFTER* (page 195)
ALLOCATE (page 196)	*ALL* (page 196)	*ALPHABETIC-LOWER* (page 198)
ALPHABETIC-UPPER (page 198)	*ALPHABETIC* (page 197)	*ALPHABET* (page 196)
ALPHANUMERIC-EDITED (page 198)	*ALPHANUMERIC* (page 198)	*ALSO* (page 198)
ALTERNATE (page 203)	*ALTER* (page 199)	*AND* (page 204)
ANY (page 204)	*AREAS* (page 205)	*AREA* (page 204)
ARE (page 204)	*ARGUMENT-NUMBER* (page 205)	*ARGUMENT-VALUE* (page 205)
ASCENDING (page 206)	*ASCII* (page 207)	*ASSIGN* (page 207)
AS (page 206)	*ATTRIBUTE* (page 209)	*AT* (page 209)
AUTHOR (page 209)	*AUTO-SKIP* (page 210)	*AUTOMATIC* (page 210)

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Table 1 – continued from previous page

Reserved Word List		
AUTOTERMINATE (page 210)	*AUTO* (page 209)	*AWAY-FROM-ZERO* (page 210)
B-AND (page 210)	*B-NOT* (page 211)	*B-OR* (page 211) B_XOR
BACKGROUND-COLOR (page 212)	*BACKGROUND-COLOUR* (page 212)	*BASED* (page 212)
BEEP (page 214)	*BEFORE* (page 214)	*BELL* (page 214)
BINARY-C-LONG (page 215)	*BINARY-CHAR* (page 215)	*BINARY-DOUBLE* (page 215)
BINARY-INT (page 215)	*BINARY-LONG-LONG* (page 217)	*BINARY-LONG* (page 215)
BINARY-SHORT (page 217)	*BINARY* (page 214)	*BLANK* (page 218)
BLINK (page 218)	*BLOCK* (page 218)	*BOTTOM* (page 218)
BYTE-LENGTH (page 219)	*BY* (page 218)	*CALL* (page 219)
CANCEL (page 223)	*CAPACITY* (page 223)	*CF* (page 223)
CHAINING (page 224)	*CHARACTERS* (page 225)	*CHARACTER* (page 225)
CH (page 223)	*CLASSIFICATION* (page 227)	*CLASS* (page 226)
CLOSE (page 227)	*COB-CRT-STATUS* (page 227)	*CODE-SET* (page 228)
CODE (page 228)	*COLLATING* (page 228)	*COLS* (page 228)
COLUMNS (page 228)	*COLUMN* (page 228)	*COL* (page 228)
COMMAND-LINE (page 229)	*COMMA* (page 228)	*COMMIT* (page 229)
COMMON (page 229)	*COMP-1* (page 230)	*COMP-2* (page 230)
COMP-3 (page 230)	*COMP-4* (page 230)	*COMP-5* (page 230)
COMP-6 (page 231)	*COMP-X* (page 231)	*COMPUTATIONAL-1* (page 232)
COMPUTATIONAL-2 (page 232)	*COMPUTATIONAL-3* (page 232)	*COMPUTATIONAL-4* (page 232)
COMPUTATIONAL-5 (page 232)	*COMPUTATIONAL-X* (page 233)	*COMPUTATIONAL* (page 231)
COMPUTE (page 233)	*COMP* (page 229)	*CONDITION* (page 235)
CONFIGURATION (page 235)	*CONSTANT* (page 235)	*CONTAINS* (page 235)
CONTENT (page 236)	*CONTINUE* (page 236)	*CONTROLS* (page 236)
CONTROL (page 236)	*CONVERSION* (page 236)	*CONVERTING* (page 237)
COPY (page 237)	*CORRESPONDING* (page 239)	*CORR* (page 239)
COUNT (page 239)	*CRT-UNDER* (page 240)	*CRT* (page 240)
CURRENCY (page 240)	*CURSOR* (page 240)	*CYCLE* (page 240)
DATA (page 241)	*DATE-COMPILED* (page 241)	*DATE-MODIFIED* (page 242)
DATE-WRITTEN (page 242)	*DATE* (page 241)	*DAY-OF-WEEK* (page 243)
DAY (page 242)	*DEBUGGING* (page 243)	*DECIMAL-POINT* (page 243)
DECLARATIVES (page 244)	*DEFAULT* (page 244)	*DELETE* (page 244)
DELIMITED (page 246)	*DELIMITER* (page 246)	*DEPENDING* (page 247)
DESCENDING (page 247)	*DETAIL* (page 247)	*DE* (page 243)
DISC (page 247)	*DISK* (page 248)	*DISPLAY* (page 248)
DIVIDE (page 250)	*DIVISION* (page 250)	*DOWN* (page 251)
DUPLICATES (page 251)	*DYNAMIC* (page 251)	*EBCDIC* (page 251)
EC (page 252)	*ELSE* (page 252)	*EMPTY-CHECK* (page 252)
END-ACCEPT (page 253)	*END-ADD* (page 253)	*END-CALL* (page 253)
END-COMPUTE (page 253)	*END-DELETE* (page 253)	*END-DISPLAY* (page 253)
END-DIVIDE (page 253)	*END-EVALUATE* (page 253)	*END-IF* (page 253)
END-MULTIPLY (page 253)	*END-OF-PAGE* (page 254)	*END-PERFORM* (page 254)
END-READ (page 254)	*END-RETURN* (page 254)	*END-REWRITE* (page 254)
END-SEARCH (page 254)	*END-START* (page 254)	*END-STRING* (page 254)
END-SUBTRACT (page 254)	*END-UNSTRING* (page 254)	*END-WRITE* (page 255)
END (page 252)	*ENTRY* (page 255)	*ENVIRONMENT-NAME* (page 255)
ENVIRONMENT-VALUE (page 255)	*ENVIRONMENT* (page 255)	*EOL* (page 255)
EOP (page 255)	*EOS* (page 256)	*EQUALS* (page 256)

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Table 1 – continued from previous page

Reserved Word List		
EQUAL (page 256)	*ERASE* (page 256)	*ERROR* (page 256)
ESCAPE (page 256)	*EVALUATE* (page 257)	*EXCEPTION* (page 257)
EXCLUSIVE (page 258)	*EXIT* (page 258)	*EXTEND* (page 258)
EXTERNAL (page 259)	*FALSE* (page 260)	*FD* (page 260)
FILE-CONTROL (page 264)	*FILE-ID* (page 264)	*FILE* (page 261)
FILLER (page 265)	*FINAL* (page 265)	*FIRST* (page 265)
FLOAT-DECIMAL-16 (page 266)	*FLOAT-DECIMAL-34* (page 267)	*FLOAT-LONG* (page 269)
FLOAT-SHORT (page 270)	*FOOTING* (page 270)	*FOREGROUND-COLOR* (page 271)
FOREGROUND-COLOUR (page 271)	*FOREVER* (page 271)	*FOR* (page 271)
FREE (page 272)	*FROM* (page 272)	*FULL* (page 273)
FUNCTION-ID (page 273)	*FUNCTION* (page 273)	*GENERATE* (page 285)
GIVING (page 285)	*GLOBAL* (page 285)	*GOBACK* (page 295)
GO (page 286)	*GREATER* (page 295)	*GROUP* (page 295)
HEADING (page 295)	*HIGH-VALUES* (page 295)	*HIGH-VALUE* (page 295)
HIGHLIGHT (page 296)	*I-O-CONTROL* (page 296)	*I-O* (page 296)
IDENTIFICATION (page 296)	*ID* (page 296)	*IF* (page 296)
IGNORE (page 297)	*IGNORING* (page 297)	*INDEXED* (page 297)
INDEX (page 297)	*INDICATE* (page 298)	*INITIALISED* (page 300)
INITIALISE (page 300)	*INITIALIZED* (page 303)	*INITIALIZE* (page 300)
INITIAL (page 298)	*INITIATE* (page 303)	*INPUT-OUTPUT* (page 304)
INPUT (page 303)	*INSPECT* (page 304)	*INSTALLATION* (page 309)
INTO (page 309)	*INTRINSIC* (page 310)	*INVALID* (page 310)
IN (page 297)	*IS* (page 310)	*JUSTIFIED* (page 311)
JUST (page 310)	*KEPT* (page 311)	*KEYBOARD* (page 311)
KEY (page 311)	*LABEL* (page 311)	*LAST* (page 311)
LEADING (page 312)	*LEFTLINE* (page 313)	*LEFT* (page 313)
LENGTH-CHECK (page 313)	*LENGTH* (page 313)	*LESS* (page 313)
LIMITS (page 313)	*LIMIT* (page 313)	*LINAGE-COUNTER* (page 317)
LINAGE (page 314)	*LINE-COUNTER* (page 318)	*LINES* (page 318)
LINE (page 318)	*LINKAGE* (page 318)	*LOCAL-STORAGE* (page 318)
LOCALE (page 319)	*LOCK* (page 319)	*LOW-VALUES* (page 319)
LOW-VALUE (page 319)	*LOWER* (page 319)	*LOWLIGHT* (page 319)
MANUAL (page 320)	*MEMORY* (page 320)	*MERGE* (page 320)
MINUS (page 323)	*MODE* (page 323)	*MOVE* (page 323)
MULTIPLE (page 324)	*MULTIPLY* (page 324)	*NAME* (page 325)
NATIONAL-EDITED (page 325)	*NATIONAL* (page 325)	*NATIVE* (page 325)
NEAREST-AWAY-FROM-ZERO (page 325)	*NEAREST-EVEN* (page 325)	*NEAREST-TOWARD-ZERO* (page 326)
NEGATIVE (page 326)	*NEXT* (page 326)	*NO-ECHO* (page 327)
NORMAL (page 327)	*NOT* (page 327)	*NOTHING* (page 327)
NO (page 326)		
NULLS (page 328)	*NULL* (page 327)	*NUMBER-OF-CALL-PARAMETERS* (page 32
NUMBERS (page 328)	*NUMBER* (page 328)	*NUMERIC-EDITED* (page 330)
NUMERIC (page 328)	*OBJECT-COMPUTER* (page 330)	*OCCURS* (page 331)
OFF (page 332)	*OF* (page 331)	*OMITTED* (page 332)
ONLY (page 334)	*ON* (page 333)	*OPEN* (page 334)
OPTIONAL (page 334)	*ORDER* (page 336)	*ORGANISATION* (page 336)
ORGANIZATION (page 336)	*OR* (page 335)	*OTHER* (page 336)
OUTPUT (page 337)	*OVERFLOW* (page 337)	*OVERLINE* (page 337)

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Table 1 – continued from previous page

Reserved Word List		
PACKED-DECIMAL (page 337)	*PADDING* (page 346)	*PAGE-COUNTER* (page 346)
PAGE (page 346)	*PARAGRAPH* (page 346)	*PERFORM* (page 347)
PF (page 348)	*PH* (page 348)	*PICTURE* (page 348)
PIC (page 348)	*PLUS* (page 352)	*POINTER* (page 353)
POSITION (page 354)	*POSITIVE* (page 354)	*PRESENT* (page 354)
PREVIOUS (page 354)	*PRINTER* (page 355)	*PRINTING* (page 355)
PROCEDURE-POINTER (page 355)	*PROCEDURES* (page 355)	*PROCEDURE* (page 355)
PROCEED (page 356)	*PROGRAM-ID* (page 356)	*PROGRAM-POINTER* (page 356)
PROGRAM (page 356)	*PROHIBITED* (page 356)	*PROMPT* (page 357)
PROTECTED (page 358)	*QUOTES* (page 358)	*QUOTE* (page 358)
RANDOM (page 359)	*RD* (page 359)	*READ* (page 359)
RECORDING (page 361)	*RECORDS* (page 361)	*RECORD* (page 361)
RECURSIVE (page 361)	*REDEFINES* (page 362)	*REEL* (page 362)
REFERENCES (page 363)	*REFERENCE* (page 362)	*RELATIVE* (page 363)
RELEASE (page 366)	*REMAINDER* (page 366)	*REMARKS* (page 367)
REMOVAL (page 367)	*RENAMES* (page 367)	*REPLACE* (page 368)
REPLACING (page 369)	*REPORTING* (page 378)	*REPORTS* (page 378)
REPORT (page 369)	*REPOSITORY* (page 378)	*REQUIRED* (page 380)
RESERVE (page 380)	*RESET* (page 380)	*RETURN-CODE* (page 381)
RETURNING (page 381)	*RETURN* (page 381)	*REVERSE-VIDEO* (page 382)
REVERSED (page 382)	*REWIND* (page 382)	*REWRITE* (page 382)
RF (page 385)	*RH* (page 385)	*RIGHT* (page 385)
ROLLBACK (page 386)	*ROUNDED* (page 386)	*RUN* (page 390)
SAME (page 390)	*SCREEN* (page 391)	*SCROLL* (page 392)
SD (page 392)	*SEARCH* (page 392)	*SECTION* (page 394)
SECURE (page 394)	*SECURITY* (page 394)	*SEGMENT-LIMIT* (page 394)
SELECT (page 395)	*SENTENCE* (page 395)	*SEPARATE* (page 396)
SEQUENCE (page 396)	*SEQUENTIAL* (page 396)	*SET* (page 400)
SHARING (page 402)	*SIGNED-INT* (page 402)	*SIGNED-LONG* (page 402)
SIGNED-SHORT (page 402)	*SIGNED* (page 402)	*SIGN* (page 402)
SIZE (page 402)	*SORT-MERGE* (page 409)	*SORT-RETURN* (page 409)
SORT (page 403)	*SOURCE-COMPUTER* (page 410)	*SOURCE* (page 409)
SPACES (page 410)	*SPACE* (page 410)	*SPECIAL-NAMES* (page 410)
STANDARD-1 (page 411)	*STANDARD-2* (page 411)	*STANDARD* (page 411)
START (page 412)	*STATIC* (page 413)	*STATUS* (page 413)
STDCALL (page 413)	*STEP* (page 413)	*STOP* (page 413)
STRING (page 414)	*SUBTRACT* (page 415)	*SUM* (page 416)
SUPPRESS (page 416)	*SYMBOLIC* (page 416)	*SYNCHRONISED* (page 417)
SYNCHRONIZED (page 417)	*SYNC* (page 417)	*SYSTEM-DEFAULT* (page 417)
TAB (page 417)	*TALLYING* (page 418)	*TALLY* (page 418)
TAPE (page 418)	*TERMINATE* (page 418)	*TEST* (page 419)
THAN (page 419)	*THEN* (page 419)	*THROUGH* (page 419)
THRU (page 420)	*TIME-OUT* (page 420)	*TIMEOUT* (page 420)
TIMES (page 420)	*TIME* (page 420)	*TOP* (page 1)
TOWARD-GREATER (page 421)	*TOWARD-LESSER* (page 421)	*TO* (page 421)
TRAILING (page 422)	*TRANSFORM* (page 422)	*TRUE* (page 422)
TRUNCATION (page 423)	*TYPE* (page 423)	*UNBOUNDED* (page 423)
UNDERLINE (page 425)		

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Table 1 – continued from previous page

Reserved Word List		
UNIT (page 425)	*UNLOCK* (page 425)	*UNSIGNED-INT* (page 425)
UNSIGNED-LONG (page 426)	*UNSIGNED-SHORT* (page 426)	*UNSIGNED* (page 425)
UNSTRING (page 426)	*UNTIL* (page 426)	*UPDATE* (page 427)
UPON (page 427)	*UPPER* (page 427)	*UP* (page 427)
USAGE (page 427)	*USER-DEFAULT* (page 429)	*USER* (page 429)
USE (page 429)	*USING* (page 429)	*VALUES* (page 430)
VALUE (page 430)	*VARYING* (page 431)	*WAIT* (page 431)
WHEN (page 431)	*WITH* (page 433)	*WORDS* (page 433)
WORKING-STORAGE (page 433)	*WRITE* (page 433)	*YYYYDDD* (page 435)
YYYYMMDD (page 435)	*ZEROES* (page 436)	*ZEROS* (page 437)
ZERO (page 435)		

GnuCOBOL 3.0 pre-release lists **900** recognized words, 824 marked implemented, as of July 2018.

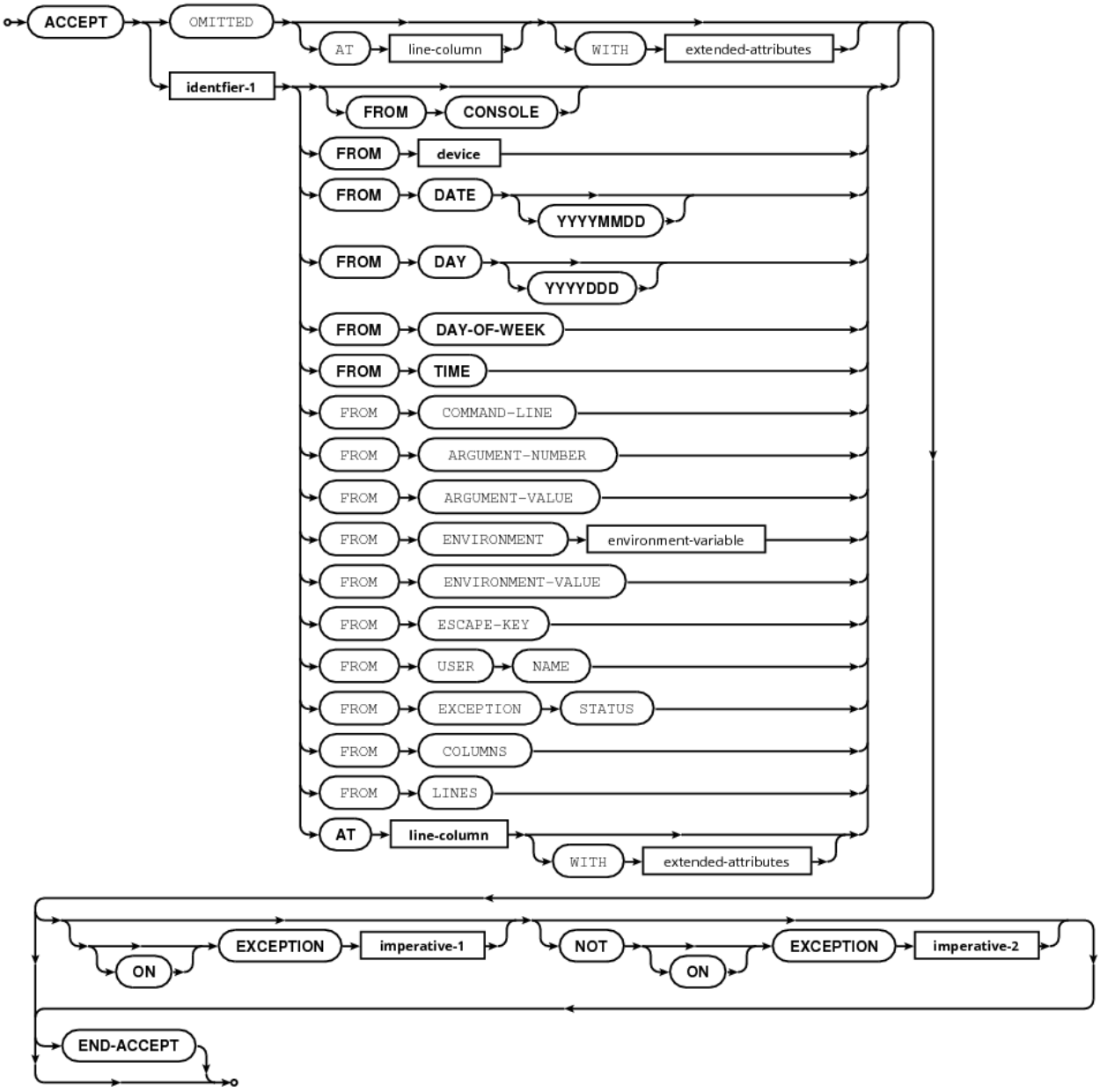
592 words listed in the reportwriter branch, 472 marked implemented by January 2015.

514 words in OC 1.1, 136 marked not yet implemented. 378 functional reserved words, in August 2008.

4.1.1 ACCEPT

Makes data available from the keyboard or operating system to named data items. GnuCOBOL supports both standard and extended `ACCEPT` statements.

Most extended `ACCEPT` statements will require an advanced terminal screen initialization, which can obscure `CONSOLE` input and output. *See Why don't I see any output from my GnuCOBOL program?* (page 139) *for some details on this issue.*



A short list of ACCEPT sources:

```
ACCEPT variable FROM CONSOLE.

ACCEPT variable FROM ENVIRONMENT "path".
ACCEPT variable FROM COMMAND-LINE.

ACCEPT variable FROM ARGUMENT-NUMBER
ACCEPT variable FROM ARGUMENT-VALUE

ACCEPT variable AT 0101.
ACCEPT screen-variable.

ACCEPT today FROM DATE.
ACCEPT today FROM DATE YYYYMMDD.
```

(continues on next page)

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```
ACCEPT thetime FROM TIME.

ACCEPT theday FROM DAY.
ACCEPT theday FROM DAY YYYYDDD.

ACCEPT weekday FROM DAY-OF-WEEK.

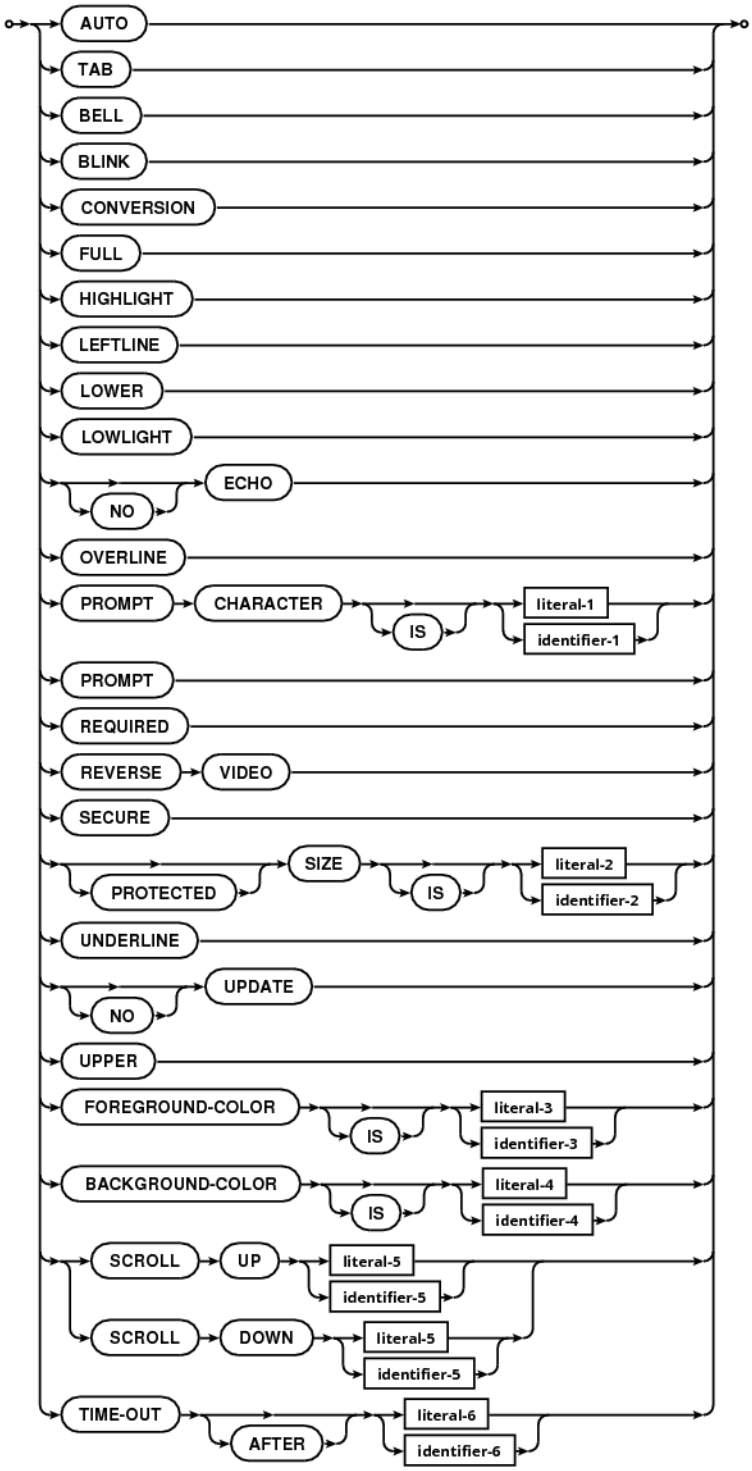
ACCEPT thekey FROM ESCAPE KEY.

ACCEPT username FROM USER NAME.

ACCEPT exception-stat FROM EXCEPTION STATUS.

ACCEPT some-data FROM device-name.
```

Extended attributes (requires `WITH` keyword):



Please note: `ACCEPT datafield WITH extended-attributes` will cause initialization of the extended IO Terminal User Interface system. That means all further IO to the display is subject to the rules of *SMCUP and RMCUP* (page 140).

ACCEPT OMITTED

```
ACCEPT OMITTED.   *> Waits for a keystroke that includes terminator.
```

This form of accept will wait for a keyboard event that terminates input; function keys, or Enter/Return, among others. `CRT STATUS` (`COB-CRT-STATUS` if not explicitly defined) is set with the keycode, listed in `copy/screenio.cpy`. `ACCEPT OMITTED` also handles a few other keycode terminations not normally used to complete an extended accept:

- COB-SCR-INSERT
- COB-SCR-DELETE
- COB-SCR-BACKSPACE
- COB-SCR-KEY-HOME
- COB-SCR-KEY-END

You can used extended attributes with `OMITTED`, handy for setting timeouts or positioning.

ACCEPT ON EXCEPTION

Empty input from the keyboard (Ctrl-D in a GNU/Linux terminal, for instance) can be detected with `ON EXCEPTION` conditional statements.

```
ACCEPT datafield
    ON EXCEPTION
        display "datafield got EOF, not changed"
END-ACCEPT
```

Otherwise, on EOF and console ACCEPT, COBOL will continue, with the accept destination field unchanged.

See *AT* (page 209), *WITH* (page 433).

EXCEPTION-STATUS

```
ACCEPT exception-pic9-4 FROM EXCEPTION-STATUS
```

comes in handy when dealing with

```
COMPUTE delicate-value ROUNDED MODE IS PROHIBITED
          = interest-by-loop - interest-by-new-formula
    ON SIZE ERROR
        DISPLAY
            "Rats.  Call the boss, the new formula fell over"
            UPON SYSERR
END-COMPUTE

ACCEPT unexpected-rounding  FROM EXCEPTION-STATUS
IF unexpected-rounding NOT EQUAL "0000" THEN
    DISPLAY
        "Rats. Unexpected rounding. Code " unexpected-rounding
        UPON SYSERR
END-IF
```

4.1.2 ACCESS

Defines a file's access mode. One of *DYNAMIC* (page 251), *RANDOM* (page 359), *SEQUENTIAL* (page 396), or *LINE* (page 318) SEQUENTIAL.

`LINE SEQUENTIAL` is not standard in the specification, but common with many COBOL implementations, and very handy when processing text files.

See *How do I get the length of a LINE SEQUENTIAL read?* (page 154) for some details.

An example setting up RANDOM access by key:

```
SELECT filename
    ASSIGN TO "filename.dat"
    ACCESS MODE IS RANDOM
    RELATIVE KEY IS keyfield.
```

4.1.3 ACTIVE-CLASS

Not yet implemented. Object COBOL feature.

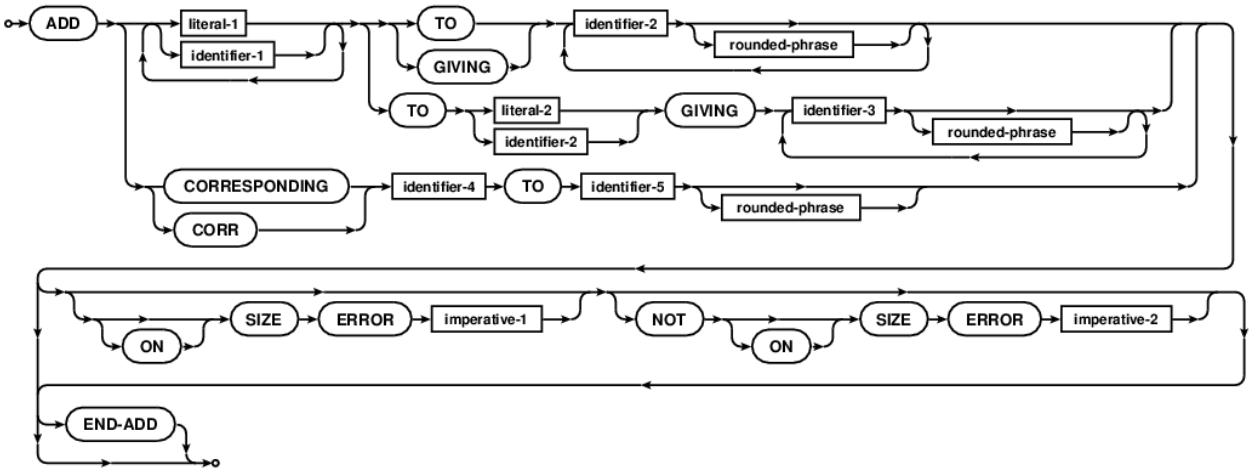
4.1.4 ADD

Sums two or more numerics, with an eye toward financial precision and error detection. Can also be used with *CORRESPONDING* (page 239) to add entire groups of matching fieldnames together.

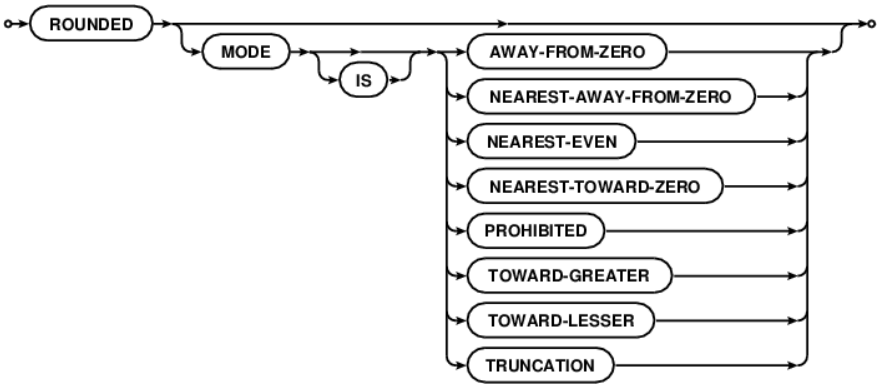
```
ADD 1 TO cobol

ADD 1 TO cobol GIVING GnuCOBOL

ADD
    a b c d f g h i j k l m n o p q r s t u v w x y z
    GIVING total-of
    ON SIZE ERROR
        PERFORM log-problem
    NOT ON SIZE ERROR
        PERFORM graph-result
END-ADD
```



With *ROUNDED* (page 386) options:



TO and GIVING

Bill Woodger points out that using TO and GIVING together can lead to some confusion. With

```
ADD 1 TO GnuCOBOL
```

`GnuCOBOL` is a *receiving field* and is modified, adding the literal to current contents.

```
ADD 1 TO GnuCOBOL GIVING NewCOBOL
```

`GnuCOBOL` is a *sending field* and is not modified. Even though it reads well as English, some programmers may assume that the `TO` field is being changed, when it is not. A more concise expression might be:

```
ADD 1 GnuCOBOL GIVING NewCOBOL
```

Both are valid, both are to specificiation, but you might make a maintainer's life easier if you don't use both TO and GIVING in the same statement.

ADD CORRESPONDING

```
*> Modified: 2016-05-18/19:10-0400
 COPY sample-template REPLACING
 ==:DATABOOK:== BY
 ==

 01 data-group.
    05 top-group.
       10 field-a        pic 9(5) value 1.
       10 field-b        pic 9(5) value 2.
       10 inner-group.
          15 field-c     pic 9(5) value 3.
       10 field-d        pic 9(5) value 4.
    05 field-e           pic 9(5) value 5.
    05 field-f           pic x(3) value "006".
    05 field-g           pic x(3) value "abc".

 01 other-group.
    05 top-group.
       10 field-c        pic 9(5).
       10 field-b        usage binary-long.
       10 field-a        usage float-short.
```

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```
    05 field-d           pic s9(5).
    05 field-z           pic s9(5).
    05 field-f           pic 9(3).
    05 field-g           pic 9(3).

 ==
 ==:CODEBOOK:== BY
 ==

 add corresponding data-group to other-group
 display "field-a: " field-a of other-group
 display "field-b: " field-b of other-group
 display "field-c: " field-c of other-group
 display "field-d: " field-d of other-group
 display "field-z: " field-z of other-group
 display "field-f: " field-f of other-group
 display "field-g: " field-g of other-group

 ==
 .
```

field-a, field-b match. field-c, field-d do not (due to grouping level). fielf-g is an erroneous outcome. There is a bug. The ADD CORRESPONDING, which is treated partly as a field by field add, but also partly like a raw group data add. (Hint: it has to do with low-nibbles in the ASCII encoding system, "abc" is equivalent to x"616263") but the non-numeric data should not be included in the field match.

```
prompt$ cobc -xj add-sample.cob
field-a: 1
field-b: +0000000002
field-c: 00000
field-d: +00000
field-z: +00000
field-f: 006
field-g: 123
```

See *Sample shortforms* (page 1433) for the `sample-template` listing.

4.1.5 ADDRESS

Allows program access to memory address reference and, under controlled conditions, assignment.

```
SET pointer-variable TO ADDRESS OF linkage-store

SET ADDRESS OF based-var TO pointer-from-c

SET prog-pointer TO ADDRESS OF PROGRAM "entry-point"

CALL "program" RETURNING ADDRESS OF linkage-or-based-var
```

For an example, using a POINTER along with a BASED POINTER, it is possible to traverse a C, null terminated, string *without a buffer allocation*, see *Can GnuCOBOL display the process environment space?* (page 969)

4.1.6 ADVANCING

Programmer control of newline output and paging.

```
DISPLAY "Legend: " WITH NO ADVANCING
WRITE printrecord AFTER ADVANCING PAGE
WRITE printrecord BEFORE ADVANCING 3 LINES

SELECT printseq
    ASSIGN TO LINE ADVANCING FILE "printer-file"
```

4.1.7 AFTER

- An optional *INSPECT* (page 304) clause
- An optional *WRITE* (page 433) clause
- When specifying out-of-band, declarative procedures
- Nested *PERFORM* (page 347) clause
- influence when loop conditional testing occurs

A sample with nested AFTER and TEST AFTER

```
PERFORM
    WITH TEST AFTER
    VARYING variable FROM 1 BY 1
    UNTIL variable > 10
        AFTER inner FROM 1 BY 1
        UNTIL inner > 4
             DISPLAY variable ", " inner
END-PERFORM.
```

Will display 55 lines of output. 1 to 11 and 1 to 5. Removing the *WITH TEST AFTER* clause would cause 40 lines of output. 1 to 10 and 1 to 4.

Same nested loop without the TEST AFTER control flow modifier

```
PERFORM
    VARYING variable FROM 1 BY 1
    UNTIL variable > 10
        AFTER inner FROM 1 BY 1
        UNTIL inner > 4
            DISPLAY variable ", " inner
END-PERFORM
```

Which gives 40 output lines. The WITH TEST AFTER in the original listing applies to both the outer and the nested loops.

With `INSPECT`:

```
INSPECT variable REPLACING "/" BY ":" AFTER INITIAL SPACE
```

With `WRITE`, usually when generating output destined for printing:

```
WRITE title-record AFTER ADVANCING PAGE
WRITE record-name AFTER ADVANCING 2 LINES
```

Declartives:

```
procedure division.
declaratives.
handlers section.
use after standard error procedure on input.
    display "Error during read" upon syserr
    exit
.
end declaratives.
```

4.1.8 ALIGNED

Not yet implemented feature that will influence the internal alignment of not yet implemented *USAGE* (page 427) `BIT` fields.

4.1.9 ALL

A multipurpose reserved in context word.

```
INSPECT variable REPLACING ALL "123" WITH "456".

MOVE ALL QUOTES TO var.
```

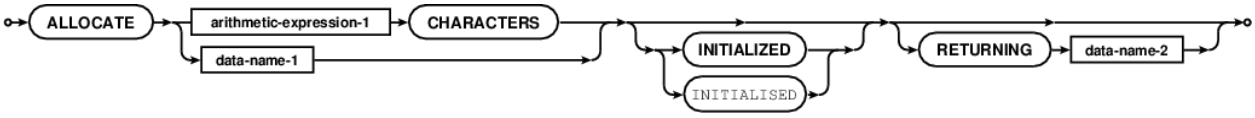
Unfortunately, GnuCOBOL does yet support the `ALL` subscripting keyword for Intrinsic Functions, so

```
COMPUTE biggest = FUNCTION MAX(table-field(ALL))
```

will not work in GnuCOBOL, *yet*.

4.1.10 ALLOCATE

Allocates working storage for a *BASED* (page 212) element, or allocate a given size of heap storage.




```
01 pointer-var         usage POINTER.
01 character-field     pic x(80) BASED value "Sample".

ALLOCATE 1024 characters returning pointer-var
ALLOCATE character-field
ALLOCATE character-field INITIALIZED RETURNING pointer-var
```

See *FREE* (page 272).

4.1.11 ALPHABET

ALPHABET is a clause in the *SPECIAL-NAMES* (page 410) paragraph of the *CONFIGURATION* (page 235) *SECTION* (page 394) of the *ENVIRONMENT* (page 255) *DIVISION* (page 250).

The COBOL ALPHABET clause allows fairly complete control over the characters sets included in some statements.

```
* Set up for a mixed case SORT COLLATING SEQUENCE IS
 ENVIRONMENT DIVISION.
 CONFIGURATION SECTION.
 SPECIAL-NAMES.
     ALPHABET mixed IS "AaBbCcDdEeFfGgHhIiJjKkLlMm" &
                       "NnOoPpQqRrSsTtUuVvWwXxYyZz".

 DATA DIVISION.
 01 accounts.
    05 tables-data OCCURS 1 TO 1000 TIMES
           DEPENDING ON total-accounts
           ASCENDING KEY account-key
           INDEXED BY account-index.


 SORT table-data
     ON DESCENDING KEY account-key
     COLLATING SEQUENCE IS mixed.
```

Generates a sort (ASCII) ordering keeping upper and lower case letters together. *The ALPHABET used in this example is not complete enough for general use, and should usually account for all slots in a character set encoding*.

Repeated in the entry on *ASCII* (page 207), here is a short GnuCOBOL fragment that will convert between EBCDIC and ASCII character set encodings.

```
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SPECIAL-NAMES.
ALPHABET ALPHA IS ASCII.
ALPHABET BETA IS EBCDIC.

PROCEDURE DIVISION.
INSPECT variable CONVERTING ALPHA TO BETA
```

Please note: Only safe for use on character data fields. This can completely trash usage binary numerics. Do not use character encoding transforms on numeric data or group items that include numeric data.

ALPHABET entries can be described using keywords, ASCII, EBCDIC, NATIVE or by LOCALE name, or by using literals, or character ranges (which use the current operating environment native character set during compile, ASCII on most POSIX systems).

Opinion:

Although small alphabets can be used to very good effect (when the data range is known and validated), most ALPHABET definitions should try and fill all character encoding slots. That is 0-127 in ASCII (which is 1 thru 128 in COBOL ordinal numbering). 0-255 for byte sized character encodings common on personal computers (the top half being very specific to default operating system environments and current process settings). NATIONAL data may require all 65,536 slots be filled for a safe, general purpose ALPHABET.

4.1.12 ALPHABETIC

One of the GnuCOBOL data class (*category*) tests.

```
IF variable IS ALPHABETIC
    DISPLAY "alphabetic"
END-IF
```

`ALPHABETIC` is defined as a data item that uses **only** `A` in the `PICTURE` clause. Finding examples of ALPHABETIC data use is difficult, which means this type is rarely used, favouring *ALPHANUMERIC* (page 198) instead.

When tested, only data that are upper case `A to Z` and lower case `a to z` will return true, all others, including any digits `0 to 9` will return false.

4.1.13 ALPHABETIC-LOWER

One of the GnuCOBOL data class (*category*) tests.

```
IF variable IS ALPHABETIC-LOWER
    DISPLAY "alphabetic-lower"
END-IF
```

4.1.14 ALPHABETIC-UPPER

One of the GnuCOBOL data class (*category*) tests.

```
DISPLAY variable "alphabetic-upper " WITH NO ADVANCING
IF variable IS ALPHABETIC-UPPER
    DISPLAY "true A-Z, and nothing but A to Z"
ELSE
    DISPLAY "false A-Z, something else in here"
END-IF
```

4.1.15 ALPHANUMERIC

A COBOL data category, probably the most common. PIC X. *ALPHANUMERIC* can be used with INITIALIZE, along with other category names.

```
INITIALIZE data-record REPLACING ALPHANUMERIC BY literal-value
```

4.1.16 ALPHANUMERIC-EDITED

A trickier to describe COBOL data category. See *PICTURE* (page 348) for details on the editing characters available with GnuCOBOL.

```
INITIALIZE data-record
    REPLACING ALPHANUMERIC-EDITED BY identifier-1
```

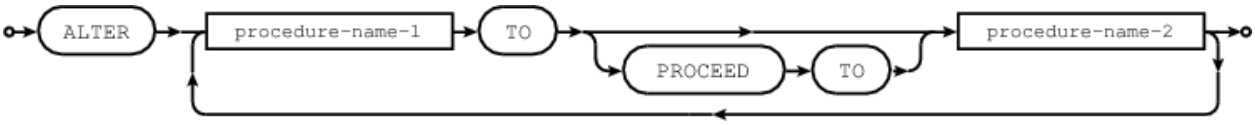
4.1.17 ALSO

A powerful, multiple conditional expression feature of *EVALUATE* (page 257).

```
EVALUATE variable ALSO second-var ALSO statuate-42
    WHEN "A"      ALSO 1 THRU 5   ALSO ANY         PERFORM first-case
    WHEN "A"      ALSO 6          ALSO 1 THRU 8    PERFORM second-case
    WHEN "A"      ALSO 6          ALSO 9           PERFORM special-case
    WHEN "A"      ALSO 7 THRU 9   ALSO ANY         PERFORM third-case
    WHEN OTHER                                     PERFORM invalid-case
END-EVALUATE
```

4.1.18 ALTER

Obsolete, but still supported verb that modifies the jump target for `GO TO` statements.



Use with care. Unless you are writing a state machine engine, maybe. `ALTER` should rarely be used in COBOL applications without due reason.

GnuCOBOL 2.0 may support this *verb*, to increase support for legacy code, but **NOT as homage to a good idea**. *To be honest, I might like to see a GnuCOBOL Flying Spaghetti Monster (that works), simply for the eye rolling of righteous indignation, and perhaps the schadenfreude.*

Reality is, 2.0 does support ALTER. NIST Test Suite runs now pass over 9,700 tests, up from just under 9,100 with 1.1.

A contrived example of ALTER label PROCEEDING TO. Two samples of the output follow, one without, and one with COB_SET_TRACE enabled.

```
 identification division.
 program-id. altering.
 author. Brian Tiffin.
 date-written. 2015-10-28/06:36-0400.
 remarks. Demonstrate ALTER.

 procedure division.
 main section.

*> And now for some altering.
 contrived.
 ALTER story TO PROCEED TO beginning
 GO TO story
 .

*> Jump to a part of the story
 story.
 GO.
 .

*> the first part
 beginning.
 ALTER story TO PROCEED to middle
 DISPLAY "This is the start of a changing story"
 GO TO story
 .

*> the middle bit
 middle.
 ALTER story TO PROCEED to ending
 DISPLAY "The story progresses"
 GO TO story
 .

*> the climatic finish
 ending.
 DISPLAY "The story ends, happily ever after"
```

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```
 .

*> fall through to the exit
 exit program.
```

Giving:

```
prompt$ cobc -xj -debug altering.cob
This is the start of a changing story
The story progresses
The story ends, happily ever after

prompt$ COB_SET_TRACE=Y ./altering
Source:     'altering.cob'
Program-Id: altering         Entry:     altering              Line: 8
Program-Id: altering         Section:   main                  Line: 8
Program-Id: altering         Paragraph: contrived             Line: 11
Program-Id: altering         Statement: ALTER                 Line: 12
Program-Id: altering         Statement: GO TO                 Line: 13
Program-Id: altering         Paragraph: story                 Line: 17
Program-Id: altering         Paragraph: beginning             Line: 22
Program-Id: altering         Statement: ALTER                 Line: 23
Program-Id: altering         Statement: DISPLAY               Line: 24
This is the start of a changing story
Program-Id: altering         Statement: GO TO                 Line: 25
Program-Id: altering         Paragraph: story                 Line: 17
Program-Id: altering         Paragraph: middle                Line: 29
Program-Id: altering         Statement: ALTER                 Line: 30
Program-Id: altering         Statement: DISPLAY               Line: 31
The story progresses
Program-Id: altering         Statement: GO TO                 Line: 32
Program-Id: altering         Paragraph: story                 Line: 17
Program-Id: altering         Paragraph: ending                Line: 36
Program-Id: altering         Statement: DISPLAY               Line: 37
The story ends, happily ever after
Program-Id: altering         Statement: EXIT PROGRAM          Line: 41
Program-Id: altering         Exit:      altering
prompt$
```

Again, except for passing more tests within the NIST COBOL85 stress test, *use of ALTER may be frowned upon by others*. But, under some circumstances, may be a justified path to modify a complex system faced with new legal requirements and only a few minutes to spare before a monthly report needs to be filed. Know it is there, and use with care and understanding.

Another issue to consider is self modifying code runs counter to many modern instruction caching and predictive branch techniques, and there is always a possibilty that a new value for a jump may not be properly synched between active cache and addressable memory.

A more realistic and pragmatic view from Bill Woodger:

```
By the time I started, an ALTERed GO TO was already anathema. Not only
where I worked, but people who'd come from other sites, and the computer
press.

In itself, it is not a bad thing, but it seems in most of its uses, it was
done badly. It was used to (attempt to) implement business-logic, in large
programs.
```

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```
Large programs of the time already suffered from being largely
"fall-through" (lack of use of PERFORM). Ordinary GO TO and DEPENDING ON
were already used, often badly or tortuously (a GO TO solely to jump over
a few conditions, a DEPENDING ON relating to a transaction-type, flying
off to one of 70 paragraphs, almost all of which (but you could be sure,
not all) would GO TO the top of that processing again to read another
record.

You make that worse by using ALTER just because you can.

The common complaint with ALTER is  that it obscures the flow of the
program for analysis, and it obscures you when something takes a dive at
2am and you're looking at a core-dump and wondering what was the current
value of the ALTERered GOs.

The latter argument is a bit fake, because the generated pseudo-assembler
shows you where the current barch-to address is stored. It may be valid for
other compilers.

The classic actual presumed OK use of ALTER is for performance. A branch
is faster than any test-and-branch. The more tests you can avoid (since
they can no longer ever be true, different from the "jump over" GO TO) the
faster the program runs.

An implementation of "PERFORM" using ALTERed GO TOs would be faster than an
actual PEFORM (in IBM Mainframe COBOLs) because you don't have to cater for
fall-through/GO TO/PERFORM potentially affecting the same label.

(As an aside I implemented "PERFORM" with GOTO &name in IBM's VS/Script
GML, because it didn't have anything for "perform" and having it made it
about 90% simpler to write a particular system specification).

I don't know what the original intent of ALTER was.

ALTER can be used safely. But it can't be used safely because no-one
believes it can be used safely. Reality vs Myth, score one for Myth.
```

And then more from Bill:

```
If COBOL didn't have PERFORM...
```

```
    ALTER PERFORM-IT TO PROCEED TO A
    ALTER RETURN-TO TO PROCEED TO NEXT-PARA
    GO TO PERFORM-IT
    .
NEXT-PARA.
    ALTER PERFORM-IT TO PROCEED TO B
    ALTER RETURN-TO TO PROCEED TO WERE-DONE
    GO TO PERFORM-IT
    .
WERE-DONE.
    DISPLAY the-counter
    GOBACK
    .
A.
```

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```
    ADD 1 TO the-counter
    GO TO RETURN-TO
    .
B.
    ADD 2 TO the-counter
    GO TO RETURN-TO
    .
PERFORM-IT.
    GO TO
    .
RETURN-TO.
    GO TO
    .
```

Or:

```
    ALTER RETURN-TO TO PROCEED TO NEXT-PARA
    GO TO A
    .
NEXT-PARA.
    ALTER RETURN-TO TO PROCEED TO WERE-DONE
    GO TO B
    .
WERE-DONE.
    DISPLAY the-counter
    GOBACK
    .
A.
    ADD 1 TO the-counter
    GO TO RETURN-TO
    .
B.
    ADD 2 TO the-counter
    GO TO RETURN-TO
    .
RETURN-TO.
    GO TO
    .
```

```
On an IBM Mainframe and prior to the greatly-improved optimisation
with their COBOL II compilers, that would avoid a whole heap of code
generated "after" the end of the paragraph, which determines whether a
PERFORM was active, so a return is needed, otherwise glibbly dribbling
on.

Of course applied piecemeal to reuse different pieces of code from
different points in the business-logic (multiple exits from the
paragraphs, effectively, even though only one exit, they are multiple
because they are to multiple potential locations) then you start to see
the torture that can ensue. "If I put an ALTER there, and another one
there, then I don't need to change anything else". Making a piece of
code into a PERFORMed paragraph or SECTION when it is originally in a
fall-through program takes a little more to do.

Obviously, if you don't start out with a fall-though program in the
first place, it is different. Reusing a piece of code doesn't have to
```

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```
become opaque.

The only-24-hours-in-a-day part of "performance" were much more serious
with much slower machines.

Remember also that the big fall-through program is on 12,000 punched
cards. "Restructuring" is more than trivial effort. You're being paid to
make the small change, not paid to take three days to do it and two
weeks to test it, even if the program is a bit nicer afterwards (no way
at all to rewrite the whole program).

I was lucky and never had to use punched cards, but I worked with a lot
of people who did, and they made me fully aware of the many problems.

Access via terminal to programs stored on disk probably had a greater
impact on structured programming than we can imagine today.
```

Simon Sobisch added some commentary to the commentary:

```
> Remember also that the big fall-through program is on 12,000 punched
> cards. "Restructuring" is more than trivial effort.

Missing option to restructure the program because of punchcard - this is
the best explanation for "why did someone ever wanted to use ALTER"
ever!

BTW: I'm one of the "this COBOL program needs a restructure"
programmers. Not "just because" but "because it's very likely that
someone [possibly I myself] needs to change the program again - if I
took 2 hours to understand the program logic this time I'll invest 2
other hours to make sure this won't happen again, restructure it, change
the comments to actually match the logic, ..".  And restructuring old
sources is sometimes the best option to deeply understand their logic,
enabling you to find the bug / place where to add the feature missing.
If you're in a hurry: keep the changed version for later when you have
the time to test it and just copy the necessary changes into the
original version for now.

I'm thankfull for having the sources on disk and multiline editors with
syntax highlighting, options to copy-and-paste, search [and replace],
... It's a wonderful time for programmers!
```

4.1.19 ALTERNATE

Defines an ALTERNATE key for *ISAM* (page 1321) data structures.

```
SELECT file
    ASSIGN TO filename
    ACCESS MODE IS RANDOM
    RECORD KEY IS key-field
    ALTERNATE KEY IS alt-key WITH DUPLICATES.
```

4.1.20 AND

A logic operator. COBOL rules of precedence are; NOT, AND, OR.

```
IF field = "A" AND num = 3
    DISPLAY "got A3"
END-IF
```

COBOL also allows abbreviated combined relational conditions.

```
IF NOT (a NOT > b AND c AND NOT d)
   code
END-IF
```

is equivalent to

```
IF NOT (((a NOT > b) AND (a NOT > c)) AND (NOT (a NOT > d)))
    code
END-IF
```

4.1.21 ANY

Allows for any value is TRUE in an *EVALUATE* (page 257) statement *WHEN* (page 431) clause.

```
EVALUATE  TRUE  ALSO  TRUE
    WHEN a > 3  ALSO  ANY      *> b can be any value **
        PERFORM a-4-b-any
    WHEN a = 3  ALSO  b = 1
        PERFORM a-3-b-1
END-EVALUATE
```

4.1.22 ANYCASE

Not yet implemented. Will allow case insensitive match of currency symbols with FUNCTION NUMVAL-C.

4.1.23 ARE

Allows for multiple conditional *VALUES* (page 430).

```
01 cond-1   PIC X.
   88 first-truth   VALUES ARE "A" "B" "C".
   88 second-truth  VALUES ARE "X" "Y" "Z".
```

4.1.24 AREA

Controls *SORT* (page 403), *MERGE* (page 320) and *RECORD* (page 361) data definitions.

```
I-O-CONTROL.
    SAME RECORD AREA FOR file1, file2.
```

4.1.25 AREAS

Plural readability option for *AREA* (page 204)

```
SAME RECORD AREAS
```

4.1.26 ARGUMENT-NUMBER

Holds the number of OS parsed command line arguments, and can act as the explicit index when retrieving *ARGUMENT-VALUE* (page 205) data. ARGUMENT-NUMBER can be used in ACCEPT FROM and DISPLAY UPON expressions.

```
ACCEPT command-line-argument-count FROM ARGUMENT-NUMBER

DISPLAY 2 UPON ARGUMENT-NUMBER
ACCEPT indexed-command-line-argument FROM ARGUMENT-VALUE
```

See *COMMAND-LINE* (page 229) for more information on the unparsed command invocation string.

4.1.27 ARGUMENT-VALUE

Returns the next command line argument. This post from John on opencobol.org is an excellent idiom for parsing command line arguments without too much worry as to the order.

```
       >>source format is free
*>*****************************************************************
*> Author:    jrls (John Ellis)
*> Date:      Nov-2008
*> Purpose:   command line processing
*>*****************************************************************
identification division.
program-id. cmdline.
data division.
*>
working-storage section.
*>****************************************
01 argv                 pic x(100) value spaces.
   88 recv                        value "-r", "--recv".
   88 email                       value "-e", "--email".
   88 delivered                   value "-d", "--delivered".
01 cmdstatus            pic x    value spaces.
   88 lastcmd                    value "1".
01 reptinfo.
   05 rept-recv         pic x(30) value spaces.
   05 rept-howsent      pic x(10) value spaces.
*>
procedure division.
 0000-start.
*>
    perform until lastcmd
         move low-values        to argv
         accept argv            from argument-value
         if argv > low-values
            perform 0100-process-arguments
```

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```
         else
            move "1"            to cmdstatus
         end-if
    end-perform
    display reptinfo.
    stop run.
*>
 0100-process-arguments.
*>
     evaluate true
         when recv
            if rept-recv = spaces
               accept rept-recv from argument-value
            else
               display "duplicate " argv
            end-if
         when email
            move "email"        to rept-howsent
         when delivered
            move "delivered"    to rept-howsent
         when other display "invalid switch: " argv
     end-evaluate.
```

Example run:

```
./cmdline --recv "john ellis" -e -f
invalid switch: -f
john ellis                    email
```

4.1.28 ARITHMETIC

Not yet implemented feature of the not yet implemented *OPTIONS* (page 335) paragraph of the *IDENTIFICATION* (page 296) *DIVISION* (page 250).

4.1.29 AS

Can be used to change the external linkage name of a program or function.

```
PROGRAM-ID. program-name AS literal.
```

Part of a *CONSTANT* (page 235) clause

```
01 const-id AS 123.
01 str-const AS "abc".
```

Can also change the reference name for *EXTERNAL* (page 259) items.

```
01 shared-data pic x(4) is external AS "newname".
```

4.1.30 ASCENDING

COBOL table support.

```
01 CLUBTABLE.
   05 MEMBER-DATA OCCURS 1 TO 7000000000 TIMES
        DEPENDING ON PEOPLE
        ASCENDING KEY IS HOURS-DONATED.
```

Sort order control.

```
sort clubtable ASCENDING key hours-donated
```

Also see *DESCENDING* (page 247).

4.1.31 ASCII

American Standard Code for Information Interchange.

One of the two main character encodings supported by GnuCOBOL.

See *EBCDIC* (page 251) for the other common encoding used in COBOL programming.

ASCII to EBCDIC conversion the GnuCOBOL way

```
SPECIAL-NAMES.
ALPHABET ALPHA IS ASCII.
ALPHABET BETA IS EBCDIC.

PROCEDURE DIVISION.
INSPECT variable CONVERTING ALPHA TO BETA
```

But note that that is only safe for character data. Numeric fields will not always convert properly with that mechanism.

See the GNU/Linux command `man ascii` for a full list of ASCII characters and numeric values. Keep in mind that COBOL is an ordinal system, and counting starts at one. See *FUNCTION ORD* (page 476) *FUNCTION CHAR* (page 446) for some details of this potential issue when programming.

4.1.32 ASSIGN

Assign a name to a file or other external resource.

```
SELECT input-file
ASSIGN TO "filename.ext"
```

```
SELECT input-file
ASSIGN USING DYNAMIC identifier
```

```
SELECT input-file
ASSIGN TO EXTERNAL identifier
```

The actual filename used is dependent on a configuration setting. Under default configuration settings, `filename-mapping` is set to `yes`.

See *What are the GnuCOBOL compile time configuration files?* (page 105) for details.

```
# If yes, file names are resolved at run time using
#   environment variables.
# For example, given ASSIGN TO "DATAFILE", the actual
```

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```
#   file name will be
#  1. the value of environment variable 'DD_DATAFILE' or
#  2. the value of environment variable 'dd_DATAFILE' or
#  3. the value of environment variable 'DATAFILE' or
#  4. the literal "DATAFILE"
# If no, the value of the assign clause is the file name.
#
# Value: 'yes', 'no'
filename-mapping: yes
```

So, under GNU/Linux, bash shell

```
$ export DD_DATAFILE='/tmp/opencobol.dat'
$ ./myprog
```

the program will find the data in `/tmp/opencobol.dat`

```
$ export DD_DATAFILE='/tmp/other.dat'
$ ./myprog
```

This run of the same program will find the data in `/tmp/other.dat`

As shown in the sample .conf comments, the order of environment variable lookup proceeds through three environment variables before using a literal as the filename.

- DD_DATAFILE
- dd_DATAFILE
- DATAFILE
- and finally “DATAFILE”

DATAFILE is the **name** used in

```
ASSIGN TO name
```

The name can be any valid COBOL identifier, or string leading to a valid operating system filename.

GnuCOBOL also accepts device name qualifiers such as:

- PRINTER
- PRINT
- DISC
- DISK
- TAPE
- RANDOM
- CARD-PUNCH
- CARD-READER
- CASSETTE
- INPUT
- INPUT OUTPUT
- MAGNETIC TAPE

- OUTPUT
- LINE ADVANCING
- DISPLAY
- KEYBOARD

`KEYBOARD` comes in especially handy with CGI programming, giving access to POST data which is set up by web servers as the standard in for CGI programs.

Many of the device qualifiers are accepted as syntax but have no logical effect on handling. For instance, a `CASSETTE` or `CARD-PUNCH` qualifier is simply ignored, with the native operating system managing the attributes of any filenames that happen to reference any non file system devices.

4.1.33 AT

Controls cursor positioning of ACCEPT and DISPLAY screen oriented verbs.

```
*> Display at line 1, column 4 <*
 DISPLAY "Name:" AT 0104
*> Accept starting at line 1, column 10 for length of field <*
 ACCEPT name-var AT 0110
```

`AT` syntax allows for 4 digit and 6 digit values. *llcc* or *lllccc*, where the total length determines if the line and column subfields are treated as 2 or 3 digits each.

4.1.34 ATTRIBUTE

Manage screen field attributes. *SET* (page 400) ON OFF for

- *BELL* (page 214)
- *BLINK* (page 218)
- *HIGHLIGHT* (page 296)
- *LOWLIGHT* (page 319)
- *REVERSE-VIDEO* (page 382)
- *UNDERLINE* (page 425)
- *LEFTLINE* (page 313)
- *OVERLINE* (page 337)

```
SET screen-name ATTRIBUTE BLINK OFF
```

4.1.35 AUTHOR

An informational statement in the *IDENTIFICATION* (page 296) DIVISION. Deemed OBSOLETE, but still commonly seen. GnuCOBOL treats this as a *to end of line* comment phrase, periods are not required. Multiples `AUTHOR` statements are allowed.

4.1.36 AUTO

Automatic cursor flow to next field in screen section.

4.1.37 AUTO-SKIP

Alias for *AUTO* (page 209)

4.1.38 AUTOMATIC

LOCK MODE IS AUTOMATIC. See *MANUAL* (page 320) and *EXCLUSIVE* (page 258) for more LOCK options.

4.1.39 AUTOTERMINATE

Alias for *AUTO* (page 209)

4.1.40 AWAY-FROM-ZERO

A rounding *MODE* (page 323). See *ROUNDED* (page 386) for more details on the different modes.

AWAY-FROM-ZERO	+2.49	-2.49	+2.50	-2.50	+3.49	-3.49	+3.50	-3.50	+3.51	-3.51
Becomes	+3	-3	+3	-3	+4	-4	+4	-4	+4	-4

A COBOL example (also demonstrating user names that are the same as in context compiler words):

```
GCobol IDENTIFICATION   DIVISION.
       PROGRAM-ID.      prog.
       ENVIRONMENT      DIVISION.
       CONFIGURATION    SECTION.
       DATA             DIVISION.
       WORKING-STORAGE  SECTION.
       01  X               PIC 9 VALUE 0.
       01  AWAY-FROM-ZERO  PIC 9 VALUE 0.
       PROCEDURE        DIVISION.
           COMPUTE X ROUNDED MODE AWAY-FROM-ZERO
                   AWAY-FROM-ZERO = 1.1
           DISPLAY X ", " AWAY-FROM-ZERO NO ADVANCING
           STOP RUN.
```

displays:

```
2, 1
```

X being rounded away from zero from 1.1 to 2.

4.1.41 B-AND

GnuCOBOL 4 or later.

A bitwise AND. Each bit of the right hand side is AND'ed with the corresponding bit in the value of the left hand side to give a resulting set of bits.

Designed for integral values.

Earlier versions.

See *What STOCK CALL LIBRARY does GnuCOBOL offer?* (page 503) **CBL_AND** for an alternative to this bitwise operation.

4.1.42 B-NOT

GnuCOBOL 4 or later.

A bitwise NOT operator. Results in a value from flipping each bit of the single argument. Designed for integral values.

Earlier versions. See *What STOCK CALL LIBRARY does GnuCOBOL offer?* (page 503) **CBL_NOT** for alternatives allowing bitwise operations.

4.1.43 B-OR

GnuCOBOL 4 or later.

A bitwise OR. Each bit of the right hand side is OR'ed with the corresponding bit in the value of the left hand side to give a resulting set of bits.

Designed for integral values.

Earlier versions.

See *What STOCK CALL LIBRARY does GnuCOBOL offer?* (page 503) **CBL_OR** for an alternative to this bitwise operation.

For example:

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20110626
      *> Purpose:   Demonstrate alternative for B-OR
      *> Tectonics: cobc -x bits.cob
      *> ****************************************************************
       identification division.
       program-id. bits.

       data division.
       working-storage section.
       01 s1 pic 999 usage comp-5.
       01 t2 pic 999 usage comp-5.
       01 len   pic 9.
       01 result usage binary-long.

      *> ****************************************************************
       procedure division.
       move 2 to s1
       move 4 to t2
       move 1 to len

      *> CBL_OR takes source, target and length value  2 OR 4 is 6.   **
       call "CBL_OR" using s1 t2 by value len returning result end-call
       display s1 space t2 space len space result

       goback.
       end program bits.
```

giving:

```
$ cobc -x bits.cob
$ ./bits
002 006 1 +0000000000
```

`s1` is read, `t2` is read and written.

For a COBOL source code solution to BIT operations, Paul Chandler was nice enough to publish BITWISE.cbl and a full listing is included at *BITWISE* (page 1361).

4.1.44 B-XOR

GnuCOBOL 4 or later.

A bitwise exclusive OR. Each bit of the right hand side is XOR'ed with the corresponding bit in the value of the left hand side to give a resulting set of bits. Exclusive OR is true if one or the other bits is true, but not both.

Designed for integral values.

Earlier versions.

See *What STOCK CALL LIBRARY does GnuCOBOL offer?* (page 503) **CBL_XOR** for an alternative to this bitwise operation.

4.1.45 BACKGROUND-COLOR

```
05 BLANK SCREEN BACKGROUND-COLOR 7 FOREGROUND-COLOR 0.
```

4.1.46 BACKGROUND-COLOUR

Alternate spelling for *BACKGROUND-COLOR* (page 212).

4.1.47 BASED

Defines unallocated working storage. The address of the variable will need to be set before access or a run-time error will occur.

```
01 based-var PIC X(80) BASED.
```

A sample posted by [human]

```
GCobol*-----------------------------------------------------------------
       IDENTIFICATION DIVISION.
       PROGRAM-ID. 'MEMALL'.
       ENVIRONMENT DIVISION.
       CONFIGURATION SECTION.
       SPECIAL-NAMES. DECIMAL-POINT IS COMMA.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
       DATA DIVISION.
       FILE SECTION.
      *
       WORKING-STORAGE SECTION.
      *
```

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```
       77  mychar      pic x.
       01  REC-TEST BASED.
           03 REC-TEST-PART1 PIC X(5500000).
           03 REC-TEST-PART2 PIC X(0100000).
           03 REC-TEST-PART3 PIC X(1200000).
           03 REC-TEST-PART4 PIC X(1200000).
           03 REC-TEST-PART5 PIC X(1700000).
      *-----------------------------------------------------------------
       LINKAGE SECTION.
      *-----------------------------------------------------------------
       PROCEDURE DIVISION.
       declaratives.
       end declaratives.
      *-----------------------------------------------------------------
       main section.
       00.
           FREE ADDRESS OF REC-TEST
           display 'MEMALL loaded and REC-TEST FREEd before ALLOCATE'
           accept   mychar
      *
           IF ADDRESS OF REC-TEST = NULL
              display 'REC-TEST was not allocated before'
           ELSE
              display 'REC-TEST was allocated before'
           END-IF
           accept  mychar
      *
           ALLOCATE  REC-TEST
           move all '9' to REC-TEST
           display 'REC-TEST allocated and filled with '
                REC-TEST (1:9)
           accept  mychar
      *
           IF ADDRESS OF REC-TEST = NULL
              display 'REC-TEST was not allocated before'
              ALLOCATE  REC-TEST
              display 'REC-TEST allocated again, filled with '
                   REC-TEST (1:9)
           ELSE
              display 'REC-TEST was allocated before'
           END-IF
           accept  mychar
      *
      *
           FREE ADDRESS OF REC-TEST
           display 'REC-TEST FREEd'
           accept  mychar
      *
           stop run
      *
           continue.
       ex. exit program.
      *-----------------------------------------------------------------
      *--- End of program MEMALL ---------------------------------------
```

4.1.48 BEEP

Ring the terminal bell during *DISPLAY* (page 248) output. Alias for *BELL* (page 214)

```
DISPLAY "Beeeeep" LINE 3 COLUMN 1 WITH BEEP END-DISPLAY.
```

4.1.49 BEFORE

Sets up a *PERFORM* (page 347) loop to test the conditional before execution of the loop body. See *AFTER* (page 195) for the alternative. `BEFORE` is the default.

```
MOVE 1 TO counter
PERFORM WITH TEST BEFORE
    UNTIL counter IS GREATER THAN OR EQUAL TO limiter
        CALL "subprogram" USING counter RETURNING result END-CALL
        MOVE result TO answers(counter)
        ADD 1 TO counter END-ADD
END-PERFORM
```

Also used with the WRITE verb.

```
WRITE record-name
    BEFORE ADVANCING some-number LINES
```

And to control how the INSPECT verb goes about its job.

```
INSPECT character-var TALLYING
   the-count FOR ALL "tests" BEFORE "prefix"
```

And in the declaratives for REPORT SECTION control.

```
USE BEFORE REPORTING
 ...
```

4.1.50 BELL

Ring the terminal bell during *DISPLAY* (page 248) output. Alias for *BEEP* (page 214)

```
DISPLAY "Beeeeep" LINE 3 COLUMN 1 WITH BELL END-DISPLAY.
```

4.1.51 BINARY

Native computational storage form. COBOL supports two main storage USAGE types, BINARY and DISPLAY. DISPLAY form holds each digit as character data, base 10. BINARY form (or USAGE COMPUTATIONAL) is stored in digital base 2 patterns, native to computing machines in general. Details vary depending on platform.

```
01 result PIC S9(8) USAGE BINARY VALUE -1234.
```

Memory will be allocated in working storage to hold `result` initialized to *negative one thousand two hundred thirty four*, as bits appropriate for the current platform and configuration settings.

4.1.52 BINARY-C-LONG

Extension.

With GnuCOBOL's tight integration with the C Application Binary Interface the compiler authors have built in support that guarantees a native system C *long* value being the same bit size between COBOL and C modules. This increases coverage of the plethora of open C library functions that can be directly used with the *CALL* (page 219) verb. Including cases where callback functions that require *long* stack parameters (that can't as easily be wrapped in thin C code layers) can now be used more effectively and safely.

4.1.53 BINARY-CHAR

Defines an 8 bit usage item stored in native base 2 form.

4.1.54 BINARY-DOUBLE

Defines a 64 bit usage item, stored in native form depending on configuration settings. Machines may store values with the highest order bit at the right (little endian), or left (big endian). Network order is big-endian which is also the form used by IBM mainframe computers. Most Intel based personal computers use little-endian form

4.1.55 BINARY-INT

Extension. Equivalent to *BINARY-LONG* (page 215) 32 bit data item.

4.1.56 BINARY-LONG

32 bit native *USAGE* (page 427) modifier.

```
BINARY-LONG SIGNED    -2147483648 [-2**31] < n < 2147483648 [2**31]
BINARY-LONG UNSIGNED                  0 <= n < 4294967296 [2**32]
```

Will *almost* fit in an `S9(9)` or `9(9)`. In COBOL, picture 9(10) doesn't really work either, as the 10 digits needed to hold 4,294,967,296 would allow for 9,999,999,999 and that actually requires 34 bits of information.

The largest value that COBOL can hold in 32 bits and still represent the decimal value required by *PICTURE* (page 348) 9, is 999,999,999. It is a fundamental difference between base-2 and base-10 representations.

For `PIC 9(9) USAGE COMP-5`, COBOL allocates 32 bits. Just don't try and go to a billion in binary and then display it as `USAGE DISPLAY` as things won't be right.

There was longstanding misinformation here, pointed out by Simon, the old, wrong documentation was `S9(8)`. Repeat. Wrong. Don't believe everything you read here. Verify it, just in case.

As an example, with GnuCOBOL in January of 2016

```
GCobol >>SOURCE FORMAT IS FREE
       identification division.
       program-id. comp32.

       environment division.
       configuration section.
       repository. function all intrinsic.

```

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```
       data division.
       working-storage section.
       01 comp32               PIC S9(9) USAGE COMP-5.
       01 comp34               PIC S9(10) USAGE COMP-5.

       procedure division.
       display "comp32 s9(9)  usage comp-5 length: "
           function length(comp32) " and "
           function byte-length(comp32) " byte-length"

       display "comp34 s9(10) usage comp-5 length: "
           function length(comp34) " and "
           function byte-length(comp34) " byte-length"
       display space

       perform varying tally from 1 by 1 until tally > 3
           evaluate tally
               when 1 display "2 ** 29 ok"
               when 2 display "2 ** 30 DISPLAY IS TRUNCATED FOR comp32"
               when 3 display "2 ** 31 size error detected for comp32"
           end-evaluate

           compute comp32 = 2 ** (28 + tally)
               on size error perform soft-exception
               not on size error
                   display "comp32 = 2 ** (28 + " tally ") =  " comp32
           end-compute

           compute comp34 = 2 ** (28 + tally)
               on size error perform soft-exception
               not on size error
                   display "comp34 = 2 ** (28 + " tally ") = " comp34
           end-compute
           display space
       end-perform
       goback.
      *> ****************************************************************

      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
         display space upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
```

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```
      end program comp32.
```

With a run sample of:

```
prompt$ cobc -xj -debug comp32.cob
comp32 s9(9)  usage comp-5 length: 000000004 and 000000004 byte-length
comp34 s9(10) usage comp-5 length: 000000008 and 000000008 byte-length

2 ** 29 ok
comp32 = 2 ** (28 + 00001) =  +536870912
comp34 = 2 ** (28 + 00001) = +0536870912

2 ** 30 DISPLAY IS TRUNCATED FOR comp32
comp32 = 2 ** (28 + 00002) =  +073741824
comp34 = 2 ** (28 + 00002) = +1073741824

2 ** 31 size error detected for comp32

--Exception Report--
Time of exception:   2016013107083456-0500
Module:              comp32
Module-path:         /home/btiffin/lang/cobol/forum/comp32
Module-source:       comp32.cob
Exception-file:      00
Exception-status:    EC-SIZE-OVERFLOW
Exception-location:  comp32; ; 31
Exception-statement: COMPUTE

comp34 = 2 ** (28 + 00003) = +2147483648
```

You can't blame COBOL for the erroneous display of `2 ** 30` when converted to decimal. You can't blame the computer either. You can only lament the tragedy that is the human machine interface, and rise to the challenge.

4.1.57 BINARY-LONG-LONG

Extension. Equivalent to *BINARY-DOUBLE* (page 215).

4.1.58 BINARY-SHORT

16 bit native *USAGE* (page 427). Will fit in `S9(5)`, or `9(5)`, but note that due to the differences in decimal and binary representations, the picture may end up with invalid decimal data. 32767 will display properly with `pic s9(5)`, 70000 (for example) will not, as it requires more then 16 bits in base-2.

4.1.59 BIT

Not yet implemented. See *What STOCK CALL LIBRARY does GnuCOBOL offer?* (page 503) for alternatives allowing bitwise operations.

4.1.60 BLANK

```
05 BLANK SCREEN BACKGROUND-COLOR 7 FOREGROUND-COLOR 0.
```

4.1.61 BLINK

Aaaaaah, my eyes!!

Causes a screen display field to blink.

When you are in a Windows environment, the BLINK attribute may not produce the blinking effect, but turn on HIGHLIGHT in the background colour. This is dependent on the implementation of the lower level screen management library used to build `libcob`. This is not allowed using normal code (HIGHLIGHT attribute is referred only to foreground colour), BLINK then allows a useful extension of the possibilities of colour management on the screen when in Text User Interface mode.

4.1.62 BLOCK

A supported, but ignored, file control block control clause. Most POSIX operating systems do not honour attempts to override file and record block sizing. Some *TAPE* (page 418) device drivers may honour the setting, but GnuCOBOL simply ignores the phrase.

```
FD file-name
  BLOCK CONTAINS 1 TO n RECORDS
```

4.1.63 BOOLEAN

An as yet unsupported data category.

4.1.64 BOTTOM

A *LINAGE* (page 314) setting for the number of lines to use for a bottom margin. The bottom margin defaults to zero lines.

```
FD  mini-report
      linage is 16 lines
          with footing at 15
          lines at top 2
          lines at bottom 2.
```

4.1.65 BY

`VARYING` loop variable step value. GnuCOBOL requires this clause and there is no default step value. Can be any numeric type or value, positive or negative, integer or floating point.

```
PERFORM the-procedure
    VARYING step-counter FROM 1 BY step-size
    UNTIL step-counter > counter-limit
```

4.1.66 BYTE-LENGTH

Human incisors average about 16mm.

More to the point, BYTE-LENGTH returns the length, in bytes, of a data item. See *FUNCTION BYTE-LENGTH* (page 445). This will become more important as *NATIONAL* (page 325) data item support increases in the GnuCOBOL implementations.

4.1.67 CALL

The GnuCOBOL `CALL` verb provides access to library functions. It accepts a string literal or a name stored in a character field identifier to resolve the control flow transfer address.

As of version 3, GnuCOBOL also supports using an entry point stored in a *PROGRAM-POINTER* (page 356), avoiding the dynamic runtime lookup. *GnuCOBOL keeps a cache of lookups during a program run*. Repeated use of a named function does not suffer much penalty, but PROGRAM-POINTER will be just that little bit faster. To set a `PROGRAM-POINTER` use *SET* (page 400) `program-reference TO ENTRY "name"` (or get the address from an API, and take part in callback programming).

If the called procedure returns, COBOL control flow proceeds in sequence from the statement immediately following the END-CALL.

The `CALL` verb accepts conditional blocks, [*NOT* (page 327)] *ON* (page 333) *EXCEPTION* (page 257), and you may need to use an explicit `END-CALL`.

Side note

Early versions of this document had `END-ACCEPT` and `END-DISPLAY` everywhere. It was pointed out that this was probably off putting, and rarely necessary. So, a big editor-automated purge occurred. It changed at least one program example.

```
CALL "function"
    ON EXCEPTION
        DISPLAY "error: exception calling function"
    NOT ON EXCEPTION
        DISPLAY "Working as intended"
END-CALL
```

That is not the same as

```
CALL "function"
    ON EXCEPTION
        DISPLAY "error calling function" END-DISPLAY
    NOT ON EXCEPTION
        DISPLAY "Working as intended" END-DISPLAY
END-CALL
```

In the first fragment, the `NOT ON EXCEPTION` binds to the `DISPLAY "error...` statement, not the `CALL`. Doh! *Thanks to Edward Hart for spotting that one when it came up.* It means you only get the "Working" if the call fails, displays the error message (and that DISPLAY won't have an exception, so the negative conditional phrase adds "Working" *to the error message*).

It compiles as:

```
CALL "function"
    ON EXCEPTION
        DISPLAY "error: exception calling function"
            NOT ON EXCEPTION
```

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```
                DISPLAY "Working as intended"
END-CALL
```

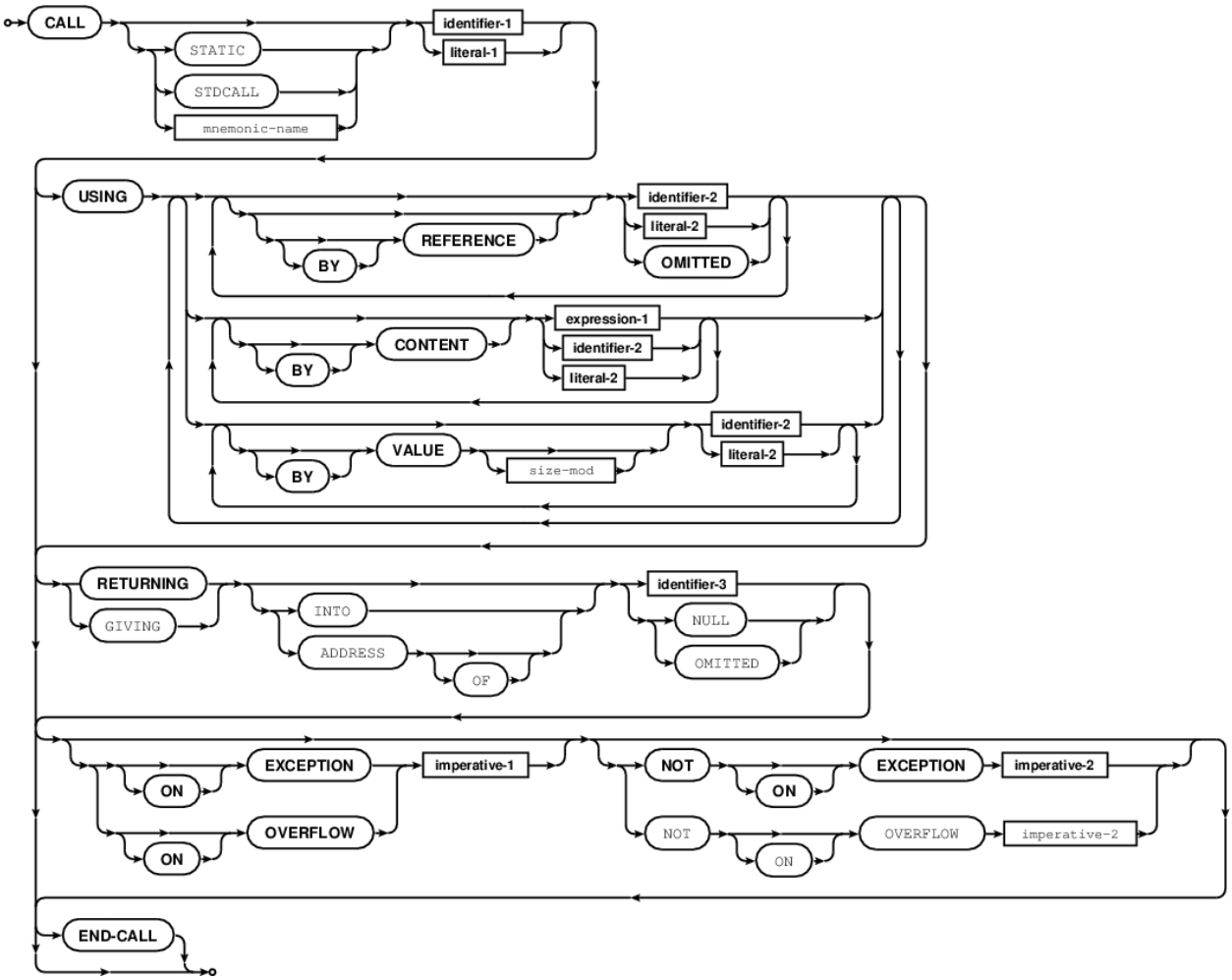
Not really *Working as intended*.

End side note on the importance of keeping an eye on explicit terminators.

The `USING` phrase of `CALL` allows argument passing to and from subprograms. GnuCOBOL includes internal rules for the data representation of the call frame entities, and these depend on the COBOL *PICTURE* (page 348) and *USAGE* (page 427) clauses.

`USING identifier-1 BY VALUE` works in most cases, but GnuCOBOL needs a little more work to make this a completely smooth and stress free feature. The `SIZE n` modifier can help here when there are bit-width issues with integer fields. `BY VALUE` gets tricky if the receiving program uses different storage classes than the caller. (COMP-3 vs COMP for instance, let alone PIC 9 USAGE DISPLAY forms linked to binary storage). At this time, the compiler is not yet complete in coverage and some responsibility needs to fall on the programmer to ensure proper `CALL` frames regarding data sizes and types.

subprogram return values are captured with a `RETURNING` phrase. A special register, *RETURN-CODE* (page 381) is maintained by GnuCOBOL when no *RETURNING* (page 381) phrase is used. GnuCOBOL assumes an integer return value when calling unless told to with `RETURNING` *OMITTED* (page 332), (void return, `RETURN-CODE` set to 0) or *NOTHING* (page 327) (`RETURN-CODE` not touched along with the void return assumptions).



See *What STOCK CALL LIBRARY does GnuCOBOL offer?* (page 503) for a list of `CALL` entry names that are included

in the GnuCOBOL run-time support libraries.

And, with just a little bit of care managing the bit widths of data items used, GnuCOBOL has direct access to the entire C API/ABI code base, all via the CALL verb.

For some old, historical information see http://gnucobol.sourceforge.net/historical/open-cobol/C-Interface.html

CALL is the verb that opens up access to the plethora of C based *ABI* (page 1350) libraries. A **plethora**, *and the standard C library is accessible without explicit linkage* as a bonus.

One item of note is C pointers. Especially those passed around as handles. When calling a C routine that returns a handle, the RETURNING identifier (USAGE POINTER) will receive a C pointer. To use that handle in later CALL statements, the argument from COBOL should usually be passed BY VALUE. This passes the C pointer, not the address of the COBOL identifier, as the default BY REFERENCE argument handling would do.

Below is a sample that allows fairly carefree use of CBL_OC_DUMP during development. ON EXCEPTION CONTINUE.

```
GCobol*>>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20110701
      *> Purpose:   Try C library formatted printing, and CALL exception
      *> Tectonics: cobc -x callon.cob
      *>        or  cobc -x callon.cob CBL_OC_DUMP.cob
      *> ****************************************************************
       identification division.
       program-id. callon.

       data division.
       working-storage section.
       01 result      usage binary-long.

       01 pie         usage float-short.
       01 stuff       pic x(12) value 'abcdefghijkl'.

      *> ****************************************************************
       procedure division.
       move 3.141592654 to pie

      *> Get a dump of the memory at pie, but don't stop if not linked
       call "CBL_OC_DUMP" using pie 4 on exception continue end-call
       display "Continues even if external function not available"

      *> Call C's printf, abort if not available
       call static "printf" using
           "float-short: %10.8f" & x"0a00"
           by value pie
           returning result
       end-call
       display pie space length of pie space result
       display "static functions rarely, if ever, trigger on exception"

      *> Get a dump of the memory used by stuff, don't stop if no link
       call "CBL_OC_DUMP" using stuff 12 on exception continue end-call
       display "Continues even if external function not available"

      *> Get a dump of the memory used by stuff, abort if not linked <*
       call "CBL_OC_DUMP" using stuff 12 end-call
```

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```
       display "Will abend without DUMP, this might not be displayed"

       goback.
       end program callon.
```

See *What is CBL_OC_DUMP?* (page 599) for details of the subprogram.

A run-time session shows:

```
$ cobc -x callon.cob
$ ./callon
Continues even if external function not available
float-short: 3.14159274
static functions rarely, if ever, trigger on exception
3.1415927 4 +0000000024
Continues even if external function not available
libcob: Cannot find module 'CBL_OC_DUMP'
$ cobc -x callon.cob CBL_OC_DUMP.cob
$ ./callon

Offset  HEX-- -- -- -5 -- -- -- -- 10 -- -- -- -- 15 --   CHARS----1----5-
000000  db 0f 49 40                                      ..I@............
Continues even if external function not available

float-short: 3.14159274
3.1415927 4 +0000000024
static functions rarely, if ever, trigger on exception

Offset  HEX-- -- -- -5 -- -- -- -- 10 -- -- -- -- 15 --   CHARS----1----5-
000000  61 62 63 64 65 66 67 68 69 6a 6b 6c               abcdefghijkl....
Continues even if external function not available

Offset  HEX-- -- -- -5 -- -- -- -- 10 -- -- -- -- 15 --   CHARS----1----5-
000000  61 62 63 64 65 66 67 68 69 6a 6b 6c               abcdefghijkl....
Will abend without DUMP, this might not be displayed
```

So, the first `CALL` to `CBL_OC_DUMP` doesn't 'fail' as the `ON EXCEPTION CONTINUE` traps the condition and lets the program carry on without a dump displayed. The last `CALL` does abend the program, with 'Cannot find module' when `CBL_OC_DUMP` is not compiled in or accessible at runtime.

It's expensive, but during development ON EXCEPTION CONTINUE can be a handy thing. Not for production; there is a measurable cost for a failed symbol lookup.

CALL STATIC

Sometimes it is just nice to link in subprograms at compile time.

GnuCOBOL 2.0 and up supports a -K"name" (multiple uses allowed) `cobc` option to inform the compiler to link that call module statically, into the object code. By default CALL is dynamic. The `STATIC` modifier tweaks the compiler tool chain to include object code.

```
CALL STATIC "puts" USING a-zstring END-CALL
```

will link to the libc function at compile time, and not rely on the run-time dynamic linker. Works well with Cygwin compiles, which can have a tough time finding the POSIX support DLLs at run-time. See *STATIC* (page 413).

One gripe: Under certain conditions the `STATIC` modifier requires the C compile phase to have access to call frame signature prototypes, from C header source files, that GnuCOBOL may not have #included during C source code generation. It can lead to the C compiler complaining about serious call frame assumption problems. The code may still run fine, but you are on your own if the arguments are incorrect (and this can include things like assumed return value as a C int).

Plus, the warnings make the compile smell funny (even though it probably doesn't), so, *griping*. It'll likely be fixed someday. Perhaps a >>IMP pragma to get at system header files during the C phase.

CALL STDCALL

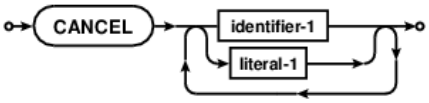
Changes the call frame handler. With `STDCALL`, called subprogram are responsible for parameter stack cleanup adjustment, not the caller. `_std` modifier is generated in the intermediate C sources. See *STDCALL* (page 413).

RETURNING OMITTED

One sticky point with COBOL and `CALL`. Foreign functions, C in particular, can specify `void` return. That means no value is placed on top of the call frame. Unless told otherwise, COBOL will assume that value is there, possibly popping it off, and corrupting, a call frame stack. To `CALL` void C, *or assembler routine, for another case*, use `CALL ... RETURNING OMITTED`.

4.1.68 CANCEL

Virtual cancel of a module is supported. Physical cancel support is on the development schedule.



4.1.69 CAPACITY

Not yet supported.

4.1.70 CD

A control clause of the as yet unsupported *COMMUNICATION* (page 229) DIVISION.

4.1.71 CENTER

An as yet unsupported keyword.

4.1.72 CF

Short form for CONTROL FOOTING, a clause used in REPORT SECTION.

4.1.73 CH

Short form for CONTROL HEADING, a clause used in PAGE descriptors in the REPORT SECTION.

4.1.74 CHAIN

Not yet supported.

Invokes a subprogram, with no return of control implied. The chained program unit virtually becomes the main program within the run unit.

4.1.75 CHAINING

Passes procedure division data through `WORKING-STORAGE` from the command line. Technically from the argc/argv parameters used by the C *ABI* (page 1350).

Note that this does not pass `CALL ... USING` data, but command line arguments.

```
GCOBOL identification division.
       program-id. chained.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 str                  pic x(80).

       procedure division chaining str.
       display "In chained with :" trim(str) ":"

       accept str from command-line
       display "COMMAND-LINE    :" trim(str) ":"

       goback.
       end program chained.
```

Sample run:

```
prompt$ cobc -x -j='"this is a test"' chained.cob
In chained with :this is a test:
COMMAND-LINE    :this is a test:
```

And now, invoked from a `CALL`, the `CHAINING` data is still that of the command line. Even though the call "works", `CALL` does not set command arguments just because the called program uses `CHAINING`.

Having said that, the `COMMAND-LINE` special register *can* be modified before hand. In the sample run below, the `chained.cob` program gets both the actual first element from the operating system argv, AND the special register set in `caller.cob`.

A caller program.

```
GCOBOL identification division.
       program-id. caller.

       data division.
       working-storage section.

       procedure division.
```

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```
       display "new COMMAND-LINE argument value" upon command-line
       call "chained" using "** this is NOT passed by chaining **"

       goback.
       end program caller.
```

```
prompt$ cobc -x caller.cob chained.cob
prompt$ ./caller "this is the original argv"
In chained with :this is the original argv:
COMMAND-LINE    :new COMMAND-LINE argument value:
```

`CHAINING str` receives the operating system value, not the argument used by `CALL`. On top of that, the `CHAINING` value is not a copy of the current `COMMAND-LINE` special register, but the actual operating system argument.

The module has the explicitly set internal COMMAND-LINE special register value from `caller.cob`, and the chained argv. This *might* come in handy, but is probably not something you'd want to do to someone that has to maintain your code; if you want them to know what is going on and where data is coming from.

4.1.76 CHARACTER

```
PADDING CHARACTER IS
```

A soon to be obsolete feature.

4.1.77 CHARACTERS

A multi use keyword.

Used in *SPECIAL-NAMES* (page 410)

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20101031
      *> Purpose:   Try out SYMBOLIC CHARACTERS
      *> Tectonics: cobc -x figurative.cob
      *> Rave:      GnuCOBOL is stone cold cool
      *> ************************************************************
       identification division.
       program-id. figurative.

       environment division.
       configuration section.
       special-names.
           symbolic characters TAB is 10
                               LF  is 11
                               CMA is 45.

       data division.
       working-storage section.
       01 a-comma pic x(1) value ",".
       01 lots-of-commas pic x(20).
```

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```
      *> ****************************************************************
       procedure division.
       display
           "thing" TAB "tabbed thing" LF
           "and" TAB "another tabbed thing" LF
           "other" CMA " things"

       move a-comma to lots-of-commas
       display "MOVE a-comma : " lots-of-commas

       move CMA to lots-of-commas
       display "MOVE symbolic: " lots-of-commas

       goback.
       end program figurative.
```

Output:

```
$ cobc -x figuratives.cob
$ ./figuratives
thing   tabbed thing
and     another tabbed thing
other, things
MOVE a-comma : ,
MOVE symbolic: ,,,,,,,,,,,,,,,,,,,
```

Used in *INSPECT* (page 304)

```
INSPECT str TALLYING TALLY FOR CHARACTERS BEFORE INITIAL ','

INSPECT str REPLACING CHARACTERS BY '*' AFTER INITIAL ':'
```

Used in a File Description *FD* (page 260)

```
FD file-name
   BLOCK CONTAINS integer-1 TO integer-2 CHARACTERS
   RECORD IS VARYING IN SIZE FROM integer-5 TO integer-6 CHARACTERS
      DEPENDING ON identifier-1.
```

In the above case, `identifier-1` will set a record size limit for write, but will be filled with the actual length read for reads. Handy for LINE SEQUENTIAL files and getting at how many characters come in on each line.

Used in *ALLOCATE* (page 196)

```
ALLOCATE 100 * cell-size CHARACTERS RETURNING heap-pointer
```

4.1.78 CLASS

Used to create character classes in SPECIAL-NAMES. In some circumstances, character classes can be used to validate data in a very concise way.

```
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SPECIAL-NAMES.
CLASS octals IS '0' THRU '7'.
```

(continues on next page)

(continued from previous page)

```
CLASS host-class IS 'A' THROUGH 'Z'
                    'a' THROUGH 'z'
                    '0' THROUGH '9'
                    '-', '.'

...

PROCEDURE DIVISION.
IF user-value IS NOT octals
    DISPLAY "Sorry, not a valid octal number"
ELSE
    DISPLAY user-value
END-IF

IF network-host IS NOT host-class
    DISPLAY "Invalid (pre international domain name standard) host"
END-IF
```

4.1.79 CLASS-ID

An as yet unsupported Object COBOL class identifier clause.

4.1.80 CLASSIFICATION

An as yet unsupported source code internationalization clause.

4.1.81 CLOSE

Close an open file. GnuCOBOL will implicitly close all open resources at termination of a run unit and will display a warning message stating it did so, and the danger of potentially unsafe termination.

```
CLOSE input-file
```

4.1.82 COB-CRT-STATUS

Predefined PIC 9(4) special register for *CRT* (page 240) status. This field is not predefined if an explicit

```
CRT STATUS IS user-field
```

is used in a *SPECIAL-NAMES* (page 410) paragraph.

4.1.83 COBOL

A `PROCEDURE DIVISION` qualifier, laying down a normal COBOL entry point.

See *EXTERN* (page 259) for the other type of program entry qualifier.

4.1.84 CODE

A clause of a report descriptor, *RD* (page 359).

4.1.85 CODE-SET

An as yet unsupported data internationalization clause.

4.1.86 COL

Alias for *COLUMN* (page 228).

4.1.87 COLLATING

Allows definition within a program unit of a character set.

```
OBJECT-COMPUTER. name.
  PROGRAM COLLATING SEQUENCE IS alphabet-1.
```

4.1.88 COLS

Alias for *COLUMNS* (page 228).

4.1.89 COLUMN

- A REPORT SECTION *RD* (page 359) descriptor clause.
- Also used for positional DISPLAY and ACCEPT, which implicitly uses SCREEN SECTION style ncurses screen IO.

```
DISPLAY var-1 LINE 1 COLUMN 23
```

When using the condensed form of extended AT, the first two (or three) digits are LINE and the last two (or three) digits are COLUMN. *These literal values can be either four or six digits*.

```
DISPLAY "Text" AT 0203
DISPLAY "Text" AT 002101 WITH REVERSE-VIDEO
```

4.1.90 COLUMNS

An *RD* (page 359) clause, plural of *COLUMN* (page 228).

4.1.91 COMMA

A *SPECIAL-NAMES* (page 410) clause supporting commas in numeric values versus the default period decimal point. COBOL was way ahead of the internationalization curve, *and this feature has caused compiler writers no little grief in its time, a challenge they rise to and deal with for the world's benefit*.

```
DECIMAL POINT IS COMMA
```

4.1.92 COMMAND-LINE

Provides access to command line arguments.

```
ACCEPT the-args FROM COMMAND-LINE END-ACCEPT
```

COMMAND-LINE is a single character field.

See *ARGUMENT-VALUE* (page 205) and *ARGUMENT-NUMBER* (page 205) for access to separate shell expanded arguments.

The special system library CBL_GC_HOSTED can also be used to access the commonly referred to `argc` and `argv` argument count and array of separate argument string pointers that are passed to `main` funtions by POSIX friendly operating systems.

4.1.93 COMMIT

Flushes ALL current locks, synching file I/O buffers. GnuCOBOL supports safe transactional processing with *ROLLBACK* (page 386) capabilities. *Assuming the ISAM handler configured when building the compiler can support LOCK_*

In tandem with ROLLBACK, the commitment boundary is from OPEN to first COMMIT or ROLLBACK, then until the next COMMIT or ROLLBACK, repeating until CLOSE.

Only a single commitment point is ever active, per file.

4.1.94 COMMON

```
PROGRAM-ID. CBL_OC_PROGRAM IS COMMON PROGRAM.
```

Ensures a nested subprogram is also available to other nested subprograms with a program unit hierarchy.

4.1.95 COMMUNICATION

currently *(March 2018)* unsupported section, but see *Does GnuCOBOL support Message Queues?* (page 672) for an alternative.

4.1.96 COMP

A binary *USAGE* (page 427) form. Short for *COMPUTATIONAL* (page 231). By COBOL standard, this form is an implementation depedent form. Usually one of the fastest native forms, but not that safe when transferring data between machines, even those compiled with the same version of GnuCOBOL, as it depends on hardware platform.

4.1.97 COMP-1

Equivalent of *FLOAT-SHORT* (page 270) single precision floating point. GnuCOBOL uses IEEE 754 standard floating point representation.

Alias for *COMPUTATIONAL-1* (page 232)

4.1.98 COMP-2

Equivalent of *FLOAT-LONG* (page 269) double precision floating point. GnuCOBOL uses IEEE 754 standard floating point representation.

See *COMPUTATIONAL-2* (page 232)

4.1.99 COMP-3

PACKED DECIMAL binary storage form. See *COMPUTATIONAL-3* (page 232)

4.1.100 COMP-4

Equivalent to *BINARY* (page 214) and *COMP* (page 229). See *COMPUTATIONAL-4* (page 232)

4.1.101 COMP-5

A hardware preferred binary storage form, with allowed *PICTURE* (page 348). This can lead to some interesting edge cases.

For example; PIC S9(4) will need 2 bytes of storage. That leads to values between -32768 and +32767. But, a PIC S9(4) is limited to display usage in the range -9999 to +9999. Internal and external view can differ considerably.

Dual PIC and BINARY fields need to be treated with care and respect. COMP-5 is subject to external high order truncation when displayed by PICTURE and during PICTURE based MOVE instructions. The compiler option `-fnotrunc` can modify this behaviour and may display fields wider than the PICTURE.

COMP-5 is always native memory storage order, independent of the `binary-byteorder` configuration setting.

COMP-5 will share the same byte order forms as C programs on the same platform.

COMP-5 byte order may not be suitable for some network data when using common Intel chip sets, as the internet uses `big-endian` form and Intel is commonly `little-endian` layout.

A compile time test, using the Compiler Directive Facility is available with a predefined ENDIAN symbol. It will hold BIG or LITTLE at compile time.

```
>>IF ENDIAN = "BIG"
big end code
>>END-IF

>>IF ENDIAN = "LITTLE"
little end code
>>END-IF
```

See *COMPUTATIONAL-5* (page 232)

4.1.102 COMP-6

Unsigned *COMP-3*, UNSIGNED PACKED.

See *COMPUTATIONAL-6* (page 233) and *COMPUTATIONAL-3* (page 232)

4.1.103 COMP-X

A binary *USAGE* (page 427) format with *PICTURE* (page 348) data allowed to be any alphanumeric type. PIC X data can be treated as computational numerics with COMP-X.

Stored in memory dependent on the `binary-byteorder` configuration setting. Can be `native` or `big-endian` order. COMP-X allows binary data that use PIC X definitions. By default, GnuCOBOL stores *BINARY* (page 214) data in `big-endian` order.

Please note that the `binary-byteorder` setting can vary from compile to compile and the same source code can produce different binary fields when this setting is changed between compiles. GnuCOBOL keeps an internal flag attached to each and every field that determines whether byte reording code is needed when managing platform byte order and current 'COBOL' byte order.

Unless involved in cross platform data sharing or networking, programmers will rarely have to worry about this as the compiler keeps track and swaps bytes as needed.

```
*> Modified: 2016-04-30/01:52-0400
 COPY sample-template REPLACING
 ==:DATABOOK:== BY
 ==

 01 from-x     pic x(4) comp-x value "WXYZ".

 ==
 ==:CODEBOOK:== BY
 ==

 display from-x
 add 1 to from-x
 display from-x

 ==
 .
```

Giving:

```
$ cobc -xj compx-sample.cob
sample-template.cob: 12: Warning: Numeric value is expected
465407834
465407835
```

See *Sample shortforms* (page 1433) for the `sample-template` listing.

COMPUTATIONAL-X (page 233) is the long form alias of COMP-X.

4.1.104 COMPUTATIONAL

Implementors choice binary storage form; GnuCOBOL is a *big-endian* (page 1318) default. With most Intel personal computers and operating systems like GNU/Linux, *COMPUTATIONAL-X* (page 233) will run faster, as internal byte swapping can be avoided.

The default byte-order is controlled by compile time configuration though, and care must be taken when making assumptions if data is being transferred over the network or between machines. See *What are the GnuCOBOL compile time configuration files?* (page 105) and *What is runtime.cfg?* (page 146) for more details on these low level issues. As this is compile time control, looking at current settings may not be accurate compared to the executable, which may have been compiled when different settings where in place. This can really only be verified from inside the executable itself, with a byte-order test at runtime.

An example for byte-order testing can be found in the CBL_OC_DUMP sources

```
OCDUMP 77  byline               pic 999    usage comp-5.

       TEST-ENDIAN SECTION.
       00.
      *    Number-bytes are shuffled in Big-Little endian
           move 128 to byline
           set address of byte to address of byline
           if function ord(byte) > 0
              set  is-big-endian-yes to true
           else
              set  is-big-endian-no  to true
           end-if
      *
           continue.
       ex. exit.
```

Where the first byte of the value 128 in byline will be zero for little-endian and non-zero for big-endian storage. Endian order testing has to make assumptions about known bit layouts of multiple byte numeric data to be reliable and it is difficult to make this determination by external means. Native order is not always applicable as GnuCOBOL will add code to swap bytes depending on the *byte-order* configuration setting at compile time if needed.

4.1.105 COMPUTATIONAL-1

Single precision float. Equivalent to *FLOAT-SHORT* (page 270).

4.1.106 COMPUTATIONAL-2

Double precision float. Equivalent to *FLOAT-LONG* (page 269).

4.1.107 COMPUTATIONAL-3

Equivalent to PACKED DECIMAL. Packed decimal is stored as two digits per byte, always sign extended and influenced by a .conf setting *binary-size*. *COMPUTATIONAL-6* (page 233) is UNSIGNED PACKED.

4.1.108 COMPUTATIONAL-4

Equivalent to BINARY.

4.1.109 COMPUTATIONAL-5

Native form.

4.1.110 COMPUTATIONAL-6

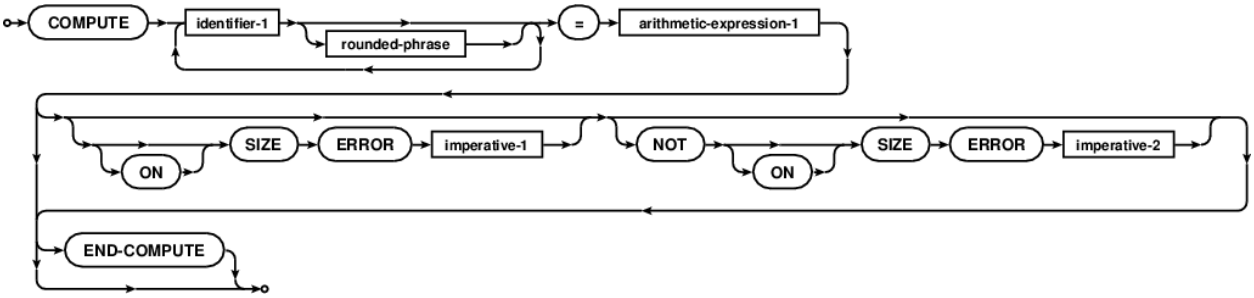
Unsigned packed decimal form, see *COMPUTATIONAL-3* (page 232).

4.1.111 COMPUTATIONAL-X

Binary form, allowing PIC X data to be treated as a computational numeric value.

4.1.112 COMPUTE

Computational arithmetic.



GnuCOBOL supports the normal gamut of arithmetic expressions.

- Add +
- Subtract -
- Multiply *
- Divide /
- Raise to power **

Order of precedence rules apply.

1. Unary minus, unary plus
2. Exponentiation
3. Multiplication, division
4. Addition, subtraction
5. Parentheses can be used to manage precedence

```
COMPUTE circular-area = radius ** 2 * FUNCTION PI END-COMPUTE
```

Spaces and expressions

Due to COBOL allowing *dash* in user names, care must be taken to properly space arithmetic expressions.

Some examples of seemingly ambiguous and potentially dangerous code

```
GCobol*> ************************************************************
       identification division.
       program-id. computing.

       data division.
```

(continues on next page)

(continued from previous page)

```
       working-storage section.
       01 answer pic s9(8).
       01 var    pic s9(8).

      *> ****************************************************************
       procedure division.
       compute answer = 3*var-1 end-compute

       goback.
       end program computing.
```

That is *not* three times var *minus one*, it is 3 times **var-1** GnuCOBOL will complain.

```
$ cobc -x computing.cob
computing.cob:18: Error: 'var-1' is not defined
```

whew, saved!

```
GCobol*> ****************************************************************
       identification division.
       program-id. computing.

       data division.
       working-storage section.
       01 answer pic s9(8).
       01 var    pic s9(8).
       01 var-1  pic s9(8).

      *> ****************************************************************
       procedure division.
       compute answer = 3*var-1 end-compute

       goback.
       end program computing.
```

With the above source, the compile will succeed.

```
$ cobc -x computing.cob
```

GnuCOBOL will, (properly, according to standard), compile this as **three** times **var-1**. Not saved, if you meant **3** times **var** minus **1**.

GnuCOBOL programmers are strongly encouraged to use full spacing inside COMPUTE statements.

```
GCobol*> ****************************************************************
       identification division.
       program-id. computing.

       data division.
       working-storage section.
       01 answer pic s9(8).
       01 var    pic s9(8).
       01 var-1  pic s9(8).

      *> ****************************************************************
       procedure division.
       compute
```

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```
           answer = 3 * var - 1
           on size error
               display "Problem, call the ghost busters"
           not on size error
               display "All good, answer is within range"
       end-compute

       goback.
       end program computing.
```

COMPUTE supports ON SIZE ERROR, NOT ON SIZE ERROR conditionals for safety, and many *ROUNDED* (page 386) modifiers for bankers. There are eight (8) different roundings.

```
COMPUTE
    total ROUNDED MODE NEAREST-AWAY-FROM-ZERO =
      total - amount * rate / time-span
END-COMPUTE
```

With the default being NEAREST-AWAY-FROM-ZERO with ROUNDED, and TRUNCATION when the *ROUNDED* (page 386) keyword is not present.

4.1.113 CONDITION

As yet unsupported USE AFTER EXCEPTION CONDITION clause.

4.1.114 CONFIGURATION

A *SECTION* (page 394) of the *ENVIRONMENT* (page 255) DIVISION. Holds paragraphs for

- *SOURCE-COMPUTER* (page 410)
- *OBJECT-COMPUTER* (page 330)
- *SPECIAL-NAMES* (page 410)
- *REPOSITORY* (page 378)

4.1.115 CONSTANT

A data definition keyword allowing for constant values. These values cannot be passed by reference, nor can the data name be used with `ADDRESS OF`.

```
01 enumerated-value CONSTANT AS 500.
01 some-string      CONSTANT AS "immutable value".
```

4.1.116 CONTAINS

An *FD* (page 260) clause:

```
FD a-file RECORD CONTAINS 80 CHARACTERS.
```

4.1.117 CONTENT

A *CALL* (page 219) clause that controls how arguments are passed.

```
CALL "subprog" USING BY CONTENT alpha-var.
```

alpha-var will not be modifiable by subprog, as a copy is passed.

See *REFERENCE* (page 362) and *VALUE* (page 430) for the other CALL argument controls.

4.1.118 CONTINUE

A placeholder, no operation verb. That's not quite true, `continue` breaks out of the current statement, doing nothing else.

The sample below isn't good design, only a *poor* example.

```
if action-flag = "C" or "R" or "U" or "D"
    continue
else
    display "invalid action-code"
end-if
```

A pretty handy use for `continue`, while developing and coming to grips with C structures and unknown datums:

```
call "CBL_OC_DUMP" using cstruct ON EXCEPTION CONTINUE end-call
```

Including CBL_OC_DUMP in the cobc *tectonics* (page 1350), causes a hex dump. Without linkage; no runtime error, just continue, avoiding a stop run.

COBOL 2020 adds `CONTINUE AFTER s.ns SECONDS` a timed sleep. Actual resolution and sub second granularity will be platform dependent, but assume milliseconds to be a safe worst case. Only available in GnuCOBOL 3.2 or greater. `CONTINUE AFTER 5.000005 SECONDS` would sleep for 5 and 5 one millionth of a second. The 5 millionths might be too much to ask for most operating systems and the actual sleep time may not be exactly 5.000005 seconds.

4.1.119 CONTROL

REPORT SECTION clause for setting control break data fields.

4.1.120 CONTROLS

REPORT SECTION clause for setting control break data fields.

4.1.121 CONVERSION

Not yet implemented.

An ignored screen attribute.

4.1.122 CONVERTING

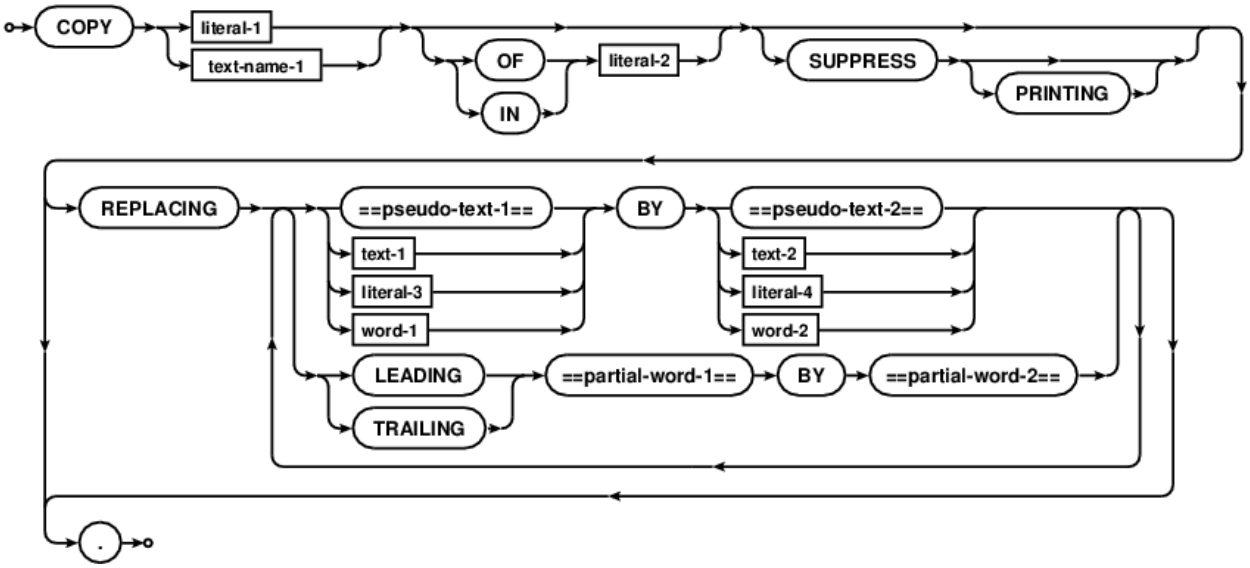
A clause of the *INSPECT* (page 304) verb.

```
INSPECT X CONVERTING "012345678" TO "999999999".
```

GnuCOBOL supports an extension statement, *TRANSFORM* (page 422) which is identical in effect to `INSPECT CONVERTING`.

4.1.123 COPY

The COBOL include preprocessor verb. Source text is inserted from an external text file, sometimes called a *copybook*, and treated as if it was typed into the current source file (with some possible *REPLACING* (page 369) modifications during the copy include operation).



Also see *REPLACE* (page 368) and *Does GnuCOBOL support COPY includes?* (page 785).

For example

Given `cobweb-gtk-data-preamble.cpy`

```
*> Repository default data names
 01 gtk-window-record.
    05 gtk-window       usage pointer.
    05 gwr-pointer      usage pointer.
    05 gwr-number       usage binary-long.
*> ...
```

with `cobweb-gtk.cob`

```
*> Include some data
 data division.
 working-storage section.

 01 important-field pic x.

 COPY cobweb-gtk-data-preamble.
```

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```
 01 more-working-store pic xx.

 procedure division.

 COPY cobweb-gtk-preamble.

 move new-button(new-box(new-window("Put up a GUI"),
     "An OK button", "cobweb-gtk-clicked"))
   to extraneous

 goback.
 end program sample.
```

then `cobc -x cobweb-gtk.cob` which will start up a compile, with part of the data division loaded with some ease of use data field names that may ship with FUNCTION-ID repositories, perhaps the REPOSITORY list itself in another copybook, and perhaps some init code needed by the library or application.

See *What extensions are used if cobc is called with/without "-ext" for COPY?* (page 103) for details regarding the search path used by `COPY`.

COPY REPLACING

In the real world, copybooks are often created with some form of tag. The tag is replaced at compile time so that multiple copies of the same record layout can be used without having conflicting names.

copybook.cpy

```
01 :tag:-record.
   05 :tag:-keyfield           PIC X(8).
   05 :tag:-description        PIC X(32).
   05 :tag:-itemlist           PIC X(8) OCCURS subitems TIMES.
```

contrived.cob

```
identification division.
program-id. contrived.

data division.
working-storage section.

COPY copybook REPLACING ==:tag:== BY ==ws==   subitems BY 16.
COPY copybook REPLACING ==:tag:== BY ==old==  subitems BY 0.

procedure division.
move "abcdefgh" to ws-keyfield old-keyfield

PERFORM read-next-partnumber

if ws-keyfield equal old-keyfield
    display "lookup didn't change key " ws-keyfield
else
    display "new key " ws-keyfield " was " old-keyfield
end-if

goback.
```

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```
read-next-partnumber.
move "hgfedcba" to ws-keyfield
.

end program contrived.
```

Full stop and COPY

Many samples in this document are single sentence COBOL programs. No periods in the procedure division, except the last and only one, required to end a COBOL program source unit. This is likely an extremely rare style of production COBOL development. There will be numerous required full stop periods in the procedure division, to separate sections and named paragraphs in almost all useful COBOL programs. Mentioning this here to setup the context for the following notice.

Of note:

COPY statements always needs a period, regardless of where they are in the source program. The period terminates the COPY statement, and does NOT get included in the compilation source.

4.1.124 CORR

Alias for *CORRESPONDING* (page 239).

4.1.125 CORRESPONDING

Move, or do arthimetic, any and all sub fields with matching names within records.

```
01 bin-record.
   05 first-will usage binary-short.
   05 second-will usage binary-long.
   05 this-wont-move usage binary-long.
   05 third-will usage binary-short.
01 num-record.
   05 first-will pic 999.
   05 second-will pic s9(9).
   05 third-will pic 999.
   05 this-doesnt-match pic s9(9).

move corresponding bin-record to num-record
display
    first-will in num-record
    second-will in num-record
    third-will in num-record
```

4.1.126 COUNT

Sets the count of characters set in an *UNSTRING* (page 426) substring.

From the GnuCOBOL Programmer's Guide's UNSTRING entry.

```
UNSTRING Input-Address
    DELIMITED BY "," OR "/"
    INTO
        Street-Address DELIMITER D1 COUNT C1
        Apt-Number DELIMITER D2 COUNT C2
        City DELIMITER D3 COUNT C3
        State DELIMITER D4 COUNT C4
        Zip-Code DELIMITER D5 COUNT C5
END-UNSTRING
```

4.1.127 CRT

```
SPECIAL-NAMES.
    CONSOLE IS CRT
    CRT STATUS is identifier-1.
```

CONSOLE IS CRT allows "CRT" and "CONSOLE" to be used interchangeably on DISPLAY but this is a default for newer GnuCOBOL implementations.

CRT STATUS IS establishes a PIC 9(4) field for screen ACCEPT status codes. There is also an implicit **COB-CRT-STATUS** register defined for all programs, that will be used if no explicit field is established.

4.1.128 CRT-UNDER

Alias for *CRT* (page 240).

4.1.129 CURRENCY

```
SPECIAL-NAMES.
    CURRENCY SIGN IS literal-1.
```

Default currency sign is the dollar sign "$".

4.1.130 CURSOR

Tracks the line/column location of screen ACCEPT.

```
SPECIAL-NAMES.
    CURSOR IS identifier-2.
```

identifier-2 is to be declared as PIC 9(4) or 9(6). If 4, the field is LLCC. With 9(6) it is LLLCCC where L is line and C is column, zero relative.

4.1.131 CYCLE

A clause that causes EXIT PERFORM to return to the top of a loop. See *FOREVER* (page 271) for an example.

4.1.132 DATA

A magical *DIVISION* (page 250). One of COBOL's major strength is the rules surrounding the DATA DIVISION and pictorial record definitions.

4.1.133 DATA-POINTER

An as yet unsupported Object COBOL feature.

4.1.134 DATE

An *ACCEPT* (page 187) source. 6 digit and 8 digit Gregorian dates.

1. ACCEPT ident-1 FROM DATE
2. ACCEPT ident-2 FROM DATE *YYYYMMDD* (page 435)

```
 identification division.
 program-id. dates.

 data division.
 working-storage section.
 01 date-2nd
    03 date-yy   pic 9(2).
    03 date-mm   pic 9(2).
    03 date-dd   pic 9(2).
 01 date-3rd
    03 date-yyyy pic 9(4).
    03 date-mm   pic 9(2).
    03 date-dd   pic 9(2).

 procedure division.
 accept date-2nd from date end-accept

*> Just before the 3rd millennium, programmers admitted     <*
*>   that 2 digit year storage was a bad idea and ambiguous <*
 accept date-3rd from date yyyymmdd end-accept

 display date-2nd space date-3rd

 goback.
 end program dates.
```

```
./dates
110701 20110701
```

4.1.135 DATE-COMPILED

An informational paragraph in the *IDENTIFICATION* (page 296) DIVISION. Deemed OBSOLETE, but still in use. GnuCOBOL treats this as an end of line comment keyword, in the same way as *>. Terminating periods are not required, and will be ignored.

4.1.136 DATE-MODIFIED

An informational paragraph in the *IDENTIFICATION* (page 296) DIVISION. Deemed OBSOLETE, but still in use. GnuCOBOL treats this as an end of line comment keyword. Terminating periods are not required, and will be ignored.

4.1.137 DATE-WRITTEN

An informational paragraph in the *IDENTIFICATION* (page 296) DIVISION. Deemed OBSOLETE, but still in use. GnuCOBOL treats this as an end of line comment keyword. Terminating periods are not required, and will be ignored.

4.1.138 DAY

An *ACCEPT* (page 187) source. Access the current date in Julian form. Returns yyddd and yyyyddd formats.

1. ACCEPT ident-1 FROM DAY
2. ACCEPT ident-2 FROM DAY *YYYYDDD* (page 435)

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      2011182 (July 01)
      *> Purpose:   Accept from day in Julian form
      *> Tectonics: cobc -x days.cob
      *> ************************************************************
       identification division.
       program-id. days.

       data division.
       working-storage section.
       01 julian-2nd.
          03 julian-yy   pic 9(2).
          03 julian-days pic 9(3).
       01 julian-3rd.
          03 julian-yyyy pic 9(4).
          03 julian-days pic 9(3).

       procedure division.
       accept julian-2nd from day end-accept

      *> Just before the 3rd millennium, programmers admitted     <*
      *> that 2 digit year storage was a bad idea and ambiguous   <*
       accept julian-3rd from day yyyyddd end-accept

       display julian-2nd space julian-3rd

       goback.
       end program days.
```

```
$ make days
cobc -W -x days.cob -o days
$ ./days
11182 2011182
```

4.1.139 DAY-OF-WEEK

An *ACCEPT* (page 187) source. Single digit day of week. 1 for Monday, 7 for Sunday.

```
accept the-day from day-of-week
```

4.1.140 DE

Report Writer shortcut for DETAIL. This author found this type of shortcut very unCOBOL, until trying to layout a report, when it made a lot more practical sense *in FIXED form COBOL*.

4.1.141 DEBUGGING

A SOURCE-COMPUTER clause and DECLARATIVE phrase.

```
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER mine
  WITH DEBUGGING MODE.
```

DEBUGGING MODE can also be toggled on with the *-fdebugging-line* cobc option, and will compile in 'D' lines.

```
PROCEDURE DIVISION.
DECLARATIVES.
decl-debug section.
  USE FOR DEBUGGING ON ALL PROCEDURES
decl-paragraph.
  DISPLAY "Why is this happening to me?"
END DECLARATIVES.
```

USE FOR DEBUGGING sets up a section that is executed when the named section is entered. Powerful. It can also name a file, and the debug section is evaluated after open, close, read, start etc. Identifiers can be also be named and the debug section will trigger when referenced (usually after).

4.1.142 DECIMAL-POINT

Allows internationalization for number formatting.

```
IDENTIFICATION DIVISION.
PROGRAM-ID. 'virgule'.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SPECIAL-NAMES.
DECIMAL-POINT IS COMMA.
```

The code above will cause GnuCOBOL to interpret numeric literals along the lines of 123,45 as one hundred twenty three and forty five one hundredths or 123.45.

DECIMAL-POINT IS COMMA, while world friendly, can be the cause of ambiguous parsing and care must be taken by developers that use comma to separate parameters to FUNCTIONs.

4.1.143 DECLARATIVES

An imperative entry that can control exception handling of file operations and turn on debug entry points.

```
procedure division.
declaratives.
handle-errors section.
    use after standard error procedure on filename-1.
handle-error.
    display "Something bad happened with " filename-1
.
helpful-debug section.
    use for debugging on main-file.
help-me.
    display "Just touched " main-file
.
end declaratives.
```

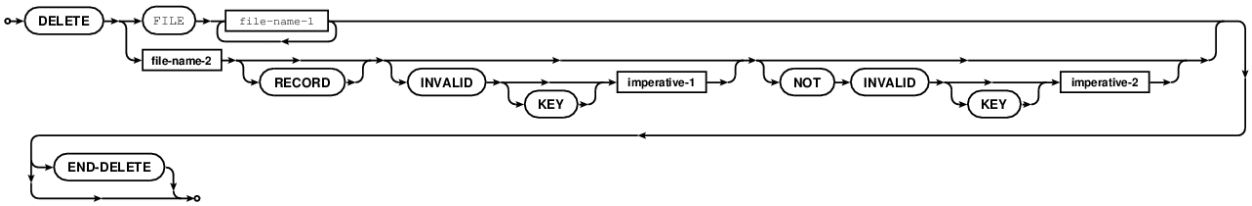
4.1.144 DEFAULT

A multi-use clause used in

- *CALL* (page 219) . . . SIZE IS DEFAULT
- *ENTRY* (page 255) . . . SIZE IS DEFAULT
- *INITIALIZE* (page 300) . . . WITH . . . THEN TO DEFAULT

4.1.145 DELETE

- Allows removal of records from *RELATIVE* (page 363) and *INDEXED* (page 297) files.
- Allows removing files by COBOL name, including all associated support files.




```
DELETE filename-1 RECORD
  INVALID KEY
    DISPLAY "no delete"
  NOT INVALID KEY
    DISPLAY "record removed"
END-DELETE
```

DELETE FILE

GnuCOBOL 2.0 and up, allows for file deletes.

```
DELETE FILE
    filename-1 filename-2 filename-3
END-DELETE
```

That code will remove files by FD SELECT name, including any implicit .idx key index files used by ISAM handlers.

No error will be raised if the assigned filename does not exist. If the file is open, DELETE FILE will fail with status "41", Already Open.

A working example:

```
identification division.
program-id. delfile.

environment division.
input-output section.
file-control.
select testing-file assign to "testing.tt"
    status is file-status.

data division.
working-storage section.
01 file-status pic xx.

procedure division.
open input testing-file
display "open status  : " file-status

delete file testing-file
display "delete status: " file-status

close testing-file
display "close status : " file-status

>>IF DELETE DEFINED
    delete file testing-file
    display "delete status: " file-status
>>END-IF

goback.
end program delfile.
```

Attempt to delete an open file, with conditionally compiled code to attempt the delete again after closing.

```
prompt$ echo -n >testing.tt
prompt$ cobc -xj delfile.cob
open status  : 00
delete status: 41
close status : 00

prompt$ ls testing.tt
testing.tt

prompt$ cobc -DDELETE -xj delfile.cob
open status  : 00
delete status: 41
close status : 00
delete status: 00

prompt$ ls testing.tt
ls: cannot access 'testing.tt': No such file or directory

prompt$ cobc -xj delfile.cob
```

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```
open status  : 35
delete status: 00
close status : 42

prompt$ ls testing.tt
ls: cannot access 'testing.tt': No such file or directory
```

That capture shows:

Creating a file `testing.tt`. *Just happens to be empty, but that has no bearing on the code runs that follow.*

First run:

- Open succeeds, “00”.
- Delete File fails, “41”, Already Open, but there is no runtime error.
- Close succeeds, “00”.
- First program pass completes, file still exists.

Second run, with conditional compile of delete after close code. File `testing.tt` still exists:

- Open succeeds.
- Delete File fails.
- Close succeeds.
- Second Delete File succeeds, file status “00”.
- Second program pass completes, file no longer exists.

Third run, without delete after close code compilation, but no `testing.tt` exists:

- Open fails, “35”, Not Exists.
- Delete File “succeeds”, “00”, but there was no file to begin with.
- Close fails, “42”, Not Open.
- Third program pass completes. The OPEN was for input and no file was created. No file was deleted as there wasn’t any file, `testing.tt` still doesn’t exist.

4.1.146 DELIMITED

A fairly powerful keyword used with the *STRING* (page 414) and *UNSTRING* (page 426) verbs. Accepts literals and the BY *SIZE* (page 402) modifier.

```
STRING null-terminated
    DELIMITED BY LOW-VALUE
    INTO no-zero
END-STRING
```

4.1.147 DELIMITER

Tracks which delimiter was used for a substring in an *UNSTRING* (page 426) operation.

From Gary’s OCic.cbl

```
UNSTRING Expand-Code-Rec
    DELIMITED BY ". " OR " "
    INTO SPI-Current-Token
    DELIMITER IN Delim
    WITH POINTER Src-Ptr
END-UNSTRING
```

4.1.148 DEPENDING

Sets a control identifier for variable *OCCURS* (page 331) table definitions. Also used in computed *GO* (page 286) statements; if the jump index does not match a label position, no jump is taken and control flows to the next statement instead.

```
01 TABLE-DATA.
   05 TABLE-ELEMENTS
       OCCURS 1 TO 100 TIMES DEPENDING ON crowd-size
       INDEXED BY cursor-var.
     10 field-1 PIC X.
```

```
GO TO para-1 para-2 para-3 DEPENDING ON jump-number
```

4.1.149 DESCENDING

Controls a descending sort and/or retrieval order, with

- *SORT* (page 403) filename ON DESCENDING KEY alt-key
- *OCCURS* (page 331) 1 TO max-size TIMES DESCENDING KEY key-for-table

4.1.150 DESTINATION

Currently unsupported data descriptor. Part of VALIDATE.

4.1.151 DETAIL

A report descriptor detail line control clause.

4.1.152 DISABLE

An unsupported COMMUNICATION SECTION control verb.

4.1.153 DISC

Alternate spelling for *DISK* (page 248).

4.1.154 DISK

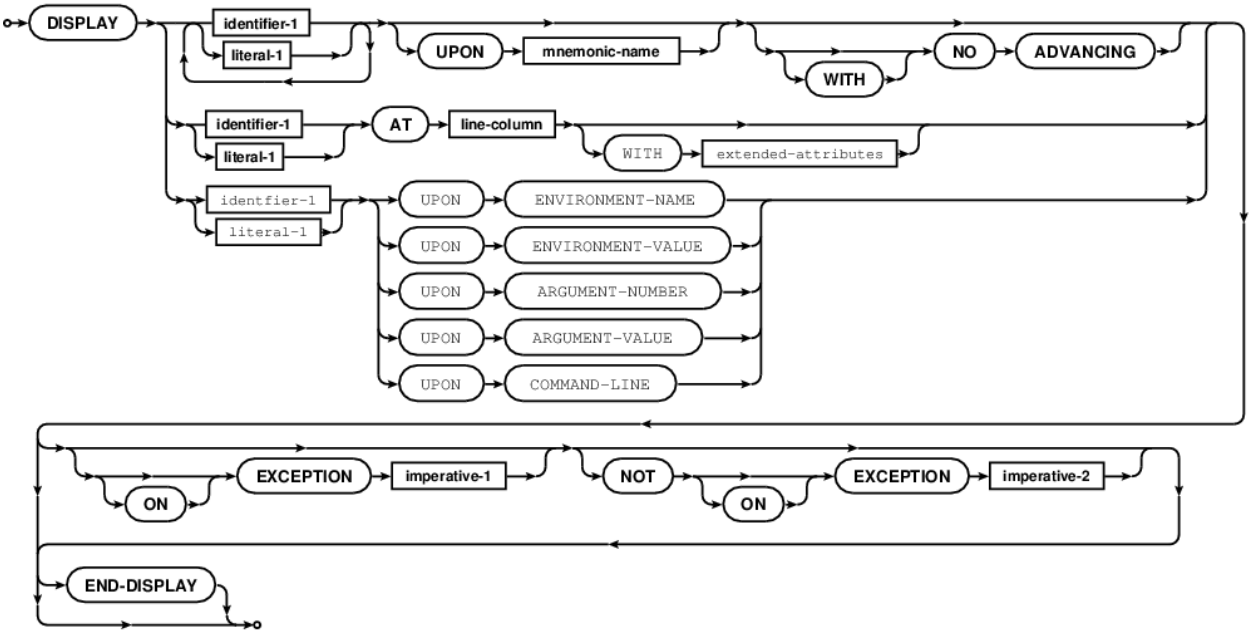
A SELECT devicename phrase.

```
ASSIGN TO DISK USING dataname
```

Alternative spelling of **DISC** is allowed.

4.1.155 DISPLAY

A general purpose output, and operating environment setting verb.



- prints values to default console or other device
- set the current *ARGUMENT-NUMBER* (page 205) influencing subsequent access ACCEPT FROM *ARGUMENT-VALUE* (page 205) statements
- specify explicit *COMMAND-LINE* (page 229) influencing subsequent access with ACCEPT FROM COMMAND-LINE, but not ARGUMENT-VALUE access
- sets environment variables, as part of a two step process. (Use the more concise SET *ENVIRONMENT* (page 255) instead)
  1. DISPLAY “envname” UPON *ENVIRONMENT-NAME* (page 255)
  2. DISPLAY “envname-value” UPON *ENVIRONMENT-VALUE* (page 255)

```
DISPLAY "First value: " a-variable " and another string"

DISPLAY "1" 23 "4"
```

The setting of environment variables does not influence the owning process shell.

```
DISPLAY "ENVNAME" UPON ENVIRONMENT-NAME
DISPLAY "COBOL value" UPON ENVIRONMENT-VALUE
     ON EXCEPTION stop run
```

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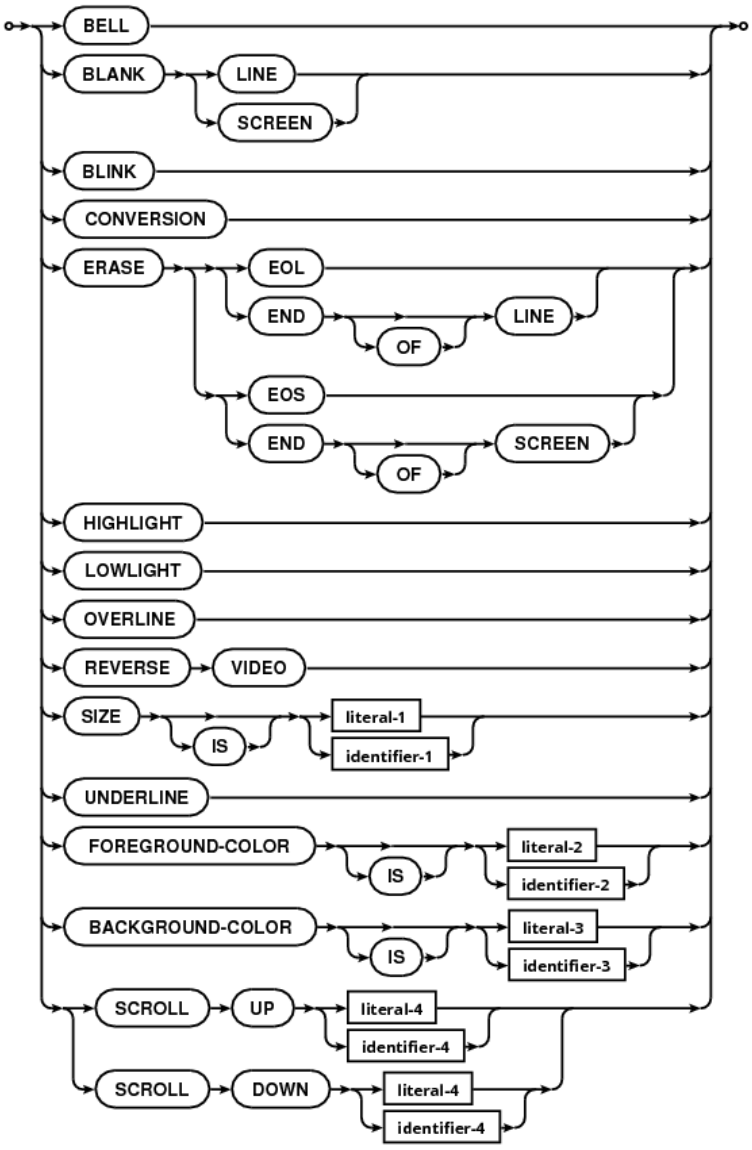
```
     NOT ON EXCEPTION continue
END-DISPLAY
CALL "SYSTEM" USING "echo $ENVNAME"
```

gives:

```
$ ENVNAME="parent shell value"
$ ./disps
COBOL value
$ echo $ENVNAME
parent shell value
```

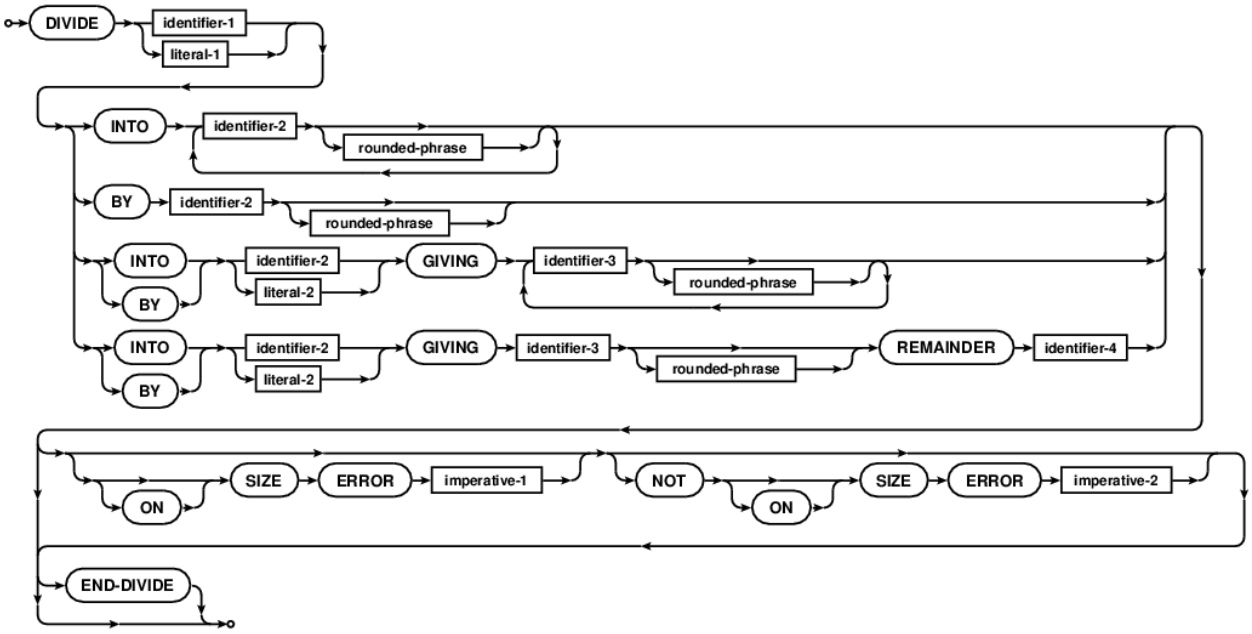
Extended attributes (requires WITH keyword):



Please note: `DISPLAY datafield WITH extended-attributes` will cause initialization of the extended IO Terminal User Interface system. That means all further IO to the display is subject to the rules of *SMCUP and RMCUP* (page 140).

4.1.156 DIVIDE

Highly precise arithmetic.



Supports various forms:

- DIVIDE INTO
- DIVIDE INTO GIVING
- DIVIDE BY GIVING
- DIVIDE INTO with REMAINDER
- DIVIDE BY with REMAINDER

For example:

```
DIVIDE dividend BY divisor GIVING answer ROUNDED REMAINDER r
    ON SIZE ERROR
        PERFORM log-division-error
        SET division-error TO TRUE
    NOT ON SIZE ERROR
        SET division-error TO FALSE
END-DIVIDE
```

The 2014 standard requires conforming implementations to use 1,000 digits of precision for intermediate results. There will be no rounding errors when properly calculating financials in a COBOL program.

4.1.157 DIVISION

Ahh, sub-divisions. I think my favourite is the DATA DIVISION. It gives COBOL a distinctive and delicious flavour in a picturesque codescape.

Divisions must be specified in the order below within each source program unit.

1. *IDENTIFICATION* (page 296) DIVISION.

2. *ENVIRONMENT* (page 255) DIVISION.
3. *DATA* (page 241) DIVISION.
4. *PROCEDURE* (page 355) DIVISION.

A handy mnemonic may be *"I Enter Data Properly"*.

GnuCOBOL is flexible enough to compile files with only a PROCEDURE DIVISION, and even then it really only needs a *PROGRAM-ID* (page 356). See *What is the shortest GnuCOBOL program?* (page 791) for an example.

4.1.158 DOWN

Allows decrement of an index control or pointer variable.

```
SET ind-1 DOWN BY 2

SET ptr-1 DOWN BY 8
```

Also used for SCREEN SECTION scroll control.

```
SCROLL DOWN 5 LINES
```

4.1.159 DUPLICATES

Allows duplicate keys in indexed files.

```
SELECT filename
  ALTERNATE RECORD KEY IS altkey WITH DUPLICATES
```

Also for SORT control.

```
SORT filename ON DESCENDING KEY keyfield
  WITH DUPLICATES IN ORDER
  USING sort-in GIVING sort-out.
```

4.1.160 DYNAMIC

A file access mode allowing runtime control over SEQUENTIAL and RANDOM access for INDEXED and RELATIVE ORGANIZATION.

```
SELECT filename
  ORGANIZATION IS RELATIVE
  ACCESS MODE IS DYNAMIC
```

4.1.161 EBCDIC

Extended Binary Coded Decimal Interchange Code.

A character encoding common to mainframe systems, therefore COBOL, therefore GnuCOBOL. Different than *ASCII* (page 207) and GnuCOBOL supports both through efficient mappings. See https://en.wikipedia.org/wiki/EBCDIC for more info.

ASCII to EBCDIC conversion the GnuCOBOL way

```
SPECIAL-NAMES.
ALPHABET ALPHA IS NATIVE.
ALPHABET BETA IS EBCDIC.

PROCEDURE DIVISION.
INSPECT variable CONVERTING ALPHA TO BETA
```

4.1.162 EC

An unsupported short form for USE AFTER EXCEPTION CONDITION

4.1.163 EGI

An unsupported COMMUNICATION SECTION word.

4.1.164 ELSE

Alternate conditional branch point.

```
IF AGE IS ZERO
   DISPLAY "Cigar time"
ELSE
   DISPLAY "What is it with kids anyway?"
END-IF
```

For multi branch conditionals, see *EVALUATE* (page 257).

4.1.165 EMI

An unsupported COMMUNICATION SECTION word.

4.1.166 EMPTY-CHECK

Alias for the *REQUIRED* (page 380) screen attribute.

4.1.167 ENABLE

An unsupported COMMUNICATION SECTION control verb.

4.1.168 END

Ends things.

- END FUNCTION
- END PROGRAM
- END DECLARATIVES

4.1.169 END-ACCEPT

Explicit terminator for *ACCEPT* (page 187).

4.1.170 END-ADD

Explicit terminator for *ADD* (page 192).

4.1.171 END-CALL

Explicit terminator for *CALL* (page 219).

4.1.172 END-CHAIN

Not yet implemented.

Will be an explicit terminator for *CHAIN* (page 224).

4.1.173 END-COMPUTE

Explicit terminator for *COMPUTE* (page 233).

4.1.174 END-DELETE

Explicit terminator for *DELETE* (page 244).

4.1.175 END-DISPLAY

Explicit terminator for *DISPLAY* (page 248).

Many samples from this FAQ used to use END-DISPLAY, they are being purged, as of October 2015, unless necessary.

4.1.176 END-DIVIDE

Explicit terminator for *DIVIDE* (page 250).

4.1.177 END-EVALUATE

Explicit terminator for *EVALUATE* (page 257).

4.1.178 END-IF

Explicit terminator for *IF* (page 296).

4.1.179 END-MULTIPLY

Explicit terminator for *MULTIPLY* (page 324).

4.1.180 END-OF-PAGE

A *LINAGE* (page 314) phrase used by *WRITE* (page 433) controlling end of page imperative clause.

4.1.181 END-PERFORM

Explicit terminator for *PERFORM* (page 347).

4.1.182 END-READ

Explicit terminator for *READ* (page 359).

4.1.183 END-RECEIVE

Explicit terminator for *RECEIVE* (page 361).

4.1.184 END-RETURN

Explicit terminator for *RETURN* (page 381).

4.1.185 END-REWRITE

Explicit terminator for *REWRITE* (page 382).

4.1.186 END-SEARCH

Explicit terminator for *SEARCH* (page 392).

4.1.187 END-START

Explicit terminator for *START* (page 412).

4.1.188 END-STRING

Explicit terminator for *STRING* (page 414).

4.1.189 END-SUBTRACT

Explicit terminator for *SUBTRACT* (page 415).

4.1.190 END-UNSTRING

Explicit terminator for *UNSTRING* (page 426).

4.1.191 END-WRITE

Explicit terminator for *WRITE* (page 433).

4.1.192 ENTRY

Allows for CALL entry points without being fully specified subprograms. Great for defining callbacks required by many GUI frameworks.

See *Does GnuCOBOL support the GIMP ToolKit, GTK+?* (page 817) for an example.

4.1.193 ENTRY-CONVENTION

An as yet unsupported clause.

4.1.194 ENVIRONMENT

Divisional name. And allows access to operating system environment variables. GnuCOBOL supports

- *CONFIGURATION* (page 235) SECTION
- *INPUT-OUTPUT* (page 304) SECTION

within the ENVIRONMENT DIVISION.

Also a context sensitive keyword for access to the process environment variables.

- SET ENVIRONMENT “env-var” TO value
- ACCEPT var FROM ENVIRONMENT “env-var” END-ACCEPT

4.1.195 ENVIRONMENT-NAME

Provides access to the running process environment variables.

4.1.196 ENVIRONMENT-VALUE

Provides access to the running process environment variables.

4.1.197 EO

An unsupported short form for USE AFTER EXCEPTION OBJECT

4.1.198 EOL

ERASE (page 256) to End Of Line.

4.1.199 EOP

LINAGE (page 314) clause short form for *END-OF-PAGE* (page 254).

4.1.200 EOS

ERASE (page 256) to End Of Screen.

4.1.201 EQUAL

Conditional expression to compare two data items for equality.

4.1.202 EQUALS

Conditional expression to compare two data items for equality.

4.1.203 ERASE

A screen section data attribute clause that can control which portions of the screen are cleared during *DISPLAY* (page 248), and *ACCEPT* (page 187).

```
01 form-record.
   02 first-field PIC xxx
      USING identifier-1
      ERASE EOL.
```

4.1.204 ERROR

A *DECLARATIVES* (page 244) clause that can control error handling.

```
USE AFTER STANDARD ERROR PROCEDURE ON filename-1
```

Program return control.

```
STOP RUN WITH ERROR STATUS stat-var.
```

4.1.205 ESCAPE

Programmer access to escape key value during *ACCEPT* (page 187).

```
ACCEPT identifier FROM ESCAPE KEY END-ACCEPT
```

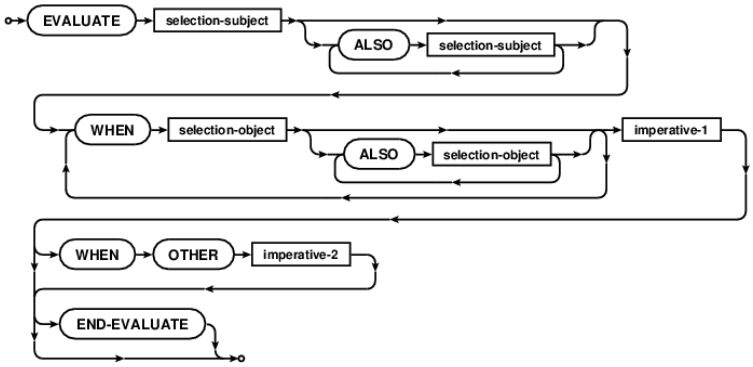
Data type is 9(4).

4.1.206 ESI

Unsupported COMMUNICATION SECTION control.

4.1.207 EVALUATE

A very powerful and concise selection construct.




```
*> evaluate variables and an expression
EVALUATE a ALSO b ALSO TRUE
    WHEN 1 ALSO 1 THRU 9 ALSO c EQUAL 1 PERFORM all-life
    WHEN 2 ALSO 1 THRU 9 ALSO c EQUAL 2 PERFORM life
    WHEN 3 THRU 9 ALSO 1 ALSO c EQUAL 9 PERFORM disability
    WHEN OTHER PERFORM invalid
END-EVALUATE

*> evaluate on arbitrary expressions
EVALUATE TRUE
    WHEN d = 1
        PERFORM d-is-one
    WHEN d > 1
        PERFORM d-greater-one
    WHEN OTHER
        PERFORM d-zero-or-negative
END-EVALUATE

EVALUATE the-day
    WHEN "MONDAY"
        PERFORM week-start-report
    WHEN "FRIDAY"
        PERFORM weeks-end-report
        PERFORM prepare-for-weekend
    WHEN OTHER
        PERFORM daily-report
END-EVALUATE

*> evaluate on false
EVALUATE FALSE
    WHEN d = 1
        PERFORM d-not-one
    WHEN OTHER
        PERFORM d-is-one
END-EVALUATE
```

4.1.208 EXCEPTION

Allow detection of CALL problem.

```
CALL "CBL_OC_DUMP" ON EXCEPTION CONTINUE END-CALL
```

4.1.209 EXCEPTION-OBJECT

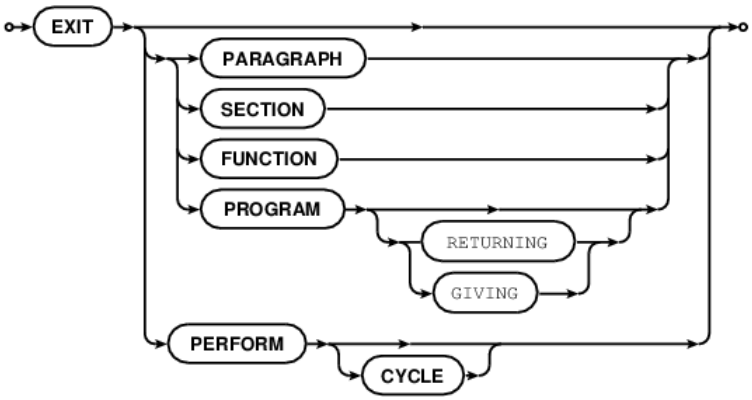
Unsupported object COBOL data item reference.

4.1.210 EXCLUSIVE

Mode control for file locks.

4.1.211 EXIT

A program control flow verb. Used for both inline, and paragraph/section programming.



GnuCOBOL supports

- EXIT
- EXIT *PARAGRAPH* (page 346)
- EXIT *SECTION* (page 394)
- EXIT *FUNCTION* (page 273)
- EXIT *PROGRAM* (page 356)
- EXIT *PERFORM* (page 347) [*CYCLE* (page 240)]

`EXIT PERFORM CYCLE` causes an inline perform to return control to the *VARYING* (page 431), *UNTIL* (page 426) or *TIMES* (page 420) clause, testing the conditional to see if another cycle is required. EXIT PERFORM without the CYCLE option causes flow to continue passed the end of the current PERFORM loop.

4.1.212 EXPANDS

Unsupported COMMUNICATION SECTION control.

4.1.213 EXTEND

Open a resource in an append mode.

4.1.214 EXTERN

A `PROCEDURE DIVISION` qualifier, laying down code that can safely be called from C without knowledge of normal COBOL libcob requirements.

See COBOL for the other type of program entry qualifier.

```
PROCEDURE DIVISION EXTERN USING BY VALUE A
```

4.1.215 EXTERNAL

Clause to specify external data item, file connection and program unit.

```
77 shared-var PIC S9(4) IS EXTERNAL AS 'shared_var'.
```

Can come in handy while cheating, errr, during development, before a better data coupling design pattern is established.

```
      *> ******************************************************
      *> Callback event handlers
      *> ******************************************************

       REPLACE ==FIELDSIZE== BY ==80==.

id     identification division.
       program-id. cobweb-button-clicked.

       environment division.
       configuration section.
       repository.
           function entry-get-text
           function all intrinsic.

       data division.
       working-storage section.
       01 gtk-entry-data                              external.
          05 gtk-entry         usage pointer.
       01 the-text-entry       pic x(FIELDSIZE).

       linkage section.
       01 gtk-widget           usage pointer.
       01 gtk-window           usage pointer.

       procedure division using by value gtk-widget gtk-window.

       move entry-get-text(gtk-entry) to the-text-entry
       display trim(the-text-entry) " (via button)"

done   goback.
       end program cobweb-button-clicked.
```

from early cobweb-gui.cob. A button linked to a text entry through an external. `gtk-entry-data` being an 01 external definition in cobweb-gui main as well.

```
01 gtk-box-data.
   05 gtk-box           usage pointer.
```

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```
01 gtk-label-data.
   05 gtk-label         usage pointer.
01 gtk-entry-data                        external.
   05 gtk-entry         usage pointer.
01 gtk-button-data.
   05 gtk-button        usage pointer.
```

Please note, as advised, this is cheating. A more practical data coupling will be developed, before cobweb-gtk hits a 1.0 reference implementation.

4.1.216 FACTORY

An unsupported object COBOL keyword.

4.1.217 FALSE

Logical false and conditional set condition.

```
01 record-1      pic 9.
   88 conditional-1 values 1,2,3 when set to false is 0.

set conditional-1 to true
display record-1

set conditional-1 to false
display record-1

if conditional-1
    display "BAD"
end-if
```

Runs as:

```
$ ./conditionals
1
0
```

Also used in `EVALUATE`, inverting the normal sense of WHEN

```
evaluate false
    when 1 equal 1
        display "Not displayed, as 1 equal 1 is true"
    when 1 equal 2
        display "This displays because 1 equal 2 is false"
    when other
        display "the truest case, nothing is false"
end-evaluate
```

4.1.218 FD

The record side of the COBOL file system. The File Descriptor. COBOL provides lots of control over file access. FD is part of that engine.

Sort files use *SD* (page 392)

Some FD phrases are old, and their uses have been overtaken by features of modern operating systems.

- BLOCK CONTAINS
- RECORDING MODE IS

Others are pretty cool. *LINAGE* (page 314) is one example. FD supports a mini report writer feature. Control over lines per page, header, footer and a line counter, `LINAGE IS`, that is implicitly maintained by GnuCOBOL during file writes. These files are usually reports, but they don't have to be, `LINAGE` can be used for a simple step counter when you'd like progress displays of file updates.

Other recognized file descriptions include:

- RECORD IS VARYING IN SIZE FROM 1 TO 999999999 DEPENDING ON size-variable Record sizes need to fit in PIC 9(9), just shy of a thousand million.
- CODE-SET IS alphabet-name
- DATA RECORD IS data-name
- LABEL RECORDS ARE STANDARD (or OMITTED)
- RECORD CONTAINS 132 CHARACTERS

```
FD filename-sample
   RECORD IS VARYING IN SIZE FROM 1 TO 32768 CHARACTERS
     DEPENDING ON record-size-sample.
```

4.1.219 FILE

`FILE` is another multi use COBOL word.

- A SECTION of the DATA DIVISION.

The `FILE` section holds file description paragraphs and buffer layouts.

```
data division.
FILE section.
fd cobol-file-selector.
01 cobol-io-buffer        pic x(132).
```

- a context word for setting name for FILE STATUS fields in *FILE-CONTROL* (page 264) paragraphs.

Some programmers don't like seeing COBOL code that does not verify and test `FILE STATUS`, so you should. It is a recommended practice.

See *GnuCOBOL FILE STATUS codes* (page 262) below for the supported status codes.

Please note that this author has a bad habit of sometimes using `PIC 99` when defining `FILE STATUS` fields. The standard states that file status values are `PIC XX`, alphanumeric entities. (That just happen to look like numbers, but that is not guaranteed, use `PIC XX` and convert to numbers or better, compare using character data; `infile-status equal "00"` etcetera).

```
environment division.
input-output section.
file-control.
   select optional data-file assign to file-name
       organization is line sequential
```

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```
       FILE STATUS is data-file-status.
   select mini-report assign to "mini-report".
```

- a context word as part of the PROCEDURE DIVISION declarative statements allowing for out-of-band exception handling for file access.

Exception handling with declaratives can be powerful, but some programmers find the out of band nature of where the source code that caused a problem compared to where the error handler is, distasteful.

```
procedure division.
declaratives.

error-handling section.
    USE AFTER EXCEPTION FILE filename-maybe.
error-handler.
    display "Exception on filename"
.
end declaratives.
```

Support for USE AFTER EXCEPTION FILE is a work in progress. Using *DECLARATIVES* (page 244) forces use of section names in the `PROCEDURE DIVISION`.

- a context word as part of DELETE FILE filenames.

```
DELETE FILE file-selector-1 file-selector-2
```

`DELETE FILE` is supported in GnuCOBOL 2.0.

GnuCOBOL FILE STATUS codes

The condition of a COBOL I/O operation is set in an identifier specified in a *FILE STATUS IS* clause.

John Ellis did us the favour of codifying the GnuCOBOL FILE STATUS codes

From http://oldsite.add1tocobol.com/tiki-list_file_gallery.php?galleryId=1 **statcodes.cpy** courtesy of John Ellis.

```
01  status-code                pic x(2) value spaces.
    88  SUCCESS                    value '00'.
    88  SUCCESS_DUPLICATE          value '02'.
    88  SUCCESS_INCOMPLETE         value '04'.
    88  SUCCESS_OPTIONAL           value '05'.
    88  SUCCESS_NO_UNIT            value '07'.
    88  END_OF_FILE                value '10'.
    88  OUT_OF_KEY_RANGE           value '14'.
    88  KEY_INVALID                value '21'.
    88  KEY_EXISTS                 value '22'.
    88  KEY_NOT_EXISTS             value '23'.
    88  PERMANENT_ERROR            value '30'.
    88  INCONSISTENT_FILENAME      value '31'.
    88  BOUNDARY_VIOLATION         value '34'.
    88  NOT_EXISTS                 value '35'.
    88  PERMISSION_DENIED          value '37'.
    88  CLOSED_WITH_LOCK           value '38'.
    88  CONFLICT_ATTRIBUTE         value '39'.
    88  ALREADY_OPEN               value '41'.
    88  NOT_OPEN                   value '42'.
```

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```
    88  READ_NOT_DONE               value '43'.
    88  RECORD_OVERFLOW            value '44'.
    88  READ_ERROR                 value '46'.
    88  INPUT_DENIED               value '47'.
    88  OUTPUT_DENIED              value '48'.
    88  I_O_DENIED                 value '49'.
    88  RECORD_LOCKED              value '51'.
    88  END_OF_PAGE                value '52'.
    88  I_O_LINAGE                 value '57'.
    88  FILE_SHARING               value '61'.
    88  NOT_AVAILABLE              value '91'.
```

Download and then in your WORKING-STORAGE SECTION use

COPY “statcodes.cpy”.

Or, perhaps even better, is a callable sub-program developed by Steve Williams as part of his most excellent World Cities COBOL tutorial samples, `checkfilestatus.cpy`.

Hosted at http://sourceforge.net/p/gnucobol/contrib/HEAD/tree/trunk/samples/worldcities/

```
GCOBOL >> SOURCE FORMAT IS FREE
identification division.
program-id. checkfilestatus.

data division.
working-storage section.
01  status-message pic x(72).
01  display-message pic x(72) value spaces.

linkage section.
01  file-name pic x(64).
01  file-status pic x(2).

procedure division using file-name file-status.
start-checkfilestatus.
    if file-status = '00' or '10'
        goback
    end-if
    evaluate file-status
    when 00 move 'SUCCESS.' TO status-message
    when 02 move 'SUCCESS DUPLICATE.' TO status-message
    when 04 move 'SUCCESS INCOMPLETE.' TO status-message
    when 05 move 'SUCCESS OPTIONAL.' TO status-message
    when 07 move 'SUCCESS NO UNIT.' TO status-message
    when 10 move 'END OF FILE.' TO status-message
    when 14 move 'OUT OF KEY RANGE.' TO status-message
    when 21 move 'KEY INVALID.' TO status-message
    when 22 move 'KEY EXISTS.' TO status-message
    when 23 move 'KEY NOT EXISTS.' TO status-message
    when 30 move 'PERMANENT ERROR.' TO status-message
    when 31 move 'INCONSISTENT FILENAME.' TO status-message
    when 34 move 'BOUNDARY VIOLATION.' TO status-message
    when 35 move 'FILE NOT FOUND.' TO status-message
    when 37 move 'PERMISSION DENIED.' TO status-message
    when 38 move 'CLOSED WITH LOCK.' TO status-message
    when 39 move 'CONFLICT ATTRIBUTE.' TO status-message
    when 41 move 'ALREADY OPEN.' TO status-message
```

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```
    when 42 move 'NOT OPEN.' TO status-message
    when 43 move 'READ NOT DONE.' TO status-message
    when 44 move 'RECORD OVERFLOW.' TO status-message
    when 46 move 'READ ERROR.' TO status-message
    when 47 move 'INPUT DENIED.' TO status-message
    when 48 move 'OUTPUT DENIED.' TO status-message
    when 49 move 'I/O DENIED.' TO status-message
    when 51 move 'RECORD LOCKED.' TO status-message
    when 52 move 'END-OF-PAGE.' TO status-message
    when 57 move 'I/O LINAGE.' TO status-message
    when 61 move 'FILE SHARING FAILURE.' TO status-message
    when 91 move 'FILE NOT AVAILABLE.' TO status-message
    end-evaluate
    string 'ERROR ' delimited by size
        file-name delimited by space
        space delimited by size
        status-message delimited by '.'
        into display-message
    end-string
    display display-message end-display
    stop run
    .
end program checkfilestatus.
```

Giving human readable messages when reporting on status conditions.

4.1.220 FILE-CONTROL

Files. The paragraph in the *INPUT-OUTPUT* (page 304) section, in the *ENVIRONMENT* (page 255) division. It's verbose, a little voodooey, and totally worth it.

```
environment division.
input-output section.
FILE-CONTROL.
  select optional data-file assign to file-name
      organization is line sequential
      file status is data-file-status.

  select mini-report assign to "mini-report".
```

4.1.221 FILE-ID

File naming clause. Assigned name may be device, FD clause specifies value of the file identifier.

```
VALUE OF FILE-ID IS file-ids in summary-array
```

more specifically

```
environment division.
input-output section.
file-control.
    select cobol-file-selector
    assign to disk
```

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```
    organization            indexed
    access mode             dynamic
    record key              fd-key-field
    file status             file-status-field.

data division.
file section.
fd cobol-file-selector label record standard
    VALUE OF FILE-ID is "actual-filename.dat".
```

An alternative, and likely more common, method is to set the actual filename (*or the enviroment variable that references the actual filename*) in the `ASSIGN` clause. GnuCOBOL has a configuration setting to control how the actual filenames are mapped, see *ASSIGN* (page 207). `VALUE OF FILE-ID` is not ISO standard COBOL.

4.1.222 FILLER

Data division clause, for unnamed data allocations; filler, if you will.

```
01 the-record.
   05 first-field  pic x(10).
   05 filler       pic x(35) value "this space intentionally left blank".
   04 third-field  pic x(10).
```

`FILLER` is an optional word, and this code snippet is equivalent.

```
01 the-record.
    05 first-field  pic x(10).
    05             pic x(35) value "this space intentionally left blank".
    05 third-field  pic x(10).
```

COBOL even allows the compiler to count the length of FILLER sub-fields when literals are involved. No need for the `pic x(35).`

```
01 the-record.
    05 first-field  pic x(10).
    05                       value "this space intentionally left blank".
    05 third-field  pic x(10).
```

Personal preference of this author is to explicitly type FILLER.

4.1.223 FINAL

A Report Writer feature to allow for end or report summation control.

```
CONTROLS ARE FINAL, datafield-1, datafield-2
```

4.1.224 FIRST

Inside an *RD* (page 359) report description, specifies placement of `FIRST DETAIL` line.

4.1.225 FLOAT-BINARY-128

Not yet supported. 128 bit floating point data type.

4.1.226 FLOAT-BINARY-32

Not yet supported. 32 bit floating point data type.

4.1.227 FLOAT-BINARY-64

Not yet supported. 64 bit floating point data type.

4.1.228 FLOAT-DECIMAL-16

IEEE Std 754-2008 defined 16 digit floating decimal data type.

64 bit internal storage.

```
#!/usr/local/bin/cobc -xj

      *> Modified: 2015-12-19/20:56-0500
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 ieee-754-16          usage float-decimal-16.

       ==
       ==:CODEBOOK:== BY
       ==

       compute ieee-754-16 = 2 ** 32
       perform 32 times
           display ieee-754-16
           divide ieee-754-16 by 4 giving ieee-754-16
       end-perform

       ==
       .
```

With a run sample showing default formatting:

```
prompt$ ./float-decimal-16-sample.cob
4294967296E0
1073741824E0
268435456E0
67108864E0
16777216E0
4194304E0
1048576E0
262144E0
65536E0
16384E0
4096E0
```

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```
1024E0
256E0
64E0
16E0
4E0
1E0
25E-2
625E-4
15625E-6
390625E-8
9765625E-10
244140625E-12
6103515625E-14
152587890625E-16
38146972656E-16
9536743164E-16
2384185791E-16
596046447E-16
149011611E-16
37252902E-16
9313225E-16
```

See *Sample shortforms* (page 1433) for the `sample-template` listing.

4.1.229 FLOAT-DECIMAL-34

IEEE Std 754-2008 defined 34 digit floating decimal data type.

128 bit internal storage.

```
#!/usr/local/bin/cobc -xj

      *> Modified: 2015-12-19/21:42-0500
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 ieee-754-34          usage float-decimal-34.
       01 as-dotnines          pic v9(34).
       01 as-nines             pic z(20).

       ==
       ==:CODEBOOK:== BY
       ==

       compute ieee-754-34 = 2 ** 64
       perform 64 times
           if ieee-754-34 less than 1.0 then
               move ieee-754-34 to as-dotnines
               display ieee-754-34 ", " as-dotnines
           else
               move ieee-754-34 to as-nines
               display ieee-754-34 ", " as-nines
           end-if
           divide ieee-754-34 by 4 giving ieee-754-34
       end-perform
```

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```
      ==
      .
```

And a run to show default and two sample picture forms:

```
$ ./float-decimal-34-sample.cob
1844674407370955161 6E0, 18446744073709551616
4611686018427387904E0,  4611686018427387904
1152921504606846976E0,  1152921504606846976
288230376151711744E0,   288230376151711744
72057594037927936E0,    72057594037927936
18014398509481984E0,    18014398509481984
4503599627370496E0,     4503599627370496
1125899906842624E0,     1125899906842624
281474976710656E0,      281474976710656
70368744177664E0,       70368744177664
17592186044416E0,       17592186044416
4398046511104E0,        4398046511104
1099511627776E0,        1099511627776
274877906944E0,         274877906944
68719476736E0,          68719476736
17179869184E0,          17179869184
4294967296E0,           4294967296
1073741824E0,           1073741824
268435456E0,            268435456
67108864E0,             67108864
16777216E0,             16777216
4194304E0,              4194304
1048576E0,              1048576
262144E0,               262144
65536E0,                65536
16384E0,                16384
4096E0,                 4096
1024E0,                 1024
256E0,                  256
64E0,                   64
16E0,                   16
4E0,                    4
1E0,                    1
25E-2, 0.25000000000000000000000000000000
625E-4, 0.06250000000000000000000000000000
15625E-6, 0.01562500000000000000000000000000
390625E-8, 0.00390625000000000000000000000000
9765625E-10, 0.00097656250000000000000000000000
244140625E-12, 0.00024414062500000000000000000000
6103515625E-14, 0.00006103515625000000000000000000
152587890625E-16, 0.00001525878906250000000000000000
3814697265625E-18, 0.00000381469726562500000000000000
95367431640625E-20, 0.00000953674316406250000000000000
2384185791015625E-22, 0.00000238418579101562500000000000
59604644775390625E-24, 0.00000059604644775390625000000000
1490116119384765625E-26, 0.00000001490116119384765625000000000
37252902984619140625E-28, 0.00000000372529029846191406250000000
9313225746154785156250E-30, 0.00000000093132257461547851562500000
2328306436538696289062500E-32, 0.00000000023283064365386962890625000
582076609134674072265625E-34, 0.00000000005820766091346740722656250
```

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```
14551915228366851806640 6E-34, 0.00000000001455191522836685180664 06
36379788070917129516601E-34, 0.00000000003637978807091712951660 1
90949470177292823791 5E-33, 0.00000000000909494701772928237915 0
22737367544323205947 87E-34, 0.00000000000227373675443232059478 7
56843418860808014869 6E-34, 0.00000000000056843418860808014869 6
14210854715202003717 4E-34, 0.00000000000014210854715202003717 4
35527136788005009293E-34, 0.00000000000003552713678800500929 3
88817841970012523 23E-34, 0.00000000000000888178419700125232 3
22204460492503130 8E-33, 0.00000000000000222044604925031308 0
55511151231257827E-33, 0.00000000000000055511151231257827 0
13877787807814456 7E-34, 0.00000000000000013877787807814456 7
34694469519536141E-34, 0.00000000000000003469446951953614 1
8673617379884035E-34, 0.00000000000000000867361737988403 5
2168404344971008E-34, 0.00000000000000000216840434497100 8
```

A float-decimal-34 as a 128 bit value:

```
2 ** 128 as D-34  = 340282366920938463463374607431768 2E5
```

And to maximum numeric digits (from 126 bits):

```
2 ** 126 as 9(38) = 85070591730234615865843651857942050000
 as numeric-edit  = 85,070,591,730,234,615,865,843,651,857,942,050,000
```

See *Sample shortforms* (page 1433) for the `sample-template` listing.

4.1.230 FLOAT-EXTENDED

Not yet supported. GnuCOBOL recognizes but does not yet support FLOAT-EXTENDED and will abend a compile.

4.1.231 FLOAT-INFINITY

Not yet supported. Value will represent floting point infinity.

4.1.232 FLOAT-LONG

GnuCOBOL supports floating point long.

```
identification division.
program-id. threes.

data division.
working-storage section.
01 fshort usage float-short.
01 flong  usage float-long.
01 fpic   pic   9v9(35).

procedure division.
compute fshort = 1 / 3
display "(1/3) as short " fshort
compute flong = 1 / 3
display "(1/3) as long  " flong
compute fpic = 1 / 6
```

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```
display "(1/6) as pic   " fpic
compute fpic rounded = 1 / 6
display "(1/6) rounded  " fpic
goback.

end program threes.
```

displays:

```
$ ./threes
(1/3) as short 0.333333343267440796
(1/3) as long  0.333333333333333315
(1/6) as pic   0.166666666666666666666666666666666666
(1/6) rounded  0.166666666666666666666666666666666667
```

4.1.233 FLOAT-NOT-A-NUMBER

Not yet supported. Value will represent a special bit pattern for floating point NAN.

4.1.234 FLOAT-SHORT

GnuCOBOL supports short floating point.

4.1.235 FOOTING

A *LINAGE* (page 314) clause that specifies the footer area of a page. A *WRITE* (page 433) statement to a linage report file will set END-OF-PAGE when the *LINAGE-COUNTER* (page 317) is within the footing area. This can be used to skip over or trigger summary lines. The footing area is part of the *page body*. When not specified, the footing area is the last line of the page body.

```
FD  mini-report
      linage is 16 lines
          with footing at 13
          lines at top 2
          lines at bottom 2.

...

write report-line from report-line-data
    at end-of-page
        write report-line from running-summary end-write

        if more-detail-records then
            add 1 to page-count
            write report-line from report-header
                after advancing page
            end-write
        end-if
end-write
```

In the above, the `AT END-OF-PAGE` condition is true when writing to report line 13, (and 14, the write of the running-summary) before advancing past the bottom margin and top margin and writing an initial header line on the next report page. *Assuming there are more records to process* given this little example.

4.1.236 FOR

Multi purpose keyword

- Used in INSPECT field TALLYING tally-field FOR ...
- USE FOR DEBUGGING
- SAME AREA FOR

4.1.237 FOREGROUND-COLOR

Screen section foreground color control. See *What are the GnuCOBOL SCREEN SECTION colour values?* (page 754)

4.1.238 FOREGROUND-COLOUR

Alternate spelling for *FOREGROUND-COLOR* (page 271).

4.1.239 FOREVER

Provides for infinite loops. Use EXIT PERFORM or EXIT PERFORM CYCLE to control program flow.

```
identification division.
program-id. foreverloop.

data division.
working-storage section.
01 cobol   pic 9 value 0.
01 c       pic 9 value 1.
01 fortran pic 9 value 2.

procedure division.

perform forever
    add 1 to cobol
    display "cobol at " cobol

    if cobol greater than fortran
        exit perform
    end-if

    if cobol greater than c
        exit perform cycle
    end-if

    display "cobol still creeping up on c"
end-perform

display "cobol surpassed c and fortran"

goback.
end program foreverloop.
```

Which produces:

```
$ cobc -free -x foreverloop.cob
$ ./foreverloop
cobol at 1
cobol still creeping up on c
cobol at 2
cobol at 3
cobol surpassed c and fortran
```

I asked on opencobol.org for some input, and an interesting conversation ensued. I've included the forum thread archive, nearly in its entirety, to give a sense of various programmer styles and group thought processing. See *Performing FOREVER?* (page 1351).

4.1.240 FORMAT

Source format directive. `cobc` defaults to `FIXED` format source. If `--free` is specified then the directive can start in column one, but due to `FIXED` format convention, by default, the directive must start in column 8 or later, allowing for the initial sequence number and comment columns.

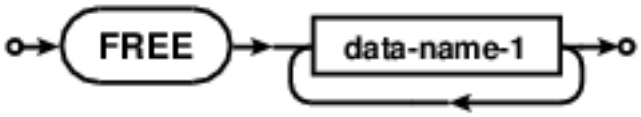
So, to enter free format COBOL, it has to be with the first greater than symbol in column 8 or later. Looks weird, for `FREE` code, but it's a rule. Unless you override the default `FIXED` behaviour with `cobc --free`.

Most samples in this manual start with a trivial short comment and

```
123456 >>SOURCE FORMAT IS FIXED
```

both to terrify and confuse beginners and to trick source code highlighters that rely on indentation. Mostly for for the former.

4.1.241 FREE



- Properly cleans up *ALLOCATE* (page 196) alloted memory
- source format directive.

```
>>SOURCE FORMAT IS FREE

 01 var PIC X(1024) BASED.

 ALLOCATE var
 CALL "buffer-thing" USING BY REFERENCE var END-CALL
 MOVE var TO working-store
 FREE var
```

4.1.242 FROM

- source of information clause to `ACCEPT`
- initial value in a `PERFORM VARYING` loop
- subtraction

```
ACCEPT var FROM ENVIRONMENT "path"
    ON EXCEPTION
        DISPLAY "No path" END-DISPLAY
    NOT ON EXCEPTION
        DISPLAY var END-DISPLAY
END-ACCEPT

PERFORM VARYING loop-index FROM 1 BY 1 UNTIL loop-index > loop-value
    SUBTRACT transaction-value(loop-index) FROM balance
END-PERFORM
```

Note: *Versions of the FAQ between Oct 2015 and July 2016 had a bug in this listing; it had to do with statement terminators.*

The old listing had a code fragment of

```
ACCEPT var FROM ENVIRONMENT "path"
    ON EXCEPTION
        DISPLAY "No path"
    NOT ON EXCEPTION
        DISPLAY var
END-ACCEPT
```

And that actually parses as

```
ACCEPT var FROM ENVIRONMENT "path"
    ON EXCEPTION
        DISPLAY "No path"
            NOT ON EXCEPTION
                DISPLAY var
END-ACCEPT
```

The `NOT ON EXCEPTION` clause was attached to the inner DISPLAY, not part of the ACCEPT statement. One of the places where COBOL can look right at a glance, but actually does what it is told, perhaps not what you meant.

As pointed out by Simon, in the conversation that uncovered this bug, *explained thanks to the sharp eyes of Edward*, `cobc -Wterminator` would display a warning for this source structure. The explicit *END-DISPLAY* (page 253) is required in this case for properly functioning code.

4.1.243 FULL

A screen section screen item control operator, requesting the normal terminator be ignored until the field is completely full or completely empty.

4.1.244 FUNCTION

Allows use of the many GnuCOBOL supported intrinsic functions.

```
DISPLAY FUNCTION TRIM("   trim off leading spaces" LEADING).
```

See *Does GnuCOBOL implement any Intrinsic FUNCTIONs?* (page 437) for details.

4.1.245 FUNCTION-ID

Implemented in GnuCOBOL 2.0 and later versions, including Sergey's C++ intermediate source version.

Functional COBOL is relatively new, although it has been in the spec for a while, it is not yet widely available to COBOL programmers. User Defined Functions are a modern COBOL feature.

Below is an example that defines a `read-url` function, that can be used in COBOL expressions, just as an intrinsic function.

This code is experimental, and hopefully a real `read-url` will be published in a `cobweb` shareable library, very soon.

curlit.cob an example of using the `read-url` function.

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
      *> Author:    Brian Tiffin
READ  *> Date:      20131211
URL   *> Purpose:   Read a web resource into working store
SAMPLE*> Credits:   Curl project sample getinmemory.c
      *> License:   GPL 3.0+
      *> Tectonics: cobc -lcurl -x curlit.cob
      *> ***************************************************************
       identification division.
       program-id. curlit.

       environment division.
       configuration section.
       repository.
           function read-url
           function all intrinsic.

       data division.
       working-storage section.

       copy "gccurlsym.cpy".

       01 web-page             pic x(16777216).
       01 curl-status          usage binary-long.

       01 gnucobolcgi          pic x(69)
            value "http://opencobol.add1tocobol.com/gnucobolcgi/" &
                  "gnucobol.cgi?query=thing".

      *> ***************************************************************
       procedure division.

      *>
      *> Read a web resource, or query into fixed ram.
      *>   Caller is in charge of sizing the buffer,
      *>     (or getting trickier with the write callback)
      *> Pass URL and working-storage variable,
      *>   get back libcURL error code or 0 for success

       move read-url("https://google.com", web-page) to curl-status

      *>
      *> Now tesing the result, relying on the gccurlsym
      *>   GnuCOBOL Curl Symbol copy book

       if curl-status not equal zero then
           display
```

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```
                curl-status " "
                CURLEMSG(curl-status) upon syserr
            end-if

           *>
           *> And display the page (suitable for piping to w3m if .html)

            display trim(web-page trailing) with no advancing

           *> FUNCTION-ID can be used pretty much anywhere a sending field
           *> is expected, so it doesn't have to be a move, and the request
           *> isn't limited to just page resources, query lines will work too

            initialize web-page
            compute curl-status = read-url(gnucobolcgi, web-page) end-compute
            if curl-status not equal zero then
                display
                    curl-status " "
                    CURLEMSG(curl-status) upon syserr
            else
                display trim(web-page trailing) with no advancing
            end-if

           *>
           *> or if it's unreliable, but worthy information, skip the check
           *>    one line networking

            move spaces to web-page
            move read-url("https://en.wikipedia.org/wiki/GNU_Cobol", web-page)
              to curl-status
            display trim(web-page trailing) with no advancing

            move spaces to web-page
            move read-url(
                    "http://sourceforge.net/rest/p/gnucobol/", web-page)
              to curl-status
            display trim(web-page trailing) with no advancing

           *>
           *> libcurl can report on many error conditions

            move spaces to web-page
            move read-url("http://notfoundsite.moc", web-page)
              to curl-status
            perform check

            move read-url("http://peoplecards.ca", web-page)
              to curl-status
            display trim(web-page trailing) with no advancing

            goback.
           *> ****************************************************************

            check.
            if curl-status not equal zero then
                display
                    curl-status " "
```

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```
            CURLEMSG(curl-status) upon syserr
       end-if.

       end program curlit.
      *> ****************************************************************
      *> ****************************************************************


      *>
      *> The function hiding all the curl details
      *>
      *> Purpose:   Call libcURL and read into memory
      *> ****************************************************************
       identification division.
       function-id. read-url.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.

       copy "gccurlsym.cpy".

       01 curl-handle          usage pointer.
       01 callback-handle      usage procedure-pointer.
       01 memory-block.
          05 memory-address    usage pointer sync.
          05 memory-size       usage binary-long sync.
          05 running-total     usage binary-long sync.
       01 curl-result          usage binary-long.

       linkage section.
       01 url                  pic x any length.
       01 buffer               pic x any length.
       01 curl-status          usage binary-long.

      *> ****************************************************************
       procedure division using url buffer returning curl-status.
       display "Read: " url upon syserr

      *> initialize libcurl, hint at missing library if need be
       call "curl_global_init" using by value CURL_GLOBAL_ALL
           on exception
               display
                   "need libcurl, link with -lcurl" upon syserr
               stop run returning 1
       end-call

      *> initialize handle
       call "curl_easy_init" returning curl-handle end-call
       if curl-handle equal NULL then
           display "no curl handle" upon syserr
           stop run returning 1
       end-if
```

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```
      *> Set the URL
       call "curl_easy_setopt" using
           by value curl-handle
           by value CURLOPT_URL
           by reference concatenate(trim(url trailing), x"00")
       end-call

      *> follow all redirects
       call "curl_easy_setopt" using
           by value curl-handle
           by value CURLOPT_FOLLOWLOCATION
           by value 1
       end-call

      *> set the call back to write to memory
       set callback-handle to address of entry "curl-write-callback"
       call "curl_easy_setopt" using
           by value curl-handle
           by value CURLOPT_WRITEFUNCTION
           by value callback-handle
       end-call

      *> set the curl handle data handling structure
       set memory-address to address of buffer
       move length(buffer) to memory-size
       move 1 to running-total

       call "curl_easy_setopt" using
           by value curl-handle
           by value CURLOPT_WRITEDATA
           by value address of memory-block
       end-call

      *> some servers demand an agent
       call "curl_easy_setopt" using
           by value curl-handle
           by value CURLOPT_USERAGENT
           by reference concatenate("libcurl-agent/1.0", x"00")
       end-call

      *> let curl do all the hard work
       call "curl_easy_perform" using
           by value curl-handle
           returning curl-result
       end-call

      *> the call back will handle filling ram, return the result code
       move curl-result to curl-status
       goback.
       end function read-url.

      *> ****************************************************************
      *> ****************************************************************

curl  *> Supporting callback
call  *> Purpose:   libcURL write callback
```

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```
back   *> ****************************************************************
       identification division.
       program-id. curl-write-callback.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 real-size            usage binary-long.

      *> libcURL will pass a pointer to this structure in the callback
       01 memory-block         based.
          05 memory-address    usage pointer sync.
          05 memory-size       usage binary-long sync.
          05 running-total     usage binary-long sync.

       01 content-buffer       pic x(65536) based.
       01 web-space            pic x(16777216) based.
       01 left-over            usage binary-long.

       linkage section.
       01 contents             usage pointer.
       01 element-size         usage binary-long.
       01 element-count        usage binary-long.
       01 memory-structure     usage pointer.

      *> ****************************************************************
       procedure division
           using
              by value contents
              by value element-size
              by value element-count
              by value memory-structure
          returning real-size.

       set address of memory-block to memory-structure
       compute real-size = element-size * element-count end-compute

      *> Fence off the end of buffer
       compute
           left-over = memory-size - running-total
       end-compute
       if left-over > 0 and < real-size then
           move left-over to real-size
       end-if

      *> if there is more buffer, and data not zero length
       if (left-over > 0) and (real-size > 1) then
           set address of content-buffer to contents
           set address of web-space to memory-address

           move content-buffer(1:real-size)
             to web-space(running-total:real-size)
```

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```
           add real-size to running-total
       end-if

      *> That if should have an else that raises a size exception <*

       goback.
       end program curl-write-callback.
```

and the copybook for libCURL messages, **gccurlsym.cpy**.

```
GNU   *> manifest constants for libcurl
Cobol *> Usage: COPY occurlsym  inside data division
      *>  Taken from include/curl/curl.h 2013-12-19

curl  *> Functional enums
       01 CURL_MAX_HTTP_HEADER CONSTANT AS     102400.

       78 CURL_GLOBAL_ALL                      VALUE 3.

       78 CURLOPT_FOLLOWLOCATION               VALUE 52.
       78 CURLOPT_WRITEDATA                    VALUE 10001.
       78 CURLOPT_URL                          VALUE 10002.
       78 CURLOPT_USERAGENT                    VALUE 10018.
       78 CURLOPT_WRITEFUNCTION                VALUE 20011.

      *> Result codes
       78 CURLE_OK                             VALUE 0.
      *> Error codes
       78 CURLE_UNSUPPORTED_PROTOCOL           VALUE 1.
       78 CURLE_FAILED_INIT                    VALUE 2.
       78 CURLE_URL_MALFORMAT                  VALUE 3.
       78 CURLE_OBSOLETE4                      VALUE 4.
       78 CURLE_COULDNT_RESOLVE_PROXY          VALUE 5.
       78 CURLE_COULDNT_RESOLVE_HOST           VALUE 6.
       78 CURLE_COULDNT_CONNECT                VALUE 7.
       78 CURLE_FTP_WEIRD_SERVER_REPLY         VALUE 8.
       78 CURLE_REMOTE_ACCESS_DENIED           VALUE 9.
       78 CURLE_OBSOLETE10                     VALUE 10.
       78 CURLE_FTP_WEIRD_PASS_REPLY           VALUE 11.
       78 CURLE_OBSOLETE12                     VALUE 12.
       78 CURLE_FTP_WEIRD_PASV_REPLY           VALUE 13.
       78 CURLE_FTP_WEIRD_227_FORMAT           VALUE 14.
       78 CURLE_FTP_CANT_GET_HOST              VALUE 15.
       78 CURLE_OBSOLETE16                     VALUE 16.
       78 CURLE_FTP_COULDNT_SET_TYPE           VALUE 17.
       78 CURLE_PARTIAL_FILE                   VALUE 18.
       78 CURLE_FTP_COULDNT_RETR_FILE          VALUE 19.
       78 CURLE_OBSOLETE20                     VALUE 20.
       78 CURLE_QUOTE_ERROR                    VALUE 21.
       78 CURLE_HTTP_RETURNED_ERROR            VALUE 22.
       78 CURLE_WRITE_ERROR                    VALUE 23.
       78 CURLE_OBSOLETE24                     VALUE 24.
       78 CURLE_UPLOAD_FAILED                  VALUE 25.
       78 CURLE_READ_ERROR                     VALUE 26.
       78 CURLE_OUT_OF_MEMORY                  VALUE 27.
       78 CURLE_OPERATION_TIMEDOUT             VALUE 28.
       78 CURLE_OBSOLETE29                     VALUE 29.
```

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```
       78 CURLE_FTP_PORT_FAILED               VALUE 30.
       78 CURLE_FTP_COULDNT_USE_REST          VALUE 31.
       78 CURLE_OBSOLETE32                    VALUE 32.
       78 CURLE_RANGE_ERROR                   VALUE 33.
       78 CURLE_HTTP_POST_ERROR               VALUE 34.
       78 CURLE_SSL_CONNECT_ERROR             VALUE 35.
       78 CURLE_BAD_DOWNLOAD_RESUME           VALUE 36.
       78 CURLE_FILE_COULDNT_READ_FILE        VALUE 37.
       78 CURLE_LDAP_CANNOT_BIND              VALUE 38.
       78 CURLE_LDAP_SEARCH_FAILED            VALUE 39.
       78 CURLE_OBSOLETE40                    VALUE 40.
       78 CURLE_FUNCTION_NOT_FOUND            VALUE 41.
       78 CURLE_ABORTED_BY_CALLBACK           VALUE 42.
       78 CURLE_BAD_FUNCTION_ARGUMENT         VALUE 43.
       78 CURLE_OBSOLETE44                    VALUE 44.
       78 CURLE_INTERFACE_FAILED              VALUE 45.
       78 CURLE_OBSOLETE46                    VALUE 46.
       78 CURLE_TOO_MANY_REDIRECTS            VALUE 47.
       78 CURLE_UNKNOWN_TELNET_OPTION         VALUE 48.
       78 CURLE_TELNET_OPTION_SYNTAX          VALUE 49.
       78 CURLE_OBSOLETE50                    VALUE 50.
       78 CURLE_PEER_FAILED_VERIFICATION      VALUE 51.
       78 CURLE_GOT_NOTHING                   VALUE 52.
       78 CURLE_SSL_ENGINE_NOTFOUND           VALUE 53.
       78 CURLE_SSL_ENGINE_SETFAILED          VALUE 54.
       78 CURLE_SEND_ERROR                    VALUE 55.
       78 CURLE_RECV_ERROR                    VALUE 56.
       78 CURLE_OBSOLETE57                    VALUE 57.
       78 CURLE_SSL_CERTPROBLEM               VALUE 58.
       78 CURLE_SSL_CIPHER                    VALUE 59.
       78 CURLE_SSL_CACERT                    VALUE 60.
       78 CURLE_BAD_CONTENT_ENCODING          VALUE 61.
       78 CURLE_LDAP_INVALID_URL              VALUE 62.
       78 CURLE_FILESIZE_EXCEEDED             VALUE 63.
       78 CURLE_USE_SSL_FAILED                VALUE 64.
       78 CURLE_SEND_FAIL_REWIND              VALUE 65.
       78 CURLE_SSL_ENGINE_INITFAILED         VALUE 66.
       78 CURLE_LOGIN_DENIED                  VALUE 67.
       78 CURLE_TFTP_NOTFOUND                 VALUE 68.
       78 CURLE_TFTP_PERM                     VALUE 69.
       78 CURLE_REMOTE_DISK_FULL              VALUE 70.
       78 CURLE_TFTP_ILLEGAL                  VALUE 71.
       78 CURLE_TFTP_UNKNOWNID                VALUE 72.
       78 CURLE_REMOTE_FILE_EXISTS            VALUE 73.
       78 CURLE_TFTP_NOSUCHUSER               VALUE 74.
       78 CURLE_CONV_FAILED                   VALUE 75.
       78 CURLE_CONV_REQD                     VALUE 76.
       78 CURLE_SSL_CACERT_BADFILE            VALUE 77.
       78 CURLE_REMOTE_FILE_NOT_FOUND         VALUE 78.
       78 CURLE_SSH                           VALUE 79.
       78 CURLE_SSL_SHUTDOWN_FAILED           VALUE 80.
       78 CURLE_AGAIN                         VALUE 81.

      *> Error strings
       01 LIBCURL_ERRORS.
          02 CURLEVALUES.
             03 FILLER PIC X(30) VALUE "CURLE_UNSUPPORTED_PROTOCOL    ".
```

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```
           03 FILLER PIC X(30) VALUE "CURLE_FAILED_INIT             ".
           03 FILLER PIC X(30) VALUE "CURLE_URL_MALFORMAT           ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE4               ".
           03 FILLER PIC X(30) VALUE "CURLE_COULDNT_RESOLVE_PROXY   ".
           03 FILLER PIC X(30) VALUE "CURLE_COULDNT_RESOLVE_HOST    ".
           03 FILLER PIC X(30) VALUE "CURLE_COULDNT_CONNECT         ".
           03 FILLER PIC X(30) VALUE "CURLE_FTP_WEIRD_SERVER_REPLY  ".
           03 FILLER PIC X(30) VALUE "CURLE_REMOTE_ACCESS_DENIED    ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE10              ".
           03 FILLER PIC X(30) VALUE "CURLE_FTP_WEIRD_PASS_REPLY    ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE12              ".
           03 FILLER PIC X(30) VALUE "CURLE_FTP_WEIRD_PASV_REPLY    ".
           03 FILLER PIC X(30) VALUE "CURLE_FTP_WEIRD_227_FORMAT    ".
           03 FILLER PIC X(30) VALUE "CURLE_FTP_CANT_GET_HOST       ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE16              ".
           03 FILLER PIC X(30) VALUE "CURLE_FTP_COULDNT_SET_TYPE    ".
           03 FILLER PIC X(30) VALUE "CURLE_PARTIAL_FILE            ".
           03 FILLER PIC X(30) VALUE "CURLE_FTP_COULDNT_RETR_FILE   ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE20              ".
           03 FILLER PIC X(30) VALUE "CURLE_QUOTE_ERROR             ".
           03 FILLER PIC X(30) VALUE "CURLE_HTTP_RETURNED_ERROR     ".
           03 FILLER PIC X(30) VALUE "CURLE_WRITE_ERROR             ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE24              ".
           03 FILLER PIC X(30) VALUE "CURLE_UPLOAD_FAILED           ".
           03 FILLER PIC X(30) VALUE "CURLE_READ_ERROR              ".
           03 FILLER PIC X(30) VALUE "CURLE_OUT_OF_MEMORY           ".
           03 FILLER PIC X(30) VALUE "CURLE_OPERATION_TIMEDOUT      ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE29              ".
           03 FILLER PIC X(30) VALUE "CURLE_FTP_PORT_FAILED         ".
           03 FILLER PIC X(30) VALUE "CURLE_FTP_COULDNT_USE_REST    ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE32              ".
           03 FILLER PIC X(30) VALUE "CURLE_RANGE_ERROR             ".
           03 FILLER PIC X(30) VALUE "CURLE_HTTP_POST_ERROR         ".
           03 FILLER PIC X(30) VALUE "CURLE_SSL_CONNECT_ERROR       ".
           03 FILLER PIC X(30) VALUE "CURLE_BAD_DOWNLOAD_RESUME     ".
           03 FILLER PIC X(30) VALUE "CURLE_FILE_COULDNT_READ_FILE  ".
           03 FILLER PIC X(30) VALUE "CURLE_LDAP_CANNOT_BIND        ".
           03 FILLER PIC X(30) VALUE "CURLE_LDAP_SEARCH_FAILED      ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE40              ".
           03 FILLER PIC X(30) VALUE "CURLE_FUNCTION_NOT_FOUND      ".
           03 FILLER PIC X(30) VALUE "CURLE_ABORTED_BY_CALLBACK     ".
           03 FILLER PIC X(30) VALUE "CURLE_BAD_FUNCTION_ARGUMENT   ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE44              ".
           03 FILLER PIC X(30) VALUE "CURLE_INTERFACE_FAILED        ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE46              ".
           03 FILLER PIC X(30) VALUE "CURLE_TOO_MANY_REDIRECTS      ".
           03 FILLER PIC X(30) VALUE "CURLE_UNKNOWN_TELNET_OPTION   ".
           03 FILLER PIC X(30) VALUE "CURLE_TELNET_OPTION_SYNTAX    ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE50              ".
           03 FILLER PIC X(30) VALUE "CURLE_PEER_FAILED_VERIFICATION".
           03 FILLER PIC X(30) VALUE "CURLE_GOT_NOTHING             ".
           03 FILLER PIC X(30) VALUE "CURLE_SSL_ENGINE_NOTFOUND     ".
           03 FILLER PIC X(30) VALUE "CURLE_SSL_ENGINE_SETFAILED    ".
           03 FILLER PIC X(30) VALUE "CURLE_SEND_ERROR              ".
           03 FILLER PIC X(30) VALUE "CURLE_RECV_ERROR              ".
           03 FILLER PIC X(30) VALUE "CURLE_OBSOLETE57              ".
           03 FILLER PIC X(30) VALUE "CURLE_SSL_CERTPROBLEM         ".
```

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```
           03 FILLER PIC X(30) VALUE "CURLE_SSL_CIPHER              ".
           03 FILLER PIC X(30) VALUE "CURLE_SSL_CACERT              ".
           03 FILLER PIC X(30) VALUE "CURLE_BAD_CONTENT_ENCODING    ".
           03 FILLER PIC X(30) VALUE "CURLE_LDAP_INVALID_URL        ".
           03 FILLER PIC X(30) VALUE "CURLE_FILESIZE_EXCEEDED       ".
           03 FILLER PIC X(30) VALUE "CURLE_USE_SSL_FAILED          ".
           03 FILLER PIC X(30) VALUE "CURLE_SEND_FAIL_REWIND        ".
           03 FILLER PIC X(30) VALUE "CURLE_SSL_ENGINE_INITFAILED   ".
           03 FILLER PIC X(30) VALUE "CURLE_LOGIN_DENIED            ".
           03 FILLER PIC X(30) VALUE "CURLE_TFTP_NOTFOUND           ".
           03 FILLER PIC X(30) VALUE "CURLE_TFTP_PERM               ".
           03 FILLER PIC X(30) VALUE "CURLE_REMOTE_DISK_FULL        ".
           03 FILLER PIC X(30) VALUE "CURLE_TFTP_ILLEGAL            ".
           03 FILLER PIC X(30) VALUE "CURLE_TFTP_UNKNOWNID          ".
           03 FILLER PIC X(30) VALUE "CURLE_REMOTE_FILE_EXISTS      ".
           03 FILLER PIC X(30) VALUE "CURLE_TFTP_NOSUCHUSER         ".
           03 FILLER PIC X(30) VALUE "CURLE_CONV_FAILED             ".
           03 FILLER PIC X(30) VALUE "CURLE_CONV_REQD               ".
           03 FILLER PIC X(30) VALUE "CURLE_SSL_CACERT_BADFILE      ".
           03 FILLER PIC X(30) VALUE "CURLE_REMOTE_FILE_NOT_FOUND   ".
           03 FILLER PIC X(30) VALUE "CURLE_SSH                     ".
           03 FILLER PIC X(30) VALUE "CURLE_SSL_SHUTDOWN_FAILED     ".
           03 FILLER PIC X(30) VALUE "CURLE_AGAIN                   ".
       01 FILLER REDEFINES LIBCURL_ERRORS.
          02 CURLEMSG OCCURS 81 TIMES PIC X(30).
```

Functional COBOL can open up new usage models, and will definitely help with source code sharing and reusable COBOL frameworks.

call-wrap wrapping a subprogram CALL as a user defined function.

Here is a sample that allows for **some** callable subprograms to be used in a functional manner (this version is limited to CALL signatures that take an integer and return an integer, but can be modified for other argument lists).

```
GNU    >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
      *> Date:      20131005
Wrap  *> Purpose:   Wrap CALL in FUNCTION
CALL  *> Tectonics: cobc -x call-wrap.cob
in UDF*> ***************************************************************
       identification division.
       program-id. call-wrap.

       environment division.
       configuration section.
       repository.
           function all intrinsic
           function f.

       data division.
       working-storage section.
       01 a                    pic s9(9) value 2.

      *> ***************************************************************
       procedure division.

      *> These are just tests
```

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```
       display "a is                    : " a

       perform 4 times
           move f("square", a) to a
           display 'f("square", a) is       : ' a
       end-perform

       display 'f("square-root", a) is : ' f("square-root", a)

       goback.
       end program call-wrap.
      *> ****************************************************************

      *> ****************************************************************
      *>  functional call wrapper
      *>
       identification division.
       function-id. f.

       data division.
       linkage section.
       01 call-name            pic x any length.
       01 argument-integer     pic s9(9).
       01 argument-result      pic s9(9).

       procedure division
           using call-name argument-integer returning argument-result.

      *> Need RAISE support added in, should get on that
       call call-name
           using argument-integer returning argument-result
           on exception
               continue
       end-call

       goback.
       end function f.
      *> ****************************************************************

      *> ****************************************************************
      *>  this is a made up example CALL target, square an int
       identification division.
       program-id. square.

       data division.
       working-storage section.
       01 the-square           pic s9(9).

       linkage section.
       01 input-integer        pic s9(9).
       01 output-integer       pic s9(9).

       procedure division using input-integer returning output-integer.

       set address of output-integer to address of the-square
       compute
           output-integer = input-integer * input-integer
```

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```
       end-compute

       goback.
       end program square.
      *> ****************************************************************

      *> ****************************************************************
      *>  another made up example, this one has for fun data conversions
       identification division.
       program-id. square-root.

       data division.
       working-storage section.
       01 the-root             pic s9(9).
       01 the-float            usage float-short.

       linkage section.
       01 input-integer        pic s9(9).
       01 output-integer       pic s9(9).

       procedure division using input-integer returning output-integer.

      *> move the integer to a float for libc sqrt
       compute the-float = input-integer end-compute

       call static "sqrt" using
           by value the-float
           returning the-float
       end-call

      *> back to integer for the return <*
       set address of output-integer to address of the-root
       compute output-integer = the-float end-compute

       goback.
       end program square-root.
```

This is a little fragile, and fully robust bindings would require a complete marshaling layer, but this works for call signatures with integer sized returns. `f` would be a poor choice of name for a generic functional wrapper, but it should be short, for use in expressions.

```
$ cobc -x -g -debug -W call-wrap.cob
$ ./call-wrap
a is                    : +000000002
f("square", a) is       : +000000004
f("square", a) is       : +000000016
f("square", a) is       : +000000256
f("square", a) is       : +000065536
f("square-root", a) is : +000000256
```

4.1.246 FUNCTION-POINTER

An entry address data type, for pointing to user defined functions.

See *PROGRAM-POINTER* (page 356).

4.1.247 GENERATE

The action verb for Report Writer output lines.

See *REPORT* (page 369) for an example.

Also see *INITIATE* (page 303), *TERMINATE* (page 418).

4.1.248 GET

Unsupported.

4.1.249 GIVING

Destination control for computations, and return value clause.

```
ADD 1 TO cobol GIVING GnuCOBOL.
```

4.1.250 GLOBAL

Multi use keyword for scope modification.

- working storage scope attribute
- a file description, *FD* (page 260) scope attribute
- USE [GLOBAL] FOR REPORTING declarative

A global identifier is accessible to all contained programs.

```
* Main program
 IDENTIFICATION   DIVISION.
 PROGRAM-ID.      main-global.

 DATA             DIVISION.
 WORKING-STORAGE SECTION.
 01 built-on      PIC xxxx/xx/xxBxx/xx/xxBxxxxxxx GLOBAL.
 01 shared-value  PIC x(32)                       GLOBAL.
 01 newline       PIC x VALUE x"0a"               GLOBAL.

 PROCEDURE        DIVISION.
     DISPLAY "Enter main-global   - " WITH NO ADVANCING
     MOVE FUNCTION WHEN-COMPILED TO built-on
     INSPECT built-on REPLACING
         ALL "/" BY ":" AFTER INITIAL SPACE
         ALL " " BY "." AFTER INITIAL SPACE
         ALL "/" BY "-"
       FIRST " " BY "/"
     DISPLAY "Built on " built-on
```

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```
     MOVE FUNCTION MODULE-ID TO shared-value
     DISPLAY "shared-value is :" FUNCTION TRIM(shared-value) ":"
     CALL "nested-global"
     DISPLAY "Back in main-global"
     DISPLAY "shared-value is :" FUNCTION TRIM(shared-value) ":"

     STOP RUN.

* Nested program, accesses GLOBAL data from Main
 IDENTIFICATION   DIVISION.
 PROGRAM-ID.      nested-global.

 PROCEDURE        DIVISION.
     DISPLAY newline "Enter nested-global - Built on " built-on

     DISPLAY
         "Caller    " FUNCTION MODULE-CALLER-ID       newline
         "Date      " FUNCTION MODULE-DATE            newline
         "Formatted " FUNCTION MODULE-FORMATTED-DATE  newline
         "Id        " FUNCTION MODULE-ID              newline
         "Path      " FUNCTION MODULE-PATH            newline
         "Source    " FUNCTION MODULE-SOURCE          newline
         "Time      " FUNCTION MODULE-TIME            newline

     MOVE FUNCTION MODULE-ID TO shared-value
     EXIT PROGRAM.

 END PROGRAM nested-global.
 END PROGRAM main-global.
```

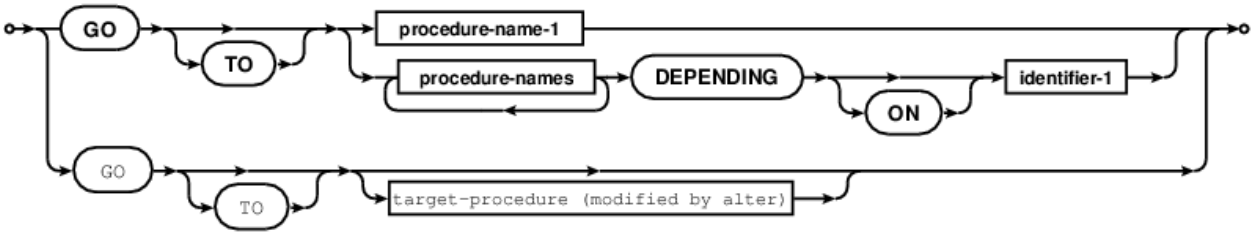
```
prompt$ cobc -xj main-global.cob
Enter main-global   - Built on 2015-10-27/23:32:46.00-0400
shared-value is :main-global:

Enter nested-global - Built on 2015-10-27/23:32:46.00-0400
Caller    main-global
Date      20151027
Formatted Oct 27 2015 23:32:46
Id        nested-global
Path      /home/btiffin/lang/cobol/faq/main-global
Source    main-global.cob
Time      233246

Back in main-global
shared-value is :nested-global:
```

4.1.251 GO

GO TO is your friend. Edsger was wrong. Transfer control to a named paragraph or section.



See *ALTER* (page 199) for details of monster grade go to power.

GO can also be qualified, for branching to same named paragraphs within different sections.

Control flow can jump forward or back; paragraph names can be forward referenced.

Any DEPENDING ON value is one relative, the first entry is branched to on 1. If there is no label in a position matching the DEPENDING ON value, no jump occurs and control flows to the next statement.

GnuCOBOL supports:

- `GO TO label`
- `GO TO list of labels DEPENDING on some-value`
- `GO TO X OF A`
- with ALTER, a plain `GO.`, where the target is set by *ALTER* (page 199) and is a no-op until altered.

Reading code with a plain

```
GO.
```

is a very good sign that `ALTER` is in play. The syntax allows for the much less friendly:

```
GO paragraph.
```

A named target may be altered after the fact, but that is much harder to spot than an unlabeled `GO`.

There are times when `GO` is appropriate, but it should be used purposefully and within reasonable limits.

Here is an unreasonable, contrived example, a hodge podge of the various GO forms, that when collected into one source file, cook up as "bsketti".

Gloss over this one. The latter listings will limit the forms to maintain some semblance of sanity.

```
*> A contrivance of spaghetti
 identification division.
 program-id. going.
 author. Brian Tiffin.
 date-written. 2015-10-28/21:56-0400.
 remarks. Demonstrate GO, qualified GO, computed GO, and ALTER.

 data division.
 working-storage section.
 01 province             pic 9 value 2.

*> ***************************************************************
 procedure division.
 main section.

*> First a simple GO TO.
 GO TO jumpover
```

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```
 DISPLAY "This is never seen"
 .

*> target of the first GO
 jumpover.
 DISPLAY "In jumpover"
 DISPLAY space
 .

*> And now a fall through into some sections

*> Branches to, and within sections
*> The first part of section-a is an unlabelled paragraph
 section-a section.
 GO TO paragraph-x
 DISPLAY "This is never seen"
 .

*> There are three paragraph-x labels
 paragraph-x.
 DISPLAY "In paragraph-x of section-a"

*> Now a jump to a section
 GO TO section-b
 DISPLAY "This is never seen"
 .

*> this section is jumped to from section-a
 section-b section.
 paragraph-x.
 DISPLAY "In paragraph-x of section-b"

*> And now, a true spaghetti dance, with back branching
 GO TO paragraph-z
 .

 paragraph-y.
 DISPLAY "back branch to paragraph-y of section-b"

*> qualified GO TO of paragraph within a section.
 GO TO paragraph-x OF section-c
 .

 paragraph-z.
 DISPLAY "In paragraph-z of section-b"
 GO TO paragraph-y
 .

*> c-section
 section-c section.
 paragraph-one.
 DISPLAY "This is never seen"
 .

*> there are three paragraph-x labels, each in different sections
 paragraph-x.
 DISPLAY "In paragraph-x of section-c"
```

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(continued from previous page)

```
 DISPLAY space
 .

*> Fall through into a computed GO example

*> Now a computed GO DEPENDING within an unlabelled paragraph.
 computed-go section.
 DISPLAY "motto, depending on province: " province
 GO TO quebec, ontario, manitoba DEPENDING ON province
 .

*> I remember / That born under the lily / I grow under the rose.
 quebec.
 DISPLAY "Je me souviens / "
 DISPLAY "Que né sous le lys / "
 DISPLAY "Je croîs sous la rose."
 GO home
 .

 *> Loyal she began. Loyal she remains.
 ontario.
 DISPLAY "Ut incepit Fidelis sic permanet."
 GO home
 .

*> Glorious and free
 manitoba.
 DISPLAY "Gloriosus et liber."
 GO home
 .

*> And now for some altering.
 home.
 DISPLAY space

 ALTER story TO PROCEED TO beginning
 GO TO story
 .

*> Jump to a part of the story
 story.
 GO.
 .

*> the first part
 beginning.
 ALTER story TO PROCEED to middle
 DISPLAY "This is the start of a changing story"
 GO TO story
 .

*> the middle bit
 middle.
 ALTER story TO PROCEED to ending
 DISPLAY "The story progresses"
 GO TO story
 .
```

(continues on next page)

(continued from previous page)

```
*> the climatic finish
 ending.
 DISPLAY "The story ends, happily ever after"
 .

*> fall through to the exit
 EXIT PROGRAM.
```

Giving:

```
$ cobc -xj going.cob
In jumpover

In paragraph-x of section-a
In paragraph-x of section-b
In paragraph-z of section-b
back branch to paragraph-y of section-b
In paragraph-x of section-c

motto, depending on province: 2
Ut incepit Fidelis sic permanet.

This is the start of a changing story
The story progresses
The story ends, happily ever after
```

Ok, now for listings of a more educational nature.

```
*> Simple GO TO
 IDENTIFICATION DIVISION.
 PROGRAM-ID. going-paragraph.
 AUTHOR. Brian Tiffin.
 DATE-WRITTEN. 2015-10-28/22:10-0400.
 REMARKS. Demonstrate GO.

 PROCEDURE DIVISION.
 main section.
 entry-point.

*> A simple GO TO.
 GO TO jumpover
 DISPLAY "This is never seen"
 .

*> target of the GO
 jumpover.
 DISPLAY "In jumpover"
 .

*> fall through to the exit
 EXIT PROGRAM.
```

Section and qualified GO (with just a little spaghetti).

```
*> GO section and to qualified paragraph labels
 IDENTIFICATION DIVISION.
```

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(continued from previous page)

```
 PROGRAM-ID. going-section.
 AUTHOR. Brian Tiffin.
 DATE-WRITTEN. 2015-10-28/22:10-0400.
 REMARKS. Demonstrate section and qualified GO

 PROCEDURE DIVISION.
 main section.
 entry-point.

 GO TO section-a
 DISPLAY "This is never seen"
 .

*> Branches to, and within sections
*> The first part of section-a is an unlabelled paragraph
 section-a section.

 GO TO paragraph-x
 DISPLAY "This is never seen"
 .

*> There are three paragraph-x labels
 paragraph-x.
 DISPLAY "In paragraph-x of section-a"

*> Now a jump to another section
 GO TO section-b
 DISPLAY "This is never seen"
 .

*> this section is jumped to from section-a
 section-b section.
 paragraph-x.
 DISPLAY "In paragraph-x of section-b"

*> And now, a little spaghettia dance, with back branching
 GO TO paragraph-z
 .

 paragraph-y.
 DISPLAY "back branch to paragraph-y of section-b"

*> qualified GO TO of paragraph within a section.
 GO TO paragraph-x OF section-c
 .

 paragraph-z.
 DISPLAY "In paragraph-z of section-b"
 GO TO paragraph-y
 .

*> c-section
 section-c section.
 paragraph-one.
 DISPLAY "This is never seen"
 .
```

(continues on next page)

(continued from previous page)

```
*> there are three paragraph-x labels, each in different sections
 paragraph-x.
 DISPLAY "In paragraph-x of section-c"
 .

*> fall through to the exit
 EXIT PROGRAM.
```

Which shows:

```
prompt$ cobc -xj going-section.cob
In paragraph-x of section-a
In paragraph-x of section-b
In paragraph-z of section-b
back branch to paragraph-y of section-b
In paragraph-x of section-c
```

Some commentary from Bill Woodger, regarding qualified GO. *Previous versions of these code listings did not include qualified GO TO and that part of the sample is due to his suggetion, listed below.*

```
A SECTION.
   If not-needed-no-more
       GO TO X
   end-if
...
X.
    EXIT.
B SECTION.
   If not-needed-no-more
       GO TO X
   end-if
...
X.
    EXIT.
```

```
In both those cases within a SECTION, the GO TO
paragraph-existing-within-SECTION is implicitly qualified as
GO TO X OF A and GO TO X OF B.

The point of using X is that of the old Copy/Paste with GO TO. If you
religiously "number" all the exits uniquely, when a SECTION is copied
and pasted (by someone else, of course) and the closing paragraph is
renamed but one of the GO TOs using it is not... pickle ensures.

On the other hand, if all the exits-from-SECTION-paragraphs are named
the same, the implicit qualification "saves" you.

You can, of course, explicitly qualify a GO TO. However, why would you
ever need or want to do that?
```

And now a small contrived sample of computed GO.

```
*> A computed GO TO
 IDENTIFICATION DIVISION.
 PROGRAM-ID. going-computed.
 AUTHOR. Brian Tiffin.
```

(continues on next page)

(continued from previous page)

```
 DATE-WRITTEN. 2015-10-28/22:10-0400.
 REMARKS. Demonstrate computed GO.

 DATA DIVISION.
 WORKING-STORAGE SECTION.
 01 province             pic 9 value 2.

*> ************************************************************
 PROCEDURE DIVISION.
 main section.

*> Now a computed GO DEPENDING
 DISPLAY "motto, depending on province: " province
 GO TO quebec, ontario, manitoba DEPENDING ON province
 .

*> I remember / That born under the lily / I grow under the rose.
 quebec.
 DISPLAY "Je me souviens / "
 DISPLAY "Que né sous le lys / "
 DISPLAY "Je croîs sous la rose."
 GO home
 .

 *> Loyal she began. Loyal she remains.
 ontario.
 DISPLAY "Ut incepit Fidelis sic permanet."
 GO home
 .

*> Glorious and free
 manitoba.
 DISPLAY "Gloriosus et liber."
 GO home
 .

*> And out
 home.
 EXIT PROGRAM.
```

Which shows:

```
prompt$ cobc -xj going-computed.cob
motto, depending on province: 2
Ut incepit Fidelis sic permanet.
```

See *ALTER* (page 199) for the example of modified GO TO branching, pulled out from the spaghetti code in the original `going.cob` listing.

GO TO ENTRY

While intended for code generators there is also a `GO TO ENTRY` extension in GnuCOBOL. Jump targets are specified with `ENTRY FOR GO TO 'label'`. These *are not* paragraphs, but labeled lines, added to the compiler to ease automatic COBOL code generation.

An example take from the test suite:

```
IDENTIFICATION DIVISION.
PROGRAM-ID. prog.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 JUMP-ENTRY    PIC 9  VALUE 6.
   88 EXT-MODUS  VALUES 3, 4.
LINKAGE SECTION.
PROCEDURE DIVISION.
    GO TO ENTRY 'STMT05'.
MAIN.
    GO TO ENTRY 'STMT01'
                'STMT02'
                'STMT03'
                'STMT04'
                'STMT05'
    DEPENDING ON JUMP-ENTRY
    DISPLAY 'NOT JUMPED'
    GOBACK.
ENTRY FOR GO TO 'STMT01'
    DISPLAY 'STMT01'
ENTRY FOR GO TO 'STMT02'
    PERFORM 3 TIMES
ENTRY FOR GO TO 'STMT03'
       DISPLAY 'STMT03'
ENTRY FOR GO TO 'STMT04'  DISPLAY 'STMT04'
       IF EXT-MODUS EXIT PERFORM END-IF
    END-PERFORM
ENTRY FOR GO TO 'STMT05'
    DISPLAY 'STMT05'
    SUBTRACT 1 FROM JUMP-ENTRY
    GO TO MAIN.
```

Other GO related blathering

For details on an esoteric programming language written with a core engine built around computed GO TO, see *What is small s.c.r.i.p.t.?* (page 1055).

Meandering a little bit now. Of the four esoteric programming languages I've written with GnuCOBOL, small s.c.r.i.p.t. is my favourite.

The home page for small s.c.r.i.p.t. is officially on the esolangs.org site, but;

Please be warned, esoteric programming fell to a somewhat unfortunate name choice back in 1997, and has since been heavily polluted with swear words. small s.c.r.i.p.t. is a derivative of one of these named systems, the most popular esolang, and you will encounter strong language on that site, but not within `small s.c.r.i.p.t.` itself.

See small s.c.r.i.p.t. on the Esoteric Programming Language site, esolangs.org, for more details of this scripting language, written around computed `GO DEPENDING ON`.

The GO DEPENDING statement that implements the core engine of small, holds 256 labels, one for each slot in the 8bit character set. Most just jump to "echo" but some few are small s.c.r.i.p.t. immediate numeric, control flow, and operational symbols.

small also includes a version of GO, setting the current source offset, with the exclamation mark operator.

```
small '05!ab1! c1! d'
```

displays:

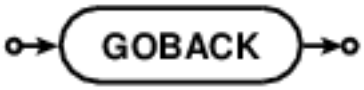
```
bcd
```

Go to absolute postion 5; display 'b', go to relative postion 1 (a skip); display 'c', skip, display 'd'.

GO is your friend, or can be, when shown the proper respect, and applied to the proper problems.

4.1.252 GOBACK

A return. This will work correctly for all cases. A return to the operating system or a return to a called program.




```
GOBACK.
```

Unlike `STOP RUN`, GOBACK will properly unwind nested programs, and only return to the operating system when it occurs in a top level program.

4.1.253 GREATER

COBOL conditional expression, IF A GREATER THAN B. See *LESS* (page 313)

4.1.254 GROUP

Report Writer data line grouping clause.

4.1.255 GROUP-USAGE

An unsupported *BIT* (page 217) clause.

4.1.256 HEADING

Report Writer RD clause specifying first line of page for `HEADING`.

4.1.257 HIGH-VALUE

A figurative *ALPHABETIC* (page 197) constant, being the highest character value in the *COLLATING* (page 228) sequence. It's invalid to *MOVE* (page 323) HIGH-VALUE to a *NUMERIC* (page 328) field.

4.1.258 HIGH-VALUES

Plural of *HIGH-VALUE* (page 295).

4.1.259 HIGHLIGHT

Screen control for field intensity. In some Windows implementations of screen management, this attribute only effects FOREGROUND colour. Use BLINK to management the intensity of the background colour with these implementations.

4.1.260 I-O

An *OPEN* (page 334) mode allowing for both read and write.

4.1.261 I-O-CONTROL

A paragraph in the *INPUT-OUTPUT* (page 304) section, allowing sharing memory areas for different files.

```
ENVIRONMENT DIVISION.
INPUT-OUTPUT SECTION.
I-O-CONTROL.
    SAME RECORD AREA FOR filename-1 filename-2.
```

4.1.262 ID

Short form for *IDENTIFICATION* (page 296).

4.1.263 IDENTIFICATION

The initial division for GnuCOBOL programs.

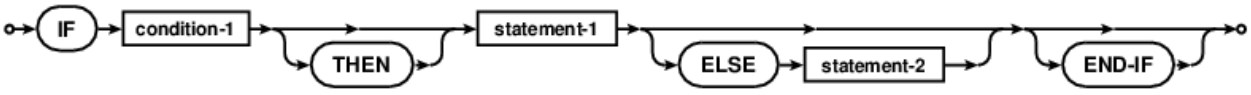
```
IDENTIFICATION DIVISION.
PROGRAM-ID. sample.
```

Many historical paragraphs from the IDENTIFICATION DIVISION have been deemed obsolete. GnuCOBOL will treat these as end of line comments. Including

- AUTHOR
- DATE-WRITTEN
- DATE-MODIFIED
- DATE-COMPILED
- INSTALLATION
- REMARKS
- SECURITY

4.1.264 IF

Conditional branching.



In COBOL, conditionals are quite powerful and there are many conditional expressions allowed with concise shortcuts.

```
IF A = 1 OR 2
    MOVE 1 TO B
END-IF
```

That is equivalent to

```
IF (A = 1) OR (A = 2)
    MOVE 1 TO B
END-IF
```

4.1.265 IGNORE

Modifier to *READ* (page 359) to inform system to ignore locks.

```
READ infile WITH IGNORE LOCK
```

4.1.266 IGNORING

```
READ filename-1 INTO identifer-1 IGNORING LOCK END-READ
```

4.1.267 IMPLEMENTS

Unsupported Object COBOL expression.

4.1.268 IN

A data structure reference and name conflict resolution qualifier.

```
MOVE "abc" TO field IN the-record IN the-structure
```

Synonym for *OF* (page 331)

4.1.269 INDEX

A COBOL data type for indexing structures, and implicitly used by such things as in memory table *SORT* (page 403).

```
01 cursor-var USAGE INDEX.

SET cursor-var UP BY 1.
```

4.1.270 INDEXED

An ISAM file organization.

```
environment division.
input-output section.
file-control.
   select optional indexing
   assign to "indexing.dat"
   organization is indexed
   access mode is dynamic
   record key is keyfield of indexing-record
   alternate record key is splitkey of indexing-record
       with duplicates
   .
```

Sets an indexing control identifier for OCCURS data arrays.

```
01 TABLE-DATA.
   05 TABLE-ELEMENTS
       OCCURS 1 TO 100 TIMES DEPENDING ON crowd-size
       INDEXED BY cursor-var.
     10 field-1 PIC X.
```

4.1.271 INDICATE

GROUP INDICATE is a REPORT SECTION *RD* (page 359) clause that specifies that printable item is output only on the first occurrence of its report group for that INITIATE, control break, or page advance.

4.1.272 INDIRECT

Not yet implemented.

4.1.273 INHERITS

An unsupported Object COBOL clause.

4.1.274 INITIAL

A modifier for the *PROGRAM-ID* (page 356) clause, that causes the entire DATA DIVISION to be set to an initial state each time the subprogram is executed by CALL.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20111226
      *> Purpose:   Small sample of INITIAL procedure division clause
      *> Tectonics: cobc -x -w -g -debug initialclause.cob
      *> ************************************************************
       identification division.
       program-id. initialclause.

      *> -*********-*********-*********-*********-*********-*********-**
       procedure division.
       call "with-initial" end-call
```

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```
       call "without-initial" end-call
       call "with-initial" end-call
       call "without-initial" end-call
       call "without-initial" end-call
       goback.
       end program initialclause.


      *> ---------+---------+---------+---------+---------+---------+---------**
      *> ---------+---------+---------+---------+---------+---------+---------**
       identification division.
       program-id. with-initial is initial.

       data division.
       working-storage section.
       01 the-value pic 99 value 42.

      *> ---------+---------+---------+---------+---------+---------+---------**
       procedure division.
       display "Inside with-initial with   : " the-value
       multiply the-value by 2 giving the-value
           on size error
               display "size overflow"
       end-multiply
       goback.
       end program with-initial.


      *> ---------+---------+---------+---------+---------+---------+---------**
      *> ---------+---------+---------+---------+---------+---------+---------**
       identification division.
       program-id. without-initial.

       data division.
       working-storage section.
       01 the-value pic 99 value 42.

      *> ---------+---------+---------+---------+---------+---------+---------**
       procedure division.
       display "Inside without-initial with: " the-value
       multiply the-value by 2 giving the-value
           on size error
               display "size overflow"
       end-multiply
       goback.
       end program without-initial.
```

Gives:

```
[btiffin@home cobol]$ ./initialclause
Inside with-initial with   : 42
Inside without-initial with: 42
Inside with-initial with   : 42
Inside without-initial with: 84
size overflow
Inside without-initial with: 84
size overflow
```

INITIAL sets the-value to 42 upon each and every entry, without-initial multiplies through 42, 84, 168 (or would have, if not constrained to pic 99).

4.1.275 INITIALISE

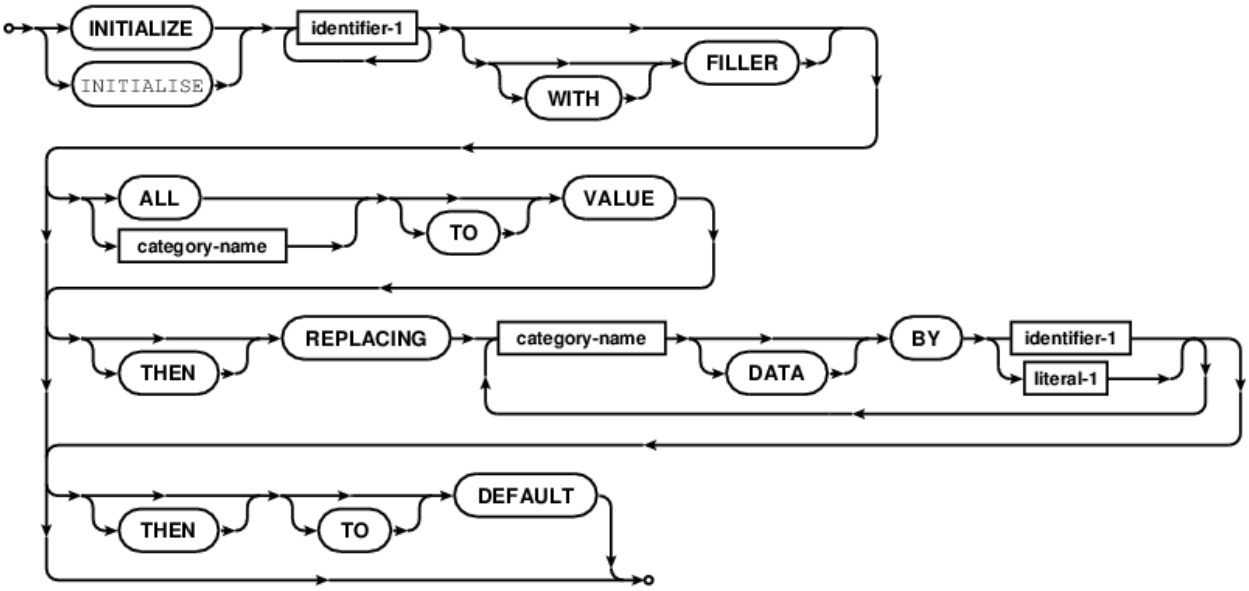
Alternate spelling for the *INITIALIZE* (page 300) verb.

4.1.276 INITIALISED

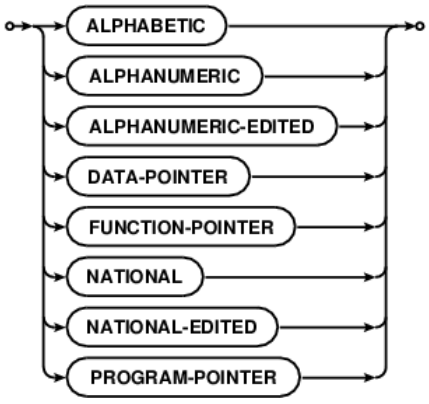
Alternate spelling for *INITIALIZED* (page 303).

4.1.277 INITIALIZE

Sets selected data to specified values.



Where `category-name` is:



A sample of the INITIALIZE verb posted to opencobol.org by *human* (page **??**)

```
GCobol*----------------------------------------------------------------
       IDENTIFICATION DIVISION.
       PROGRAM-ID. 'INITTEST'.
       ENVIRONMENT DIVISION.
       CONFIGURATION SECTION.
       SPECIAL-NAMES. DECIMAL-POINT IS COMMA.
       INPUT-OUTPUT SECTION.
       DATA DIVISION.
      *
       WORKING-STORAGE SECTION.
      *
       77  mychar      pic x.
       77  mynumeric   pic 9.
       01  REC-TEST BASED.
           03 REC-TEST-PART1 PIC X(10) value all '9'.
           03 REC-TEST-PART2 PIC X(10) value all 'A'.
       01  fillertest.
           03 fillertest-1 PIC 9(10) value 2222222222.
           03 filler       PIC X     value '|'.
           03 fillertest-2 PIC X(10) value all 'A'.
           03 filler       PIC 9(03) value 111.
           03 filler       PIC X     value '.'.
      *----------------------------------------------------------------
       LINKAGE SECTION.
      *----------------------------------------------------------------
       PROCEDURE DIVISION.
      *----------------------------------------------------------------
       Main section.
       00.
      *
           display 'fillertest '
                   'on start:'
           end-display
           display fillertest
           end-display
           accept  mychar
      *
           initialize fillertest
           display 'fillertest '
                   'after initialize:'
           end-display
           display fillertest
           end-display
           accept  mychar
      *
           initialize fillertest replacing numeric by 9
           display 'fillertest '
                   'after initialize replacing numeric by 9:'
           end-display
           display fillertest
           end-display
           accept  mychar
      *
           initialize fillertest replacing alphanumeric by 'X'
           display 'fillertest '
                   'after initialize replacing alphanumeric by "X":'
           end-display
```

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```
           display fillertest
           end-display
           accept  mychar
      *
           initialize fillertest replacing alphanumeric by all 'X'
           display 'fillertest '
                   'after initialize replacing alphanumeric by all "X":'
           end-display
           display fillertest
           end-display
           accept  mychar
      *
           initialize fillertest with filler
           display 'fillertest '
                   'after initialize with filler:'
           end-display
           display fillertest
           end-display
           accept  mychar
      *
           initialize fillertest all to value
           display 'fillertest '
                   'after initialize all to value:'
           end-display
           display fillertest
           end-display
           accept  mychar
      *
           ALLOCATE  REC-TEST
           display 'REC-TEST after allocating:'
           end-display
           display REC-TEST
           end-display
           accept  mychar
      *
           initialize REC-TEST all to value
           display 'REC-TEST after initalize all to value:'
           end-display
           display REC-TEST
           end-display
           accept  mychar
      *
           stop run
      *
           continue.
       ex. exit program.
      *-----------------------------------------------------------------
      *--- End of program INITTEST -------------------------------------
```

Outputs:

```
fillertest on start:
2222222222|AAAAAAAAAA111.
fillertest after initialize:
0000000000|          111.
fillertest after initialize replacing numeric by 9:
0000000009|          111.
```

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```
fillertest after initialize replacing alphanumeric by "X":
0000000009|X         111.
fillertest after initialize replacing alphanumeric by all "X":
0000000009|XXXXXXXXXX111.
fillertest after initialize with filler:
0000000000           000
fillertest after initialize all to value:
2222222222|AAAAAAAAAA111.
REC-TEST after allocating:

REC-TEST after initalize all to value:
9999999999AAAAAAAAAA
```

4.1.278 INITIALIZED

A modifier for the *ALLOCATE* (page 196) verb, filling the target with a default value.

```
77 based-var   PIC X(9) BASED VALUE "ALLOCATED".
77 pointer-var USAGE POINTER.

ALLOCATE based-var
DISPLAY ":" based-var ":"
FREE based-var
ALLOCATE based-var INITIALIZED RETURNING pointer-var
DISPLAY ":" based-var ":"
```

displays:

```
:         :
:ALLOCATED:
```

4.1.279 INITIATE

Initialize internal storage and controls for named `REPORT SECTION` entries.

Also see *GENERATE* (page 285), *TERMINATE* (page 418) and *REPORT* (page 369).

4.1.280 INPUT

A mode of the *OPEN* (page 334) verb for file access.

```
OPEN INPUT datafile
```

Note that `OPEN INPUT` will fail if the named files does not exist, unless the associated *SELECT* (page 395) phrase includes the *OPTIONAL* (page 334) keyword. GnuCOBOL returns a status "35" and aborts a run without an `OPTIONAL SELECT`.

A *SORT* (page 403) clause allowing programmer controlled input read passes where sortable records are passed to the sort algorithm using *RELEASE* (page 366).

```
procedure division.
sort sort-work
    on descending key work-rec
    collating sequence is mixed
    input procedure is sort-transform
    output procedure is output-uppercase.

display sort-return
goback.
```

See the *SORT* (page 403) entry for an example program that exercises an `INPUT PROCEDURE`.

4.1.281 INPUT-OUTPUT

A section in the ENVIRONMENT DIVISION of a COBOL source file containing FILE and I-O control paragraphs.

```
environment division.
input-output section.
file-control.
    select htmlfile
    assign to filename
    organization is record sequential.
```

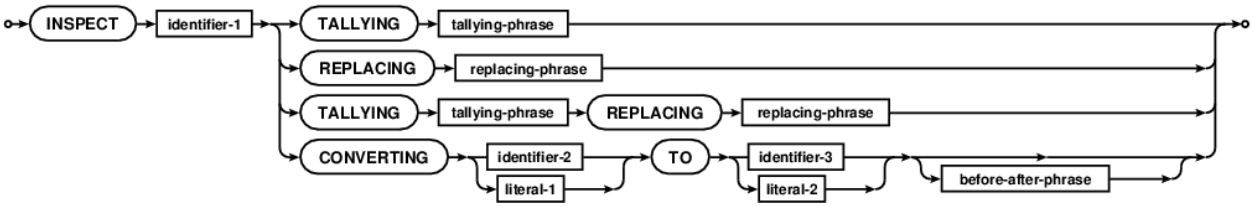
GnuCOBOL supports

- *FILE-CONTROL* (page 264)
- *I-O-CONTROL* (page 296)

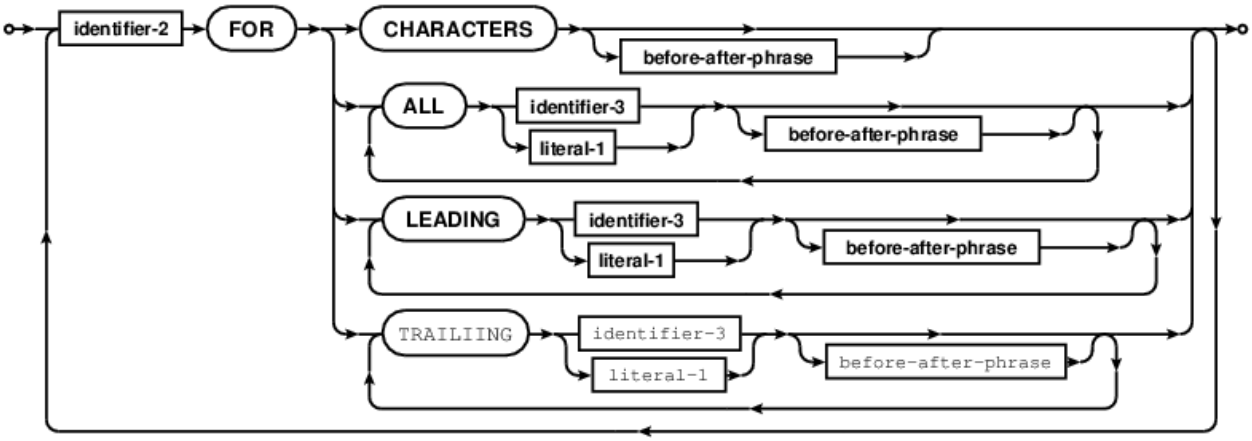
paragraphs within the INPUT-OUTPUT SECTION.

4.1.282 INSPECT

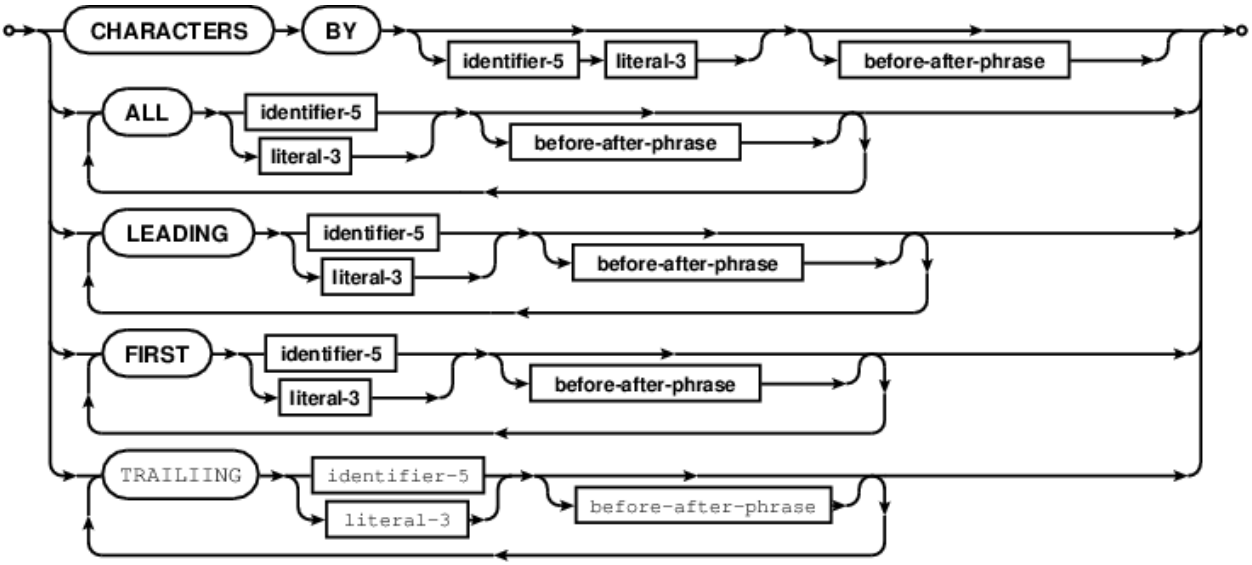
Provides very powerful parsing and replacement to COBOL, and GnuCOBOL supports the full gamut of options. GnuCOBOL also supports a few common extensions, such as the `TRAILING` modifier for `INSPECT ... REPLACING ...`.



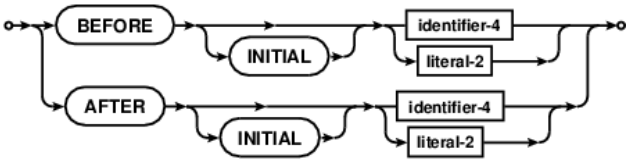
With `tallying-phrase`



And `replacing-phrase`



Where `before-after-phrase` is



A small example that reformats `WHEN-COMPILED` for a more readable display:

```
GCobol identification division.
       program-id. inspecting.

       data division.
       working-storage section.
       01  ORIGINAL            pic XXXX/XX/XXBXX/XX/XXXXXXX/XX.
       01  DATEREC             pic XXXX/XX/XXBXX/XX/XXXXXXX/XX.

       procedure division.

       move function when-compiled to DATEREC ORIGINAL
```

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```
       INSPECT DATEREC REPLACING ALL "/" BY ":" AFTER INITIAL SPACE

       display "Formatted function WHEN-COMPILED " ORIGINAL
       display " after INSPECT REPLACING         " DATEREC

       goback.
       end program inspecting.
```

Example output:

```
Formatted function WHEN-COMPILED 2010/03/25 23/05/0900-04/00
 after INSPECT REPLACING         2010/03/25 23:05:0900-04:00
```

See *ASCII* (page 207) for a quick way of converting character data to *EBCDIC* (page 251).

printable characters

Here is a short sample of replacing character fields with printable, *and trimmable* fields, or printable with dotted replacements.

It is a work in progress. This example uses two different methods. Two working-storage fields, or only one field and an all-code ALPHABET. Plus this is using details for CCSID-37, EBCDIC code page 37. It may include a a lot more printables than would normally be practical for z/OS work.

```
ocular*> Printable characters
      *> tectonics: cobc -xjd printables.cob | cat -v
       identification division.
       program-id. printables.

       environment division.
       configuration section.
       special-names.
           alphabet all-codes is 01 thru 256.

       repository.
           function all intrinsic.

       data division.
       working-storage section.
      *> maybe-printable is pretty much equivalent to all-codes alphabet
       01 maybe-printable constant as
             x"000102030405060708090A0B0C0D0E0F" &
             x"101112131415161718191A1B1C1D1E1F" &
             x"202122232425262728292A2B2C2D2E2F" &
             x"303132333435363738393A3B3C3D3E3F" &
             x"404142434445464748494A4B4C4D4E4F" &
             x"505152535455565758595A5B5C5D5E5F" &
             x"606162636465666768696A6B6C6D6E6F" &
             x"707172737475767778797A7B7C7D7E7F" &
             x"808182838485868788898A8B8C8D8E8F" &
             x"909192939495969798999A9B9C9D9E9F" &
             x"A0A1A2A3A4A5A6A7A8A9AAABACADAEAF" &
             x"B0B1B2B3B4B5B6B7B8B9BABBBCBDBEBF" &
             x"C0C1C2C3C4C5C6C7C8C9CACBCCCDCECF" &
```

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```
             x"D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF" &
             x"E0E1E2E3E4E5E6E7E8E9EAEBECEDEEEF" &
             x"F0F1F2F3F4F5F6F7F8F9FAFBFCFDFEFF".

      *> convert to spaces
       01 printable constant as
       >>IF CHARSET = "EBCDIC"
             x"40404040404040404040404040404040" &
             x"40404040404040404040404040404040" &
             x"40404040404040404040404040404040" &
             x"40404040404040404040404040404040" &
             x"404142434445464748494A4B4C4D4E4F" &
             x"505152535455565758595A5B5C5D5E5F" &
             x"606162636465666768696A6B6C6D6E6F" &
             x"707172737475767778797A7B7C7D7E7F" &
             x"808182838485868788898A8B8C8D8E8F" &
             x"909192939495969798999A9B9C9D9E9F" &
             x"A0A1A2A3A4A5A6A7A8A9AAABACADAEAF" &
             x"B0B1B2B3B4B5B6B7B8B9BABBBCBDBEBF" &
             x"C0C1C2C3C4C5C6C7C8C9CACBCCCDCECF" &
             x"D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF" &
             x"E0E1E2E3E4E5E6E7E8E9EAEBECEDEEEF" &
             x"F0F1F2F3F4F5F6F7F8F9FAFBFCFDFE40" &
       >>ELSE
             x"20202020202020202020202020202020" &
             x"20202020202020202020202020202020" &
             x"20212223242526272829 2A2B2C2D2E2F" &
             x"30313233343536373839 3A3B3C3D3E3F" &
             x"404142434445464748494A4B4C4D4E4F" &
             x"505152535455565758595A5B5C5D5E5F" &
             x"606162636465666768696A6B6C6D6E6F" &
             x"707172737475767778797A7B7C7D7E20" &
             x"20202020202020202020202020202020" &
             x"20202020202020202020202020202020" &
             x"20202020202020202020202020202020" &
             x"20202020202020202020202020202020" &
             x"20202020202020202020202020202020" &
             x"20202020202020202020202020202020" &
             x"20202020202020202020202020202020".
       >>END-IF

      *> convert to periods
       01 dotted constant as
       >>IF CHARSET = "EBCDIC"
             x"7D7D7D7D7D7D7D7D7D7D7D7D7D7D7D7D" &
             x"7D7D7D7D7D7D7D7D7D7D7D7D7D7D7D7D" &
             x"7D7D7D7D7D7D7D7D7D7D7D7D7D7D7D7D" &
             x"7D7D7D7D7D7D7D7D7D7D7D7D7D7D7D7D" &
             x"404142434445464748494A4B4C4D4E4F" &
             x"505152535455565758595A5B5C5D5E5F" &
             x"606162636465666768696A6B6C6D6E6F" &
             x"707172737475767778797A7B7C7D7E7F" &
             x"808182838485868788898A8B8C8D8E8F" &
             x"909192939495969798999A9B9C9D9E9F" &
             x"A0A1A2A3A4A5A6A7A8A9AAABACADAEAF" &
             x"B0B1B2B3B4B5B6B7B8B9BABBBCBDBEBF" &
```

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```
           x"C0C1C2C3C4C5C6C7C8C9CACBCCCDCECF" &
           x"D0D1D2D3D4D5D6D7D8D9DADBDCDDDEDF" &
           x"E0E1E2E3E4E5E6E7E8E9EAEBECEDEEEF" &
           x"F0F1F2F3F4F5F6F7F8F9FAFBFCFDFE7D" &
       >>ELSE
           x"2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E" &
           x"2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E" &
           x"202122232425262728292A2B2C2D2E2F" &
           x"303132333435363738393A3B3C3D3E3F" &
           x"404142434445464748494A4B4C4D4E4F" &
           x"505152535455565758595A5B5C5D5E5F" &
           x"606162636465666768696A6B6C6D6E6F" &
           x"707172737475767778797A7B7C7D7E2E" &
           x"2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E" &
           x"2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E" &
           x"2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E" &
           x"2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E" &
           x"2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E" &
           x"2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E" &
           x"2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E" &
           x"2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E2E".
       >>END-IF

       01 testing.
          05 value x"00010203" & " abcd " & x"0d0a" & x"8899EEFF".

       procedure division.
       sample-main.

      *> First using the two working-storage character fields
       display testing
       inspect testing converting maybe-printable to printable
       display ":" testing ":"
       display space

      *> Second using an ALPHABET and the replacement character field
       initialize testing with filler all to value
       display testing
       inspect testing converting all-codes to printable
       display ":" testing ":"
       display space

      *> third using the ALPHABET and the dotted replacement
       initialize testing with filler all to value
       display testing
       inspect testing converting all-codes to dotted
       display ":" testing ":"

       goback.
       end program printables.
```

The plan is to eventually have a copybook that ships with GnuCOBOL, or Intrinsic Function extension to handle conversion/testing for printable fields.

Sample run showing:

```
prompt$ cobc -xjd printables.cob | cat -v
^@^A^B^C abcd ^M
M-^HM-^YM-nM-^?
:     abcd       :

^@^A^B^C abcd ^M
M-^HM-^YM-nM-^?
:     abcd       :

^@^A^B^C abcd ^M
M-^HM-^YM-nM-^?
:.... abcd ......:
```

The raw data is split into two lines as `cat -v` sees the `x"0a"` as a newline, not a character to use `^ and M-` notation for.

Use `INSPECT CONVERTING` for single character mappings and `INSPECT REPLACING` for equal length character string changes.

The *FUNCTION SUBSTITUTE* (page 491) extension built into GnuCOBOL allows unequal length string replacements.

4.1.283 INSTALLATION

An informational clause in the *IDENTIFICATION* (page 296) DIVISION. Deemed OBSOLETE, but still in use. GnuCOBOL treats this as an end of line comment keyword, *periods not required*, all source up to the next newline is simply ignored.

4.1.284 INTERFACE

Unsupported.

4.1.285 INTERFACE-ID

Not yet implemented. An unsupported Object COBOL clause in the *IDENTIFICATION* (page 296) division.

4.1.286 INTERMEDIATE

Not yet implemented.

4.1.287 INTO

Division. See *DIVIDE* (page 250) for more details.

```
DIVIDE A INTO B GIVING C.
```

With *READ* (page 359)

```
READ filespec RECORD INTO record-space
```

With *RETURNING* (page 381)

```
CALL "subprogram" RETURNING INTO result
```

With *STRING* (page 414) and *UNSTRING* (page 426)

```
STRING source-field DELIMITED BY LOW-VALUE ... INTO destination-field

UNSTRING source-field DELIMITED BY "," INTO dest-field-1 ...
```

4.1.288 INTRINSIC

Used in REPOSITORY to allow the optional use of "FUNCTION" keyword.

```
environment division.
configuration section.
repository.
    function all intrinsic.
```

The source unit will now allow for program lines such as

```
move trim("  abc") to dest
move function trim("  abc") to dest
```

to compile the same code.

4.1.289 INVALID

Key exception imperative phrase.

```
READ filename-1
    INVALID KEY
        DISPLAY "Bad key" END-DISPLAY
    NOT INVALID KEY
        DISPLAY "Good read" END-DISPLAY
END-READ
```

Please note that scope terminators are very good idea inside imperative clauses, so it is wise to get in the habit of explicitly terminating any and all reserved words that allow optional terminators, otherwise there is risk that one imperative conditional will be syntactically attached to an unintended phrase, leading to hard to track down and non-obvious problems.

4.1.290 INVOKE

Unsupported Object COBOL method call.

4.1.291 IS

Readability word. `A IS LESS THAN B` is equivalent to `A LESS B`.

4.1.292 JUST

Alias for *JUSTIFIED* (page 311).

4.1.293 JUSTIFIED

Tweaks storage rules in weird *JUST* (page 310) ways, lessening the voodoo behind *MOVE* (page 323) instructions, *he said, sarcastically*.

```
77 str1 pic x(40) justified right.
```

4.1.294 KEPT

File I-O locking modifier.

```
READ WITH KEPT LOCK
```

4.1.295 KEY

Multi use, always means key:

```
- RELATIVE KEY IS
- ALTERNATE RECORD KEY IS
- NOT INVALID KEY
- SORT filename ON DESCENDING KEY keyfield
- START indexing KEY IS LESS THAN keyfield
```

4.1.296 KEYBOARD

A special value for Standard Input device. Handy for getting at CGI POST data.

```
file-control.
    select cgi-in
    assign to keyboard.
```

4.1.297 LABEL

A record label. As with most record labels, falling into disuse.

4.1.298 LAST

- Used in START to prepare a read of the last record.

```
START filename-1 LAST
    INVALID KEY
        MOVE ZERO TO record-count
        >>D DISPLAY "No last record for " filename-1
END-START
```

- A Report Writer RD clause specifying line on page for `LAST DETAIL` report output.

4.1.299 LC_ALL

A reserved but unsupported category group. See *Setting Locale* (page 1350). GnuCOBOL is 'locale' aware, but it is currently more *external* than in COBOL source. For now, it is safest to assume **LC_ALL=C**, but this can be configured differently when GnuCOBOL is built.

4.1.300 LC_COLLATE

A reserved but unsupported category name. Will be used with SET.

4.1.301 LC_CTYPE

A reserved but unsupported Locale category name. Will be used with SET.

4.1.302 LC_MESSAGES

A reserved but unsupported category name. See *Setting Locale* (page 1350). GnuCOBOL is 'locale' aware, but it is currently more *external* than in COBOL source.

GnuCOBOL 2.0 extends locale support to the compiler messages.

```
$ export LC_MESSAGES=es_ES
$ cobc -x fdfgffd.cob
cobc: fdfgffd.cob: No existe el fichero o el directorio
```

4.1.303 LC_MONETARY

A reserved but unsupported Locale category name. Will be used with SET.

4.1.304 LC_NUMERIC

A reserved but unsupported Locale category name. Will be used with SET.

4.1.305 LC_TIME

A reserved but unsupported Locale category name. Will be used with SET.

4.1.306 LEADING

Multipurpose.

```
DISPLAY FUNCTION TRIM(var-1 LEADING)

INSPECT FUNCTION REVERSE(TEST-CASE)
    TALLYING B-COUNT
    FOR LEADING ' '.
DISPLAY B-COUNT.

INSPECT X REPLACING LEADING ZEROS BY SPACES.
```

as well as use in the COBOL preprocessor:

```
COPY "copy.inc"
    REPLACING LEADING ==TEST== BY ==FIRST==
              LEADING ==NORM== BY ==SECOND==.
```

4.1.307 LEFT

SYNCHRONIZED (page 417) control.

4.1.308 LEFT-JUSTIFY

Not yet implemented.

4.1.309 LEFTLINE

Screen attribute. Horizontal line will appear to the left of the field.

See *OVERLINE* (page 337) and *UNDERLINE* (page 425).

4.1.310 LENGTH

A 'cell-count' length. Not always the same as *BYTE-LENGTH* (page 219).

Due to a possible ambiguity with *FUNCTION LENGTH* (page 466), the **OF** keyword is mandatory in some parsing contexts during compiles.

4.1.311 LENGTH-CHECK

Alias for the *FULL* (page 273) screen attribute.

4.1.312 LESS

A comparison operation.

```
IF requested LESS THAN OR EQUAL TO balance
    PERFORM transfer
ELSE
    PERFORM reject
END-IF
```

4.1.313 LIMIT

Report Writer RD clause for `PAGE LIMIT IS lines-per-page LINES.`

4.1.314 LIMITS

Recognized Report Writer clause.

4.1.315 LINAGE

LINAGE is a clause in a File Descriptor *FD* (page 260) which triggers the run time library to maintain a *LINAGE-COUNTER* (page 317) *SPECIAL-REGISTER* during file `WRITE` operations and can be used for paging, skip line control, *and others* such and *FOOTING* (page 270) areas.

```
COBOL ************************************************************
      * Example of LINAGE File Descriptor
      * Author: Brian Tiffin
      * Date:   10-July-2008
      * Tectonics: $ cocb -x linage.cob
      *            $ ./linage <filename ["linage.cob"]>
      *            $ cat -n mini-report
      ************************************************************
       IDENTIFICATION DIVISION.
       PROGRAM-ID. linage-demo.

       ENVIRONMENT DIVISION.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
           select optional data-file assign to file-name
               organization is line sequential
               file status is data-file-status.
           select mini-report assign to "mini-report".

       DATA DIVISION.
       FILE SECTION.
       FD  data-file.
       01  data-record.
           88 endofdata        value high-values.
           02 data-line         pic x(80).
       FD  mini-report
           linage is 16 lines
               with footing at 15
               lines at top 2
               lines at bottom 2.
       01  report-line          pic x(80).

       WORKING-STORAGE SECTION.
       01  command-arguments    pic x(1024).
       01  file-name            pic x(160).
       01  data-file-status     pic xx.
       01  lc                   pic 99.
       01  report-line-blank.
           02 filler            pic x(18) value all "*".
           02 filler            pic x(05) value spaces.
           02 filler            pic x(34)
              VALUE "THIS PAGE INTENTIONALLY LEFT BLANK".
           02 filler            pic x(05) value spaces.
           02 filler            pic x(18) value all "*".
       01  report-line-data.
           02 body-tag          pic 9(6).
           02 line-3            pic x(74).
       01  report-line-header.
           02 filler            pic x(6) VALUE "PAGE: ".
           02 page-no           pic 9999.
           02 filler            pic x(24).
           02 filler            pic x(5) VALUE " LC: ".
```

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```
           02 header-tag       pic 9(6).
           02 filler            pic x(23).
           02 filler            pic x(6) VALUE "DATE: ".
           02 page-date         pic x(6).

       01  page-count           pic 9999.

       PROCEDURE DIVISION.

       accept command-arguments from command-line end-accept.
       string
           command-arguments delimited by space
           into file-name
       end-string.
       if file-name equal spaces
           move "linage.cob" to file-name
       end-if.

       open input data-file.
       read data-file
           at end
               display "File: " function trim(file-name) " open error"
               go to early-exit
       end-read.

       open output mini-report.

       write report-line
           from report-line-blank
       end-write.

       move 1 to page-count.
       accept page-date from date end-accept.
       move page-count to page-no.
       write report-line
           from report-line-header
           after advancing page
       end-write.

       perform readwrite-loop until endofdata.

       display
           "Normal termination, file name: "
           function trim(file-name)
           " ending status: "
           data-file-status
       close mini-report.

      * Goto considered harmful?  Bah!  :)
       early-exit.
       close data-file.
       exit program.
       stop run.

      ******************************************************************
       readwrite-loop.
       move data-record to report-line-data
```

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```
       move linage-counter to body-tag
       write report-line from report-line-data
           end-of-page
               add 1 to page-count end-add
               move page-count to page-no
               move linage-counter to header-tag
               write report-line from report-line-header
                   after advancing page
               end-write
       end-write
       read data-file
           at end set endofdata to true
       end-read
       .

      ****************************************************************
      * Commentary
      * LINAGE is set at a 20 line logical page
      *  16 body lines
      *   2 top lines
      *   A footer line at 15 (inside the body count)
      *   2 bottom lines
      * Build with:
      * $ cobc -x -Wall -Wtruncate linage.cob
      * Evaluate with:
      * $ ./linage
      * This will read in linage.cob and produce a useless mini-report
      * $ cat -n mini-report
      ****************************************************************
       END PROGRAM linage-demo.
```

Using

```
$ ./linage except.cob
```

Produces a *mini-report* of:

```
******************     THIS PAGE INTENTIONALLY LEFT BLANK     ******************









PAGE: 0001                          LC: 000000                          DATE: 090206
```

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```
000001 IDENTIFICATION DIVISION.
000002 PROGRAM-ID. MINIPROG.
000003 ENVIRONMENT DIVISION.
000004 CONFIGURATION SECTION.
000005 SOURCE-COMPUTER. LINUX.
000006 OBJECT-COMPUTER. LINUX.
000007 SPECIAL-NAMES.
000008 INPUT-OUTPUT SECTION.
000009 FILE-CONTROL.
000010 SELECT PRINTFILE ASSIGN TO "XXRXWXX"
000011 FILE STATUS RXWSTAT.
000012 DATA DIVISION.
000013 FILE SECTION.
000014 FD PRINTFILE.




PAGE: 0002                        LC: 000015                        DATE: 090206
000001 01 PRINTREC PIC X(132).
000002 WORKING-STORAGE SECTION.
000003 01 RXWSTAT PIC XX.
000004 01 str     pic x(4).
000005 PROCEDURE DIVISION.
000006 A00-MAIN SECTION.
000007 001-MAIN-PROCEDURE.
000008 OPEN INPUT PRINTFILE.
000009 DISPLAY "File Status: " RXWSTAT.
000010 DISPLAY "EXCEPTION-FILE: " FUNCTION EXCEPTION-FILE.
000011 DISPLAY "Return Length: "
000012 FUNCTION LENGTH (FUNCTION EXCEPTION-FILE).
000013 DISPLAY "EXCEPTION-STATUS: " FUNCTION EXCEPTION-STATUS.
000014 DISPLAY "EXCEPTION-STATEMENT: " FUNCTION EXCEPTION-STATEMENT.




PAGE: 0003                        LC: 000015                        DATE: 090206
000001 STRING "TOOLONG" DELIMITED SIZE INTO RXWSTAT.
000002 DISPLAY "EXCEPTION-STATUS: " FUNCTION EXCEPTION-STATUS.
000003 DISPLAY "EXCEPTION-STATEMENT: " FUNCTION EXCEPTION-STATEMENT.
000004 DISPLAY "EXCEPTION-LOCATION: " FUNCTION EXCEPTION-LOCATION.
000005 STOP RUN.
```

See *except.cob* under the *FUNCTION EXCEPTION-STATUS* (page 457) entry.

4.1.316 LINAGE-COUNTER

An internal GnuCOBOL noun, or *Special Register*. Value is readonly and is maintained during WRITEs to files that have a *LINAGE* (page 314) clause. Useful for quick reports and logical page layouts.

4.1.317 LINE

- LINE *SEQUENTIAL* (page 396) files.
- Screen and Report section line control.

For `LINE SEQUENTIAL` files, the length of a read, and the length to write can be managed with an *FD* (page 260) clause.

```
FD testfile
    RECORD IS VARYING IN SIZE FROM 0 TO 132 CHARACTERS
    DEPENDING ON actual.
```

The programmer defined identifier **actual** can be pretty much any *NUMERIC* (page 328) type. It will be set after *READ* (page 359) and will determine the length to *WRITE* (page 433).

See *How do I get the length of a LINE SEQUENTIAL read?* (page 154) for more details.

`LINE` is also a keyword with extended *ACCEPT* (page 187), *DISPLAY* (page 248), with *SCREEN* (page 391) and *REPORT* (page 369) SECTION layouts, and descriptors.

```
ACCEPT identifier LINE NUMBER 10 POSITION NUMBER 20.
```

When using the condensed form of extended AT, the first two (or three) digits are LINE and the last two (or three) digits are COLUMN. *These literal values can be either four or six digits.*

```
DISPLAY "Text" AT 0203
DISPLAY "Text" AT 002101 WITH REVERSE-VIDEO
```

4.1.318 LINE-COUNTER

Special register for the Report Writer module.

4.1.319 LINES

- Screen section line control
- Screen occurs control
- and area scrolling
- Report Writer paging control

4.1.320 LINKAGE

A *SECTION* (page 394) in the *DATA* (page 241) DIVISION. Used for call frame data handling when the current run unit may not be in charge of the location of working storage. Defaults to uninitialized references which must be set with *USING* (page 429) in a CALL or explicitly with SET ADDRESS. References without initialization will cause an addressing segfault.

4.1.321 LOCAL-STORAGE

A *SECTION* (page 394) in the *DATA* (page 241) DIVISION. Data defined in local storage will be local to the running module and re-entrant within subprogram call trees.

4.1.322 LOCALE

Unsupported in GnuCOBOL 1.1pre-rel. Support added in 2.0

A *SPECIAL-NAMES* (page 410) entry giving GnuCOBOL an international flair.

```
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SPECIAL-NAMES.
    LOCALE spanish IS 'ES_es'.
```

4.1.323 LOCK

Record management.

```
SELECT filename-1 ASSIGN TO 'master.dat' LOCK MODE IS MANUAL.
```

4.1.324 LOW-VALUE

A figurative *ALPHABETIC* (page 197) constant, being the lowest character value in the *COLLATING* (page 228) sequence.

```
MOVE LOW-VALUE TO alphanumeric-1.

IF alphabetic-1 EQUALS LOW-VALUE
    DISPLAY "Failed validation"
END-IF.
```

It's invalid to *MOVE* (page 323) LOW-VALUE to a numeric field.

4.1.325 LOW-VALUES

A pluralized form of *LOW-VALUE* (page 319). Equivalent.

```
MOVE LOW-VALUES TO alphanumeric-1.
```

4.1.326 LOWER

Screen field attribute. Converting input to lower case.

4.1.327 LOWLIGHT

A screen attribute for DISPLAY and SCREEN SECTION fields.

```
SCREEN SECTION.
01 example.
    05 FILLER
        LINE 1 COLUMN 10
        VALUE IS "Example:"
        LOWLIGHT.
```

Will display the *Example:* legend in a dimmed video if supported with the current terminal settings.

4.1.328 MANUAL

LOCK MODE IS MANUAL WITH LOCK ON MULTIPLE RECORDS. See *AUTOMATIC* (page 210) and *EXCLUSIVE* (page 258) for more LOCK options.

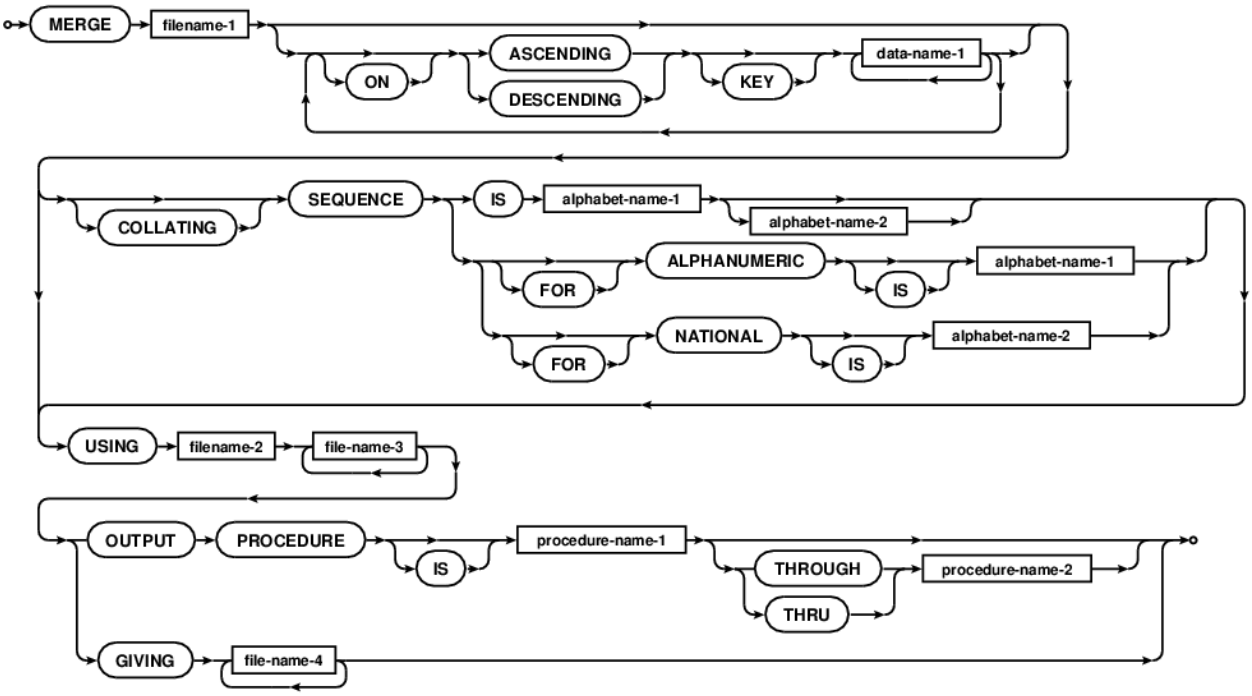
4.1.329 MEMORY

An OBJECT-COMPUTER clause.

```
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
OBJECT-COMPUTER.
MEMORY SIZE IS 8 CHARACTERS.
```

4.1.330 MERGE

Combines two or more identically sequenced files on a set of specified keys.




```
MERGE sort-file
    ON DESCENDING KEY key-field-1
    WITH DUPLICATES IN ORDER
    COLLATING SEQUENCE IS user-alphabet
    USING filename-1 filename-2
    GIVING filename-3
```

A more complete example, merging regional transaction files with those of HQ, in preparation for a batch run.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin
```

(continues on next page)

(continued from previous page)

```
      *> Date:      20140610
      *> Purpose:   Demonstrate a merge pass
      *> Tectonics: cobc -x gnucobol-merge-sample.cob
      *> ************************************************************
       identification division.
       program-id. gnucobol-merge-sample.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

files  input-output section.
       file-control.
           select master-file
               assign to "master-sample.dat"
               organization is line sequential.

           select eastern-transaction-file
               assign to "east-transact-sample.dat"
               organization is line sequential.

           select western-transaction-file
               assign to "west-transact-sample.dat"
               organization is line sequential.

           select merged-transactions
               assign to "merged-transactions.dat"
               organization is line sequential.

           select working-merge
               assign to "merge.tmp".

data   data division.
       file section.
       fd master-file.
          01 master-record     pic x(64).

       fd eastern-transaction-file.
          01 transact-rec      pic x(64).

       fd western-transaction-file.
          01 transact-rec      pic x(64).

       fd merged-transactions.
          01 new-rec           pic x(64).

       sd working-merge.
          01 merge-rec.
             02 master-key     pic 9(8).
             02 filler         pic x.
             02 action         pic xxx.
             02 filler         PIC x(52).

      *> ************************************************************
      *> not much code
      *>     trick.  DEP, CHQ, BAL are action keywords.  They sort
```

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```
      *>     descending as DEP, CHQ, BAL, so main can do all deposits,
      *>     then all withdrawals, then balance reports, for each id.
      *> ***************************************************************
code   procedure division.
       merge working-merge
           on ascending key master-key
              descending key action
           using eastern-transaction-file,
                 western-transaction-file,
                 master-file
           giving merged-transactions
done   goback.
       end program gnucobol-merge-sample.
```

Input data files (64 byte records, 8 character id, 3 character action) of `master-sample.dat`

```
11111111 BAL            critical corporate data
22222222 BAL            even more critical
33333333 BAL            big account this one
44444444 BAL            a smaller, but no less important account
```

and some regional files, `east-transact-sample.dat`

```
11111111 CHQ 0001111.11 withdrawal from account one
33333333 DEP 0333333.33 third of a million in, pocket change
33333333 CHQ 0000333.33 payroll
33333333 CHQ 0000333.33 payroll
33333333 CHQ 0000333.33 payroll
55555555 DEP 0000555.55 deposit to new record five
55555555 CHQ 0000055.55 withdrawal from account five
```

and `west-transact-sample.dat`

```
11111111 CHQ 0001111.11 withdrawal from account one
44444444 DEP 0000044.44 deposit to account four
66666666 BAL            balance request for account six
```

giving a new night run tranasction file, `merged-transactions.dat`.

```
$ cobc -x gnucobol-merge-sample.cob  -g -debug
$ COB_SET_TRACE=YES ./gnucobol-merge-sample
Source:     'gnucobol-merge-sample.cob'
Program-Id: gnucobol-merge-sample Entry:     gnucobol-merge-sample  Line: 64
Program-Id: gnucobol-merge-sample Section:   (None)                 Line: 64
Program-Id: gnucobol-merge-sample Paragraph: (None)                 Line: 64
Program-Id: gnucobol-merge-sample Statement: MERGE                  Line: 64
Program-Id: gnucobol-merge-sample Statement: GOBACK                 Line: 70
Program-Id: gnucobol-merge-sample Exit:      gnucobol-merge-sample
```

and

```
$ cat merged-transactions.dat
11111111 CHQ 0001111.11 withdrawal from account one
11111111 CHQ 0001111.11 withdrawal from account one
11111111 BAL            critical corporate data
22222222 BAL            even more critical
```

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```
33333333 DEP 0333333.33 third of a million in, pocket change
33333333 CHQ 0000333.33 payroll
33333333 CHQ 0000333.33 payroll
33333333 CHQ 0000333.33 payroll
33333333 BAL            big account this one
44444444 DEP 0000044.44 deposit to account four
44444444 BAL            a smaller, but no less important account
55555555 DEP 0000555.55 deposit to new record five
55555555 CHQ 0000055.55 withdrawal from account five
66666666 BAL            balance request for account six
```

- The merged transaction file will be created each time.
- *The MERGE verb will not complain if some input files are not found.*

4.1.331 MESSAGE

Unsupported Communication Section clause.

4.1.332 METHOD

Unsupported Object COBOL feature.

4.1.333 METHOD-ID

Unsupported Object COBOL feature.

4.1.334 MINUS

Screen section relative line and column control. *Relative to last fixed line or column given in layout. Two fields in a row, at minus 8, will be aligned, not offset from each other.*

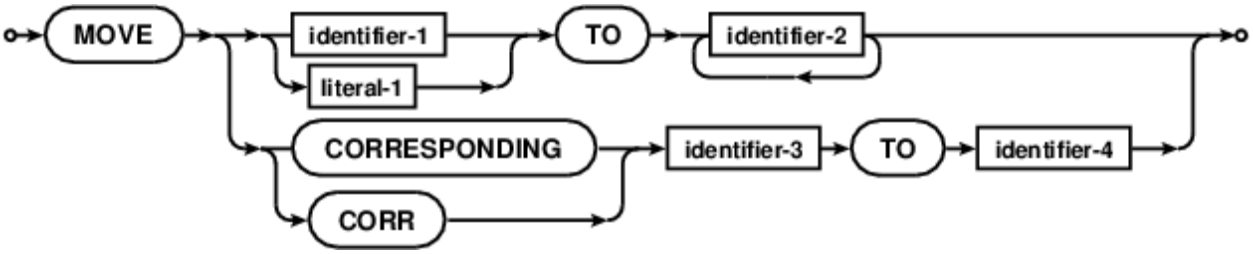
```
05 some-field pic x(16)
    line number is plus 1
    column number is minus 8
```

4.1.335 MODE

Locking mode. See *MANUAL* (page 320), *AUTOMATIC* (page 210), *EXCLUSIVE* (page 258).

4.1.336 MOVE

A workhorse of the COBOL paradigm. MOVE is a highly flexible, intelligent, safe, and sometimes perplexing data movement verb.




```
01 alphanum-3              PIC XXX.
01 num2                    PIC 99.

MOVE "ABCDEFG" TO xvar3
DISPLAY xvar3

MOVE 12345 TO num2
DISPLAY num2
```

displays:

```
ABC
45
```

Note the 45, MOVE uses a right to left rule when moving numerics, high digits are truncated, not low digits. A left to right rule is used when moving character data.

Entire groups (of similarily named sub items) can be moved with

```
MOVE CORRESPONDING ident-1 TO ident-2
```

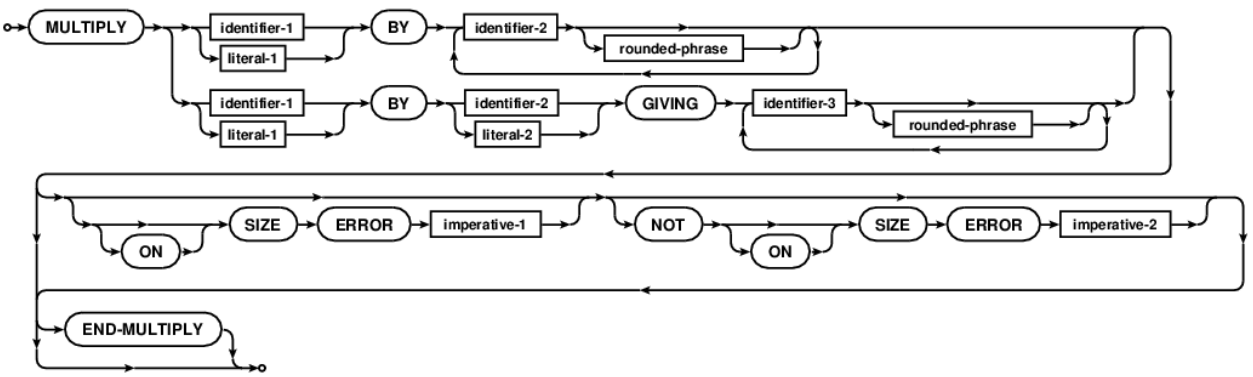
only the group items of the same name (and relative hierarchy level) will be transferred from the ident-1 group to the ident-2 fields.

4.1.337 MULTIPLE

```
LOCK MODE IS MANUAL WITH LOCK ON MULTIPLE RECORDS.
```

4.1.338 MULTIPLY

A standard mathematics operation. Overflow and otherwise untrustable results can be handled with an `ON SIZE ERROR` phrase. COBOL will silently allow size errors (leaving any receiving fields with previous values) if the phrase is not used. The responsibility for managing unreliable results is placed in the hands of the application programmer.



```
MULTIPLY var-1 BY var-2 GIVING var-3
    ON SIZE ERROR
        SET invalid-result TO TRUE
END-MULTIPLY
```

4.1.339 NAME

An *ACCEPT* (page 187) source for accessing login user names.

```
ACCEPT username FROM USER NAME.
```

4.1.340 NATIONAL

NATIONAL character usage. Not yet supported. GnuCOBOL does support PICTURE N.

4.1.341 NATIONAL-EDITED

Category.

4.1.342 NATIVE

An *ALPHABET* (page 196). Most mainframes are *EBCDIC* (page 251), and most other systems are *ASCII* (page 207). Most of this document assumes ASCII coding conventions. With a reasonable amount of diligence, GnuCOBOL programs can be written to perform correctly running under any native platform character set.

4.1.343 NEAREST-AWAY-FROM-ZERO

A *ROUNDED* (page 386) *MODE* (page 323). `NEAREST-AWAY-FROM-ZERO` is the GnuCOBOL, *(and COBOL 2014 standard)* default when only the keyword `ROUNDED`, without `MODE`, is specified.

NEAREST-AWAY-FROM-ZERO	+2.49	-2.49	+2.50	-2.50	+3.49	-3.49	+3.50	-3.50	+3.51	-3.51
Becomes	+2	-2	+3	-3	+3	-3	+4	-4	+4	-4

4.1.344 NEAREST-EVEN

A *ROUNDED* (page 386) *MODE* (page 323). `NEAREST-EVEN` is commonly referred to as *Banker's rounding*. An alternating system where 2.5 rounds down to 2, and 3.5 rounds up to 4.

NEAREST-EVEN	+2.49	-2.49	+2.50	-2.50	+3.49	-3.49	+3.50	-3.50	+3.51	-3.51
Becomes	+2	-2	+2	-2	+3	-3	+4	-4	+4	-4

4.1.345 NEAREST-TOWARD-ZERO

A *ROUNDED* (page 386) *MODE* (page 323). Positive values round downward, negative values round upward.

NEAREST-TOWARD-ZERO	+2.49	-2.49	+2.50	-2.50	+3.49	-3.49	+3.50	-3.50	+3.51	-3.51
Becomes	+2	-2	+2	-2	+3	-3	+3	-3	+4	-4

4.1.346 NEGATIVE

Conditional expression.

```
IF a IS NEGATIVE
    SET in-the-red TO TRUE
END-IF
```

4.1.347 NESTED

An unsupported program-prototype CALL clause.

4.1.348 NEXT

- With *READ* (page 359), to read the next record, possibly by *KEY* (page 311).
- Also an obsolete, but supported, control flow verb with `NEXT SENTENCE`.

```
READ index-sequential-file NEXT RECORD INTO ident-1

IF condition-1
    NEXT SENTENCE
ELSE
    PERFORM do-something.
```

NEXT SENTENCE

Think of `NEXT SENTENCE` as "go look ahead for a full stop source code period, and jump past it" flow control. *CONTINUE* (page 236) is a smarter, inner structure friendly, "jump out a level - usually by doing nothing" flow control mechanism. *Many of the samples in this document are single sentence programs, and NEXT SENTENCE doesn't really apply with that style.*

4.1.349 NO

Specify NO locks, NO sharing, NO rewind, NO carriage return.

```
CLOSE filename-1 WITH NO REWIND

READ file-1 WITH NO LOCK

DISPLAY field-1 WITH NO ADVANCING
```

4.1.350 NO-ECHO

Screen field attribute, alias for *SECURE* (page 394), intended for passwords or other sensitive data input.

4.1.351 NONE

Unsupported *DEFAULT* (page 244) IS NONE.

4.1.352 NORMAL

Program return control

```
STOP RUN WITH NORMAL STATUS status-val
```

See *ERROR* (page 256)

4.1.353 NOT

Conditional negation. See *AND* (page 204), *OR* (page 335). Also used in operational conditional expressions such as NOT ON SIZE ERROR, *in which case, the conditional statements can trust that the operation was sound, not overflowing the receiving data field.*

```
IF NOT production
    CALL "test-thing"
        NOT ON EXCEPTION
            DISPLAY "Linkage to thing, OK, called"
    END-CALL
END-IF
```

4.1.354 NOTHING

A GnuCOBOL extension for *CALL* (page 219) *RETURNING* (page 381). It assumes a void response and does not effect the previous value of *RETURN-CODE*.

OMITTED resets `RETURN-CODE` to zero.

```
CALL "func" RETURNING NOTHING
```

4.1.355 NULL

Represents a zero address in a pointer. A symbolic literal.

```
SET ADDRESS OF based-var TO NULL

IF ptr EQUAL NULL
    DISPLAY "ptr not valid"
END-IF
```

NULL is not LOW-VALUE.

It is also not *nothing*. **Don't do this**, *I have mistakenly used*

```
CALL "thing" RETURNING NULL END-CALL
```

when meaning ‘‘void‘‘ return. **It’s wrong**. It’s

```
CALL "thing" RETURNING OMITTED END-CALL
```

Please note.

```
MOVE CONCATENATE(TRIM(cbl-string TRAILING) NULL) TO c-string
```

is wrong as well, and is not the same as

```
MOVE CONCATENATE(TRIM(cbl-string TRAILING) LOW-VALUE) TO c-string
```

or a literal ‘‘x”00”‘‘ for LOW-VALUE. NULL is a pointer content type, not really a value. It can be referenced

```
CALL "c-function" USING NULL
```

is good code. NULL can’t be dereferenced

```
CALL "c-function" USING BY VALUE NULL
```

is invalid code, and it won’t compile.

4.1.356 NULLS

Plural of *NULL* (page 327).

```
MOVE ALL NULLS TO var-space
```

4.1.357 NUMBER

Screen section *LINE* (page 318) *COLUMN* (page 228) control.

```
05 some-field pic x(16) LINE NUMBER 5.
```

4.1.358 NUMBER-OF-CALL-PARAMETERS

Predefined special register for use in subprograms.

4.1.359 NUMBERS

Plural of *NUMBER* (page 328).

4.1.360 NUMERIC

- Category-name and category test.
- Linkage data clause for ANY NUMERIC

```
if NUMERIC '20140101' then
    display 'only numbers'
end-if

if NUMERIC '2014010a' then
    display 'only numbers'
end-if
```

The first tests true, and the second does not.

GnuCOBOL 2.0 and above supports a data clause that is the equivalent of *ANY LENGTH* for numbers.

```
*> Tectonics: cobc -xj any-numeric-sample.cob
 identification division.
 program-id. any-numeric.
 author. Brian Tiffin.
 date-written. 2015-12-15/01:08-0500.
 date-modified. 2015-12-15/22:45-0500.
 date-compiled.
 installation. Requires GnuCOBOL 2 or greater.
 remarks. Demonstrate ANY NUMERIC in linkage items.

 environment division.
 configuration section.
 repository.
     function variant-size
     function all intrinsic.

 data division.
 working-storage section.
 01 the-first-number   pic 9(5)  value 42.
 01 the-second-number  pic 9(30) value 42.
 01 the-third-number   pic 99    value 42.
 01 what-size          usage binary-long.

 procedure division.

 move variant-size(the-first-number) to what-size
 perform show-result

 move variant-size(the-second-number) to what-size
 perform show-result

 move variant-size(the-third-number) to what-size
 perform show-result

 goback.

 show-result.
 display "Length  : " what-size
 .

 end program any-numeric.
*> ****************************************************************

 identification division.
 function-id. variant-size.
```

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```
 data division.
 linkage section.
 01 a-number           pic 9 any numeric.
 01 what-size          usage binary-long.

 procedure division using a-number returning what-size.

 display "Received: " a-number
 move function length(a-number) to what-size

 goback.
 end function variant-size.
```

And a run sample of:

```
prompt$ cobc -xj any-numeric-sample.cob
Received: 00042
Length  : +0000000005
Received: 00000000000000000000000000000042
Length  : +0000000030
Received: 42
Length  : +0000000002
```

4.1.361 NUMERIC-EDITED

Category-name.

```
INITIALIZE data-record REPLACING NUMERIC-EDITED BY literal-value
```

4.1.362 OBJECT

Unsupported Object COBOL feature.

4.1.363 OBJECT-COMPUTER

Environment division, configuration section run-time machine paragraph.

GnuCOBOL supports

```
GCobol identification division.
       program-id. runtime-computer.

       environment division.
       configuration section.
       object-computer.
           memory size is 8 characters
           program collating sequence is bigiron-alphabet
           segment-limit is 64
           character classificiation is spanish-locale.
       special-names.
           alphabet bigiron-alphabet is ebcdic
           symbolic characters BS  is  9
```

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```
                                TAB is 10
                                LF  is 11
                            NEWLINE is 11
                                CMA is 45
          locale spanish-locale is "es_ES".
      repository.
          function all intrinsic.
```

4.1.364 OBJECT-REFERENCE

Unsupported Object COBOL feature.

4.1.365 OCCURS

Controls multiple occurrences of data structures, allowing for arrays, commonly called "tables" in COBOL. All tables use 1 relative indexing, there is no element 0 in COBOL *but there can a zero in the* `depending on` variable.

```
01 days-in-week.
   05 day-name  pic x(9) occurs 7 times.
   05 day-names redefines day-name.
      10 value "Sunday   ".
      10 value "Monday   ".
      10 value "Tuesday  ".
      10 value "Wednesday".
      10 value "Thursday ".
      10 value "Friday   ".
      10 value "Saturday ".

01 main-table.
   05 main-record occurs 1 to 366 times depending on the-day-in-year.
      10 main-field pic x occurs from 1 to 132 times depending on the-len.

...

display trim(day-name(weekday)) ":"
move data-size-from-read to the-len
display main-record(what-day)
```

Would display a day by name (assuming the first day being Sunday), and then a `main-record` with the contained `main-field` limited to a given length.

4.1.366 OF

A data structure reference and name conflict resolution qualifier. Also a critical keyword to disambiguate *FUNCTION LENGTH* from the *LENGTH OF* phrases.

Synonym for *IN* (page 297) in many cases.

```
MOVE "abc" TO the-field OF the-record IN the-structure
```

`OF` also takes on a lexical role for the LENGTH clause as there is a conflict from this existent extension and the intrinsic function:

```
environment division.
configuration section.
repository.
    function all intrinsic

01 some-field         pic x(80).
01 some-len           constant as LENGTH OF some-field.
01 other-field        pic x(some-len).

DISPLAY LENGTH OF other-field
DISPLAY LENGTH(other-field)
```

In the above, `LENGTH OF` can be used at compile time and run time. `FUNCTION LENGTH` is run time only. The `OF` is mandatory for `LENGTH OF` to allow `FUNCTION LENGTH(item)` to be used without the `FUNCTION` keyword.

4.1.367 OFF

A control status and setting for an external switch. See *ON* (page 333).

```
SPECIAL-NAMES.
    SWITCH-1 IS mainframe
        ON STATUS IS bigiron
        OFF STATUS IS pc

...

SET mainframe TO OFF
```

4.1.368 OMITTED

Allows for:

- placeholders in call frames, see *OPTIONAL* (page 334)
- testing for explicitly omitted parameters
- specifying omitted label records
- and void returns for *CALL* (page 219)
- PROCEDURE DIVISION RETURNING OMITTED generates subprograms with `void` returns. *A GnuCOBOL extension.*
- a console ACCEPT placeholder to await a terminating read without using working store

OMITTED with CALL arguments is only allowed with BY *REFERENCE* (page 362) data.

```
CALL "thing" USING
    BY REFERENCE string-var
    BY VALUE number-var
    BY REFERENCE OMITTED
    GIVING NULL
END-CALL

...

PROGRAM-ID. thing.
```

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```
DATA DIVISION.
WORKING-STORAGE SECTION.
77 default-float usage float-long.

LINKAGE-SECTION.
77 string-var pic x(80).
77 number-var pic 9(8).
77 float-var usage float-long.

PROCEDURE DIVISION
    USING
        BY REFERENCE OPTIONAL string-var
        BY VALUE number-var
        BY REFERENCE OPTIONAL float-var
    RETURNING OMITTED.

IF float-var IS OMITTED
    SET ADDRESS OF float-var TO ADDRESS OF default-float
END-IF
```

For ACCEPT, it can be used to wait for user input of the Press Enter to continue variety.

```
DISPLAY "Tap Enter to continue"
ACCEPT OMITTED
```

4.1.369 ON

Turn on a switch. See *OFF* (page 332).

```
SPECIAL-NAMES.
    SWITCH-1 IS mainframe
        ON STATUS IS bigiron
        OFF STATUS IS pc

...

>>DEFINE IS-BIG PARAMETER
>>IF IS-BIG IS DEFINED

SET mainframe TO ON

>>END-IF
```

Debug control

```
USE FOR DEBUGGING ON ALL PROCEDURES
```

Starts conditional clause.

- [NOT] ON EXCEPTION
- [NOT] ON SIZE ERROR

```
ADD 1 TO wafer-thin-mint
    ON SIZE ERROR
```

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```
        SET get-a-bucket TO TRUE
END-ADD
```

Sets a size limiting index on a table

```
table
       01 wordlist             based.
          05 word-table occurs 0 to maxwords times
              depending ON wordcount
              descending key is wordstr
              indexed by wl-index.
             10 wordstr        pic x(20).
             10 wordline       usage binary-long.
```

See *SIZE* (page 402), *EXCEPTION* (page 257), *AT* (page 209).

4.1.370 ONLY

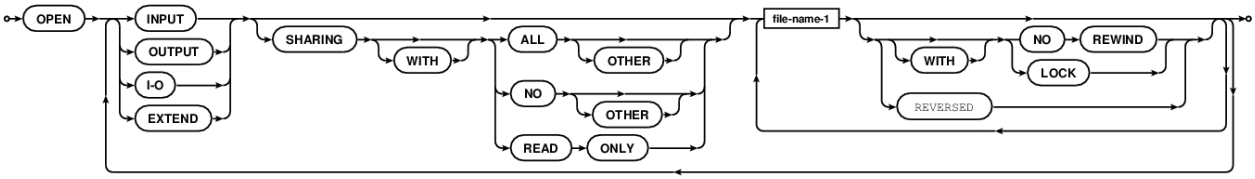
Sharing control.

```
SELECT file-name-1
  ASSIGN TO "actual-name"
  SHARING WITH READ ONLY
```

ONLY is also an unsupported Object COBOL *FACTORY* (page 260) phrase.

4.1.371 OPEN

Opens a file selector.



Modes include

- *INPUT* (page 303)
- *OUTPUT* (page 337)
- *I-O* (page 296)
- *EXTEND* (page 258)

May be *OPTIONAL* (page 334) in the *FD* (page 260).

```
OPEN INPUT SHARING WITH ALL OTHER infile
OPEN EXTEND SHARING WITH NO OTHER myfile
```

4.1.372 OPTIONAL

- Allows for referencing non-existent files.

- Allows for optionally *OMITTED* (page 332) call arguments.

Code below shows optional file open and optional CALL arguments.

```
ENVIRONMENT DIVISION.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
    SELECT OPTIONAL nofile ASSIGN TO "file.not"
           ORGANIZATION IS LINE SEQUENTIAL.

...

DATA DIVISION.
LINKAGE SECTION.
77 arg PIC 99.

PROCEDURE DIVISION USING OPTIONAL arg

OPEN INPUT nofile
CLOSE nofile

IF arg IS OMITTED OR NOT NUMERIC
    MOVE 0 TO RETURN-CODE
ELSE
    MOVE arg TO RETURN-CODE
END-IF
GOBACK.
```

The use of OPTIONAL in a SELECT statement can be important when input files may not exist. Without the OPTIONAL phrase, processing will halt during OPEN INPUT, which may *or may not* be a useful behaviour.

4.1.373 OPTIONS

A paragraph of the *IDENTIFICATION* (page 296) division. Currently supports *ENTRY-CONVENTION* (page 255) and DEFAULT *ROUNDED* (page 386) program wide settings.

```
IDENTIFICATION DIVISION.
PROGRAM-ID. sample.

OPTIONS.
    ENTRY-CONVENTION IS EXTERN
    DEFAULT ROUNDED MODE IS NEAREST-EVEN.
```

4.1.374 OR

Logical operation. See *AND* (page 204), *NOT* (page 327). GnuCOBOL supports COBOL's logical expression shortcuts. Order of precedence can be controlled with parenthesis, and default to NOT, AND, OR, right to left.

```
IF A EQUAL 1 OR 2 OR 3 OR 5
    DISPLAY "FORE!"
END-IF
```

Be careful with NOT OR, it might not do what a quick glance makes it seem.

```
MOVE 1 to A
IF A NOT EQUAL 1 OR 2
    DISPLAY "NOT 1 OR 2 (unexpected?)"
END-IF
```

Will display `NOT 1 OR 2 (unexpected?)`. *All* values are (not equal to 1) OR (not equal to 2), including 1 and 2.

1 tests true in that case, not being 2. And 2 tests true, not being 1. Same for 3, 4, and all numbers. Use NOT AND instead, if you really need to use shortform logicals, or write it as NOT (A = 1 OR 2).

4.1.375 ORDER

Sort clause to influence how duplicates are managed.

```
sort sort-work
    ascending key work-rec with duplicates in order
    using  sort-in
    giving sort-out.
```

In 1.1pre-rel, WITH DUPLICATES IN ORDER is a default.

4.1.376 ORGANISATION

Alternate spelling for *ORGANIZATION* (page 336).

4.1.377 ORGANIZATION

Defines a file's storage organization. One of

- *INDEXED* (page 297)
- *RELATIVE* (page 363)
- *SEQUENTIAL* (page 396)
- GnuCOBOL also supports a *LINE SEQUENTIAL* (page 1321) structure.

4.1.378 OTHER

File sharing option, ALL OTHER, NO OTHER.

EVALUATE (page 257)'s else clause.

```
GCobol*> Here be dragons <*
       EVALUATE TRUE
           WHEN a IS 1
               PERFORM paragraph-1
           WHEN OTHER
               ALTER paragraph-1 TO paragraph-2
               PERFORM paragraph-3
       END-EVALUATE
```

4.1.379 OUTPUT

- File *OPEN* (page 334) mode.
- Procedure named in *SORT* (page 403)

```
sort sort-work
    on descending key work-rec
    collating sequence is mixed
    input procedure is sort-transform
    output procedure is output-uppercase.
```

4.1.380 OVERFLOW

Conditional clause for *STRING* (page 414) and *UNSTRING* (page 426) that will trigger on space overflow conditions.

4.1.381 OVERLINE

A display control for *SCREEN* (page 391) section fields, placing a horizontal line over the input field.

4.1.382 OVERRIDE

Unsupported Object COBOL METHOD-ID clause.

4.1.383 PACKED-DECIMAL

Numeric *USAGE* (page 427) clause, equivalent to *COMPUTATIONAL-3* (page 232). Holds each digit in a 4-bit field.

From the opencobol-2.0 tarball testsuite

```
GCobol >>SOURCE FORMAT IS FIXED

       IDENTIFICATION   DIVISION.
       PROGRAM-ID.      prog.
       DATA             DIVISION.
       WORKING-STORAGE  SECTION.
       01 G-1.
         02 X-1         PIC 9(1) VALUE 1                PACKED-DECIMAL.
         02 FILLER      PIC X(18) VALUE SPACE.
       01 G-2.
         02 X-2         PIC 9(2) VALUE 12               PACKED-DECIMAL.
         02 FILLER      PIC X(18) VALUE SPACE.
       01 G-3.
         02 X-3         PIC 9(3) VALUE 123              PACKED-DECIMAL.
         02 FILLER      PIC X(18) VALUE SPACE.
       01 G-4.
         02 X-4         PIC 9(4) VALUE 1234             PACKED-DECIMAL.
         02 FILLER      PIC X(18) VALUE SPACE.
       01 G-5.
         02 X-5         PIC 9(5) VALUE 12345            PACKED-DECIMAL.
         02 FILLER      PIC X(18) VALUE SPACE.
       01 G-6.
         02 X-6         PIC 9(6) VALUE 123456           PACKED-DECIMAL.
```

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```
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-7.
           02 X-7          PIC 9(7) VALUE 1234567           PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-8.
           02 X-8          PIC 9(8) VALUE 12345678          PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-9.
           02 X-9          PIC 9(9) VALUE 123456789         PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-10.
           02 X-10         PIC 9(10) VALUE 1234567890       PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-11.
           02 X-11         PIC 9(11) VALUE 12345678901      PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-12.
           02 X-12         PIC 9(12) VALUE 123456789012     PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-13.
           02 X-13         PIC 9(13) VALUE 1234567890123    PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-14.
           02 X-14         PIC 9(14) VALUE 12345678901234   PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-15.
           02 X-15         PIC 9(15) VALUE 123456789012345  PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-16.
           02 X-16         PIC 9(16) VALUE 1234567890123456 PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-17.
           02 X-17         PIC 9(17) VALUE 12345678901234567
                                                           PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-18.
           02 X-18         PIC 9(18) VALUE 123456789012345678
                                                           PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S1.
           02 X-S1         PIC S9(1) VALUE -1               PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S2.
           02 X-S2         PIC S9(2) VALUE -12              PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S3.
           02 X-S3         PIC S9(3) VALUE -123             PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S4.
           02 X-S4         PIC S9(4) VALUE -1234            PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S5.
           02 X-S5         PIC S9(5) VALUE -12345           PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S6.
           02 X-S6         PIC S9(6) VALUE -123456          PACKED-DECIMAL.
           02 FILLER       PIC X(18) VALUE SPACE.
```

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```
       01 G-S7.
         02 X-S7         PIC S9(7) VALUE -1234567         PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S8.
         02 X-S8         PIC S9(8) VALUE -12345678        PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S9.
         02 X-S9         PIC S9(9) VALUE -123456789       PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S10.
         02 X-S10        PIC S9(10) VALUE -1234567890     PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S11.
         02 X-S11        PIC S9(11) VALUE -12345678901    PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S12.
         02 X-S12        PIC S9(12) VALUE -123456789012   PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S13.
         02 X-S13        PIC S9(13) VALUE -1234567890123  PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S14.
         02 X-S14        PIC S9(14) VALUE -12345678901234 PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S15.
         02 X-S15        PIC S9(15) VALUE -123456789012345
                                                          PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S16.
         02 X-S16        PIC S9(16) VALUE -1234567890123456
                                                          PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S17.
         02 X-S17        PIC S9(17) VALUE -12345678901234567
                                                          PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.
       01 G-S18.
         02 X-S18        PIC S9(18) VALUE -123456789012345678
                                                          PACKED-DECIMAL.
         02 FILLER       PIC X(18) VALUE SPACE.

       PROCEDURE        DIVISION.
      *>   Dump all values <*
           DISPLAY
               "PACKED-DECIMAL, 1, 12, 123,"
           END-DISPLAY
           DISPLAY
               " ..., 123456789012345678"
           END-DISPLAY
           CALL "dump" USING G-1 END-CALL.
           CALL "dump" USING G-2 END-CALL.
           CALL "dump" USING G-3 END-CALL.
           CALL "dump" USING G-4 END-CALL.
           CALL "dump" USING G-5 END-CALL.
           CALL "dump" USING G-6 END-CALL.
           CALL "dump" USING G-7 END-CALL.
           CALL "dump" USING G-8 END-CALL.
```

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```
           CALL "dump" USING G-9 END-CALL.
           CALL "dump" USING G-10 END-CALL.
           CALL "dump" USING G-11 END-CALL.
           CALL "dump" USING G-12 END-CALL.
           CALL "dump" USING G-13 END-CALL.
           CALL "dump" USING G-14 END-CALL.
           CALL "dump" USING G-15 END-CALL.
           CALL "dump" USING G-16 END-CALL.
           CALL "dump" USING G-17 END-CALL.
           CALL "dump" USING G-18 END-CALL.

           DISPLAY SPACE END-DISPLAY
           DISPLAY
               "PACKED-DECIMAL, -1, -12, -123,"
           END-DISPLAY
           DISPLAY
               " ..., -12345789012345678"
           END-DISPLAY
           CALL "dump" USING G-S1 END-CALL.
           CALL "dump" USING G-S2 END-CALL.
           CALL "dump" USING G-S3 END-CALL.
           CALL "dump" USING G-S4 END-CALL.
           CALL "dump" USING G-S5 END-CALL.
           CALL "dump" USING G-S6 END-CALL.
           CALL "dump" USING G-S7 END-CALL.
           CALL "dump" USING G-S8 END-CALL.
           CALL "dump" USING G-S9 END-CALL.
           CALL "dump" USING G-S10 END-CALL.
           CALL "dump" USING G-S11 END-CALL.
           CALL "dump" USING G-S12 END-CALL.
           CALL "dump" USING G-S13 END-CALL.
           CALL "dump" USING G-S14 END-CALL.
           CALL "dump" USING G-S15 END-CALL.
           CALL "dump" USING G-S16 END-CALL.
           CALL "dump" USING G-S17 END-CALL.
           CALL "dump" USING G-S18 END-CALL.

           DISPLAY SPACE END-DISPLAY.
           DISPLAY
               "PACKED-DECIMAL, 1, 12, 123,"
           END-DISPLAY.
           DISPLAY
               " ..., 123456789012345678"
               " after subfield INITIALIZE"
           END-DISPLAY.
           INITIALIZE X-1 ALL TO VALUE.
           CALL "dump" USING G-1 END-CALL.
           INITIALIZE X-2 ALL TO VALUE.
           CALL "dump" USING G-2 END-CALL.
           INITIALIZE X-3 ALL TO VALUE.
           CALL "dump" USING G-3 END-CALL.
           INITIALIZE X-4 ALL TO VALUE.
           CALL "dump" USING G-4 END-CALL.
           INITIALIZE X-5 ALL TO VALUE.
           CALL "dump" USING G-5 END-CALL.
           INITIALIZE X-6 ALL TO VALUE.
           CALL "dump" USING G-6 END-CALL.
```

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```
           INITIALIZE X-7 ALL TO VALUE.
           CALL "dump" USING G-7 END-CALL.
           INITIALIZE X-8 ALL TO VALUE.
           CALL "dump" USING G-8 END-CALL.
           INITIALIZE X-9 ALL TO VALUE.
           CALL "dump" USING G-9 END-CALL.
           INITIALIZE X-10 ALL TO VALUE.
           CALL "dump" USING G-10 END-CALL.
           INITIALIZE X-11 ALL TO VALUE.
           CALL "dump" USING G-11 END-CALL.
           INITIALIZE X-12 ALL TO VALUE.
           CALL "dump" USING G-12 END-CALL.
           INITIALIZE X-13 ALL TO VALUE.
           CALL "dump" USING G-13 END-CALL.
           INITIALIZE X-14 ALL TO VALUE.
           CALL "dump" USING G-14 END-CALL.
           INITIALIZE X-15 ALL TO VALUE.
           CALL "dump" USING G-15 END-CALL.
           INITIALIZE X-16 ALL TO VALUE.
           CALL "dump" USING G-16 END-CALL.
           INITIALIZE X-17 ALL TO VALUE.
           CALL "dump" USING G-17 END-CALL.
           INITIALIZE X-18 ALL TO VALUE.
           CALL "dump" USING G-18 END-CALL.

           DISPLAY SPACE END-DISPLAY.
           DISPLAY
               "PACKED-DECIMAL, -1, -12, -123,"
           END-DISPLAY.
           DISPLAY
               " ..., -123456789012345678"
               " after subfield INITIALIZE"
           END-DISPLAY.
           INITIALIZE X-S1 ALL TO VALUE.
           CALL "dump" USING G-S1 END-CALL.
           INITIALIZE X-S2 ALL TO VALUE.
           CALL "dump" USING G-S2 END-CALL.
           INITIALIZE X-S3 ALL TO VALUE.
           CALL "dump" USING G-S3 END-CALL.
           INITIALIZE X-S4 ALL TO VALUE.
           CALL "dump" USING G-S4 END-CALL.
           INITIALIZE X-S5 ALL TO VALUE.
           CALL "dump" USING G-S5 END-CALL.
           INITIALIZE X-S6 ALL TO VALUE.
           CALL "dump" USING G-S6 END-CALL.
           INITIALIZE X-S7 ALL TO VALUE.
           CALL "dump" USING G-S7 END-CALL.
           INITIALIZE X-S8 ALL TO VALUE.
           CALL "dump" USING G-S8 END-CALL.
           INITIALIZE X-S9 ALL TO VALUE.
           CALL "dump" USING G-S9 END-CALL.
           INITIALIZE X-S10 ALL TO VALUE.
           CALL "dump" USING G-S10 END-CALL.
           INITIALIZE X-S11 ALL TO VALUE.
           CALL "dump" USING G-S11 END-CALL.
           INITIALIZE X-S12 ALL TO VALUE.
           CALL "dump" USING G-S12 END-CALL.
```

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```
           INITIALIZE X-S13 ALL TO VALUE.
           CALL "dump" USING G-S13 END-CALL.
           INITIALIZE X-S14 ALL TO VALUE.
           CALL "dump" USING G-S14 END-CALL.
           INITIALIZE X-S15 ALL TO VALUE.
           CALL "dump" USING G-S15 END-CALL.
           INITIALIZE X-S16 ALL TO VALUE.
           CALL "dump" USING G-S16 END-CALL.
           INITIALIZE X-S17 ALL TO VALUE.
           CALL "dump" USING G-S17 END-CALL.
           INITIALIZE X-S18 ALL TO VALUE.
           CALL "dump" USING G-S18 END-CALL.

           DISPLAY SPACE END-DISPLAY.
           DISPLAY
               "PACKED-DECIMAL, 1, 12, 123,"
           END-DISPLAY.
           DISPLAY
               " ..., 123456789012345678"
               " after subfield ZERO"
           END-DISPLAY.
           MOVE ZERO TO X-1.
           CALL "dump" USING G-1 END-CALL.
           MOVE ZERO TO X-2.
           CALL "dump" USING G-2 END-CALL.
           MOVE ZERO TO X-3.
           CALL "dump" USING G-3 END-CALL.
           MOVE ZERO TO X-4.
           CALL "dump" USING G-4 END-CALL.
           MOVE ZERO TO X-5.
           CALL "dump" USING G-5 END-CALL.
           MOVE ZERO TO X-6.
           CALL "dump" USING G-6 END-CALL.
           MOVE ZERO TO X-7.
           CALL "dump" USING G-7 END-CALL.
           MOVE ZERO TO X-8.
           CALL "dump" USING G-8 END-CALL.
           MOVE ZERO TO X-9.
           CALL "dump" USING G-9 END-CALL.
           MOVE ZERO TO X-10.
           CALL "dump" USING G-10 END-CALL.
           MOVE ZERO TO X-11.
           CALL "dump" USING G-11 END-CALL.
           MOVE ZERO TO X-12.
           CALL "dump" USING G-12 END-CALL.
           MOVE ZERO TO X-13.
           CALL "dump" USING G-13 END-CALL.
           MOVE ZERO TO X-14.
           CALL "dump" USING G-14 END-CALL.
           MOVE ZERO TO X-15.
           CALL "dump" USING G-15 END-CALL.
           MOVE ZERO TO X-16.
           CALL "dump" USING G-16 END-CALL.
           MOVE ZERO TO X-17.
           CALL "dump" USING G-17 END-CALL.
           MOVE ZERO TO X-18.
           CALL "dump" USING G-18 END-CALL.
```

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```
           DISPLAY SPACE END-DISPLAY.
           DISPLAY
               "PACKED-DECIMAL, -1, -12, -123,"
           END-DISPLAY.
           DISPLAY
               " ..., -12345678901234567 8"
               " after subfield ZERO"
           END-DISPLAY.
           MOVE ZERO TO X-S1.
           CALL "dump" USING G-S1 END-CALL.
           MOVE ZERO TO X-S2.
           CALL "dump" USING G-S2 END-CALL.
           MOVE ZERO TO X-S3.
           CALL "dump" USING G-S3 END-CALL.
           MOVE ZERO TO X-S4.
           CALL "dump" USING G-S4 END-CALL.
           MOVE ZERO TO X-S5.
           CALL "dump" USING G-S5 END-CALL.
           MOVE ZERO TO X-S6.
           CALL "dump" USING G-S6 END-CALL.
           MOVE ZERO TO X-S7.
           CALL "dump" USING G-S7 END-CALL.
           MOVE ZERO TO X-S8.
           CALL "dump" USING G-S8 END-CALL.
           MOVE ZERO TO X-S9.
           CALL "dump" USING G-S9 END-CALL.
           MOVE ZERO TO X-S10.
           CALL "dump" USING G-S10 END-CALL.
           MOVE ZERO TO X-S11.
           CALL "dump" USING G-S11 END-CALL.
           MOVE ZERO TO X-S12.
           CALL "dump" USING G-S12 END-CALL.
           MOVE ZERO TO X-S13.
           CALL "dump" USING G-S13 END-CALL.
           MOVE ZERO TO X-S14.
           CALL "dump" USING G-S14 END-CALL.
           MOVE ZERO TO X-S15.
           CALL "dump" USING G-S15 END-CALL.
           MOVE ZERO TO X-S16.
           CALL "dump" USING G-S16 END-CALL.
           MOVE ZERO TO X-S17.
           CALL "dump" USING G-S17 END-CALL.
           MOVE ZERO TO X-S18.
           CALL "dump" USING G-S18 END-CALL.
           STOP RUN.
```

With a support file to dump the first 10 bytes of each record

```
#include <stdio.h>
#ifdef  __INTEL_COMPILER
#pragma warning ( disable : 1419 )
#endif
int dump (unsigned char *data);
int dump (unsigned char *data)
{
  int i;
```

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(continued from previous page)

```
  for (i = 0; i < 10; i++)
    printf ("%02x", data[i]);
  puts ("");
  return 0;
}
/**/
```

Which compiles and captures as:

```
$ cobc -x packed-decimal.cob dump.c
$ ./packed-decimal
PACKED-DECIMAL, 1, 12, 123,
 ..., 123456789012345678
1f202020202020202020
012f2020202020202020
123f2020202020202020
01234f20202020202020
12345f20202020202020
0123456f202020202020
1234567f202020202020
012345678f2020202020
123456789f2020202020
01234567890f20202020
12345678901f20202020
0123456789012f202020
1234567890123f202020
012345678901234f2020
123456789012345f2020
0123456789012345678f

PACKED-DECIMAL, -1, -12, -123,
 ..., -123456789012345678
1d202020202020202020
012d2020202020202020
123d2020202020202020
01234d20202020202020
12345d20202020202020
0123456d202020202020
1234567d202020202020
012345678d2020202020
123456789d2020202020
01234567890d20202020
12345678901d20202020
0123456789012d202020
1234567890123d202020
012345678901234d2020
123456789012345d2020
0123456789012345678d

PACKED-DECIMAL, 1, 12, 123,
 ..., 123456789012345678 after subfield INITIALIZE
1f202020202020202020
012f2020202020202020
```

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(continued from previous page)

```
123f2020202020202020
01234f20202020202020
12345f20202020202020
0123456f202020202020
1234567f202020202020
012345678f2020202020
123456789f2020202020
01234567890f20202020
12345678901f20202020
0123456789012f202020
1234567890123f202020
012345678901234f2020
123456789012345f2020
01234567890123456f20
12345678901234567f20
0123456789012345678f

PACKED-DECIMAL, -1, -12, -123,
 ..., -123456789012345678 after subfield INITIALIZE
1d202020202020202020
012d2020202020202020
123d2020202020202020
01234d20202020202020
12345d20202020202020
0123456d202020202020
1234567d202020202020
012345678d2020202020
123456789d2020202020
01234567890d20202020
12345678901d20202020
0123456789012d202020
1234567890123d202020
012345678901234d2020
123456789012345d2020
01234567890123456d20
12345678901234567d20
0123456789012345678d

PACKED-DECIMAL, 1, 12, 123,
 ..., 123456789012345678 after subfield ZERO
0f202020202020202020
000f2020202020202020
000f2020202020202020
00000f20202020202020
00000f20202020202020
0000000f202020202020
0000000f202020202020
000000000f2020202020
000000000f2020202020
00000000000f20202020
00000000000f20202020
0000000000000f202020
0000000000000f202020
000000000000000f2020
000000000000000f2020
0000000000000000f20
0000000000000000f20
```

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```
000000000000000000f

PACKED-DECIMAL, -1, -12, -123,
 ..., -123456789012345678 after subfield ZERO
0c202020202020202020
000c2020202020202020
000c2020202020202020
00000c20202020202020
00000c20202020202020
0000000c202020202020
0000000c202020202020
000000000c2020202020
000000000c2020202020
00000000000c20202020
00000000000c20202020
0000000000000c202020
0000000000000c202020
000000000000000c2020
000000000000000c2020
0000000000000000c20
0000000000000000c20
000000000000000000c
```

4.1.384 PADDING

Defines a character to use for short record padding.

```
ORGANIZATION IS LINE SEQUENTIAL PADDING CHARACTER IS '*'
```

4.1.385 PAGE

Write and Report writer clause.

```
WRITE theline AFTER ADVANCING PAGE

PAGE LIMITS ARE 66 LINES 132 COLUMNS
    HEADING iS 4 FIRST DETAIL IS 6
    LAST CONTROL HEADING IS 58
    LAST DETAIL IS 60
    FOOTING IS 62
```

4.1.386 PAGE-COUNTER

A special register, qualified by Report Name.

4.1.387 PARAGRAPH

An allowable *EXIT* (page 258) point.

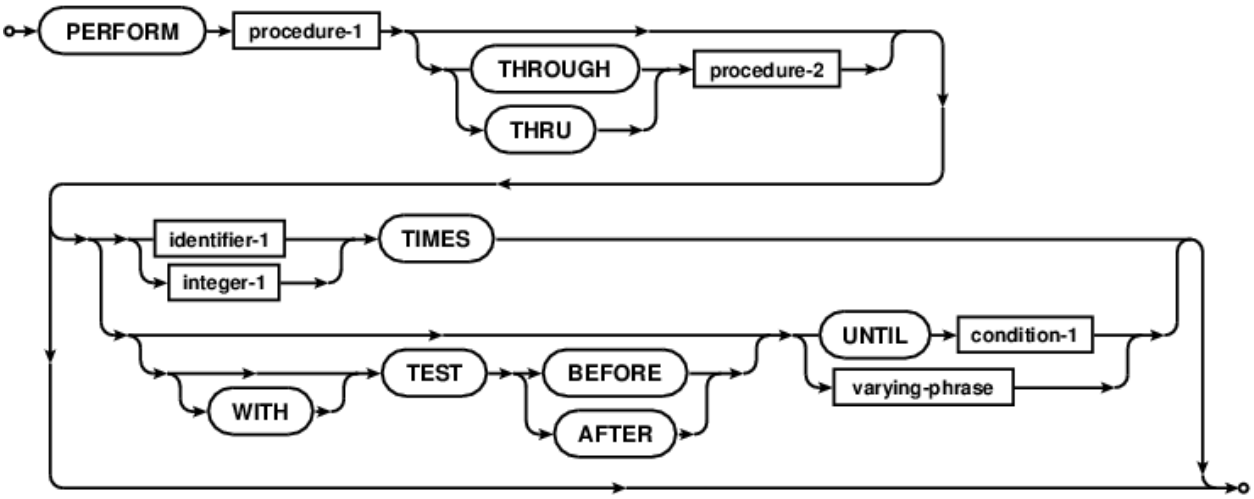
```
NAMED-PARAGRAPH.
    PERFORM FOREVER
        IF solution
            EXIT PARAGRAPH
        END-IF
        PERFORM solve-the-puzzle.
    END-PERFORM.
```

4.1.388 PERFORM

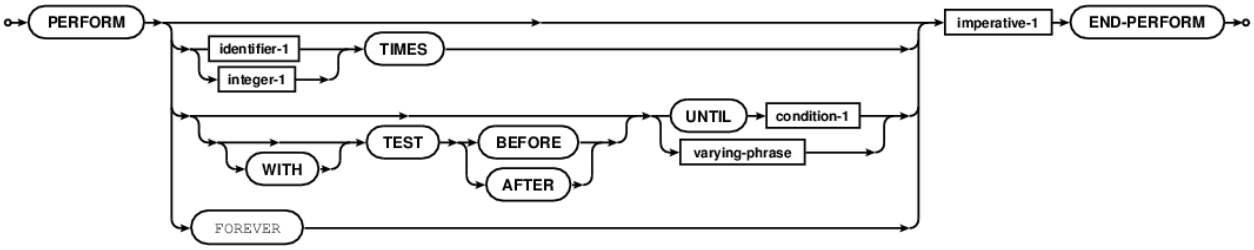
A COBOL procedural and inline control flow verb.

Historic COBOL used only *named procedure* performs, modern COBOL adds *inline* perform loops.

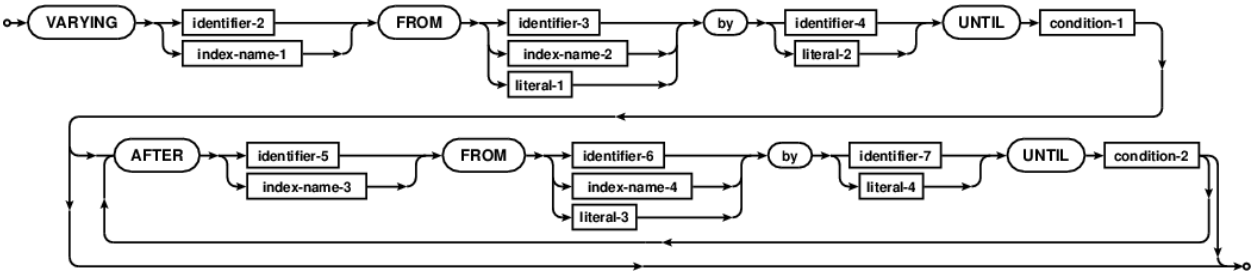
The procedural form.



And the *inline* loop form.



Both forms using a varying-phrase of



In the diagram above, the keyword BY was shown in the non-standard font. GnuCOBOL differs to the standard here, in that BY is not an optional clause in GnuCOBOL. The spec allows a default of ‘‘BY 1‘‘ if not explicitly stated, GnuCOBOL has no such default, and the clause is mandatory.

A named procedure perform inside an inline loop example:

```
beginning.
    PERFORM FOREVER
        PERFORM miracles
    END-PERFORM
    GOBACK.

miracles.
    DISPLAY wonders
```

4.1.389 PF

Report Writer alias for *PAGE* (page 346) *FOOTING* (page 270).

4.1.390 PH

Report Writer alias for *PAGE* (page 346) *HEADING* (page 295).

4.1.391 PIC

A commonly used short form of *PICTURE* (page 348).

4.1.392 PICTURE

The PICTURE clause, more commonly *PIC* (page 348), is easily one of COBOL's greatest strengths. Fully detailed pictorial data definitions. The internal complexity is left to compiler authors, while developers and management are free to describe data at a very high conceptual level.

The two most common picture characters are 9 and X, for numeric and alphanumeric data respectively. For alphabetic data, A can be used.

Aside from data storage pictures, a vast array of *edit* pictures are allowed for control of input and output formatting.

```
+, -, A, B, N, X, Z, "*", 'CR', 'DB', E, S, V, ".", ",", P, currency symbol
```

GnuCOBOL offers full standards support of all alpha, alphanumeric and numeric storage specifiers as well as full support for edit and numeric-edit clauses. See *currency symbol* (page 1319) for details on handling monentary prefixes, which defaults to "$", *without the quotes*. CR and DB are literals for display of CRedit and DeBit items, and there are no actual quotes around them, or the asterisk, period or comma symbols; shown above for clarity.

PICTURE symbols:

```
A    A character position for ALPHABETIC or SPACE
B    A blank insertion
E    Marks the start of an exponent for floating point values
N    A NATIONAL character position
P    An assumed decimal scaling postion
S    An indicator of the presence of an operational sign
```

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```
V    An indicator of the location of an assumed decimcal point
X    A character position for any character
Z    A leading numeric character, space when zero
9    A character position for digits
0    A zero insertion
/    A slash insertion
,    A comma insertion
.    An editing symbol for decimal point alignment, and a period insertion
+    A sign control symbol
-    A sign control symbol
CR   A sign control pair, displayed when value negative
DB   A sign control pair, displayed when value negative
*    A cheque protection symbol, leading zeroes replaced by asterisk

Symbols are case insensitive.  CR, cr, Cr, cR are equivalent for example.

PICTURE clauses can also contain a valid currency picture, (default is
dollar sign) defined in the configuration section, special-names
paragraph. For example:

CURRENCY SIGN IS "CAD" PICTURE SYMBOL "c"
CURRENCY SIGN IS "CLP" PICTURE SYMBOL "C"

Currency sign picture symbols are case sensitive.  Currency picture
symbols are limited in that they cannot override the other predefined
symbols or some COBOL syntax symbols.
```

An example of some of the PICTURE options

```
*>>source format is free
*> ******************************************************************
*> Author:    jrls (John Ellis)
*> Date:      Oct-2008
*> Purpose:   formated output examples using pic strings.
*> ******************************************************************

identification division.
program-id. picstring.
data division.
working-storage section.
*><*

01  header.
    05  filler          pic xxx  value "ln".
    05  filler          pic x(11) value "    disp1".
    05  filler          pic x(11) value "    disp2".
    05  filler          pic x(11) value "    disp3".
    05  filler          pic x(11) value "    disp4".
    05  filler          pic x(12) value "    disp5".
    05  filler          pic x(9)  value "   an1".
    05  filler          pic x(14) value "      phone".
    05  filler          pic x(10) value "   date".
*><*
01  headerLines         pic x(90) value all "-".
*><*
01  displayformats.
    05  linenum         pic 99  value 1.
```

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```
    05  disp1           pic zzz,zz9.99 value zero.
    05  filler          pic x value spaces.
    05  disp2           pic $zz,zz9.99 value zero.
    05  filler          pic x value spaces.
    05  disp3           pic ---,--9.99 value zero.
    05  filler          pic x value spaces.
    05  disp4           pic $-z,zz9.99 value zero.
    05  filler          pic x value spaces.
    05  disp5           pic -zz,zz9.zz- blank  zero value zero.
    05  filler          pic x value spaces.
*><*an1 is actually a string field because of the embedded blanks,
*><* thus you put value spaces.
    05  an1             pic 99b99b99    value spaces.
    05  filler          pic x value spaces.
    05  phone           pic bxxxbxxxbxxxx value spaces.
    05  filler          pic x value spaces.
    05  dispdate        pic 99/99/9999  value zero.
*><*

procedure division.
0000-start.
*><*
    display headerLines.
    display header.
    display headerLines.
*><**************************************************
    move 220.22         to disp1,
                           disp2.
    move -220.22        to disp3,
                           disp4,
                           disp5.

    inspect disp5 replacing first "-" by "(",
                            first "-" by ")".

    move 10122008       to dispdate.
*><**************************************************
*><*Please note the results of moving 'abcd' to an1.
*><*an1 will show up as 00 00 00 because alpha data was
*><*moved into instead of numeric data.
*><*
*><*The phone field will display " abc def ghij" because
*><*'b' in the pic string.
*><**************************************************
    move "abcd"         to an1.
    move "abcdefghij"   to phone.

    display displayformats.

    add 1               to linenum.
    move zero           to disp4,
                           disp5.
*><**************************************************
*><*Here after moving data to an1 and phone, I use the
*><*inspect statement to replace the blanks.
*><**************************************************
    move "123456"       to an1.
```

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```
    move "5555551234"   to phone.

    inspect an1 replacing all " " by "-".

    inspect phone replacing first " " by "(",
                            first " " by ")",
                            first " " by "-".

    display displayformats.

    inspect phone converting "23456789" to "adgjmptw".
    display phone.

    perform 0010-endProgram.
*><*
0010-endProgram.
    stop run.
*><*
```

Outputs:

```
-------------------------------------------------------------------------------------
ln     disp1     disp2    disp3      disp4     disp5      an1          phone       date
-------------------------------------------------------------------------------------
01    220.22   $220.22  -220.22   $-220.22   (220.22) 00 00 00  abc def ghij 10/12/
↪2008
02    220.22   $220.22  -220.22     $ 0.00            12-34-56 (555)555-1234 10/12/
↪2008
(jjj)jjj-1adg
```

A PICTURE that allows for comma separated thousands:

```
01 show-value     PIC zzz,zzz,999.

move 1 to show-value
display ":" show-value ":"

move 123 to show-value
display ":" show-value ":"

move 123456 to show-value
display ":" show-value ":"

move 123456789 to show-value
display ":" show-value ":"
```

Gives:

```
:        001:
:        123:
:    123,456:
:123,456,789:
```

The commas, which are "insert edit" picture items, when associated with the special Z and asterisk field edit characters, take on the aspect of the space fill on zero or asterisk fill on zero nature of the * and Z items.

Floating currency symbols work in a similar, but slightly different way.

```
01 show-value      PIC ***,***,999.
```

Gives:

```
:********001:
:********123:
:****123,456:
:123,456,789:
```

Making this a little more money oriented, and

```
01 show-value      PIC $$$,$$$,$$9.
```

Gives:

```
:          $1:
:        $123:
:    $123,456:
:$23,456,789:
```

Which is not a great way of treating multimillionaire customers, so

```
01 show-value      PIC $$$$,$$$,$$9.99.

move 123456789.50 to show-value
display ":" show-value ":"
```

would be a better form, showing:

```
:           $1.50:
:         $123.50:
:     $123,456.50:
:$123,456,789.50:
```

For your bigger customers, GnuCOBOL handles up to 38 characters of picture, so bring in that business. Then treat people to some powerful programming and entice them to fill up those accounts and make the big orders.

```
01 big-value pic $$$$,$$$,$$$,$$$,$$$,$$$,$$$,$$$,$$$,$$$,$$9.99.
```

```
:                                          $1.50:
:                                        $123.50:
:                                    $123,456.50:
:                                $123,456,789.50:
:                          $1,550,057,000,000.00:
```

Accoring to the internet, that last number is the Gross Domestic Product of Canada as reported in 2015. Lots and lots of wiggle room.

4.1.393 PLUS

Screen section relative line / column control during layout. Relative to last literal, not last PLUS or *MINUS* (page 323). In the code below, both value-4 and value-5 will be displayed on line 4.

```
01 form-1 AUTO.
   05 LINE 01 COLUMN 01 VALUE "Form!".
```

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```
   05 LINE PLUS 3 COLUMN 01 VALUE value-4.
   05 LINE PLUS 3 COLUMN 10 VALUE value-5.
```

4.1.394 POINTER

Allocates a restricted use variable for holding addresses. These identifiers are restricted in the sense that you do not normally *MOVE* (page 323) data to a `POINTER` but use the *SET* (page 400) statement instead.

In COBOL, unlike C, there is no *pointer arthimetic by type*. Setting a pointer *UP* (page 427) or *DOWN* (page 251) is by single byte units. There is no automatic calculation that multiplies the delta value by the size of the thing pointed to, as COBOL does not distinguish the *pointed at* type and always assumes single bytes. For example `SET ptr-short UP BY 1` does not add the size of a short to the reference, but simply increases the contents of the pointer by 1.

Pointers are often used when interfacing with C:

```
01  c-handle        USAGE IS POINTER.

CALL "open-lib" RETURNING c-handle
    ON EXCEPTION
        DISPLAY "Can't link open-lib"
        STOP RUN RETURNING 1
END-CALL
IF c-handle EQUAL NULL
    DISPLAY "Can't open-lib"
    STOP RUN RETURNING 1
END-IF

CALL "use-lib" USING BY VALUE c-handle BY CONTENT "Hello" & x"00"
CALL "close-lib" USING BY VALUE c-handle

*> Interfacing with the C ABI includes a little bit of voodoo.
*> Pass a REFERENCE or use RETURNING if C sets the value. Use
*>   VALUE when you want C to have its view of the pointer, not
*>   the REFERENCE address of the COBOL POINTER.  So most inits
*>   are BY REFERENCE (or RETURNING) and most usage, including
*>   rundown of C ABI tools, is usually USING BY VALUE.
*>
```

Given that GnuCOBOL is so tightly bound to the C *ABI* (page 1350), there are times when a COBOL programmer is faced with variable length zero byte terminated C *strings* and structures. Many times, a reasonable sized *PICTURE* (page 348) clause will suffice, but sometimes that places artificial limits on otherwise less restrictive code. C character arrays can be arbitrary size, COBOL is fixed.

By the way, the term *string* is used loosely with C, C has no *string* type but instead has character arrays, most often terminated by a null byte of zero that determines the size at runtime.

If it is only for DISPLAY purposes, one idiom for accessing C `char *` data is using POINTER and BASED memory. From an embedded Perl sample:

```
data   01 perl-pointer usage pointer.
       01 perl-char    pic x based.
       01 next-char    pic x based.

code   set address of perl-char to perl-pointer
       perform until perl-char equal x"00"
```

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```
           set perl-pointer up by 1
           set address of next-char to perl-pointer

           if next-char not equal x"00" then
               display perl-char with no advancing
           else
               display perl-char
           end-if

           set address of perl-char to perl-pointer
       end-perform
```

Similar code sequences can be used to traverse more complicated structures, sliding through data by setting the address of *BASED* (page 212) storage.

4.1.395 POSITION

Alias for *COLUMN* (page 228) in screen section layouts. Also an obsolete, recognized, but not supported, tape layout clause:

```
MULTIPLE FILE TAPE CONTAINS file-1 POSITION 1 file-2 POSITION 80
```

4.1.396 POSITIVE

Class condition.

```
IF amount IS POSITIVE
    DISPLAY "Not broke yet"
END-IF
```

4.1.397 PREFIXED

Not yet implemented.

4.1.398 PRESENT

Report Writer clause used for optional field and group output.

```
05 field PIC X(16) PRESENT WHEN sum > 0.
```

4.1.399 PREVIOUS

Previous key *READ* (page 359) control for *INDEXED* (page 297) files.

```
READ file-1 PREVIOUS RECORD
```

4.1.400 PRINTER

Special name.

```
SPECIAL-NAMES.
    PRINTER IS myprint

DISPLAY "test" UPON PRINTER
```

Reacts to

COBPRINTER A command used to `popen` with data lines written when UPON PRINTER is used for WRITE or DISPLAY.

```
export COBPRINTER='cat >>printfile.txt'
```

COB_DISPLAY_PRINTER A filename that is used with `fopen(fd-file, "a")` before each write UPON PRINTER.

```
export COB_DISPLAY_FILE='printfile.txt'
```

4.1.401 PRINTING

Report Writer declarative to *SUPPRESS* (page 416) report printing.

4.1.402 PROCEDURE

- The COBOL *DIVISION* (page 250) that holds the executable statements.
- Also used with *INPUT* (page 303) and *OUTPUT* (page 337) sort procedures.

4.1.403 PROCEDURE-POINTER

Alias for *PROGRAM-POINTER* (page 356), capable of holding a callable address.

```
01 callback-handler USAGE PROCEDURE-POINTER.

SET callback-handler TO ENTRY "react-to-click"
CALL "register-event" USING
    BY VALUE object-handle
    BY CONTENT z"onclick"
    BY VALUE callback-handler
END-CALL
```

4.1.404 PROCEDURES

Debug module declarative clause.

```
USE FOR DEBUGGING ON ALL PROCEDURES
```

4.1.405 PROCEED

Used in *ALTER* (page 199).

```
ALTER paragraph-1 TO PROCEED TO paragraph-x
```

4.1.406 PROGRAM

An *EXIT* (page 258) point.

```
EXIT PROGRAM.
```

4.1.407 PROGRAM-ID

The program identifier. Case sensitive, unlike all other GnuCOBOL identifiers. GnuCOBOL produces C Application Binary Interface linkable entities and this identifier must conform to those rules. Dashes in names are replaced by a hex string equivalent.

4.1.408 PROGRAM-POINTER

A data *USAGE* (page 427) clause defining a field that can hold the executable address of a *CALL* (page 219) routine.

```
77 callback USAGE PROGRAM-POINTER.
...
SET callback TO ENTRY a-program-id
CALL callback
    on exception "no linkage to callback" upon syserr
END-CALL
```

4.1.409 PROHIBITED

A *ROUNDED* (page 386) modifier, for no rounding allowed.

```
COMPUTE var ROUNDED MODE IS PROHIBITED = 1.1 END-COMPUTE
```

Sets an exception, 4101, that can be retrieved with

```
ACCEPT unexpected-rounding FROM EXCEPTION STATUS END-ACCEPT
```

For example

```
GCobol
       identification division.
       program-id. SAMPLE.

       data division.
       working-storage section.
       01 unexpected-round   pic 9(4).
       01 delicate-value     pic 99v99.

       procedure division.
```

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```
      *> No SIZE conditional, will set an exception status
       compute
           delicate-value rounded mode is prohibited = 1.177
       accept unexpected-round from exception status
       display delicate-value ", " unexpected-round

      *> SIZE conditional, but rounding allowed, no exception raised
       compute
           delicate-value rounded = 1.177
           on size error
               display "size error: " with no advancing
       end-compute
       accept unexpected-round from exception status
       display delicate-value ", " unexpected-round

      *> SIZE conditional, but allowed with assumed
      *>  ROUNDED MODE IS NEAREST-AWAY-FROM-ZERO
       compute
           delicate-value = 1.175 + 1.946
           on size error
               display "size error: " with no advancing
       end-compute
       accept unexpected-round from exception status
       display delicate-value ", " unexpected-round

      *> trigger a SIZE conditional, set the exception code
       compute
           delicate-value rounded mode is prohibited = 1.175 + 1.946
           on size error
               display "size error: " with no advancing
       end-compute
       accept unexpected-round from exception status
       display delicate-value ", " unexpected-round

       goback.
       end program SAMPLE.
```

gives:

```
01.17, 4101
01.18, 0000
03.12, 0000
size error: 03.12, 4101
```

4.1.410 PROMPT

Screen section input control.

```
PROMPT IS ':'
```

4.1.411 PROPERTY

Unsupported Object COBOL phrase.

4.1.412 PROTECTED

Extended *ACCEPT* (page 187) field attribute.

```
ACCEPT variable-1
   LINE <line> COLUMN <column>
   WITH
      AUTO-SKIP | AUTO
      [PROTECTED] SIZE [IS] variable-2 | literal-2
END-ACCEPT
```

4.1.413 PROTOTYPE

Unsupported Object COBOL phrase.

4.1.414 PURGE

Unsupported Communication Section clause.

4.1.415 QUEUE

Unsupported Communication Section clause.

4.1.416 QUOTE

A figurative constant representing “”.

```
DISPLAY QUOTE 123 QUOTE
```

Outputs:

```
"123"
```

4.1.417 QUOTES

A figurative constant representing “”.

```
01 var PICTURE X(4).

MOVE ALL QUOTES TO var
DISPLAY var
```

Outputs:

```
""""
```

4.1.418 RAISE

Exception handling. There IS support for exceptions in GnuCOBOL but it is currently fairly limited. See *FUNCTION EXCEPTION-LOCATION* (page 456) for a sample. RAISE is not yet recognized.

4.1.419 RAISING

Exception handling. There IS support for exceptions in GnuCOBOL but it is currently limited. RAISING is not yet recognized.

4.1.420 RANDOM

A file access mode. RANDOM access allows seeks to any point in a file, usually by *KEY* (page 311).

There is also an intrinsic for generating random numbers, *FUNCTION RANDOM* (page 481).

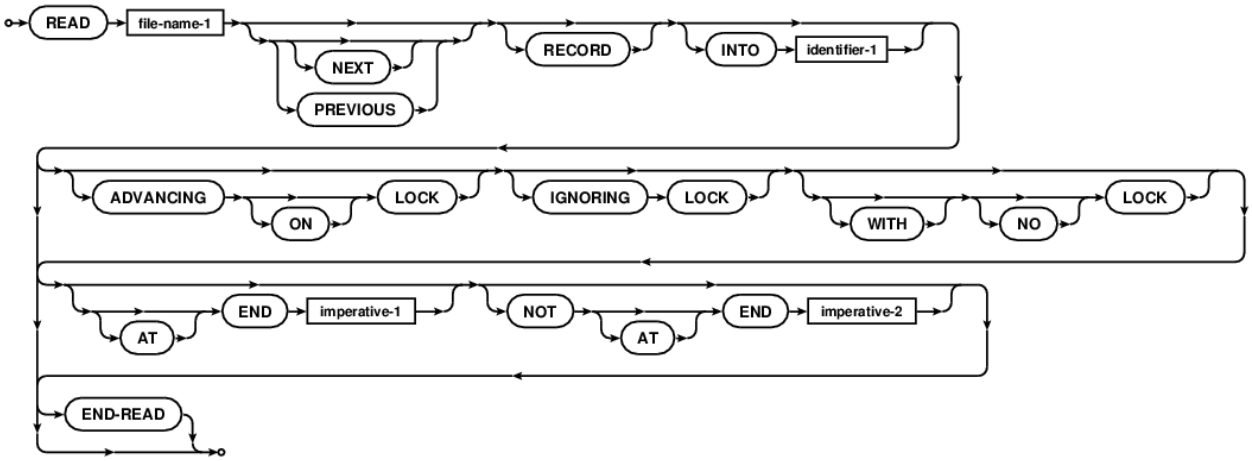
4.1.421 RD

Report writer *DATA* (page 241) division, *REPORT* (page 369) section descriptor.

```
DATA DIVISION.
REPORT SECTION.
RD report-1
    PAGE LIMIT IS 66 LINES.
```

4.1.422 READ

A staple of COBOL. Read a record, *forwards or backwards, with or without locking*.



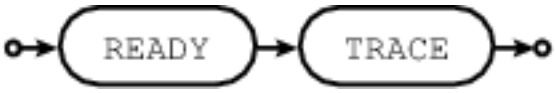

```
READ infile PREVIOUS RECORD INTO back-record
   AT END
       SET attop TO TRUE
   NOT AT END
       PERFORM cursor-calculator
END-READ
```

Please note that using `AT END` may not be the best way of handling end of file. Bill Woodger is always quick to point out that checking `FILE STATUS` is usually the better route.

For instance, if an `OPEN` fails, then a `READ` loop using `AT END` will never be triggered. Error conditions with a `READ` will also not trigger an `AT END`. This can lead to infinite loops, or worse, bad data.

4.1.423 READY

Along with *RESET* (page 380), allows for programmatic control over *TRACE* (page 421) line output.



A sample of run-time line trace:

```
identification division.
program-id. tracing.

data division.
working-storage section.
01 indicator pic 9.

procedure division.
move 1 to indicator
READY TRACE
perform until indicator > 5
    display "traced line: " indicator
    add 1 to indicator
end-perform
RESET TRACE
display "not traced"
goback.
end program tracing.
```

With and without line tracing.

```
prompt$ cobc -x tracing.cob
prompt$ ./tracing
traced line: 1
traced line: 2
traced line: 3
traced line: 4
traced line: 5
not traced

prompt$ cobc -x -debug tracing.cob
prompt$ ./tracing
Source :    'tracing.cob'
Program-Id: tracing          Statement: PERFORM              Line: 11
Program-Id: tracing          Statement: DISPLAY              Line: 12
traced line: 1
Program-Id: tracing          Statement: ADD                  Line: 13
Program-Id: tracing          Statement: DISPLAY              Line: 12
traced line: 2
Program-Id: tracing          Statement: ADD                  Line: 13
Program-Id: tracing          Statement: DISPLAY              Line: 12
traced line: 3
Program-Id: tracing          Statement: ADD                  Line: 13
Program-Id: tracing          Statement: DISPLAY              Line: 12
traced line: 4
Program-Id: tracing          Statement: ADD                  Line: 13
Program-Id: tracing          Statement: DISPLAY              Line: 12
traced line: 5
```

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```
Program-Id: tracing          Statement: ADD                    Line: 13
Program-Id: tracing          Statement: RESET TRACE            Line: 15
not traced
```

COB_SET_TRACE=Y with `cobc -debug` (or -ftrace or -ftraceall) will trace ALL lines by default, but will still honour RESET and READY TRACE blocks.

4.1.424 RECEIVE

An unsupported Communication Section clause.

4.1.425 RECORD

Multiple use phrase.

```
FD file
    RECORD IS VARYING IN SIZE FROM 1 TO 80 CHARACTERS
        DEPENDING ON size-field

SELECT file
    ASSIGN TO filename
    ACCESS MODE IS RANDOM
    RECORD KEY IS key-field
    ALTERNATE KEY IS alt-key WITH DUPLICATES.

READ infile NEXT RECORD INTO display-rec END-READ
```

4.1.426 RECORDING

An obsolete, recognized, but ignored file descriptor clause.

```
FD file
    RECORD IS VARYING IN SIZE FROM 1 TO 80 CHARACTERS
        DEPENDING ON size-field
    RECORDING MODE IS F.
```

4.1.427 RECORDS

Multiple use phrase.

```
UNLOCK file-1s RECORDS
```

4.1.428 RECURSIVE

Specifies a PROGRAM-ID as having the recursive attribute. Recursive sub programs can CALL themselves.

This qualifier has implications on how GnuCOBOL allocates storage. Normally storage is stacked, recursion can chew through stack space very quickly. Sub programs marked RECURSIVE are usually allocated using the memory heap.

```
PROGRAM-ID nextbigthing IS RECURSIVE.
```

4.1.429 REDEFINES

A very powerful *DATA* (page 241) division control allowing for redefinition of memory storage, including incompatible data by type.

```
IDENTIFICATION   DIVISION.
PROGRAM-ID.      prog.
DATA             DIVISION.
WORKING-STORAGE  SECTION.
01 ALONE         PIC X.
01 G             REDEFINES ALONE.
  02 A           PIC X.
  02 B           REDEFINES A PIC 9.
PROCEDURE        DIVISION.
    STOP RUN.
```

In the above, working-storage memory is only allocated for ALONE. G references the same address as ALONE. Inside G, A is defined, but again, takes up no space in working-storage. A references the same address as G, which is ALONE.

B is A, which is G, which is ALONE.

`REDEFINES` is *very powerful* as it is easy to screw up if you are not careful. :-)

If you start creating COBOL records with pointers, computational items and what not, and start pre-guessing memory overlays with PIC X(n) *or what not*, then things can go wrong between runs on different machines or instances of machines. `REDEFINES` puts the programmer in the driver seat when it comes to protecting the datatype in the original data item.

With care, REDEFINES can come in pretty handy too. The variant record layouts and field type take up no extra space in memory.

4.1.430 REEL

A tape device qualifier

```
CLOSE file REEL FOR REMOVAL
```

4.1.431 REFERENCE

The default COBOL *CALL* (page 219) argument passing mode. CALL arguments can be

```
BY REFERENCE
BY CONTENT
BY VALUE
```

where by reference passes a reference pointer, allowing data modification inside sub programs. User defined functions are always passed arguments `BY REFERENCE`.

4.1.432 REFERENCES

Debugging declarative

```
USE FOR DEBUGGING ON ALL REFERENCES TO some-field.
```

4.1.433 RELATION

Unsupported.

4.1.434 RELATIVE

File organization where the position of a logical record is determined by its relative record number.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20110806
      *> Purpose:   RELATIVE file organization
      *> Tectonics: cobc -g -debug -W -x relatives.cob
      *> ***************************************************************
       identification division.
       program-id. relatives.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       input-output section.
       file-control.
           select optional relatives
               assign to "relatives.dat"
               file status is filestatus
               organization is relative
               access mode is dynamic
               relative key is nicknum.

       data division.
       file section.
       fd relatives.
          01 person.
             05 firstname      pic x(48).
             05 lastname       pic x(64).
             05 relationship   pic x(32).

       working-storage section.
       77 filestatus pic 9(2).
          88 ineof value 1 when set to false is 0.

       77 satisfaction pic 9.
          88 satisfied value 1 when set to false is 0.

       77 nicknum   pic 9(2).
```

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```
       77 title-line pic x(34).
          88 writing-names value "Adding, Overwriting.  00 to finish".
          88 reading-names value "Which record?         00 to quit".
       77 problem   pic x(80).

       screen section.
       01 detail-screen.
          05           line 1 column 1  from title-line erase eos.
          05           line 2 column 1  value "Record: ".
          05 pic 9(2)  line 2 column 16 using nicknum.
          05           line 3 column 1  value "First name: ".
          05 pic x(48) line 3 column 16 using firstname.
          05           line 4 column 1  value "Last name: ".
          05 pic x(64) line 4 column 16 using lastname.
          05           line 5 column 1  value "Relation: ".
          05 pic x(32) line 5 column 16 using relationship.
          05 pic x(80) line 6 column 1  from problem.

       01 show-screen.
          05           line 1 column 1  from title-line erase eos.
          05           line 2 column 1  value "Record: ".
          05 pic 9(2)  line 2 column 16 using nicknum.
          05           line 3 column 1  value "First name: ".
          05 pic x(48) line 3 column 16 from firstname.
          05           line 4 column 1  value "Last name: ".
          05 pic x(64) line 4 column 16 from lastname.
          05           line 5 column 1  value "Relation: ".
          05 pic x(32) line 5 column 16 from relationship.
          05 pic x(80) line 6 column 1  from problem.

      *> -*********-*********-*********-*********-*********-*********-**
       procedure division.
       beginning.

      *> Open the file and find the highest record number
      *> which is a sequential read operation after START
           open input relatives

           move 99 to nicknum
           start relatives key is less than or equal to nicknum
               invalid key
                   move concatenate('NO START' space filestatus)
                     to problem
                   move 00 to nicknum
               not invalid key
                   read relatives next end-read
           end-start

      *> Close and open for i-o
           close relatives
           open i-o relatives

      *> Prompt for numbers and names to add until 00
           set writing-names to true
           set satisfied to false
           perform fill-file through fill-file-end
               until satisfied
```

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```
           close relatives

       *> Prompt for numbers to view names of until 00
           open input relatives

           set reading-names to true
           set satisfied to false
           perform record-request through record-request-end
               until satisfied

           perform close-shop
       .
       ending.
           goback.

       *> get some user data to add
       fill-file.
           display detail-screen.
           accept detail-screen.
           move spaces to problem
           if nicknum equal 0
               set satisfied to true
               go to fill-file-end
           end-if.
       .
       write-file.
           write person
               invalid key
                   move concatenate("overwriting: " nicknum) to problem
                   rewrite person
                       invalid key
                           move concatenate(
                               exception-location() space nicknum
                               space filestatus)
                           to problem
                   end-rewrite
           end-write.
           display detail-screen

       .
       fill-file-end.
       .

       *> get keys to display
       record-request.
           display show-screen
           accept show-screen
           move spaces to problem
           if nicknum equals 0
               set satisfied to true
               go to record-request-end
           end-if
       .

       *> The magic of relative record number reads
       read-relation.
```

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```
           read relatives
               invalid key
                   move exception-location() to problem
               not invalid key
                   move spaces to problem
           end-read
           display show-screen
       .

       record-request-end.
       .

      *> get out <*
       close-shop.
           close relatives.
           goback.
       .
       end program relatives.
```

with sample screens:

```
Adding, Overwriting.  00 to finish
Record:         04
First name:     Brad_____________________________________________
Last name:      Tiffin___________________________________________________________
Relation:       brother_____________________________
```

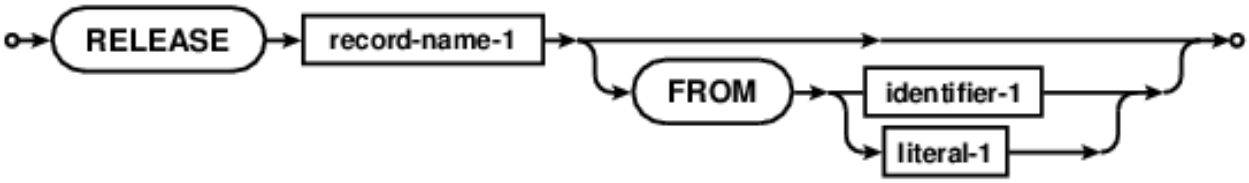
allowing for new record additions or overwrites of existing key numbers, and:

```
Which record?         00 to quit
Record:         03
First name:     Brian
Last name:      Tiffin
Relation:
```

where typing in a *nicknum* record number retrieves the relative record.

4.1.435 RELEASE

Release a record to a *SORT* (page 403).



Used with INPUT PROCEDURE of SORT verb.

```
RELEASE record-1 FROM identifier-1
```

4.1.436 REMAINDER

Access to integer remainders during division. See *DIVIDE* (page 250) and *COMPUTE* (page 233).

```
DIVIDE
    hex-val BY 16 GIVING left-nibble REMAINDER right-nibble
END-DIVIDE
```

4.1.437 REMARKS

An informational paragraph in the *IDENTIFICATION* (page 296) DIVISION. Deemed OBSOLETE, but still in use. GnuCOBOL treats this as an end of line comment.

4.1.438 REMOVAL

A close clause.

```
CLOSE filename-1 REEL FOR REMOVAL
```

Specifies that the file is stored on multiple removable tapes/disks. Not all systems support such devices.

4.1.439 RENAMES

GnuCOBOL supports regrouping of level 02-49 data items with level 66 and RENAMES.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20110606
      *> Purpose:   Demonstration of 66-level datanames
      *> Tectonics: cobc
      *> ***************************************************************
       identification division.
       program-id. sixtysix.

       data division.
       working-storage section.
       01 master.
          05 field-1 pic s9(9).
          05 field-2 pic x(16).
          05 field-3 pic x(4).
          05 field-4 pic s9(9).
       66 sixtysix renames field-2.
       66 group-66 renames field-2 through field-4.

      *> ***************************************************************
       procedure division.
       move -66 to field-1
       move "sixtysix" to field-2
       move "ABCD" to field-3
       multiply field-1 by -1 giving field-4
       display "master  : " master
       display "field-1 : " field-1
       display "sixtysix: " sixtysix
       display "group-66: " group-66
```

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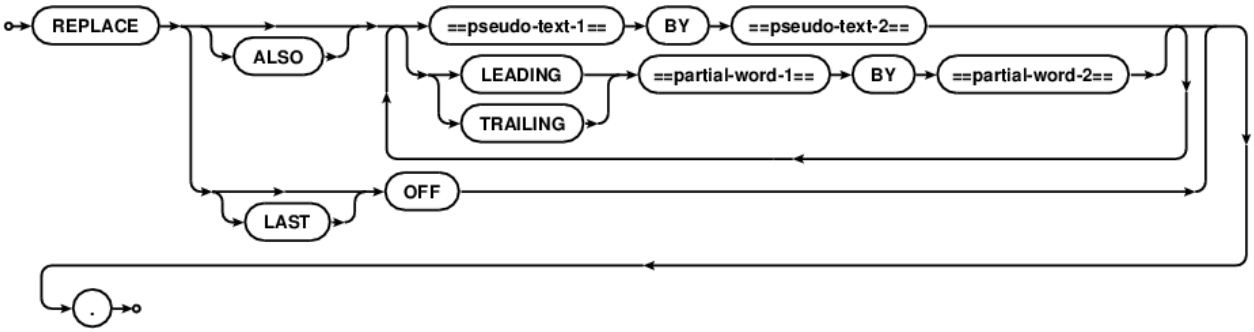
```
       goback.
       end program sixtysix.
```

giving:

```
$ ./sixtysix
master  : 00000006vsixtysix        ABCD000000066
field-1 : -000000066
sixtysix: sixtysix
group-66: sixtysix        ABCD000000066
```

4.1.440 REPLACE

A COBOL preprocessor text manipulation directive.



For example:

```
REPLACE ==MARKER== BY ==DISPLAY "REPLACE EXAMPLE" END-DISPLAY==.
identification division.
program-id. prog.

procedure division.
MARKER
goback.
end program prog.
```

And then to see how that REPLACE is working, use *cobc* with the -E argument

```
# 1 "replacing.cob"

 identification division.
 program-id. prog.

 procedure division.
 DISPLAY "REPLACE EXAMPLE" END-DISPLAY
 goback.
 end program prog.
```

REPLACE is a state sensitive word that keeps a stack of active replacements when nested. How these work can be controlled with

```
REPLACE OFF.
REPLACE LAST OFF.
REPLACE ALSO ==partial-text== BY ==partial-replacement==.
```

- *ALSO* (page 198) stacks
- *LAST* (page 311) pops last, forgetting current
- *OFF* (page 332) without *LAST* (page 311) forgets all active replacements.

`REPLACE ALSO` can be your friend when you need to override some small issues with generic source code templates.

4.1.441 REPLACING

- An *INSPECT* (page 304) sub-clause.
- A *COPY* (page 237) text manipulation preprocessor clause.

The preprocessor `REPLACING` clause uses pseudo-text for its operands; COBOL text delimited by literal ==. Substitutions can also use straight text, but pseudo-text is likely more prevalent in existing COBOL sources, as it helps avoid unintentional replacements of coincidentally matching program sources.

```
COPY "copy.inc"
    REPLACING LEADING  ==TEST== BY ==FIRST==
              TRAILING ==NORM== BY ==SECOND==.
```

4.1.442 REPORT

Report Writer section and File descriptor clause.

Thanks to Ron Norman, GnuCOBOL supports the Report Writer module.

This example copied from Jay Moseley's Hercules support for Report Writer tutorial, with permission.

```
000100 IDENTIFICATION DIVISION.
000200 PROGRAM-ID. RWEX06.
000300 AUTHOR. JAY MOSELEY.
000400 DATE-WRITTEN. APRIL, 2008.
000410* ************************************************************ *
000412* * MODIFICATIONS:                                              *
000414* * CORRECT PARAGRAPH NAME AND GO TO CODING ERRORS.             *
000416* ************************************************************ *
000500 DATE-COMPILED.
000600
000700* ************************************************************ *
000800* REPORT WRITER EXAMPLE #6.                                     *
000900* ************************************************************ *
001000
001100 ENVIRONMENT DIVISION.
001200 CONFIGURATION SECTION.
001300 SOURCE-COMPUTER. IBM-370.
001400 OBJECT-COMPUTER. IBM-370.
001500
001600 INPUT-OUTPUT SECTION.
001700 FILE-CONTROL.
001800
001900     SELECT PAYROLL-REGISTER-DATA
002000         ASSIGN TO EXTERNAL DATAIN
002005                   ORGANIZATION IS LINE SEQUENTIAL.
002100
002200     SELECT REPORT-FILE
```

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```
002300         ASSIGN TO EXTERNAL LINE ADVANCING SYSPRINT.
002400
002500 DATA DIVISION.
002600 FILE SECTION.
002700
002800 FD  PAYROLL-REGISTER-DATA
002900     LABEL RECORDS ARE OMITTED
003000     BLOCK CONTAINS 0 RECORDS
003100     RECORD CONTAINS 80 CHARACTERS
003200     DATA RECORD IS PAYROLL-REGISTER-RECORD.
003300
003400 01  PAYROLL-REGISTER-RECORD.
003500     03  PRR-DEPARTMENT-NUMBER   PIC 9(02).
003600     03  FILLER                  PIC X(01).
003700     03  PRR-EMPLOYEE-KEY.
003800         05  PRR-EMPLOYEE-NO     PIC 9(04).
003900         05  FILLER              PIC X(01).
004000         05  PRR-GENDER          PIC X(01).
004100         05  FILLER              PIC X(01).
004200         05  PRR-EMPLOYEE-NAME   PIC X(20).
004300     03  FILLER                  PIC X(01).
004400     03  PRR-PAY-DATE            PIC 9(08).
004500     03  FILLER                  REDEFINES PRR-PAY-DATE.
004600         05  PRR-PAY-DATE-YEAR   PIC 9(04).
004700         05  PRR-PAY-DATE-MONTH  PIC 9(02).
004800         05  PRR-PAY-DATE-DAY    PIC 9(02).
004900     03  FILLER                  PIC X(01).
005000     03  PRR-GROSS-PAY           PIC 9(04)V99.
005100     03  FILLER                  PIC X(01).
005200     03  PRR-FICA-WH             PIC 9(03)V99.
005300     03  FILLER                  PIC X(01).
005400     03  PRR-FED-WH              PIC 9(03)V99.
005500     03  FILLER                  PIC X(01).
005600     03  PRR-MISC-DED            PIC 9(03)V99.
005700     03  FILLER                  PIC X(01).
005800     03  PRR-NET-PAY             PIC 9(04)V99.
005900     03  FILLER                  PIC X(09).
006000
006100 FD  REPORT-FILE
006200     LABEL RECORDS ARE OMITTED
006300     REPORT IS QUARTERLY-PAY-REGISTER.
006400
006500 WORKING-STORAGE SECTION.
006600 77  END-OF-FILE-SWITCH          PIC X(1)    VALUE 'N'.
006700     88  END-OF-FILE                         VALUE 'Y'.
006800
006900 01  WS-EMPLOYEE-KEY.
007000     03  WS-EMPLOYEE-NUMBER      PIC 9(04).
007100     03  FILLER                  PIC X(03).
007200     03  WS-EMPLOYEE-NAME        PIC X(20).
007300
007400 01  WS-PERCENTS-COMPUTED.
007500     03  WPC-DEPT                OCCURS 6 TIMES
007600                                 INDEXED BY WPCD-IX.
007700         05  WPC-PERCENT         OCCURS 5 TIMES
007800                                 INDEXED BY WPCC-IX
007900                                 PIC 9(3)V99.
```

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```
008000
008100 01  DEPARTMENT-TABLE.
008200     03  FILLER PIC X(17) VALUE '01MANAGEMENT     '.
008300     03  FILLER PIC X(50) VALUE ZEROS.
008400     03  FILLER PIC X(17) VALUE '05ADMINISTRATIVE '.
008500     03  FILLER PIC X(50) VALUE ZEROS.
008600     03  FILLER PIC X(17) VALUE '10SKILLED NURSING'.
008700     03  FILLER PIC X(50) VALUE ZEROS.
008800     03  FILLER PIC X(17) VALUE '15PATIENT SUPPORT'.
008900     03  FILLER PIC X(50) VALUE ZEROS.
009000     03  FILLER PIC X(17) VALUE '20HOUSEKEEPING   '.
009100     03  FILLER PIC X(50) VALUE ZEROS.
009200     03  FILLER PIC X(17) VALUE '25MAINTENANCE    '.
009300     03  FILLER PIC X(50) VALUE ZEROS.
009400 01  FILLER REDEFINES DEPARTMENT-TABLE.
009500     03  DEPARTMENT-ENTRY      OCCURS 6 TIMES
009600                               INDEXED BY DE-IX.
009700         05  DE-NUMBER         PIC 9(02).
009800         05  DE-NAME           PIC X(15).
009900         05  DE-GROSS          PIC 9(08)V99.
010000         05  DE-FICA           PIC 9(08)V99.
010100         05  DE-FWT            PIC 9(08)V99.
010200         05  DE-MISC           PIC 9(08)V99.
010300         05  DE-NET            PIC 9(08)V99.
010400
010500 REPORT SECTION.
010600 RD  QUARTERLY-PAY-REGISTER
010700     CONTROLS ARE FINAL, PRR-DEPARTMENT-NUMBER,
010800         PRR-EMPLOYEE-KEY
010900     PAGE LIMIT IS 66 LINES
011000     HEADING 1
011100     FIRST DETAIL 7
011200     LAST DETAIL 60.
011300
011400 01  TYPE PAGE HEADING.
011500     02  LINE 1.
011600         03  COLUMN 39   PIC X(13) VALUE 'C E N T U R Y'.
011700         03  COLUMN 55   PIC X(13) VALUE 'M E D I C A L'.
011800         03  COLUMN 71   PIC X(11) VALUE 'C E N T E R'.
011900     02  LINE 2.
012000         03  COLUMN 35   PIC X(17) VALUE 'Q U A R T E R L Y'.
012100         03  COLUMN 55   PIC X(13) VALUE 'P A Y R O L L'.
012200         03  COLUMN 71   PIC X(15) VALUE 'R E G I S T E R'.
012300         03  COLUMN 111  PIC X(04) VALUE 'PAGE'.
012400         03  COLUMN 116  PIC ZZZZ9 SOURCE PAGE-COUNTER.
012500     02  LINE 4.
012600         03  COLUMN 06   PIC X(28) VALUE
012700             '--------- EMPLOYEE ---------'.
012800         03  COLUMN 40   PIC X(05) VALUE 'GROSS'.
012900         03  COLUMN 54   PIC X(04) VALUE 'FICA'.
013000         03  COLUMN 66   PIC X(07) VALUE 'FED W/H'.
013100         03  COLUMN 80   PIC X(05) VALUE 'MISC.'.
013200         03  COLUMN 95   PIC X(03) VALUE 'NET'.
013300     02  LINE 5.
013400         03  COLUMN 07   PIC X(02) VALUE 'NO'.
013500         03  COLUMN 22   PIC X(04) VALUE 'NAME'.
013600         03  COLUMN 41   PIC X(03) VALUE 'PAY'.
```

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```
013700         03  COLUMN 55   PIC X(03) VALUE 'TAX'.
013800         03  COLUMN 68   PIC X(03) VALUE 'TAX'.
013900         03  COLUMN 79   PIC X(07) VALUE 'DEDUCT.'.
014000         03  COLUMN 95   PIC X(03) VALUE 'PAY'.
014100
014200 01  DEPT-HEAD TYPE CONTROL HEADING PRR-DEPARTMENT-NUMBER
014300     NEXT GROUP PLUS 1.
014400     02  LINE PLUS 1.
014500         03 COLUMN 01    PIC X(18) VALUE
014600            'DEPARTMENT NUMBER:'.
014700         03  COLUMN 21   PIC 9(02) SOURCE PRR-DEPARTMENT-NUMBER.
014800         03  COLUMN 24   PIC X(15) SOURCE DE-NAME (DE-IX).
014900
015000 01  EMPLOYEE-DETAIL TYPE DETAIL.
015100     02  LINE PLUS 1.
015200         03  COLUMN 01   PIC X(27) SOURCE PRR-EMPLOYEE-KEY.
015300         03  COLUMN 50   PIC 9(04).99 SOURCE PRR-GROSS-PAY.
015400         03  COLUMN 60   PIC 9(03).99 SOURCE PRR-FICA-WH.
015500         03  COLUMN 70   PIC 9(03).99 SOURCE PRR-FED-WH.
015600         03  COLUMN 80   PIC 9(03).99 SOURCE PRR-MISC-DED.
015700         03  COLUMN 90   PIC 9(04).99 SOURCE PRR-NET-PAY.
015800
015900 01  EMPL-FOOT TYPE CONTROL FOOTING PRR-EMPLOYEE-KEY.
016000     02  LINE PLUS 1.
016100         03  COLUMN 06   PIC ZZZ9  SOURCE WS-EMPLOYEE-NUMBER.
016200         03  COLUMN 14   PIC X(20) SOURCE WS-EMPLOYEE-NAME.
016300         03  COLUMN 38   PIC $$,$$9.99 SUM PRR-GROSS-PAY.
016400         03  COLUMN 53   PIC $$$9.99 SUM PRR-FICA-WH.
016500         03  COLUMN 66   PIC $$$9.99 SUM PRR-FED-WH.
016600         03  COLUMN 79   PIC $$$9.99 SUM PRR-MISC-DED.
016700         03  COLUMN 92   PIC $$,$$9.99 SUM PRR-NET-PAY.
016800
016900 01  DEPT-FOOT TYPE CONTROL FOOTING PRR-DEPARTMENT-NUMBER
017000     NEXT GROUP PLUS 2.
017100     02  LINE PLUS 2.
017200         03  COLUMN 14   PIC X(20) VALUE
017300             'DEPARTMENT TOTALS'.
017400         03  DEPT-FOOT-GROSS       COLUMN 38   PIC $$,$$9.99
017500                                   SUM PRR-GROSS-PAY.
017600         03  COLUMN 48   PIC X         VALUE '*'.
017700         03  DEPT-FOOT-FICA        COLUMN 53   PIC $$$9.99
017800                                   SUM PRR-FICA-WH.
017900         03  COLUMN 61   PIC X         VALUE '*'.
018000         03  DEPT-FOOT-FWT         COLUMN 66   PIC $$$9.99
018100                                   SUM PRR-FED-WH.
018200         03  COLUMN 74   PIC X         VALUE '*'.
018300         03  DEPT-FOOT-MISC        COLUMN 79   PIC $$$9.99
018400                                   SUM PRR-MISC-DED.
018500         03  COLUMN 87   PIC X         VALUE '*'.
018600         03  DEPT-FOOT-NET         COLUMN 92   PIC $$,$$9.99
018700                                   SUM PRR-NET-PAY.
018800         03  COLUMN 102  PIC X         VALUE '*'.
018900
019000 01  COMP-FOOT TYPE CONTROL FOOTING FINAL.
019100     02  LINE PLUS 2.
019200         03  COLUMN 14   PIC X(20) VALUE
019300             'COMPANY TOTALS'.
```

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```
019400         03  CO-GROSS     COLUMN 37   PIC $$$,$$9.99
019500                           SUM PRR-GROSS-PAY.
019600         03  COLUMN 48    PIC XX        VALUE '**'.
019700         03  CO-FICA      COLUMN 51   PIC $$,$$9.99
019800                           SUM PRR-FICA-WH.
019900         03  COLUMN 61    PIC XX        VALUE '**'.
020000         03  CO-FWT       COLUMN 64   PIC $$,$$9.99
020100                           SUM PRR-FED-WH.
020200         03  COLUMN 74    PIC XX        VALUE '**'.
020300         03  CO-MISC      COLUMN 77   PIC $$,$$9.99
020400                           SUM PRR-MISC-DED.
020500         03  COLUMN 87    PIC XX        VALUE '**'.
020600         03  CO-NET       COLUMN 91   PIC $$$,$$9.99
020700                           SUM PRR-NET-PAY.
020800         03  COLUMN 102   PIC XX        VALUE '**'.
020900
021000 01  REPORT-FOOT TYPE REPORT FOOTING.
021100     02  LINE 1.
021200         03  COLUMN 39    PIC X(13) VALUE 'C e n t u r y'.
021300         03  COLUMN 55    PIC X(13) VALUE 'M e d i c a l'.
021400         03  COLUMN 71    PIC X(11) VALUE 'C e n t e r'.
021500     02  LINE 2.
021600         03  COLUMN 35    PIC X(17) VALUE 'Q u a r t e r l y'.
021700         03  COLUMN 55    PIC X(13) VALUE 'P a y r o l l'.
021800         03  COLUMN 71    PIC X(15) VALUE 'R e g i s t e r'.
021900         03  COLUMN 111   PIC X(04) VALUE 'PAGE'.
022000         03  COLUMN 116   PIC ZZZZ9 SOURCE PAGE-COUNTER.
022100     02  LINE 4.
022200         03  COLUMN 40    PIC X(05) VALUE 'GROSS'.
022300         03  COLUMN 58    PIC X(04) VALUE 'FICA'.
022400         03  COLUMN 74    PIC X(07) VALUE 'FED W/H'.
022500         03  COLUMN 92    PIC X(05) VALUE 'MISC.'.
022600         03  COLUMN 111   PIC X(03) VALUE 'NET'.
022700     02  LINE 5.
022800         03  COLUMN 41    PIC X(03) VALUE 'PAY'.
022900         03  COLUMN 59    PIC X(03) VALUE 'TAX'.
023000         03  COLUMN 76    PIC X(03) VALUE 'TAX'.
023100         03  COLUMN 91    PIC X(07) VALUE 'DEDUCT.'.
023200         03  COLUMN 111   PIC X(03) VALUE 'PAY'.
023300
023400     02  LINE PLUS 2.
023500         03  COLUMN 05    PIC X(29) VALUE
023600             '* * * DEPARTMENT TOTALS * * *'.
023700     02  LINE PLUS 2.
023800         03  COLUMN 05    PIC 9(02) SOURCE DE-NUMBER (1).
023900         03  COLUMN 08    PIC X(15) SOURCE DE-NAME (1).
024000         03  COLUMN 38    PIC $$,$$9.99 SOURCE DE-GROSS (1).
024100         03  COLUMN 48    PIC ZZ9 SOURCE WPC-PERCENT (1 1).
024200         03  COLUMN 51    PIC X VALUE '%'.
024300         03  COLUMN 57    PIC $$$9.99   SOURCE DE-FICA (1).
024400         03  COLUMN 65    PIC ZZ9 SOURCE WPC-PERCENT (1 2).
024500         03  COLUMN 68    PIC X VALUE '%'.
024600         03  COLUMN 74    PIC $$$9.99   SOURCE DE-FWT (1).
024700         03  COLUMN 82    PIC ZZ9 SOURCE WPC-PERCENT (1 3).
024800         03  COLUMN 85    PIC X VALUE '%'.
024900         03  COLUMN 91    PIC $$$9.99   SOURCE DE-MISC (1).
025000         03  COLUMN 99    PIC ZZ9 SOURCE WPC-PERCENT (1 4).
```

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```
025100          03  COLUMN 102  PIC X VALUE '%'.
025200          03  COLUMN 108  PIC $$,$$9.99 SOURCE DE-NET (1).
025300          03  COLUMN 118  PIC ZZ9 SOURCE WPC-PERCENT (1 5).
025400          03  COLUMN 121  PIC X VALUE '%'.
025500      02  LINE PLUS 2.
025600          03  COLUMN 05   PIC 9(02) SOURCE DE-NUMBER (2).
025700          03  COLUMN 08   PIC X(15) SOURCE DE-NAME (2).
025800          03  COLUMN 38   PIC $$,$$9.99 SOURCE DE-GROSS (2).
025900          03  COLUMN 48   PIC ZZ9 SOURCE WPC-PERCENT (2 1).
026000          03  COLUMN 51   PIC X VALUE '%'.
026100          03  COLUMN 57   PIC $$$9.99   SOURCE DE-FICA (2).
026200          03  COLUMN 65   PIC ZZ9 SOURCE WPC-PERCENT (2 2).
026300          03  COLUMN 68   PIC X VALUE '%'.
026400          03  COLUMN 74   PIC $$$9.99   SOURCE DE-FWT (2).
026500          03  COLUMN 82   PIC ZZ9 SOURCE WPC-PERCENT (2 3).
026600          03  COLUMN 85   PIC X VALUE '%'.
026700          03  COLUMN 91   PIC $$$9.99   SOURCE DE-MISC (2).
026800          03  COLUMN 99   PIC ZZ9 SOURCE WPC-PERCENT (2 4).
026900          03  COLUMN 102  PIC X VALUE '%'.
027000          03  COLUMN 108  PIC $$,$$9.99 SOURCE DE-NET (2).
027100          03  COLUMN 118  PIC ZZ9 SOURCE WPC-PERCENT (2 5).
027200          03  COLUMN 121  PIC X VALUE '%'.
027300      02  LINE PLUS 2.
027400          03  COLUMN 05   PIC 9(02) SOURCE DE-NUMBER (3).
027500          03  COLUMN 08   PIC X(15) SOURCE DE-NAME (3).
027600          03  COLUMN 38   PIC $$,$$9.99 SOURCE DE-GROSS (3).
027700          03  COLUMN 48   PIC ZZ9 SOURCE WPC-PERCENT (3 1).
027800          03  COLUMN 51   PIC X VALUE '%'.
027900          03  COLUMN 57   PIC $$$9.99   SOURCE DE-FICA (3).
028000          03  COLUMN 65   PIC ZZ9 SOURCE WPC-PERCENT (3 2).
028100          03  COLUMN 68   PIC X VALUE '%'.
028200          03  COLUMN 74   PIC $$$9.99   SOURCE DE-FWT (3).
028300          03  COLUMN 82   PIC ZZ9 SOURCE WPC-PERCENT (3 3).
028400          03  COLUMN 85   PIC X VALUE '%'.
028500          03  COLUMN 91   PIC $$$9.99   SOURCE DE-MISC (3).
028600          03  COLUMN 99   PIC ZZ9 SOURCE WPC-PERCENT (3 4).
028700          03  COLUMN 102  PIC X VALUE '%'.
028800          03  COLUMN 108  PIC $$,$$9.99 SOURCE DE-NET (3).
028900          03  COLUMN 118  PIC ZZ9 SOURCE WPC-PERCENT (3 5).
029000          03  COLUMN 121  PIC X VALUE '%'.
029100      02  LINE PLUS 2.
029200          03  COLUMN 05   PIC 9(02) SOURCE DE-NUMBER (4).
029300          03  COLUMN 08   PIC X(15) SOURCE DE-NAME (4).
029400          03  COLUMN 38   PIC $$,$$9.99 SOURCE DE-GROSS (4).
029500          03  COLUMN 48   PIC ZZ9 SOURCE WPC-PERCENT (4 1).
029600          03  COLUMN 51   PIC X VALUE '%'.
029700          03  COLUMN 57   PIC $$$9.99   SOURCE DE-FICA (4).
029800          03  COLUMN 65   PIC ZZ9 SOURCE WPC-PERCENT (4 2).
029900          03  COLUMN 68   PIC X VALUE '%'.
030000          03  COLUMN 74   PIC $$$9.99   SOURCE DE-FWT (4).
030100          03  COLUMN 82   PIC ZZ9 SOURCE WPC-PERCENT (4 3).
030200          03  COLUMN 85   PIC X VALUE '%'.
030300          03  COLUMN 91   PIC $$$9.99   SOURCE DE-MISC (4).
030400          03  COLUMN 99   PIC ZZ9 SOURCE WPC-PERCENT (4 4).
030500          03  COLUMN 102  PIC X VALUE '%'.
030600          03  COLUMN 108  PIC $$,$$9.99 SOURCE DE-NET (4).
030700          03  COLUMN 118  PIC ZZ9 SOURCE WPC-PERCENT (4 5).
```

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```
030800          03  COLUMN 121  PIC X VALUE '%'.
030900      02  LINE PLUS 2.
031000          03  COLUMN 05   PIC 9(02) SOURCE DE-NUMBER (5).
031100          03  COLUMN 08   PIC X(15) SOURCE DE-NAME (5).
031200          03  COLUMN 38   PIC $$,$$9.99 SOURCE DE-GROSS (5).
031300          03  COLUMN 48   PIC ZZ9 SOURCE WPC-PERCENT (5 1).
031400          03  COLUMN 51   PIC X VALUE '%'.
031500          03  COLUMN 57   PIC $$$9.99   SOURCE DE-FICA (5).
031600          03  COLUMN 65   PIC ZZ9 SOURCE WPC-PERCENT (5 2).
031700          03  COLUMN 68   PIC X VALUE '%'.
031800          03  COLUMN 74   PIC $$$9.99   SOURCE DE-FWT (5).
031900          03  COLUMN 82   PIC ZZ9 SOURCE WPC-PERCENT (5 3).
032000          03  COLUMN 85   PIC X VALUE '%'.
032100          03  COLUMN 91   PIC $$$9.99   SOURCE DE-MISC (5).
032200          03  COLUMN 99   PIC ZZ9 SOURCE WPC-PERCENT (5 4).
032300          03  COLUMN 102  PIC X VALUE '%'.
032400          03  COLUMN 108  PIC $$,$$9.99 SOURCE DE-NET (5).
032500          03  COLUMN 118  PIC ZZ9 SOURCE WPC-PERCENT (5 5).
032600          03  COLUMN 121  PIC X VALUE '%'.
032700      02  LINE PLUS 2.
032800          03  COLUMN 05   PIC 9(02) SOURCE DE-NUMBER (6).
032900          03  COLUMN 08   PIC X(15) SOURCE DE-NAME (6).
033000          03  COLUMN 38   PIC $$,$$9.99 SOURCE DE-GROSS (6).
033100          03  COLUMN 48   PIC ZZ9 SOURCE WPC-PERCENT (6 1).
033200          03  COLUMN 51   PIC X VALUE '%'.
033300          03  COLUMN 57   PIC $$$9.99   SOURCE DE-FICA (6).
033400          03  COLUMN 65   PIC ZZ9 SOURCE WPC-PERCENT (6 2).
033500          03  COLUMN 68   PIC X VALUE '%'.
033600          03  COLUMN 74   PIC $$$9.99   SOURCE DE-FWT (6).
033700          03  COLUMN 82   PIC ZZ9 SOURCE WPC-PERCENT (6 3).
033800          03  COLUMN 85   PIC X VALUE '%'.
033900          03  COLUMN 91   PIC $$$9.99   SOURCE DE-MISC (6).
034000          03  COLUMN 99   PIC ZZ9 SOURCE WPC-PERCENT (6 4).
034100          03  COLUMN 102  PIC X VALUE '%'.
034200          03  COLUMN 108  PIC $$,$$9.99 SOURCE DE-NET (6).
034300          03  COLUMN 118  PIC ZZ9 SOURCE WPC-PERCENT (6 5).
034400          03  COLUMN 121  PIC X VALUE '%'.
034500      02  LINE PLUS 2.
034600          03  COLUMN 37   PIC $$$,$$9.99 SOURCE CO-GROSS.
034700          03  COLUMN 48   PIC X(5) VALUE '100%'.
034800          03  COLUMN 55   PIC $$,$$9.99  SOURCE CO-FICA.
034900          03  COLUMN 65   PIC X(5) VALUE '100%'.
035000          03  COLUMN 72   PIC $$,$$9.99  SOURCE CO-FWT.
035100          03  COLUMN 82   PIC X(5) VALUE '100%'.
035200          03  COLUMN 89   PIC $$,$$9.99  SOURCE CO-MISC.
035300          03  COLUMN 99   PIC X(5) VALUE '100%'.
035400          03  COLUMN 107  PIC $$$,$$9.99 SOURCE CO-NET.
035500          03  COLUMN 118  PIC X(5) VALUE '100%'.
035600
035700 PROCEDURE DIVISION.
035800
035900 DECLARATIVES.
036000
036100 DEPT-HEAD-USE SECTION. USE BEFORE REPORTING DEPT-HEAD.
036200 DEPT-HEAD-PROC.
036300     SET DE-IX TO +1.
036400     SEARCH DEPARTMENT-ENTRY
```

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```
036500         WHEN DE-NUMBER (DE-IX) = PRR-DEPARTMENT-NUMBER
036600             MOVE ZEROS TO DE-GROSS (DE-IX), DE-FICA (DE-IX),
036700                           DE-FWT (DE-IX), DE-MISC (DE-IX),
036800                           DE-NET (DE-IX).
036900
037000 DEPT-HEAD-EXIT.
037100     EXIT.
037200
037300 EMPL-FOOT-USE SECTION. USE BEFORE REPORTING EMPL-FOOT.
037400 EMPL-FOOT-PROC.
037500     MOVE PRR-EMPLOYEE-KEY TO WS-EMPLOYEE-KEY.
037600
037700 EMPL-FOOT-EXIT.
037800     EXIT.
037900
038000 DEPT-FOOT-USE SECTION. USE BEFORE REPORTING DEPT-FOOT.
038100 DEPT-FOOT-PROC.
038200     MOVE DEPT-FOOT-GROSS TO DE-GROSS (DE-IX).
038300     MOVE DEPT-FOOT-FICA TO DE-FICA (DE-IX).
038400     MOVE DEPT-FOOT-FWT TO DE-FWT (DE-IX).
038500     MOVE DEPT-FOOT-MISC TO DE-MISC (DE-IX).
038600     MOVE DEPT-FOOT-NET TO DE-NET (DE-IX).
      *     SUPPRESS PRINTING.
038700
038800 DEPT-FOOT-EXIT.
038900     EXIT.
039000
039100 COMP-FOOT-USE SECTION. USE BEFORE REPORTING COMP-FOOT.
039200 COMP-FOOT-PROC.
039300     PERFORM COMP-FOOT-CALC
039400         VARYING WPCD-IX FROM +1 BY +1
039500         UNTIL WPCD-IX > +6.
039600     GO TO COMP-FOOT-EXIT.
039700
039800 COMP-FOOT-CALC.
039900     SET DE-IX TO WPCD-IX.
040000     SET WPCC-IX TO +1.
040100     COMPUTE WPC-PERCENT (WPCD-IX WPCC-IX) ROUNDED =
040200         ((DE-GROSS (DE-IX) / CO-GROSS) * 100) + .5.
040300     SET WPCC-IX TO +2.
040400     COMPUTE WPC-PERCENT (WPCD-IX WPCC-IX) ROUNDED =
040500         ((DE-FICA (DE-IX) / CO-FICA) * 100) + .5.
040600     SET WPCC-IX TO +3.
040700     COMPUTE WPC-PERCENT (WPCD-IX WPCC-IX) ROUNDED =
040800         ((DE-FWT (DE-IX) / CO-FWT) * 100) + .5.
040900     SET WPCC-IX TO +4.
041000     COMPUTE WPC-PERCENT (WPCD-IX WPCC-IX) ROUNDED =
041100         ((DE-MISC (DE-IX) / CO-MISC) * 100) + .5.
041200     SET WPCC-IX TO +5.
041300     COMPUTE WPC-PERCENT (WPCD-IX WPCC-IX) ROUNDED =
041400         ((DE-NET (DE-IX) / CO-NET) * 100) + .5.
041500
041600 COMP-FOOT-EXIT.
041700     EXIT.
041800
041900 END DECLARATIVES.
042000
```

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```
042100 000-INITIATE.
042200
042300     OPEN INPUT PAYROLL-REGISTER-DATA,
042400          OUTPUT REPORT-FILE.
042500
042600     INITIATE QUARTERLY-PAY-REGISTER.
042700
042800     READ PAYROLL-REGISTER-DATA
042900         AT END
043000             MOVE 'Y' TO END-OF-FILE-SWITCH.
043200
043300     PERFORM 100-PROCESS-PAYROLL-DATA THRU 199-EXIT
043400         UNTIL END-OF-FILE.
043500
043600 000-TERMINATE.
043700     TERMINATE QUARTERLY-PAY-REGISTER.
043800
043900     CLOSE PAYROLL-REGISTER-DATA,
044000           REPORT-FILE.
044100
044200     STOP RUN.
044300
044400 100-PROCESS-PAYROLL-DATA.
044500     GENERATE QUARTERLY-PAY-REGISTER.
044600     READ PAYROLL-REGISTER-DATA
044700         AT END
044800             MOVE 'Y' TO END-OF-FILE-SWITCH.
045000
045100 199-EXIT.
045200     EXIT.
045300
```

with

```
$ cobc -x rwex06.cob
# example has SELECTs for DATAIN and SYSPRINT
export DD_DATAIN=./ex06data.txt
export DD_SYSPRINT=./ex06report.txt
./rwex06
cat ex06report.txt
```

giving

```
                                C E N T U R Y   M E D I C A L   C E N T E R
                              Q U A R T E R L Y   P A Y R O L L   R E G I S T E R                    PAGE    1

     --------- EMPLOYEE ---------      GROSS        FICA       FED W/H       MISC.         NET
      NO            NAME               PAY          TAX         TAX        DEDUCT.        PAY

 DEPARTMENT NUMBER:  01 MANAGEMENT

     6622    GAVIN SHAFER           $1,040.00      $60.84      $134.48        $4.75       $839.93
     7078    VERA ALSTON            $1,800.00     $105.30      $138.24        $3.75     $1,552.71
     8093    GRADY KAISER           $2,300.00     $134.57      $247.53        $6.50     $1,911.43

             DEPARTMENT TOTALS      $5,140.00 *   $300.71 *    $520.25 *     $15.00 *   $4,304.07 *


 DEPARTMENT NUMBER:  05 ADMINISTRATIVE

     1720    PAULINE WINSTON          $680.00      $39.79      $290.36        $3.50       $526.37
     2116    HERMAN COX               $610.00      $35.69       $76.52        $7.25       $490.55
     6925    ADOLF TRUJILLO           $625.00      $36.55      $118.95        $4.00       $465.50

             DEPARTMENT TOTALS      $1,915.00 *   $112.03 *    $485.83 *     $14.75 *   $1,482.42 *


 DEPARTMENT NUMBER:  10 SKILLED NURSING
```

```
     1504    TIFFANY KEIR           $1,740.00      $101.82      $187.74        $1.75      $1,448.69
     6640    ALEXANDER CATHEY       $1,950.00      $114.06      $371.10        $7.25      $1,457.59
     9465    STEVE HUGHES           $1,475.00       $86.30      $239.40        $3.00      $1,146.30

             DEPARTMENT TOTALS      $5,165.00 *    $302.18 *    $798.24 *     $12.00 *    $4,052.58 *


DEPARTMENT NUMBER:  15 PATIENT SUPPORT

     2903    KAYLA VERBECK            $840.00       $49.14      $136.32        $5.25        $649.29
     5196    CLAIRE KELLAR            $886.00       $51.82      $102.80        $6.75        $724.63

             DEPARTMENT TOTALS      $1,726.00 *    $100.96 *    $239.12 *     $12.00 *    $1,373.92 *


DEPARTMENT NUMBER:  20 HOUSEKEEPING

     5190    MARYANN GLAZENER         $540.00       $31.62       $69.84        $3.50        $435.10
     6580    CAROLINE TROMBETTA       $480.00       $28.08       $51.78        $2.75        $396.39
     9507    ADRIANA CHANGAZI         $498.00       $29.16       $80.82        $6.75        $381.27

             DEPARTMENT TOTALS      $1,518.00 *     $88.86 *    $202.44 *     $13.00 *    $1,212.76 *


DEPARTMENT NUMBER:  25 MAINTENANCE

      428    MELVIN BEHRENS           $468.00       $27.36       $50.52        $5.00        $385.12
     2003    BALDWIN SIMONSEN         $670.00       $39.22      $113.46        $4.75        $512.57
     6491    LEO TILLEY               $606.00       $35.46       $46.56        $3.50        $520.48

             DEPARTMENT TOTALS      $1,744.00 *    $102.04 *    $210.54 *     $13.25 *    $1,418.17 *

             COMPANY TOTALS        $17,208.00 ** $1,006.78 ** $2,456.42 **    $80.00 **  $13,843.92 **
```

```
                                C e n t u r y   M e d i c a l   C e n t e r
                              Q u a r t e r l y   P a y r o l l   R e g i s t e r                    PAGE     2

                                  GROSS              FICA             FED W/H           MISC.             NET
                                   PAY               TAX                TAX            DEDUCT.           PAY

    * * * DEPARTMENT TOTALS * * *

    01 MANAGEMENT                $5,140.00  30%     $300.71  30%     $520.25  21%      $15.00  19%     $4,304.07  31%

    05 ADMINISTRATIVE            $1,915.00  11%     $112.03  11%     $485.83  20%      $14.75  18%     $1,482.42  11%

    10 SKILLED NURSING           $5,165.00  30%     $302.18  30%     $798.24  33%      $12.00  15%     $4,052.58  29%

    15 PATIENT SUPPORT           $1,726.00  10%     $100.96  10%     $239.12  10%      $12.00  15%     $1,373.92  10%

    20 HOUSEKEEPING              $1,518.00   9%      $88.86   9%     $202.44   8%      $13.00  16%     $1,212.76   9%

    25 MAINTENANCE               $1,744.00  10%     $102.04  10%     $210.54   9%      $13.25  17%     $1,418.17  10%

                                $17,208.00 100%   $1,006.78 100%   $2,456.42 100%      $80.00 100%   $13,843.92 100%
```

Please see http://www.jaymoseley.com/hercules/compiling/cobolrw.htm for a full Report Writer tutorial, and the source archive (plus data for the DATAIN required above). Jay gave permission for this copy, but do yourself a favour and read through the tutorial. It's well done.

4.1.443 REPORTING

`USE BEFORE REPORTING` declarative for Report Writer.

4.1.444 REPORTS

Report Writer file descriptor clause associating files with named reports.

4.1.445 REPOSITORY

A paragraph of the *CONFIGURATION* (page 235) SECTION. GnuCOBOL supports the **FUNCTION ALL INTRINSIC** clause of the REPOSITORY. Allows source code to use intrinsic functions without the *FUNCTION* (page 273) keyword.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20110213
      *> Purpose:   Demonstrate an intrinsic function shortcut
      *> Tectonics: cobc -x functionall.cob
      *> ***************************************************************
       identification division.
       program-id. functionall.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

      *> ***************************************************************
       procedure division.
       display function pi space function e
       display pi space e

       goback.
       end program functionall.
```

Sample output:

```
$ cobc -x functionall.cob
$ ./functionall
3.14159265358979323846264338327950 29 2.71828182845904523536028747135266 25
3.14159265358979323846264338327950 29 2.71828182845904523536028747135266 25
```

Without the **repository** paragraph:

```
$ cobc -x functionall.cob
functionall.cob:19: Error: 'pi' undefined
functionall.cob:19: Error: 'e' undefined
```

Function library main module

There is a plan to have libraries of user defined functions define a *main* module, named the same as the external library filename (for use with `cobcrun`) that displays a REPOSITORY paragraph suitable for cut and paste into application programs.

```
$ cobcrun cobweb-gtk
```

```
*> cobweb-gtk UDF repository follows
 repository.
     function new-builder
     function new-window
     function new-scrolled-window
     function new-box
     function new-frame
     function new-image
     function new-label
     function new-entry
     function new-button
```

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```
    function new-checkbutton
    function new-spinner
    function new-vte
    function new-textview
    function rundown-signals
    function signal-attach
    function builder-signal-attach
    function builder-get-object
    function show-widget
    function hide-widget
    function set-sensitive-widget
    function entry-get-text
    function entry-set-text
    function textview-get-text
    function textview-set-text
    function gtk-go
    function all intrinsic.
```

4.1.446 REQUIRED

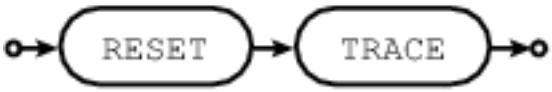
Recognized but ignored Screen section field attribute.

4.1.447 RESERVE

An unsupported *SELECT* (page 395) clause.

4.1.448 RESET

- Report Writer data control field clause.
- program trace line output verb



See *REPORT* (page 369) for more details on SUM reset controls, and page counter resets.

```
SUM OF identifier-1 RESET ON FINAL

NEXT GROUP IS NEXT PAGE WITH RESET
```

Statement tracing is controlled by environment and cobc options.

- -debug
- -ftrace
- -ftracell
- COB_SET_TRACE environment setting

```
READY TRACE
display "statement trace"
RESET TRACE
```

```
Program-Id: tracing          Statement: DISPLAY              Line: 12
statement trace
```

See *READY* (page 360) for more details.

4.1.449 RESUME

Unsupported declarative control flow statement.

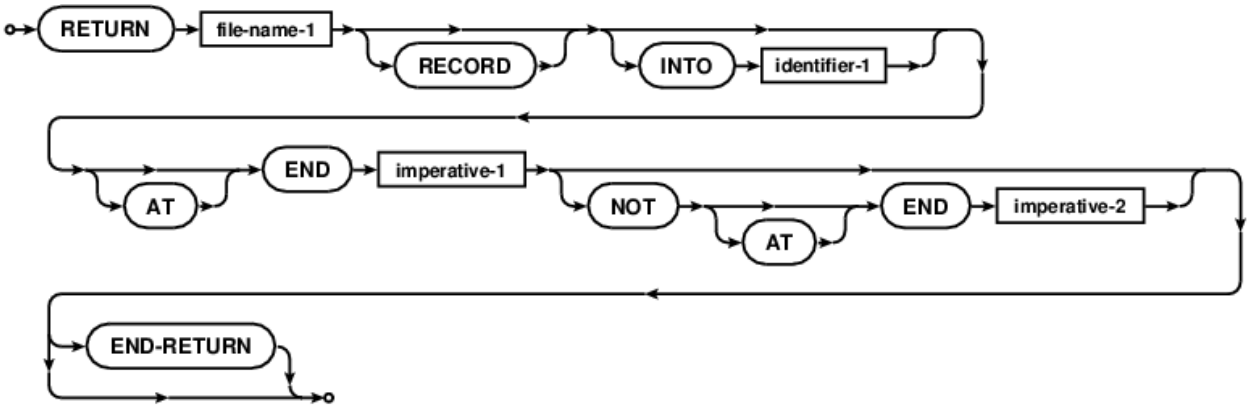
4.1.450 RETRY

Unsupported record locking wait and retry clause.

- RETRY n TIMES
- RETRY FOR n SECONDS
- RETRY FOREVER

4.1.451 RETURN

Return records in a *SORT* (page 403) OUTPUT PROCEDURE.



4.1.452 RETURN-CODE

Predefined subprogram return value. USAGE BINARY-LONG.

See *A 5-7-5 haiku?* (page 50)

4.1.453 RETURNING

- Specify the destination of CALL results.

```
01 result PIC S9(8).

CALL "libfunc" RETURNING result END-CALL
```

- Specify the return field for a subprogram or user defined function.

```
PROCEDURE DIVISION USING thing RETURNING otherthing
```

4.1.454 REVERSE-VIDEO

SCREEN (page 391) section field display attribute. Functionality dependent on terminal and operating system support and settings.

4.1.455 REVERSED

An ignored clause for *OPEN* (page 334).

4.1.456 REWIND

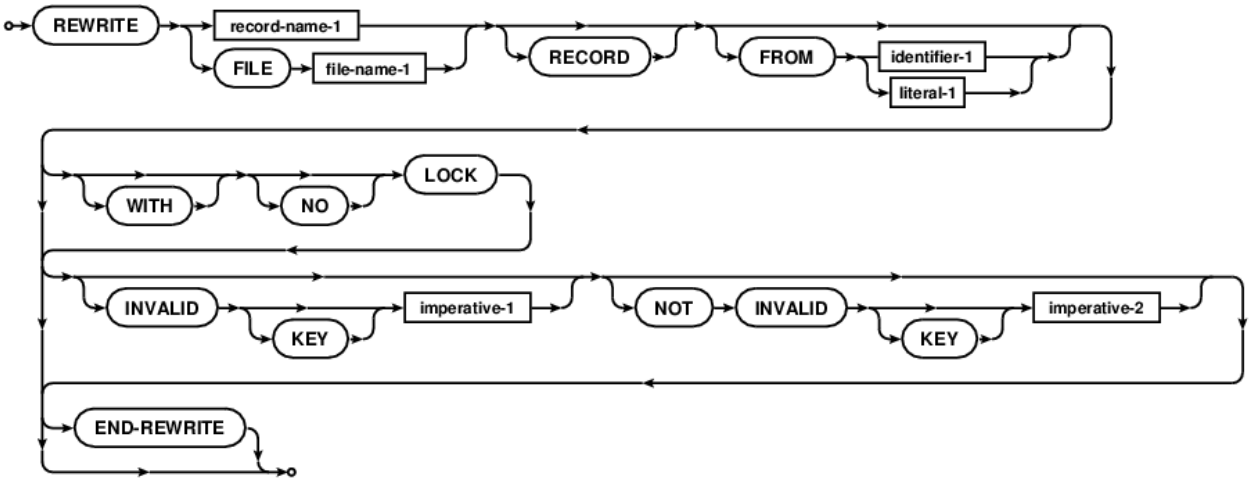
A really cool lyric in the Black Eyed Peas song, "Hey Mama".

Historically used for for tape drive control. It is supported syntax, but ignored by GnuCOBOL.

```
close tax-file with no rewind
```

4.1.457 REWRITE

Allows overwrite of records where the primary key already exists.




```
write person
    invalid key
        move concatenate("overwriting: " nicknum) to problem
        rewrite person
            invalid key
                move concatenate(
                    exception-location() space nicknum
                    space filestatus)
                to problem
        end-rewrite
end-write.
```

And a sample program to show REWRITE used with a sample SEQUENTIAL file.

```
GCOBOL >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *><* =================
      *><* rewriting example
      *><* =================
      *><* :Author:    Brian Tiffin
      *><* :Date:      17-Feb-2009, 29-Apr-2016
      *><* :Purpose:   Demonstrate SEQUENTIAL REWRITE
      *><* :Copyright: Dedicated to the public domain
      *><* :Tectonics:
      *><*    cobc -xj rewriting.cob
      *><*    dd if=rewriting.dat cbs=53 conv=unblock status=none
      *> ************************************************************
       identification division.
       program-id. rewriting-test.

       environment division.
       configuration section.

       input-output section.
       file-control.
          select rewriting
          assign to "rewriting.dat"
          status is rewriting-status
          organization is sequential
          access mode is sequential
          .

       data division.
       file section.
       fd rewriting.
       01 rewriting-record     pic x(44).

       working-storage section.
       01 rewriting-status.
          03 high-status       pic xx.
             88 rewriting-ok   values '00' thru '09'.

       01 record-stat pic x.
          88 no-more-records value low-value false high-value.

       01 data-line.
          05 value
             "The first two data lines will be overwritten".

       01 redata-line.
          05 value
             "I'm a big fan of COBOL and GnuCOBOL features".

      *> ************************************************************
       procedure division.

      *> Populate a sample database, create or overwrite
       display "WRITE four records" end-display
       perform populate-sample
```

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```
      *> open the data file again, for input and output
       open i-o rewriting
       perform rewriting-check

       display "REWRITE the first two records" end-display
       perform rewrite-a-record
       perform rewrite-a-record

      *> and with that we are done with rewriting sample
       close rewriting

       goback.
      *> ****************************************************************

      *><* read next sequential paragraph
       read-next-record.
           read rewriting next record
               at end set no-more-records to true
           end-read
           display "Read: "rewriting-record end-display
           perform rewriting-check
       .

      *><* Write paragraph
       write-rewriting-record.
           write rewriting-record end-write
           perform rewriting-check
       .

       rewrite-rewriting-record.
           rewrite rewriting-record end-rewrite
           perform rewriting-check
       .

      *><* file status quick check.  For this sample, keep running
       rewriting-check.
           if not rewriting-ok then
               display
                   "file io problem: " rewriting-status upon syserr
               end-display
           end-if
       .

      *><* demonstrate a record rewrite
       rewrite-a-record.
           perform read-next-record
           if no-more-records then
               display "no record to rewrite" upon syserr end-display
           else
               move redata-line to rewriting-record
               perform rewrite-rewriting-record
           end-if
       .

      *><* populate a sample file
       populate-sample.
           open output rewriting
```

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```
           perform rewriting-check

           move data-line to rewriting-record
           perform 4 times
               perform write-rewriting-record
           end-perform

      *> close sample file, as the rewrite demo needs a different mode
           close rewriting
           perform rewriting-check
       .

       end program rewriting-test.
      *><*
      *><* Last Update: 20160429
```

With a sample run of:

```
prompt$ cobc -xj rewriting.cob
WRITE four records
REWRITE the first two records
Read: The first two data lines will be overwritten
Read: The first two data lines will be overwritten

prompt$ dd if=rewriting.dat cbs=44 conv=unblock status=none
I'm a big fan of COBOL and GnuCOBOL features
I'm a big fan of COBOL and GnuCOBOL features
The first two data lines will be overwritten
The first two data lines will be overwritten
```

The `dd` command was used instead of `cat` for verification as SEQUENTIAL files have no implied newlines. With `cat`, the file will display as one long line of data (unless is happens to contain explicit newline bytes).

REWRITE can work with LINE SEQUENTIAL files (support in the reportwriter branch), but the record lengths must be identical when each line is overwritten, and well, it's asking for trouble. Better to READ and WRITE a new file.

Please note that REWRITE is a fairly risky operation. Failures may leave files in a state where re-runs are impossible and original information is effectively lost.

4.1.458 RF

Short form for REPORT FOOTING.

4.1.459 RH

Short form for REPORT HEADING.

4.1.460 RIGHT

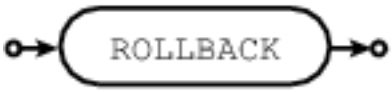
Ignored *SYNCHRONIZED* (page 417) clause.

4.1.461 RIGHT-JUSTIFY

Not yet implemented.

4.1.462 ROLLBACK

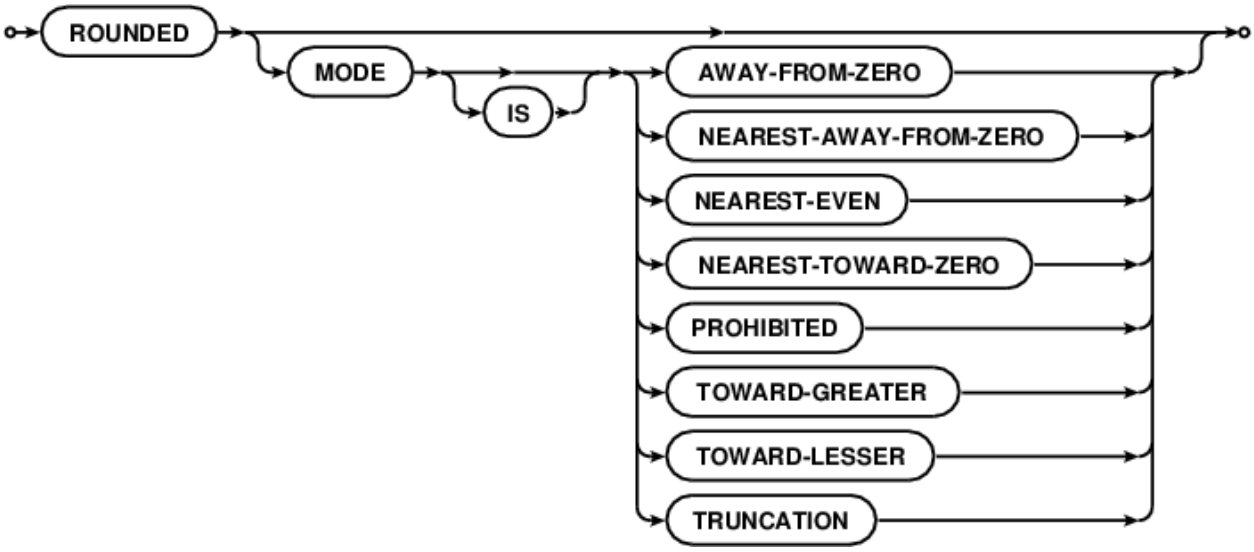
Recognized but not fully supported revert of transactional file writes.



See *COMMIT* (page 229).

4.1.463 ROUNDED

Well defined rounding clause applied to arithmetic. Defined well enough for bank managers to feel comfortable handing their calculations over to a bunch of programmers.




```
COMPUTE total-value ROUNDED = 1.0 / 6.0
```

Recent standards have defined quite a few explicit `ROUNDED MODE IS` behaviour modifiers.

- *AWAY-FROM-ZERO* (page 210)
- *NEAREST-AWAY-FROM-ZERO* (page 325)
- *NEAREST-EVEN* (page 325)
- *NEAREST-TOWARD-ZERO* (page 326)
- *PROHIBITED* (page 356)
- *TOWARD-GREATER* (page 421)
- *TOWARD-LESSER* (page 421)
- *TRUNCATION* (page 423)

With the default being NEAREST-AWAY-FROM-ZERO with modeless ROUNDED, and TRUNCATION when the *ROUNDED* (page 386) keyword is not present.

An example of the various ROUNDED MODE phrases:

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ************************************************************
      *>****J* gnucobol/rounding
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20151018   Modified:  2015-10-18/14:40-0400
      *> LICENSE
      *>   Copyright 2015 Brian Tiffin
      *>   GNU General Public License, GPL, 3.0 (or greater)
      *> PURPOSE
      *>   ROUNDED MODE examples
      *> TECTONICS
      *>   cobc -x rounding.cob -g -debug
      *> ************************************************************
       identification division.
       program-id. rounding.
       author. Brian Tiffin.
       date-written. 2015-10-18/14:40-0400.
       remarks. Exercise the various ROUNDED MODE options.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 samples.
          05 filler occurs 10 times.
             10 val       pic s9v99.

       01 results.
          05 filler occurs 7 times.
             10 mode-name pic x(22).
             10 filler occurs 10 times.
                15 res    pic s9.

       01 prohibit-bad    pic s9v999 value 2.499.
       01 prohibit-good   pic s9v99 value 2.49.
       01 no-round        pic s9v99.

       01 value-index     pic 99.
       01 mode-index      pic 9.

      *> ************************************************************
       procedure division.
       move +2.49 to val(1)
       move -2.49 to val(2)
       move +2.50 to val(3)
       move -2.50 to val(4)
       move +3.49 to val(5)
```

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```
       move -3.49 to val(6)
       move +3.50 to val(7)
       move -3.50 to val(8)
       move +3.51 to val(9)
       move -3.51 to val(10)

       move "away-from-zero" to mode-name(1)
       move "nearest-away-from-zero" to mode-name(2)
       move "nearest-even" to mode-name(3)
       move "nearest-toward-zero" to mode-name(4)
       move "toward-greater" to mode-name(5)
       move "toward-lesser" to mode-name(6)
       move "truncation" to mode-name(7)

       perform varying value-index from 1 by 1 until value-index > 10
           add val(value-index) zero giving res(1, value-index)
               rounded mode away-from-zero
           add val(value-index) zero giving res(2, value-index)
               rounded mode nearest-away-from-zero
           add val(value-index) zero giving res(3, value-index)
               rounded mode nearest-even
           add val(value-index) zero giving res(4, value-index)
               rounded mode nearest-toward-zero
           add val(value-index) zero giving res(5, value-index)
               rounded mode toward-greater
           add val(value-index) zero giving res(6, value-index)
               rounded mode toward-lesser
           add val(value-index) zero giving res(7, value-index)
               rounded mode truncation
       end-perform
       display "                       " with no advancing
       perform varying value-index from 1 by 1 until value-index > 9
           display val(value-index) " " with no advancing
       end-perform
       display val(10)

       perform varying mode-index from 1 by 1 until mode-index > 7
           display mode-name(mode-index) with no advancing
           perform varying value-index from 1 by 1 until value-index > 10
               display "  " res(mode-index, value-index) "  "
                   with no advancing
           end-perform
           evaluate true
               when mode-index = 2
                   display "default ROUNDED"
               when mode-index = 3
                   display "Banker's rounding"
               when mode-index = 7
                   display "no ROUNDED given"
               when other
                   display space
           end-evaluate
       end-perform
       .

      *> fall through to this labelled paragraph
       prohibited-rounding.
```

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```
       display space
       display "PROHIBITED example"
       display "------------------"
       display "Attempt to ADD " prohibit-bad
               " ZERO GIVING an s9v99 ROUNDED MODE PROHIBITED"
       add prohibit-bad zero giving no-round rounded mode prohibited
           on size error
               perform soft-exception
           not on size error
               display prohibit-bad ", " no-round
       end-add

       display space
       display "Attempt to ADD " prohibit-good
               " ZERO GIVING an s9v99 ROUNDED MODE PROHIBITED"
       add prohibit-good zero giving no-round rounded mode prohibited
           on size error
               perform soft-exception
           not on size error
               display prohibit-good ", " no-round
       end-add

       goback.
      *> ****************************************************************

      *> informational warnings and abends
       soft-exception.
         display "Module:              " module-id upon syserr
         display "Module Path:         " module-path upon syserr
         display "Module Source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
         perform soft-exception
         stop run returning 127
       .

       end program rounding.
      *> ****************************************************************
      *>****
```

```
>>ELSE
==============
rounding usage
==============

./rounding

Introduction
------------

Displays an example of the various ROUNDED MODE clauses supported by
```

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```
GnuCOBOL.

Source
------

.. code-include::  rounding.cob
   :language: cobol
>>END-IF
```

Giving:

```
prompt$ cobc -x rounding.cob -g -debug
prompt$ ./rounding
```

```
                      +2.49 -2.49 +2.50 -2.50 +3.49 -3.49 +3.50 -3.50 +3.51 -3.51
  away-from-zero        +3    -3    +3    -3    +4    -4    +4    -4    +4    -4
  nearest-away-from-zero +2   -2    +3    -3    +3    -3    +4    -4    +4    -4  default ROUNDED
  nearest-even          +2    -2    +2    -2    +3    -3    +4    -4    +4    -4  Banker's rounding
  nearest-toward-zero   +2    -2    +2    -2    +3    -3    +3    -3    +4    -4
  toward-greater        +3    -2    +3    -2    +4    -3    +4    -3    +4    -3
  toward-lesser         +2    -3    +2    -3    +3    -4    +3    -4    +3    -4
  truncation            +2    -2    +2    -2    +3    -3    +3    -3    +3    -3  no ROUNDED given

  PROHIBITED example
  ------------------
  Attempt to ADD +2.499 ZERO GIVING an s9v99 ROUNDED MODE PROHIBITED
  Module:              rounding
  Module Path:         /home/btiffin/lang/cobol/forum/rounding
  Module Source:       rounding.cob
  Exception-file:      00
  Exception-status:    EC-SIZE-TRUNCATION
  Exception-location:  rounding; prohibited-rounding; 106
  Exception-statement: ADD

  Attempt to ADD +2.49 ZERO GIVING an s9v99 ROUNDED MODE PROHIBITED
  +2.49, +2.49
```

4.1.464 ROUNDING

Not yet implemented.

Will be part of an *OPTIONS* (page 335) paragraph in the `IDENTIFICATION DIVISION` to explicitly set behaviour for INTERMEDIATE ROUNDING.

4.1.465 RUN

A stopping point.

```
STOP RUN RETURNING 1
```

Terminates run regardless of nesting depth, returning control (and result) to operating system. See *GOBACK* (page 295) and EXIT *PROGRAM* (page 356) for other run unit terminations.

4.1.466 SAME

I-O-CONTROL clause for SAME RECORD AREA.

4.1.467 SCREEN

Screen section. curses/ncurses based terminal user interface.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************ <*
      *> Author:    Brian Tiffin
      *> Date:      20110701
      *> Purpose:   Play with 2.0 screen section
      *> Tectonics: cobc -x screening.cob
      *> ************************************************************ <*
       identification division.
       program-id. screening.

       data division.
       working-storage section.
       01 some-data pic s9(9).

       screen section.
       01 detail-screen.
          03 line 1 column 1 value "title line".
          03 line 2 column 1 value "field: ".
          03 line 2 column 16 using some-data.

      *> ************************************************************ <*
       procedure division.
       accept detail-screen end-accept
       goback.

       end program screening.
```

being a poor representation of the plethora of field attribute control allowed in GnuCOBOL screen section.

Screen field attributes include:

- JUSTIFIED RIGHT
- BLANK WHEN ZERO
- OCCURS integer-val TIMES
- BELL, BEEP
- AUTO, AUTO-SKIP, AUTOTERMINATE
- UNDERLINE
- OVERLINE
- SECURE
- REQUIRED
- FULL
- PROMPT
- REVERSE-VIDEO
- BLANK LINE
- BLANK SCREEN
- ERASE EOL

- ERASE EOS
- SIGN IS LEADING SEPARATE CHARACTER
- SIGN IS TRAILING SEPARATE CHARACTER
- LINE NUMBER IS [PLUS] integer-val
- COLUMN NUMBER IS [PLUS] integer-val
- FOREGROUND-COLOR IS integer-val HIGHLIGHT, LOWLIGHT
- BACKGROUND-COLOR IS integer-val BLINK
- PICTURE IS picture-clause USING identifier
- PICTURE IS picture-clause FROM identifier, literal
- PICTURE IS picture-clause TO identifier
- VALUE is literal

During ACCEPT, *USING* (page 429) fields are read/write, *FROM* (page 272) fields are read and *TO* (page 421) fields are write.

See *What are the GnuCOBOL SCREEN SECTION colour values?* (page 754) for colour values.

Also see *Why don't I see any output from my GnuCOBOL program?* (page 139) and *Does GnuCOBOL support SCREEN SECTION?* (page 754) for more details and tidbits.

4.1.468 SCROLL

Screen section attribute for group OCCURS scrolling.

```
SCROLL UP 8
SCROLL DOWN 4
```

4.1.469 SD

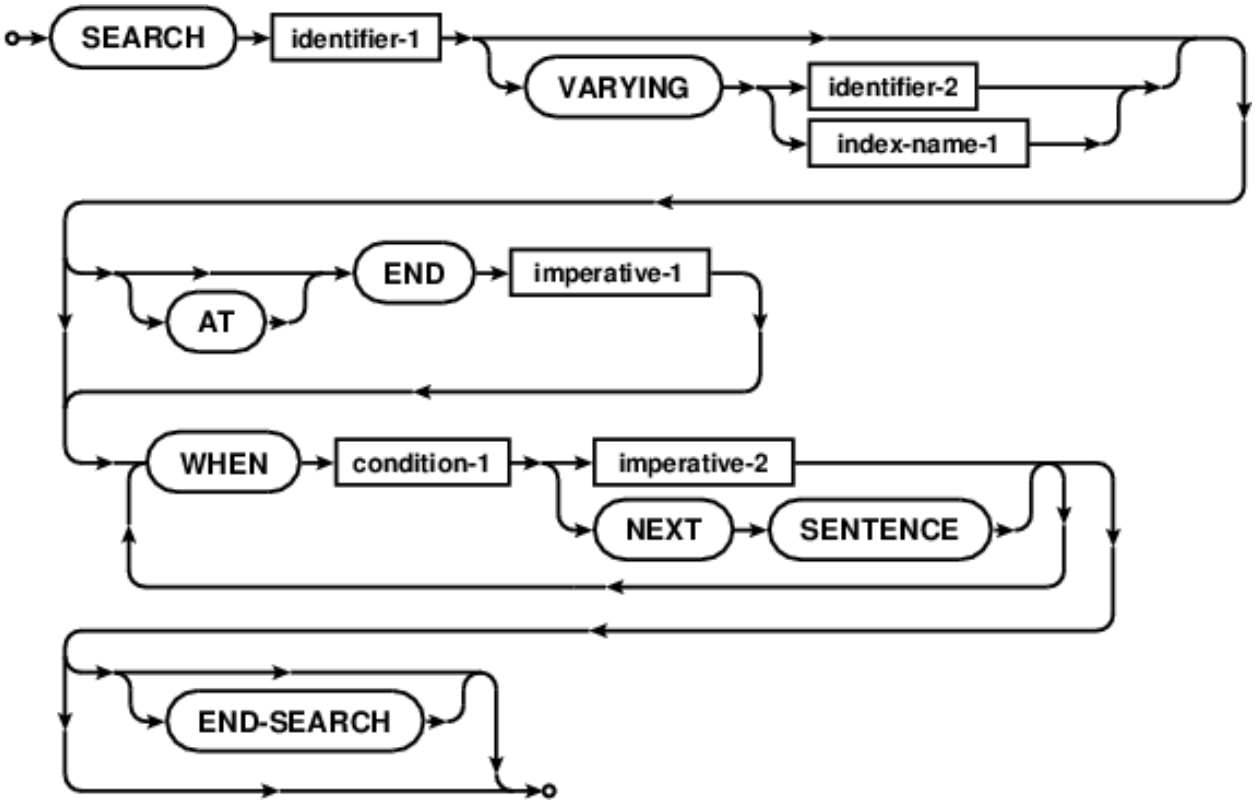
SORT (page 403) file data descriptor.

```
SD sort-file-1
    RECORD CONTAINS 80 CHARACTERS.
```

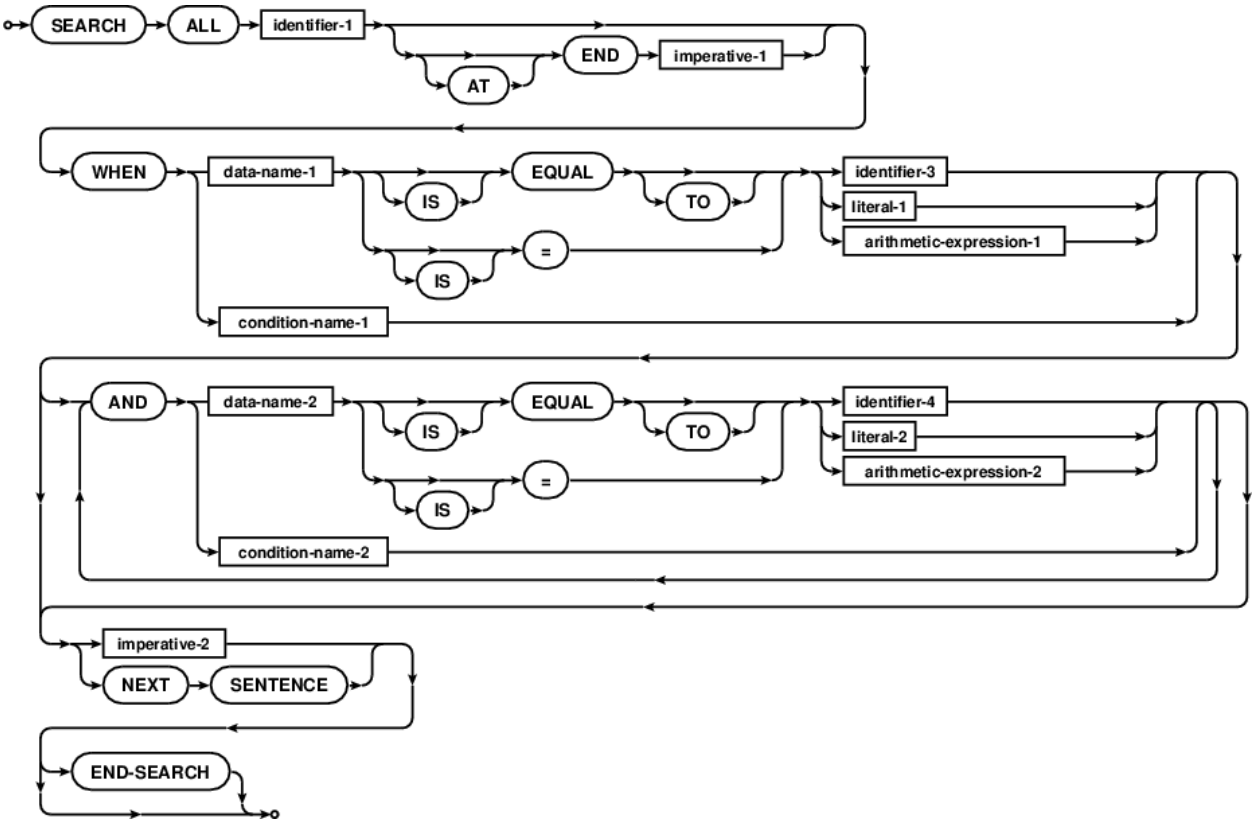
4.1.470 SEARCH

A powerful table and file search verb. Comes in two forms, linear and binary search all.

Serial search:



Binary search:



Linear search can be used on unsorted data, search all requires the information to be properly sorted by defined table

or file key.

See *Linear SEARCH* (page 914) and *SORT and binary SEARCH ALL* for examples.

4.1.471 SECONDS

Clause of unsupported read/write *RETRY* (page 381) on lock.

4.1.472 SECTION

COBOL source code is organized in *DIVISION* (page 250), *SECTION* (page 394), paragraphs and sentences. GnuCOBOL supports user named sections and recognizes the following list of pre-defined sections.

- *CONFIGURATION* (page 235)
- *INPUT-OUTPUT* (page 304)
- *FILE* (page 261)
- *WORKING-STORAGE* (page 433)
- *LOCAL-STORAGE* (page 318)
- *LINKAGE* (page 318)
- *REPORT* (page 369)
- *SCREEN* (page 391)

Use of DECLARATIVES **requires** user named sections.

User defined section and paragraph names provide for source code organization and use of *PERFORM* (page 347) (*arguably*, with paragraph *THROUGH* (page 419) paragraph) for tried and true COBOL procedural programming.

Most samples in this document do not take advantage of the *programming in the large* features provided by section programming. Perhaps check out http://sourceforge.net/projects/acas/ for PITL sources.

4.1.473 SECURE

SCREEN (page 391) section field attribute. Displayed as asterisks.

4.1.474 SECURITY

An informational paragraph in the *IDENTIFICATION* (page 296) DIVISION. Deemed OBSOLETE, but still in use. GnuCOBOL treats this as an end of line comment.

4.1.475 SEGMENT

Unsupported Communication section clause.

4.1.476 SEGMENT-LIMIT

An ignored clause of the OBJECT-COMPUTER paragraph.

4.1.477 SELECT

FILE-CONTROL (page 264) phrase. Associates files with names, descriptors, and options.

```
ENVIRONMENT DIVISION.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
    SELECT OPTIONAL fileresource
        ASSIGN TO external-name
        FILE STATUS IS identifier
        COLLATING SEQUENCE IS alphabet-name
        LOCK MODE IS MANUAL WITH LOCK ON MULTIPLE RECORDS
        RECORD DELIMITER IS STANDARD
        RESERVE num AREA
        SHARING WITH NO OTHER
        ORGANIZATION IS INDEXED
            ACCESS MODE IS DYNAMIC
            RECORD KEY IS key-field
            ALTERNATE RECORD KEY IS key-field-2 WITH DUPLICATES
            ALTERNATE RECORD KEY IS key-field-3
            ALTERNATE RECORD KEY IS splitkey
                SOURCE IS first-part OF indexing-record
                          last-part OF indexing-record
                WITH DUPLICATES.
```

On the issue of verbosity, that phrase counts as verbose. On the other hand, naming a quick file can be as simple as

```
SELECT myfile ASSIGN TO "name.txt".
```

For GnuCOBOL, on POSIX, that will be treated as a *LINE* (page 318) *SEQUENTIAL* (page 396) file by default.

Note the *OPTIONAL* (page 334) in the big crufty file descriptor. Optional files allow for OPEN when non existent.

4.1.478 SELF

Unsupported Object COBOL clause.

4.1.479 SEND

Unsupported Communication section verb.

4.1.480 SENTENCE

An obsolete control flow clause. *CONTINUE* (page 236) is preferred to NEXT SENTENCE.

Flow jumps to the next sentence, normally determined by full stop period, and not just the next statement.

```
100-entry.
    MOVE data-field TO formatted-field
    IF sub-field IS GREATER THAN 10 THEN
        PERFORM DO-STUFF
    ELSE
        NEXT SENTENCE
    END-IF
```

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```
    DISPLAY "Still the first sentence".   *> Note the period

    DISPLAY "NEXT SENTENCE would jump to here"
.
```

Above, the first display line would be skipped over by NEXT SENTENCE, as the statement is still part of the MOVE and IF "sentence". The next sentence occurs after the full stop. Used properly, it can be powerful, but it has hidden GO TO properties that can make it hard to quickly understand code flow.

4.1.481 SEPARATE

Fine tuned control over leading and trailing sign indicator.

```
77 field-1 PICTURE S9(8) SIGN IS TRAILING SEPARATE.
```

This option can make it much easier to port data into and out of systems as the sign is not encoded in the value, and less prone to binary representation differences between different hardware architectures.

4.1.482 SEQUENCE

Controls *COLLATING* (page 228) sequence for character compares, by defining a character set.

4.1.483 SEQUENTIAL

GnuCOBOL supports both fixed length SEQUENTIAL and newline terminated *LINE* (page 318) SEQUENTIAL file access.

The POSIX `dd` command can come in handy when dealing with COBOL SEQUENTIAL file access modes. Normal SEQUENTIAL (unlike LINE SEQUENTIAL) files have no implicit newlines between records. Records are simply a number of bytes, usually (but not always) equal fixed length. `dd` has options for handling fixed length records.

For example:

```
dd if=inputfile.dat cbs=80 conv=unblock status=none
```

Will add newlines after reading and converting 80 byte records.

```
dd if=textfile.txt of=output.dat cbs=80 conv=block status=none
```

will read a normal newline terminated text file and write out space padded 80 byte records. See the man page for `dd` for more information and the many options available regarding input, output byte size and conversion types.

See *REWRITE* (page 382) for a sample program that uses READ, WRITE and REWRITE on a

```
ORGANIZATION IS SEQUENTIAL
ACCESS MODE IS SEQUENTIAL
```

dataset.

Variable length sequential

A contrived example of Variable Length Sequential file processing:

```
*> GnuCOBOL variable length sequential read/write, contrived
*> tectonics: cobc -xjd varseq-sample.cob
 identification division.
 program-id. varseq-sample.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 input-output section.
 file-control.
     select optional varseq assign to varseq-name
     organization is sequential
     file status is varseq-stat.

 data division.
 file section.
 fd varseq
     record is varying in size
     from 0 to 36 depending on varseq-size.
 01 varseq-record.
    05 pic x occurs 0 to 36 depending on varseq-size.

 working-storage section.
 01 varseq-name.
    05 value "varseq.dat".
 01 varseq-stat          pic xx.
    88 varseq-ok             value "00".
    88 varseq-eof            value "10".
 01 varseq-size          pic 99.

*> a semi realistic record type, trigger is "CUSTINFO"
 01 varseq-master.
    05 record-marker     pic x(8).
    05 cust-total        pic s9(8)v99 usage comp-5.
    05 cust-hint         pic x(16).

*> different fillers for the 1 to 36 byte samples
 01 fake-data-1.
    05 value "0123456789abcdefghijklmnopqrstuvwxyz".
 01 fake-data-2.
    05 value "zyxwvutsrqponmlkjihgfedcba9876543210".
 01 fake-data-3.
    05 value "###################------------------".
 01 fake-data-4.
    05 value "==================++++++++++++++++++".

*> 5 different fake data sources, every fifth is type CUSTINFO
 01 random-integer pic 99.
 01 random-float   usage float-long.

 procedure division.
 varseq-sample.

*> fill the file with fake data, different lengths
 perform populate-varseq
```

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```
*> now read through the fake data
 perform scan-varseq

 goback.
*> ******************************************************

 populate-varseq.
*> fill in some semi-realistic customer data
*>   "CUSTINFO" determines this special record type
 move "CUSTINFO" to record-marker
 move 1234.56 to cust-total
 move "Likes dogs, golf" to cust-hint

 open output varseq
 if not varseq-ok then
     display "error opening " varseq-name " for write "
              varseq-stat upon syserr
 end-if

*> contrived loop to fill in 0 to 36 byte records
*>  every random fifth, write out the semi-realistic customer
*>      each time customer data is written, double the total
 perform varying tally from 0 by 1 until tally > 36
     move tally to varseq-size
     compute random-float = random() * 5.0
     compute random-integer = random-float + 1.0
     if varseq-size greater than 0 then
         evaluate random-integer
             when 1
                 move fake-data-1(1:varseq-size) to varseq-record
             when 2
                 move fake-data-2(1:varseq-size) to varseq-record
             when 3
                 move fake-data-3(1:varseq-size) to varseq-record
             when 4
                 move fake-data-4(1:varseq-size) to varseq-record
             when 5
                 move length(varseq-master) to varseq-size
                 move varseq-master to varseq-record
                 add cust-total to cust-total
         end-evaluate
     end-if
     write varseq-record
     if not varseq-ok then
         display "error writing " varseq-name
                 "at " tally " with " varseq-stat
            upon syserr
     end-if
 end-perform
*> write out one more zero length record
 move 0 to varseq-size
 write varseq-record
 if not varseq-ok then
     display "error writing " varseq-name
             "at 0 with " varseq-stat
        upon syserr
```

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```
 end-if

*> close the made up data, report any anomalies
 close varseq
 if not varseq-ok then
     display "error closing write " varseq-name upon syserr
 end-if
 .

*> do a read pass, if the first eight bytes are the magic key
*> treat data as the semi-real customer info
*> total should double on each display of the dog lovin golfer
*> a real application would likely have a varseq-recordtype field
*> instead of just looking for "CUSTINFO" as a magic key
 scan-varseq.

 open input varseq
 if not varseq-ok then
     display "error opening " varseq-name " for read "
              varseq-stat upon syserr
     *> just bail if open fails
     exit paragraph
 end-if

 perform until varseq-eof
     read varseq
     if varseq-ok then
         display "read " varseq-size " bytes " with no advancing
         if varseq-record(1:8) equal "CUSTINFO" then
             move varseq-record to varseq-master
             display "Customer info: " cust-total ", " cust-hint
         else
             display trim(varseq-record)
         end-if
     else
         if not varseq-eof then
             display "error reading " varseq-name upon syserr
         end-if
     end-if
 end-perform

*> close the read pass, report any anomalies
 close varseq
 if not varseq-ok and not varseq-eof then
     display "error closing read " varseq-name upon syserr
 end-if
 .

 end program varseq-sample.
```

Showing (with GnuCOBOL 2.0, configured with VBISAM):

```
prompt$ cobc -xjd varseq-sample.cob
read 00 bytes
read 01 bytes z
read 02 bytes ==
read 03 bytes ===
```

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```
read 32 bytes Customer info: +00001234.56, Likes dogs, golf
read 05 bytes 01234
read 06 bytes zyxwvu
read 07 bytes =======
read 08 bytes zyxwvuts
read 09 bytes #########
read 10 bytes ##########
read 11 bytes ==========
read 12 bytes zyxwvutsrqpo
read 13 bytes #############
read 32 bytes Customer info: +00002469.12, Likes dogs, golf
read 32 bytes Customer info: +00004938.24, Likes dogs, golf
read 16 bytes ================
read 17 bytes =================
read 18 bytes 0123456789abcdefgh
read 19 bytes ==================+
read 20 bytes 0123456789abcdefghij
read 21 bytes zyxwvutsrqponmlkjihgf
read 22 bytes 0123456789abcdefghijkl
read 32 bytes Customer info: +00009876.48, Likes dogs, golf
read 24 bytes 0123456789abcdefghijklmn
read 25 bytes ##################-------
read 26 bytes 0123456789abcdefghijklmnop
read 27 bytes 0123456789abcdefghijklmnopq
read 32 bytes Customer info: +00019752.96, Likes dogs, golf
read 29 bytes zyxwvutsrqponmlkjihgfedcba987
read 30 bytes ##################------------
read 32 bytes Customer info: +00039505.92, Likes dogs, golf
read 32 bytes ==================++++++++++++++
read 33 bytes zyxwvutsrqponmlkjihgfedcba9876543
read 34 bytes ==================+++++++++++++++++
read 35 bytes ##################-----------------
read 36 bytes ##################------------------
read 00 bytes
```

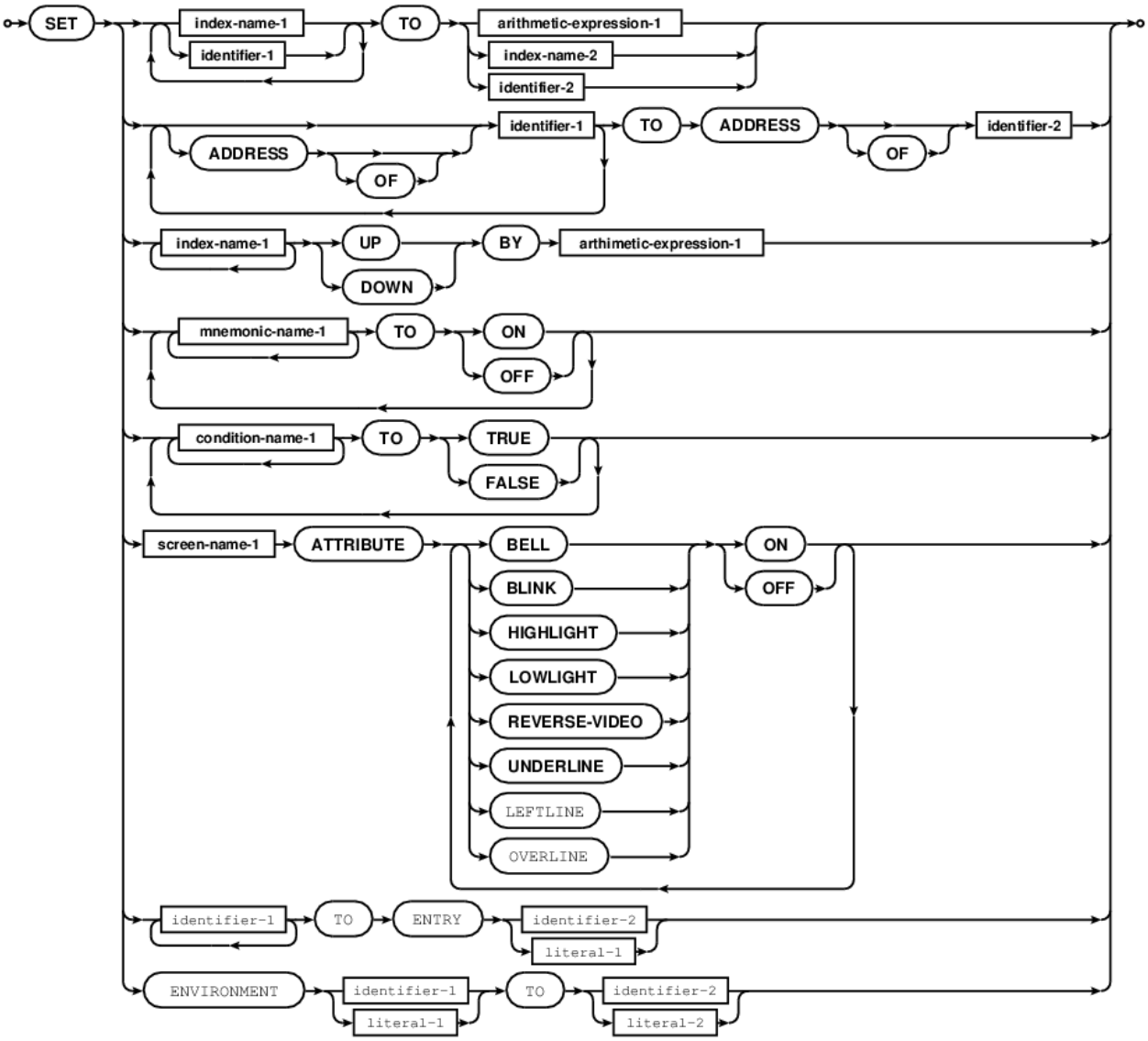
A real program using variable length sequential would have more meaningful reasons to use the different lengths, very likely with different record layouts interspersed throughout the file. And there would be a more rigorous list of type tags used to determine what each record actually contained. In this case the records are just random data except for the ones marked "CUSTINFO".

One feature of variable length records is that there has to be a way to determine the expected record contents, often marked in the record itself in the first few bytes of each record. Otherwise the runtime won't know where to put records, or what the fields are supposed to mean.

This is one of the reasons that in COBOL, you *WRITE* (page 433) records and *READ* (page 359) files. Each file can have different records. `READ` may not know what is next, but `WRITE` always knows what record is being written.

4.1.484 SET

Multi-purpose verb for assigning values and operating enviroment settings.



- SET ADDRESS OF ptr-var TO var.
- SET ENVIRONMENT “name” TO “value”.
- SET screen-name-1 ATTRIBUTE BLINK OFF
- SET condition-name-1 TO TRUE

That last one is pretty cool. An 88 level conditional set TRUE will cause the associated value to change to a value that satisfies the condition as true.

```
01 field-1 pic 99.
   88 cond-1 value 42.

MOVE 0 TO field-1
DISPLAY field-1
SET cond-1 TO TRUE
DISPLAY field-1
```

00 and 42 are displayed.

4.1.485 SHARING

File sharing option.

- SHARING WITH NO OTHER
- SHARING WITH ALL OTHER
- SHARING WITH READ ONLY

Functionality dependent on build options and operating system running GnuCOBOL.

4.1.486 SIGN

Fine tuned control over leading and trailing sign indicator.

```
77 field-1 PICTURE S9(8) SIGN IS TRAILING SEPARATE.
```

4.1.487 SIGNED

GnuCOBOL supports the full gamut of COBOL numeric data storage. SIGNED and *UNSIGNED* (page 425) being part and parcel.

4.1.488 SIGNED-INT

A native storage format *NUMERIC* (page 328) data *USAGE* (page 427) clause (meaning it may be 16/32/64/nnn bits, depending on C ABI specifications for the operating system and hardware). Equivalent to *BINARY-LONG* (page 215), BINARY-LONG SIGNED, and *SIGNED-LONG* (page 402).

4.1.489 SIGNED-LONG

A native storage format *NUMERIC* (page 328) data *USAGE* (page 427) clause. Platform dependent and can be 32 bits or 64 bits, with SIGN.

4.1.490 SIGNED-SHORT

A native storage format *NUMERIC* (page 328) data *USAGE* (page 427) clause. Equivalent to *BINARY-SHORT* (page 217) SIGNED.

4.1.491 SIZE

Multi purpose.

- GnuCOBOL allows SIZE IS control on CALL arguments.

```
CALL "c-function" USING
    BY VALUE UNSIGNED SIZE IS 2 short-field
    RETURNING new-value
END-CALL
```

Will properly pass a 16 bit unsigned value.

- Arithmetic operations allow for declaratives ON SIZE errors.

```
ADD 1 TO gnucobol
    ON SIZE ERROR
        SET erroneous TO TRUE
    NOT ON SIZE ERROR
        DISPLAY "ADDING 1 TO COBOL"
END-ADD
```

- *STRING* (page 414) has a DELIMITED BY SIZE option, to include entire fields.

```
STRING
   field-1        DELIMITED BY SIZE
   " slash/slash" DELIMITED BY "/"
   field-2        DELIMTTED BY SIZE
   INTO response-field
   ON OVERFLOW
      DISPLAY "response truncated" UPON SYSERR
END-STRING
```

- In the OBJECT-COMPUTER paragraph

```
MEMORY SIZE IS integer-1 WORDS
```

but that would scanned and ignored by GnuCOBOL.

4.1.492 SORT

Sort a file or table.

File sort:

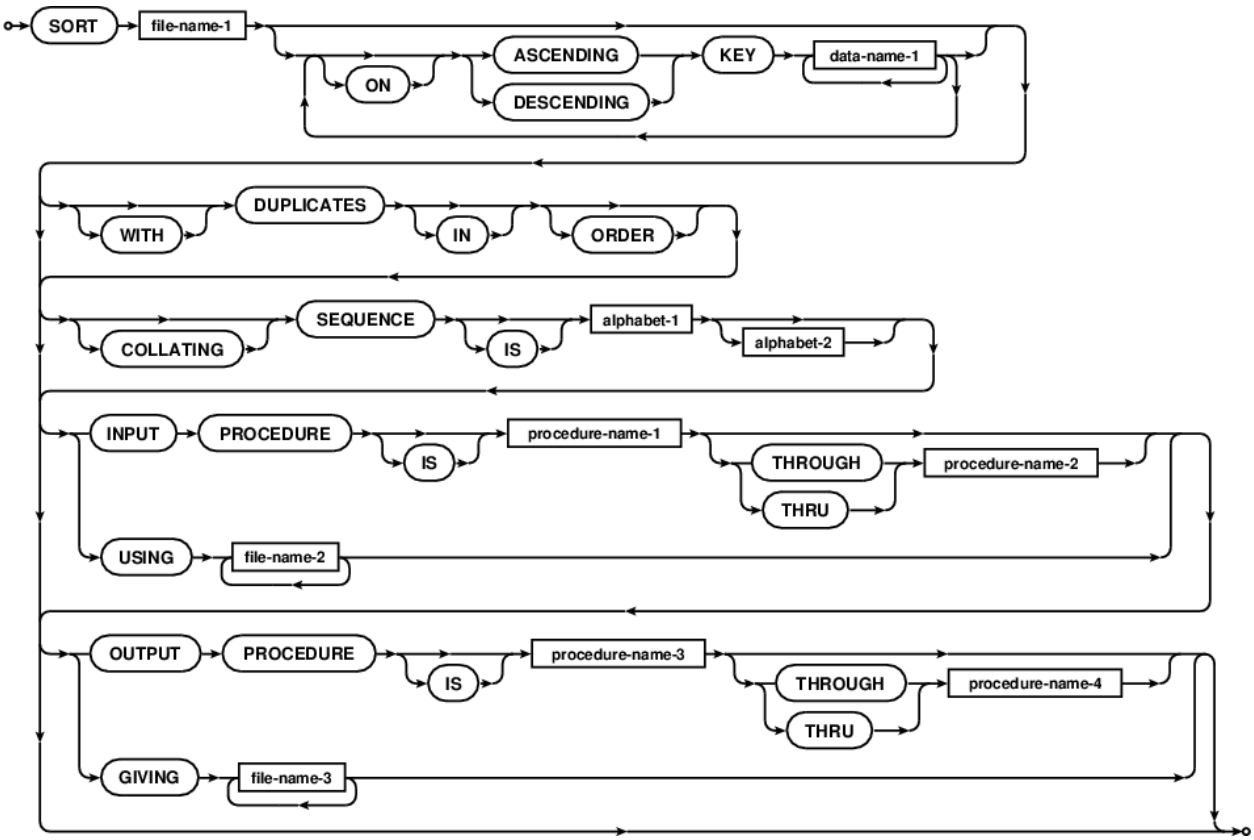
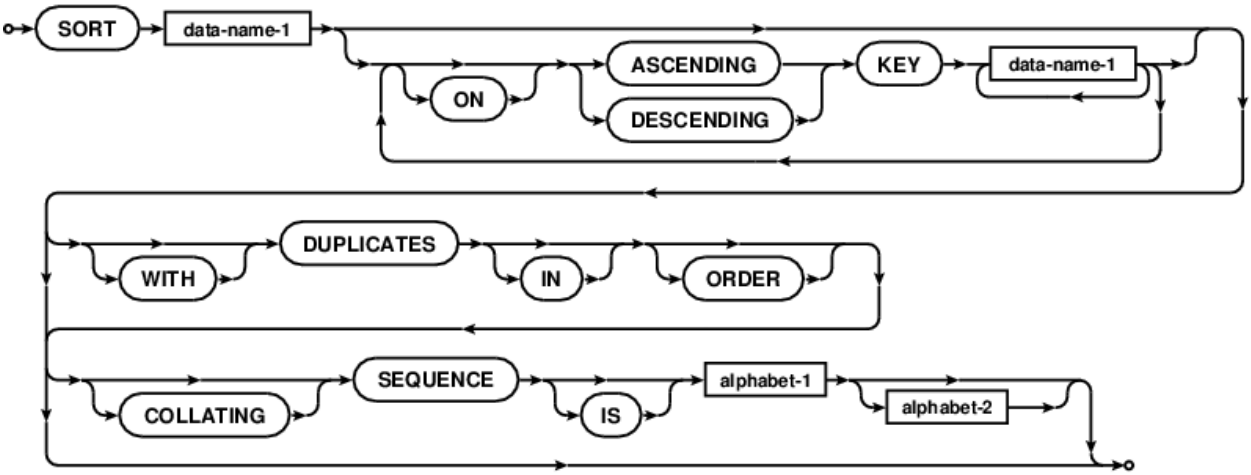


Table sort:



GnuCOBOL fully supports USING, GIVING as well as INPUT PROCEDURE and OUTPUT PROCEDURE clauses for the SORT verb.

```
GCobol* GnuCOBOL SORT verb example using standard in and standard out
       identification division.
       program-id. sorting.

       environment division.
       input-output section.
       file-control.
```

(continues on next page)

(continued from previous page)

```
           select sort-in
               assign keyboard
               organization line sequential.
           select sort-out
               assign display
               organization line sequential.
           select sort-work
               assign "sortwork".

       data division.
       file section.
       fd sort-in.
          01 in-rec        pic x(255).
       fd sort-out.
          01 out-rec       pic x(255).
       sd sort-work.
          01 work-rec      pic x(255).

       procedure division.
       sort sort-work
           ascending key work-rec
           using  sort-in
           giving sort-out.

       goback.
       exit program.
       end program sorting.
```

In the next sample, demonstrating INPUT PROCEDURE and OUTPUT PROCEDURE take note of the *RETURN* (page 381) and *RELEASE* (page 366) verbs as they are key to record by record control over sort operations.

Also, just to complicate things, this sample sorts using a mixed-case alphabet (but also places capital A out of order to demonstrate special cases that can codified in an *ALPHABET* (page 196)).

```
GCobol >>SOURCE FORMAT IS FIXED
      ************************************************************
      * Author:    Brian Tiffin
      * Date:      02-Sep-2008
      * Purpose:   A GnuCOBOL SORT verb example
      * Tectonics: cobc -x sorting.cob
      *     ./sorting <input >output
      *   or simply
      *     ./sorting
      *   for keyboard and screen demos
      ************************************************************
       identification division.
       program-id. sorting.

       environment division.
       configuration section.
      * This sets up a sort order lower then upper except for A and a
       special-names.
           alphabet mixed is " AabBcCdDeEfFgGhHiIjJkKlLmMnNoOpPqQrRsStTu
      -"UvVwWxXyYzZ0123456789".

       input-output section.
       file-control.
```

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```
           select sort-in
               assign keyboard
               organization is line sequential.
           select sort-out
               assign display
               organization is line sequential.
           select sort-work
               assign "sortwork".

       data division.
       file section.
       fd sort-in.
          01 in-rec        pic x(255).
       fd sort-out.
          01 out-rec       pic x(255).
       sd sort-work.
          01 work-rec      pic x(255).

       working-storage section.
       01 loop-flag        pic x value low-value.

       procedure division.
       sort sort-work
           on descending key work-rec
           collating sequence is mixed
           input procedure is sort-transform
           output procedure is output-uppercase.

       display sort-return.
       goback.

      ****************************************************************
       sort-transform.
       move low-value to loop-flag
       open input sort-in
       read sort-in
           at end move high-value to loop-flag
       end-read
       perform
           until loop-flag = high-value
               move FUNCTION LOWER-CASE(in-rec) to work-rec
               release work-rec
               read sort-in
                   at end move high-value to loop-flag
               end-read
       end-perform
       close sort-in
       .

      ****************************************************************
       output-uppercase.
       move low-value to loop-flag
       open output sort-out
       return sort-work
           at end move high-value to loop-flag
       end-return
       perform
```

(continues on next page)

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```
           until loop-flag = high-value
               move FUNCTION UPPER-CASE(work-rec) to out-rec
               write out-rec end-write
               return sort-work
                   at end move high-value to loop-flag
               end-return
       end-perform
       close sort-out
       .

       exit program.
       end program sorting.
```

Here is a snippet describing TABLE sorts by [John]

```
table define

    01  nbr-of-columns  pic 9(4) value zero.
    01  tcindex2        usage is index.
    01  dbtables.
        03  tables-columns  occurs 1 to 1000 times
                depending on nbr-of-columns
                ascending key tcTable, tcColumn
                              indexed by tcindex.
        05  tcTable     pic x(64)   value spaces.
        05  tcColumn    pic x(64)   value spaces.
            05  tcAlias pic x(10)   value spaces.
        05  tcOrder pic 9(4)    value zero.
            05  tcType  pic x(10)   value spaces.
            05  tcMaxLen    pic 9(4)    value zero.
    *><*
    01  aliasName.
        05          pic x value "t".
        05 anVal        pic 9(3)    value zero.

     01 showdata.
        05  sdTable     pic x(17) value spaces.
        05  sdColumn    pic x(17) value spaces.
        05  sdType      pic x(10) value spaces.
        05  sdOrder     pic zzzzz-.
        05  sdMaxLen    pic zzzzz.

table load

   perform varying rows from 1 by 1
       until rows > dbNumRows
       call "dbNextRow"     using by value dbResult,
                                   by reference ColumnBuff,
                                   by reference CbuffDesc
            returning dbResult
       add 1            to nbr-of-columns
       set tcindex          up by 1
       move cbTable         to tcTable(tcindex)
       move cbColumn        to tcColumn(tcindex)
       move cbType          to tcType(tcindex)
       move cbOrder         to tcOrder(tcindex)
       move cbMaxLen        to tcMaxLen(tcindex)
```

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```
       if nbr-of-columns = 1
          add 1         to anVal
       else
          set tcindex2      to tcindex
          set tcindex2      down by 1
          if cbTable <> tcTable(tcindex2)
             add 1          to anVal
          end-if
       end-if
       move aliasName       to tcAlias(tcindex)
   end-perform.


table sort

    sort tables-columns ascending key tcTable, tcColumn.

display table

    perform varying tcindex from 1 by 1
        until tcindex > nbr-of-columns
        move tcTable(tcindex)       to sdTable
        move tcColumn(tcindex)      to sdColumn
        move tcOrder(tcindex)       to sdOrder
        move tcType(tcindex)        to sdType
        move tcMaxLen(tcindex)      to sdMaxLen
        display showdata
    end-perform.
```

Exercise for the audience. Could the above code be simplified by using

```
MOVE CORRESPONDING cbRecord to table-columns(tcindex)
...
MOVE CORRESPONDING table-columns(tcindex) to showdata
```

with a few judicious field name changes?

A GCSORT support tool

Update: Rebranded as GCSORT from OCSort.

There is an external sort utility referenced in *What is GCSORT?* (page 851)

IN ORDER

The COBOL spec includes a sub-clause for `SORT` when duplicates are involved.

```
SORT
    WITH DUPLICATES

SORT
    WITH DUPLICATES IN ORDER
```

The `IN ORDER` clause is a default, and effectively ignored with GnuCOBOL, all sort operations are IN ORDER, meaning that duplicate keyed entries remain in the same order as they occur in the original input after a sort. There

is no rearrangement of records with duplicate keys. This may cause some deltas with other COBOL compilers when `IN ORDER` is not specified, in that those compilers may well rearrange the records with duplicate keys. GnuCOBOL will not and differences may be detected when analyzing GnuCOBOL as a replacement for other compilers. Be aware of the default `IN ORDER` when testing GnuCOBOL viability in detail. Thanks to Mickey White for bringing this difference to attention. This default `IN ORDER` behaviour applies to both file and in memory table sorts.

4.1.493 SORT-MERGE

Used in an I-O-CONTROL paragraph with the SAME clause:

```
SAME SORT-MERGE AREA FOR filename-1.
```

The SORT-MERGE keyword and SORT keyword are equivalent in this case.

4.1.494 SORT-RETURN

A *SPECIAL-REGISTER* used by the GnuCOBOL SORT routines.

- +000000000 for success
- +000000016 for failure

A programmer may set SORT-RETURN in an INPUT PROCEDURE.

4.1.495 SOURCE

Compiler directive controlling source code handling.

```
>>SOURCE FORMAT IS FIXED
>>SOURCE FORMAT IS FREE
```

GnuCOBOL allows use of this directive at programmer whim, multiple times per file, *within current scan rules*. **cobc** defaults to FIXED format source handling, so the directive must occur beyond the sequence and indicator columns, column 8 or later, unless the **-free** compile option is used on the command line.

This can be handy when keeping indent sensitive syntax highlighters happy; use the sequence number and comment column for a reference tag, followed by an explicit

```
GCobol >>SOURCE FORMAT IS what-it-is-fixed-being-boxey-but-nice
```

or rolly eyes, wondering why old people can only count to 80, *132 if they are really old.*

```
e_e    >>source free
```

SOURCE is also used when defining split key ISAM. Split key support was added originally added to the reportwriter branch, and will be in GnuCOBOL 3.0.

```
SELECT ...
    RECORD KEY IS newkey-name SOURCE is dname-a dname-f dname-c
```

Also a Report Writer data source clause.

```
011400 01  TYPE PAGE HEADING.
011500     02  LINE 1.
011600         03  COLUMN 39   PIC X(13) VALUE 'C E N T U R Y'.
011700         03  COLUMN 55   PIC X(13) VALUE 'M E D I C A L'.
011800         03  COLUMN 71   PIC X(11) VALUE 'C E N T E R'.
011900     02  LINE 2.
012000         03  COLUMN 35   PIC X(17) VALUE 'Q U A R T E R L Y'.
012100         03  COLUMN 55   PIC X(13) VALUE 'P A Y R O L L'.
012200         03  COLUMN 71   PIC X(15) VALUE 'R E G I S T E R'.
012300         03  COLUMN 111  PIC X(04) VALUE 'PAGE'.
012400         03  COLUMN 116  PIC ZZZZ9 source PAGE-COUNTER.
```

4.1.496 SOURCE-COMPUTER

A paragraph of the *IDENTIFICATION* (page 296) division. Treated as a comment.

4.1.497 SOURCES

`SOURCES ARE` report writer clause.

4.1.498 SPACE

A figurative constant representing a space character.

4.1.499 SPACES

A figurative constant representing space characters.

4.1.500 SPECIAL-NAMES

GnuCOBOL supports a fair complete set of the SPECIAL-NAMES in common use.

- CONSOLE IS CRT
- SYSIN IS mnemonic-name-1
- SYSOUT IS
- SYSLIST IS
- SYSLST IS
- PRINTER IS
- SYSERR IS
- CONSOLE IS mnemonic-name-7
- SWITCH-1 IS mnemonic-name-n ON STATUS IS condition-name-1 OFF STATUS IS condition-name-2
- SWITCH-2
- . . .
- SWITCH-8 IS . . .

- C01 IS mnemonic-name-m
- ...
- C12 IS
- ALPHABET alphabet-name IS NATIVE, STANDARD-1, STANDARD-2, EBCDIC literal-1 THRU literal-2 [ALSO literal-3]
- SYMBOLIC CHARACTERS symbol-character IS integer-1 IN alphabet-name
- CLASS class-name IS literal THRU literal-2
- LOCALE locale-name IS identifier-1
- CURRENCY SIGN IS literal
- DECIMAL-POINT IS COMMA
- CURSOR IS identifier-1
- CRT STATUS IS identifier-1
- SCREEN CONTROL IS identifier-1 **PENDING**
- EVENT STATUS IS identifier-1 **PENDING**

4.1.501 STANDARD

- LABEL RECORDS ARE STANDARD

4.1.502 STANDARD-1

- ALPHABET IS STANDARD-1
- RECORD DELIMITER IS STANDARD-1

equivalent to *ASCII* (page 207)

4.1.503 STANDARD-2

- ALPHABET IS STANDARD-1
- RECORD DELIMITER IS STANDARD-1

equivalent to *ASCII* (page 207)

4.1.504 STANDARD-BINARY

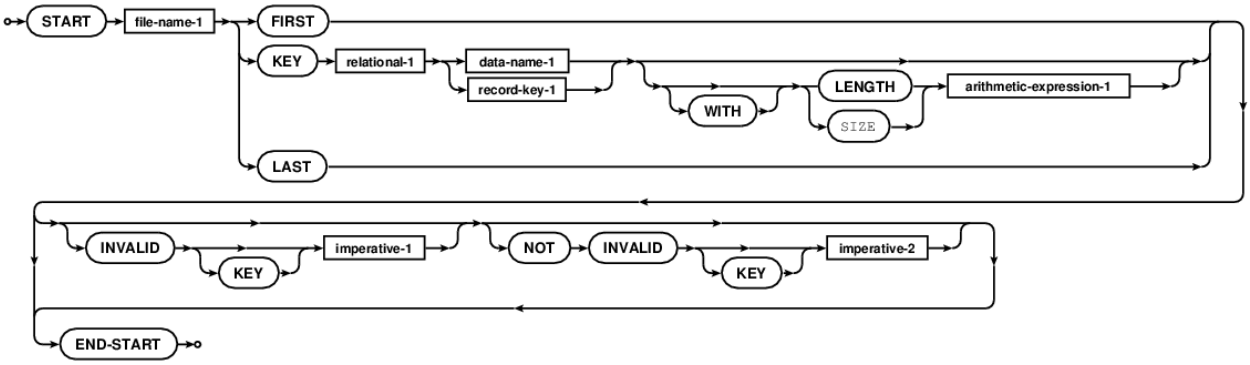
Not yet implemented.

4.1.505 STANDARD-DECIMAL

Not yet implemented.

4.1.506 START

Sets internal file fields that will influence sequential *READ* (page 359) *NEXT* (page 326) and *READ* (page 359) *PREVIOUS* (page 354) for *INDEXED* (page 297) files.



Can also be used to seek to the *FIRST* (page 265) or *LAST* (page 311) record of a file for *SEQUENTIAL* (page 396) access modes.

```
start indexing
   key is less than
       keyfield of indexing-record
   invalid key
       display "bad start: " keyfield of indexing-record
       set no-more-records to true
   not invalid key
       read indexing previous record
           at end set no-more-records to true
       end-read
end-start
```

The conditionals are quite powerful.

```
KEY IS GREATER THAN
KEY IS >
KEY IS LESS THAN
KEY IS <
KEY IS EQUAL TO
KEY IS =

KEY IS NOT GREATER THAN
KEY IS NOT >
KEY IS NOT LESS THAN
KEY IS NOT <
KEY IS NOT EQUAL TO
KEY IS NOT =

KEY IS <>
KEY IS GREATER THAN OR EQUAL TO
KEY IS >=
KEY IS LESS THAN OR EQUAL TO
KEY IS <=
```

See *Does GnuCOBOL support ISAM?* (page 656) for some example source code.

4.1.507 STATEMENT

Unsupported.

4.1.508 STATIC

Static linkage to CALL targets, resolved at compile time.

```
CALL STATIC "puts" USING a-zstring RETURNING out-count END-CALL
```

is handy when working on Cygwin and getting at `libc` routines.

4.1.509 STATUS

Multi-purpose.

- CRT STATUS IS
- FILE STATUS IS
- EVENT STATUS IS
- SWITCH-1 IS thing ON STATUS IS conditional-1

See *GnuCOBOL FILE STATUS codes* (page 262) for more info on `FILE STATUS`.

4.1.510 STDCALL

A *CALL* (page 219) modifier, tweaking things explicitly for Win32 call and return protocols (which is, historically, a difference between Pascal and C application binary interface argument stack cleanup assumptions).

`STDCALL` generates code that places the responsibility of parameter stack cleanup on the called subprogram, not the caller. This implies the callee knows how many arguments to expect, and is not as flexible as the default behaviour. Unlike the default `cdecl` mode where callers are responsible for adjusting the parameter stack after a call.

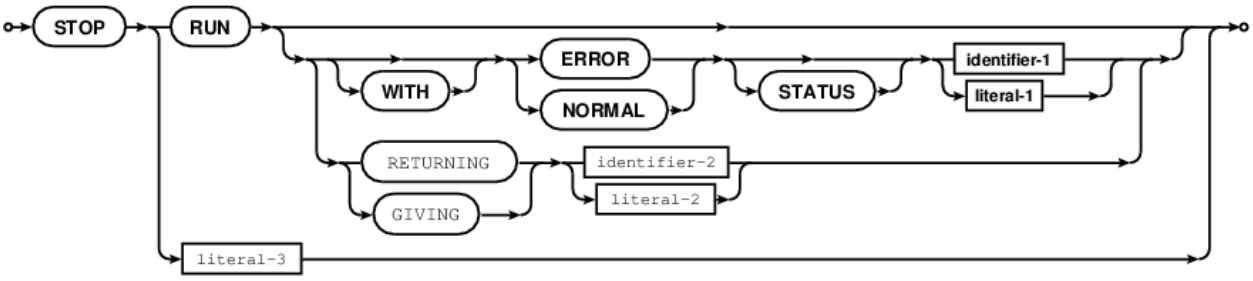
```
CALL STDCALL "CreateWindowEx" USING ...
```

4.1.511 STEP

Report Writer *OCCURS* (page 331) sub-clause.

4.1.512 STOP

End a run and return control to the operating system.



Example of stop returning a status value:

```
STOP RUN RETURNING 5.
```

Forms include:

- STOP RUN
- STOP RUN RETURNING stat
- STOP RUN GIVING stat
- STOP RUN WITH ERROR STATUS stat
- STOP RUN WITH NORMAL STATUS stat

This permanent stop returns control to the operating system, with no regard to program nesting. The entire process is halted.

Temporary STOP

There is a special case, non standard extension, supported with GnuCOBOL 2.0:

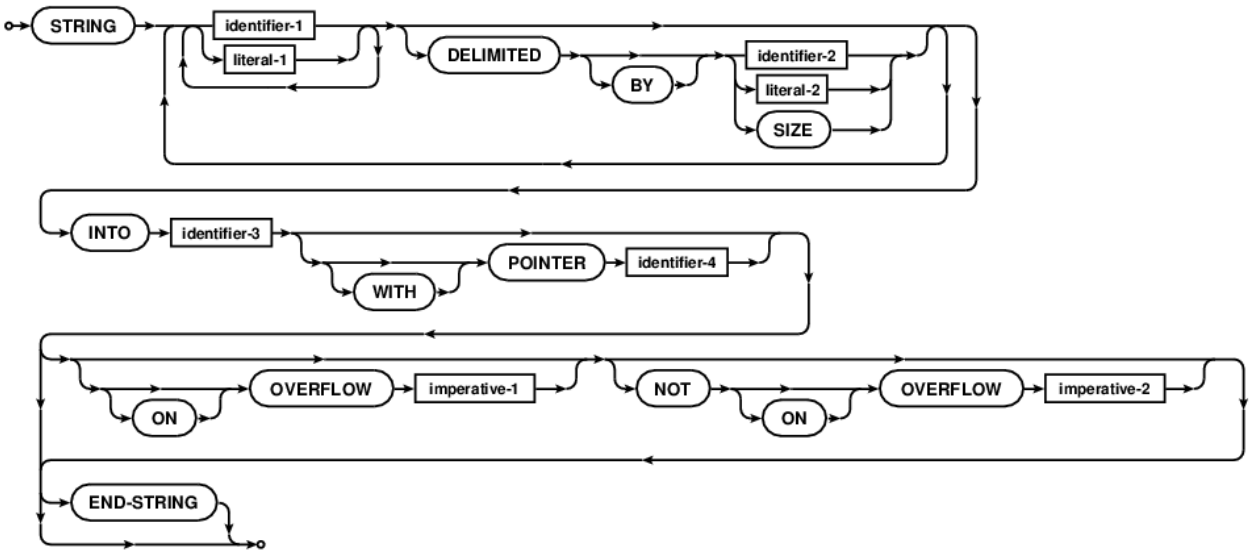
- STOP literal

This will pause a program with the given message, assumed to be a string literal, then await a keyboard return as if `ACCEPT OMITTED END-ACCEPT` was compiled in. Execution continues after the message has been acknowledged.

Ctrl-C, (or similar) keystroke would send a terminating signal to the program.

4.1.513 STRING

String together a set of variables with controlled delimiters.




```
01 var PICTURE X(5).

STRING
   "abc" DELIMITED BY "b"
```

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(continued from previous page)

```
   "def" DELIMITED BY SIZE
   "ghi" DELIMITED BY "z"
   INTO var
   ON OVERFLOW
       DISPLAY "var is full at" SPACE LENGTH OF var
END-STRING

DISPLAY var
```

Outputs:

```
var is full at 5
adefg
```

GnuCOBOL also fully supports the WITH POINTER clause to set the initial and track the position in the output character variable.

4.1.514 STRONG

Unsupported.

4.1.515 SUB-QUEUE-1

Unsupported Communication section clause.

4.1.516 SUB-QUEUE-2

Unsupported Communication section clause.

4.1.517 SUB-QUEUE-3

Unsupported Communication section clause.

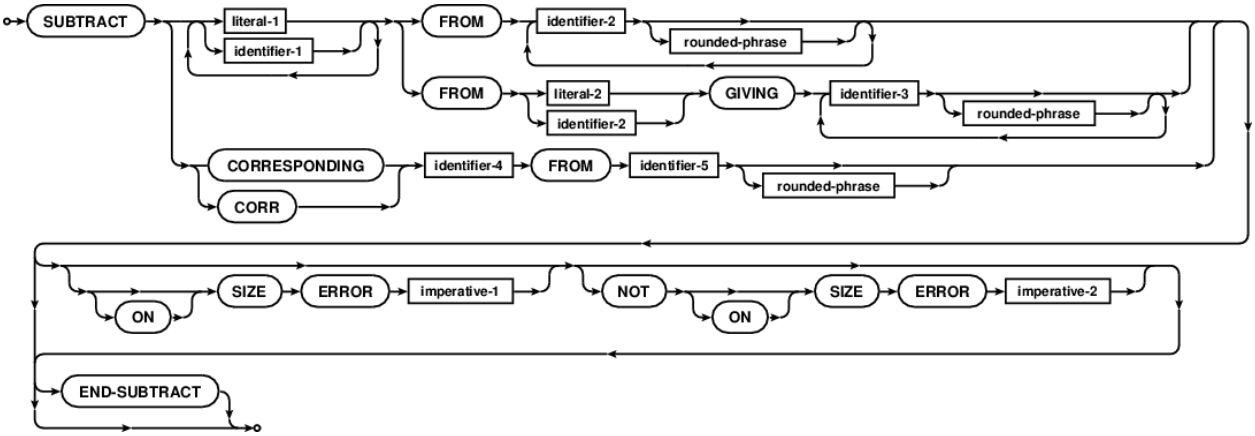
4.1.518 SUBTRACT

Arithmetic operation.

```
SUBTRACT a b c FROM d ROUNDED END-SUBTRACT

SUBTRACT a FROM b GIVING c
    ON SIZE ERROR
        SET math-error TO TRUE
    NOT ON SIZE ERROR
        SET math-error TO FALSE
END-SUBTRACT

SUBTRACT CORRESPONDING record-a FROM record-b ROUNDED
    ON SIZE ERROR
        SET something-wrong TO TRUE
END-SUBTRACT
```



4.1.519 SUM

A report writer, break controlled, tally field.

```
03  COLUMN 38   PIC $$,$$9.99 SUM PRR-GROSS-PAY.
```

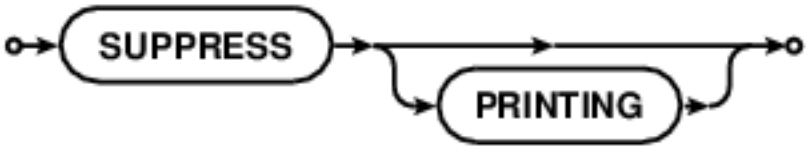
See *REPORT* (page 369).

4.1.520 SUPER

Unsupported Object COBOL keyword.

4.1.521 SUPPRESS

- Report Writer SUPPRESS PRINTING declarative.
- File write SUPPRESS WHEN alternate sparse key clause.



4.1.522 SYMBOL

Not yet implemented.

```
CURRENCY SIGN IS "&" PICTURE SYMBOL IS 'literal'
```

4.1.523 SYMBOLIC

SPECIAL-NAMES (page 410) clause for SYMBOLIC characters, allowing user define figurative constants similar to QUOTES.

```
SPECIAL-NAMES.
    SYMBOLIC CHARACTERS NUL IS 1
                        SOH IS 2
                        BEL IS 8
                        TAB IS 9.
```

can also be laid out as

```
SPECIAL-NAMES.
    SYMBOLIC CHARACTERS    NUL SOH BEL TAB
                     ARE     1   2   8   9.
```

4.1.524 SYNC

Alias for *SYNCHRONIZED* (page 417)

4.1.525 SYNCHRONISED

Alternate spelling for *SYNCHRONIZED* (page 417).

4.1.526 SYNCHRONIZED

Control padding inside record definitions, in particular to match C structures.

```
01 infile.
   03 slice    occurs 1 to 64 times depending on slices.
      05 lone-char   pic x   synchronized.
      05 stext usage pointer synchronized.
      05 val    float-long    synchronized.
      05 ftext usage pointer synchronized.
```

The pointers will align with the host expectations when passed to the C *ABI* (page 1350), *avoiding those embarrassing bus errors during big screen demos and presentations*.

4.1.527 SYSTEM-DEFAULT

OBJECT-COMPUTER (page 330) clause for locale support.

```
CHARACTER CLASSIFICATION IS SYSTEM-DEFAULT
```

4.1.528 TAB

Extended ACCEPT field attribute. Alias for *AUTO* (page 209).

4.1.529 TABLE

Unsupported keyword, but GnuCOBOL fully supports tables, including *SORT* (page 403).

4.1.530 TALLY

Automatically defined register.

Defined as:

```
GLOBAL PIC 9(5) USAGE BINARY VALUE ZERO
```

From tests/testsuite.src/run_extensions.at

```
IDENTIFICATION   DIVISION.
PROGRAM-ID.      callee.
PROCEDURE        DIVISION.
    ADD 1 TO TALLY END-ADD
    CALL "nested" END-CALL
    STOP RUN.

IDENTIFICATION   DIVISION.
PROGRAM-ID.      nested.
PROCEDURE        DIVISION.
    DISPLAY tally END-DISPLAY
    STOP RUN.
END PROGRAM      nested.
```

Display 00001.

4.1.531 TALLYING

INSPECT (page 304) clause for counting occurrences of a literal.

```
INSPECT record-1 TALLYING ident-1 FOR LEADING "0"
```

4.1.532 TAPE

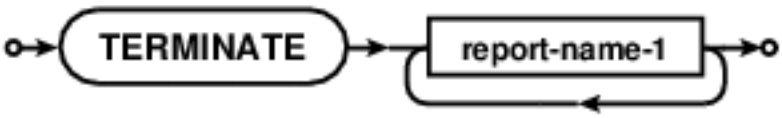
A device type used in *ASSIGN* (page 207).

4.1.533 TERMINAL

Unsupported Communication section clause.

4.1.534 TERMINATE

Report Writer verb to finish up a report.



See *INITIATE* (page 303) and *REPORT* (page 369).

4.1.535 TEST

Allows control over when loop conditionals are tested. WITH TEST BEFORE is the default. WITH TEST AFTER will always evaluate the body of the loop at least once.

```
perform
    with test after
    varying x from 1 by xstep
    until x >= function e
        if x > function e
            move function e to x-value
        else
            move x to x-value
        end-if
        compute recip = 1 / x end-compute
        move recip to y-value
        write outrec end-write
end-perform
```

4.1.536 TEXT

Unsupported Communication section clause.

4.1.537 THAN

Part of the conditional clauses for readability.

```
IF A GREATER THAN 10
    DISPLAY "A > 10"
END-IF
```

4.1.538 THEN

A somewhat disdained keyword that is part of the IF THEN ELSE control structure.

```
IF A > 10 THEN
   DISPLAY "A GREATER THAN 10"
ELSE
   DISPLAY "A LESS THAN OR EQUAL TO 10"
END-IF
```

4.1.539 THROUGH

Used in definitions for alphabets in *SPECIAL-NAMES* (page 410) and a procedural clause allowing *PERFORM* (page 347) from one label THROUGH (inclusive) to another label and all paragraphs in between. Also used to specify grouping with *RENAMES* (page 367).

```
PERFORM 100-open-files THROUGH 100-files-end
```

4.1.540 THRU

Commonly used alias for *THROUGH* (page 419).

```
01 testing-field pic 9.
   88 first-half   values 0 thru 4
   88 second-half  values 5 thru 9.

evaluate testing-field
    when 0 thru 7
        display "0 thru 7"
    when first-half
        display "first half"
end-evaluate

PERFORM first-paragraph THRU last-paragraph.
```

4.1.541 TIME

An *ACCEPT* (page 187) FROM source. Allows access to current clock; two digit hour, minute, second, hundreths.

```
01 current-time.
   05 ct-hours      pic 99.
   05 ct-minutes    pic 99.
   05 ct-seconds    pic 99.
   05 ct-hundredths pic 99.

ACCEPT current-time FROM TIME
```

4.1.542 TIME-OUT

Alternate spelling for *TIMEOUT* (page 420).

4.1.543 TIMEOUT

A screen field attribute. An extended ACCEPT will complete, as if a terminating keystroke had occured, at the end of timeout.

For systems using curses, ncurses, pdcurses, etc, timeout values will be in milliseconds, scaled by `COB_TIMEOUT_SCALE`. Negative values will cause a blocking read, wait until keyboard interaction. Zero will return immediately, with a CRT-STATUS indicator if no keystrokes are waiting. *Maybe? depending?*.

4.1.544 TIMES

- Used in an OCCURS clause of the data division.

```
01 squeeze usage index value 10.
01 accordian.
   05 pleat occurs 1 to 10 times depending on sqeeze pic x.
```

- A counted loop.

```
PERFORM 5 TIMES
    DISPLAY "DERP"
END-PERFORM
```

The implicit internal counter is not accessible to COBOL sources inside the loop.

4.1.545 TO

Multi-purpose destination specifier.

```
ADD 1 TO cobol GIVING GnuCOBOL
    ON SIZE ERROR
        DISPLAY "Potential exceeds expectations"
END-ADD
```

4.1.546 TOP

A *LINAGE* (page 314) clause, setting the number of lines used for the top margin of a page. Default top margin is zero.

```
FD  mini-report
    linage is 16 lines
        with footing at 15
        lines at top 2
        lines at bottom 2.
```

4.1.547 TOWARD-GREATER

A *ROUNDED* (page 386) *MODE* (page 323), where all fractions round up.

TOWARD-GREATER	+2.49	-2.49	+2.50	-2.50	+3.49	-3.49	+3.50	-3.50	+3.51	-3.51
Becomes	+3	-2	+3	-2	+4	-3	+4	-3	+4	-3

4.1.548 TOWARD-LESSER

A *ROUNDED* (page 386) *MODE* (page 323), where all fractions round down.

TOWARD-LESSER	+2.49	-2.49	+2.50	-2.50	+3.49	-3.49	+3.50	-3.50	+3.51	-3.51
Becomes	+2	-3	+2	-3	+3	-4	+3	-4	+3	-4

4.1.549 TRACE

Turning on and off runtime program statement trace output.

See *READY* (page 360) and *RESET* (page 380).

```
READY TRACE
display "traced output, showing source line"
RESET TRACE
```

4.1.550 TRAILING

Multi-purpose. FUNCTION TRIM allows a TRAILING keyword. An INSPECT TALLYING sub-clause.

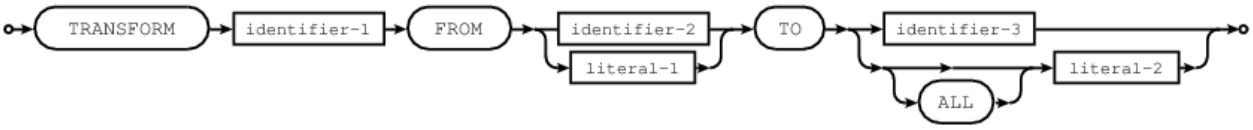
4.1.551 TRAILING-SIGN

Not yet implemented.

Will control bit position assumptions for sign bits.

4.1.552 TRANSFORM

An extension, nearly equivalent to `INSPECT var CONVERTING pattern-1 TO pattern-2.`



Patterns need to be the same size, a character position by character position global replace of the source.

```
move "ABBCCCBBA" to data-to-change
TRANSFORM data-to-change FROM "ABC" TO "XYZ"
display data-to-change

XYYZZZYYX
```

Every A replaced by X, B by Y, C by Z.

4.1.553 TRUE

- Used in `EVALUATE` to trigger control flow when the WHEN test expression succeeds as true.
- A *SET* (page 400) target.
- When used with a conditional 88 level name, will set the corresponding field to a listed `VALUE`, the first, in case of `VALUES`.

```
01 field-1 pic x.
   88 cond-1 values 'a','b','c'.

move 'b' to field-1
SET cond-1 TO TRUE

EVALUATE TRUE
    WHEN field-1 equal 'a'
        display field-1
    WHEN field-1 equal 'b' or 'c'
```

(continues on next page)

(continued from previous page)

```
        display "internal fail setting cond-1 true"
END-EVALUATE
```

Displays:

```
a
```

To make friends and influence people, you can also `EVALUATE FALSE`, which adds floating, invisible NOT logic to all the conditional tests. A sure fire way of getting people to like you.

```
EVALUATE FALSE
    WHEN 0 equal 1
        display "Yes, that is, false"
END-EVALUATE
```

4.1.554 TRUNCATION

A *ROUNDED* (page 386) *MODE* (page 323) behaviour. `TRUNCATION` is the default action when no `ROUNDED` or `ROUNDED MODE` phrase is specified for a calculation. By default, COBOL simply truncates fractional results, regardless of magnitude.

TRUNCATION	+2.49	-2.49	+2.50	-2.50	+3.49	-3.49	+3.50	-3.50	+3.51	-3.51
Becomes	+2	-2	+2	-2	+3	-3	+3	-3	+3	-3

2.99 becomes 2 when truncating, -2.99 becomes -2, for example. For a receiving field with 2 decimal places, -2.999 becomes -2.99, as does -2.991.

4.1.555 TYPE

- A Report Writer report group clause.
- Also, an unsupported data description clause.

4.1.556 TYPEDEF

Unsupported data description clause that will allow user defined record layouts.

4.1.557 UCS-4

Currently unsupported Universal Character Set alphabet. UCS-4 would store international code points in 4 bytes.

4.1.558 UNBOUNDED

An unrestricted upper limit for *OCCURS* (page 331) *DEPENDING* (page 247) table definitions.

```
sample identification division.
       program-id. unbound.

       environment division.
       configuration section.
       special-names.
       repository.
           function all intrinsic.

       data             division.
       working-storage section.
       01 n                pic 9(03).
       01 p                usage pointer.

       linkage section.
      *> unbound tables need to be in linkage
       01 a-table.
          03 rows occurs 0 to unbounded times depending on n.
             05 col1       pic x.
             05 filler     pic x value '-'.
             05 col2       pic xxx.
             05 filler     pic x value ':'.
             05 col3       pic x(16).

       procedure division.
      *> 123 is just an arbitrary limit
       display "How many entries (1-123)? " with no advancing
       accept n
       display space
       if n < 1 or > 123 then move 1 to n end-if

      *> show the user requested table length
       display n " entries gives " length(a-table) " table bytes"
       end-display

       allocate function length(a-table) characters
           initialized to all '?' returning p
       set address of a-table to p

      *> Show the first record as question marks
       display rows(1)

      *> Show the last record with some data
       initialize rows(n) with filler all to value then to default
       move "A" to col1(n)
       move "BCD" to col2(n)
       move "Some data" to col3(n)
       display rows(n)
       goback.
       end program unbound.
```

Sample run:

```
prompt$ cobc -xj unbound.cob -debug
How many entries (1-123)? 27

027 entries gives 000000594 table bytes
```

(continues on next page)

(continued from previous page)

```
??????????????????????
A-BCD:Some data
```

4.1.559 UNDERLINE

SCREEN (page 391) section field attribute. For terminfo, the terminal is sent `smul`, the character field, and then `rmul`. For a VT100 or VT100 emulation, that becomes Escape, open square bracket, 4m (smul) and Escape, open square bracket, 24m (rmul).

In this author's opinion, underlining is a terminal capability worthy of disabling, on a modern X11 console. Along with blink and SMCUP, RMCUP shadow screens. For extended screen operations with GnuCOBOL, it can be beneficial to read up on `termcap` and `terminfo`.

4.1.560 UNIT

A close option, alias for *REEL* (page 362).

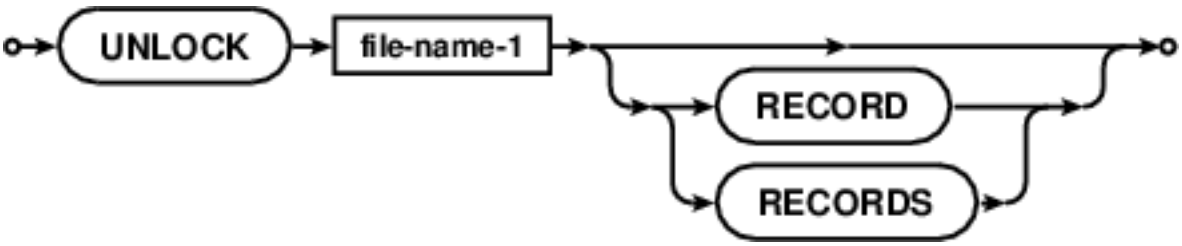
```
CLOSE file-1 UNIT WITH NO REWIND
```

4.1.561 UNIVERSAL

Unsupported Object COBOL exception object clause.

4.1.562 UNLOCK

Manual record unlock and buffer write sync.



A small code sample:

```
UNLOCK filename-1 RECORDS
```

4.1.563 UNSIGNED

Usage modifier, specifying that a value will not include any sign and therefore can't be negative.

4.1.564 UNSIGNED-INT

A native storage format *NUMERIC* (page 328) data *USAGE* (page 427) clause. Equivalent to *BINARY-LONG* (page 215) UNSIGNED and the same size as *SIGNED-INT* (page 402).

4.1.565 UNSIGNED-LONG

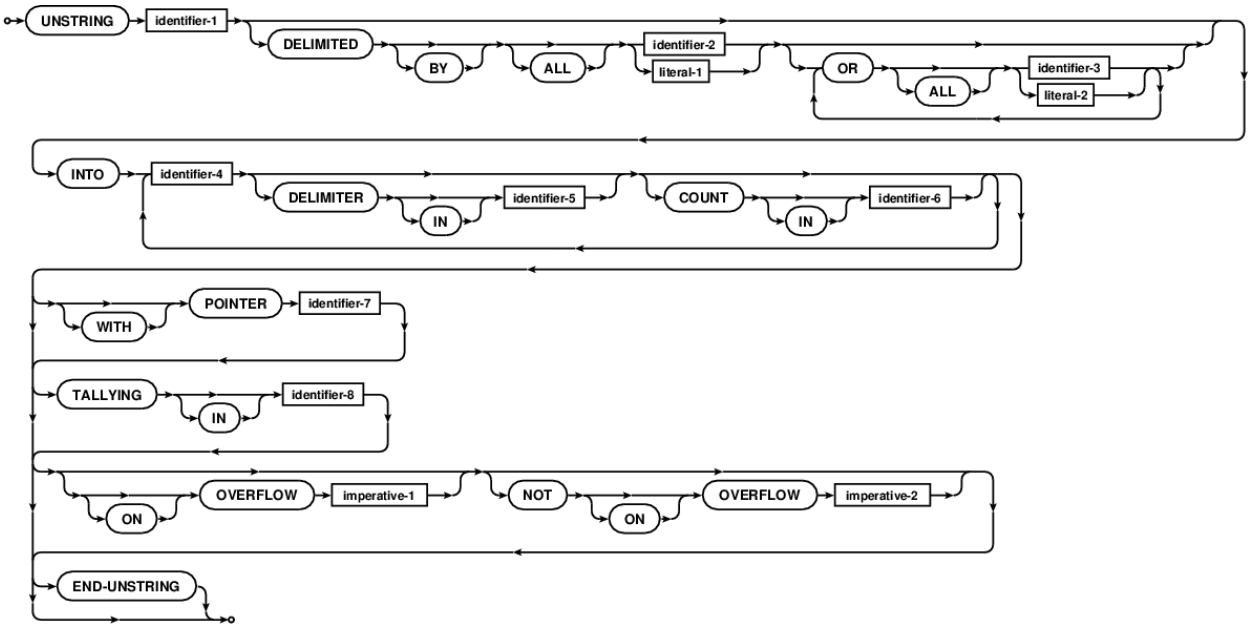
A native storage format *NUMERIC* (page 328) data *USAGE* (page 427) clause. Platform dependent and can be 32 bits or 64 bits, unsigned.

4.1.566 UNSIGNED-SHORT

A native storage format *NUMERIC* (page 328) data *USAGE* (page 427) clause. Equivalent to *BINARY-SHORT* (page 217) UNSIGNED and sized as *SIGNED-SHORT* (page 402).

4.1.567 UNSTRING

A powerful string decomposition verb.




```
UNSTRING Input-Address
    DELIMITED BY "," OR "/"
    INTO
        Street-Address DELIMITER D1 COUNT C1
        Apt-Number DELIMITER D2 COUNT C2
        City DELIMITER D3 COUNT C3
        State DELIMITER D4 COUNT C4
        Zip-Code DELIMITER D5 COUNT C5
    WITH POINTER ptr-1
    ON OVERFLOW
        SET more-fields TO TRUE
END-UNSTRING
```

4.1.568 UNTIL

Sets a loop conditional.

```
PERFORM VARYING ident-1 FROM 1 BY 1 UNTIL ident-1 > 10
    CALL "thing" USING BY VALUE ident-1 END-CALL
END-PERFORM
```

4.1.569 UP

Index and pointer modification.

```
SET ptr-1 UP BY 4
SET ind-1 UP BY 1
```

4.1.570 UPDATE

SCREEN (page 391) section field attribute.

4.1.571 UPON

A *DISPLAY* (page 248) destination clause.

```
display "Warning: read length truncated" upon syserr

display "This is going to be cool" UPON PRINTER
```

There is code going into the reportwriter branch to allow shell script control when using a PRINTER destination.

- Set `COBPRINTER` to a command string to be used by `popen` to control external print support features.

```
prompt$ export COBPRINTER='cat >>prt.log'
```

- Use `COB_DISPLAY_PRINTER` as a filename to `fopen(file, "a");` for each write UPON PRINTER.

```
prompt$ export COB_DISPLAY_PRINTER='prt.log'
```

4.1.572 UPPER

A screen field attribute, input data converted to UPPERCASE.

4.1.573 USAGE

GnuCOBOL uses standard *big-endian* (page 1318) internal storage by default. USAGE clauses influence the data representation. The INTEL architecture uses *little-endian* (page 1318) form and GnuCOBOL programmers developing for this common chipset may need to pay heed to this for performance purposes. As per the standards, GnuCOBOL supports COMPUTATIONAL-5 native usage.

GnuCOBOL enables use of one to eight byte binary representations in both big and little endian forms.

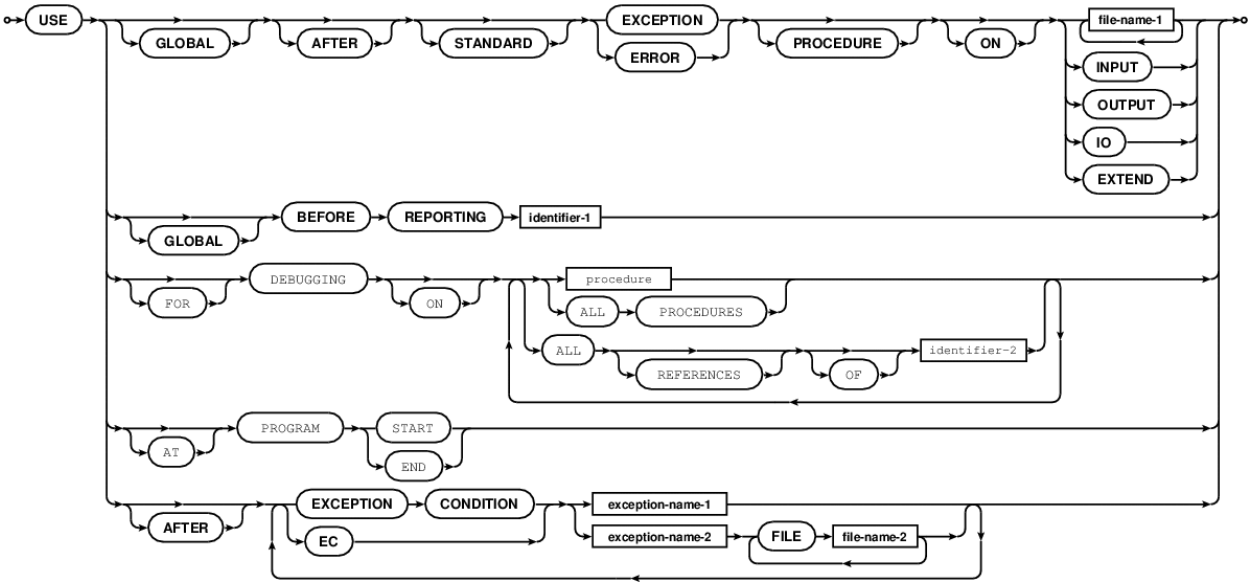
Along with full support of all common COBOL *PICTURE* (page 348) clauses both storage and display, GnuCOBOL supports USAGE clauses of:

- BINARY
- COMPUTATIONAL, COMP

- COMP-1
- COMP-2
- COMP-3
- COMP-4
- COMP-5
- COMP-X
- FLOAT-LONG
- FLOAT-SHORT
- DISPLAY
- INDEX
- PACKED-DECIMAL
- POINTER
- PROGRAM-POINTER
- SIGNED-SHORT
- SIGNED-INT
- SIGNED-LONG
- UNSIGNED-SHORT
- UNSIGNED-INT
- UNSIGNED-LONG
- BINARY-CHAR SIGNED
- BINARY-CHAR UNSIGNED
- BINARY-CHAR
- BINARY-SHORT SIGNED
- BINARY-SHORT UNSIGNED
- BINARY-SHORT
- BINARY-LONG SIGNED
- BINARY-LONG UNSIGNED
- BINARY-LONG
- BINARY-DOUBLE SIGNED
- BINARY-DOUBLE UNSIGNED
- BINARY-DOUBLE
- BINARY-C-LONG SIGNED
- BINARY-C-LONG UNSIGNED
- BINARY-C-LONG

4.1.574 USE

Sets up *DECLARATIVES* (page 244) paragraphs.



- USE BEFORE DEBUGGING
- USE AFTER EXCEPTION

4.1.575 USER

An *ACCEPT* (page 187) source for getting process owner user name.

4.1.576 USER-DEFAULT

OBJECT-COMPUTER (page 330) clause for locale support.

```
CHARACTER CLASSIFICATION IS USER-DEFAULT
```

4.1.577 USING

Specifies arguments to *CALL* (page 219) and in *PROCEDURE* (page 355) declarations.

- BY *REFERENCE* (page 362) (default, pointer to modifiable data is passed)
- BY *CONTENT* (page 236) (reference to a copy of the data)
- BY *VALUE* (page 430) (actual dereferenced value is placed into call frame)

4.1.578 UTF-16

Unsupported internationalization clause.

4.1.579 UTF-8

Unsupported internationalization clause.

4.1.580 VAL-STATUS

Alias for the unsupported *VALIDATE-STATUS* (page 430) clause of the *VALIDATE* (page 430) statement.

4.1.581 VALID

Unsupported.

4.1.582 VALIDATE

Unsupported data validation verb.

4.1.583 VALIDATE-STATUS

Unsupported clause of the *VALIDATE* (page 430) statement.

4.1.584 VALUE

Muti use keyword.

- A *CALL* (page 219) frame argument modifier. Dereferencing the argument.
- Sets initial values in data descriptions
- as well as values deemed true with 88 level conditional names.

```
01 important-data    pic x(6) value "secret".

01 vip-status-test   pic x(3).
   88 vip            value  "you".
   88 guest          values "him", "her".

call "subprogram" using by value 42 end-call
```

4.1.585 VALUES

Plural of *VALUE* (page 430) when more than one entry is used in an 88 conditional name.

```
01 testing-field               PIC 9.
   88 status-ok                value 0.
   88 status-warning           values 1,2,4,5.
   88 status-golook            value 3.
   88 status-error             values 6 thru 8.
   88 status-run-for-the-hills value 9.
```

4.1.586 VARYING

- Sets a looping variable with *PERFORM* (page 347).

```
PERFORM VARYING loop-counter FROM 1 BY 1 UNTIL loop-counter > 10
    DISPLAY loop-counter
END-PERFORM
```

- An FD clause for variant sized records

```
FD infile
   RECORD IS VARYING IN SIZE FROM 1 TO 65535 CHARACTERS
   DEPENDING ON infile-record-length.
01 infile-record.
   05 infile-data      PIC X OCCURS 1 TO 65535 TIMES
                       DEPENDING ON infile-record-length.
```

With the *DEPENDING* (page 247) clause, GnuCOBOL will set the actual length of a *READ* (page 359) into the `DEPENDING ON` identifier, which also sets the length for *WRITE* (page 433).

The entire FD clause can be shortened, without setting a range, to:

```
FD infile RECORD VARYING DEPENDING ON infile-record-length.
```

Especially useful for `RECORD BINARY SEQUENTIAL` and `LINE` *SEQUENTIAL* (page 396) file access.

4.1.587 WAIT

SHARING (page 402) file access *LOCK* (page 319) timeout management. **Support depends on ISAM engine in use**. BDB, VBISAM, and others, have locking timeout support. On timeout FILE *STATUS* (page 413) will be set to "47" input-denied.

```
READ infile NEXT RECORD WITH WAIT END-READ
```

4.1.588 WHEN

A very powerful keyword used in EVALUATE phrases for specifying conditional expressions.

```
EVALUATE TRUE
    WHEN A = 10
        DISPLAY "A = 10"
    WHEN A = 15
        PERFORM A-IS-15
    WHEN B IS EQUAL 6
        PERFORM B-IS-6
    WHEN C IS GREATER THAN 5
        DISPLAY "C > 5"
    WHEN OTHER
        DISPLAY "Default imperative"
 END-EVALUATE
```

4.1.589 WHEN-COMPILED

An obsolete special register.

```
identification division.
program-id. when-compiled-sample.
date-written. 2015-10-28/00:17-0400.

procedure division.
display when-compiled

stop run.
```

The special register returns a build time stamp in the form MM/DD/YYhh.mm.ss which is an ambiguous value, and its use is discouraged.

```
prompt$ cobc -xj when-compiled-sample.cob
10/28/1500.20.10
```

The preferred method is *FUNCTION WHEN-COMPILED* (page 499).

```
identification division.
program-id. when-compiled-sample.
date-written. 2015-10-28/00:21-0400.

procedure division.
display when-compiled
display function when-compiled

stop run.
```

Producing a more reasonable value:

```
$ cobc -xj when-compiled-sample.cob
10/28/1500.21.29
2015102800212900-0400
```

Far less ambiguous, and more in tune with international concerns.

When `FUNCTION ALL INTRINSIC` is in effect in the `CONFIGURATION SECTION`, the latter output format takes precedence over the old special register form.

```
identification division.
program-id. when-compiled-sample.
date-written. 2015-10-28/00:21-0400.

environment division.
configuration section.
repository.
    function all intrinsic.

procedure division.
display when-compiled
display function when-compiled

stop run.
```

giving:

```
prompt$ cobc -xj when-compiled-sample.cob
2015102800263700-0400
2015102800263700-0400
```

Advice: Use `FUNCTION WHEN-COMPILED` explicitly, or ensure code is compiled with `FUNCTION ALL INTRINSIC` set in the *REPOSITORY* (page 378) paragraph.

Note: WHEN-COMPILED is set once during any particular compilation pass, all programs, and/or nested programs within a source build will have the same value. The same is true for FUNCTION WHEN-COMPILED.

Also please note: This is for **source code** compiles. Programs in previously compiled, binary object or link libraries will have their own separate WHEN-COMPILED value, set when the library was compiled, not when a program using *CALL* (page 219) links to it. Both the caller and called will have a setting, taken from the date and time when `cobc` passed over the sources, and not during any later, non source form, object linkage times.

4.1.590 WINAPI

An as yet unimplemented `PROCEDURE DIVISION` qualifier

See COBOL and *EXTERN* (page 259) for the other program entry qualifiers.

4.1.591 WITH

Multi-purpose keyword.

- WITH LOCK
- WITH screen-attribute-list
- WITH ROLLBACK (pending)

4.1.592 WORDS

Ignored *OBJECT-COMPUTER* (page 330) *MEMORY* (page 320) clause.

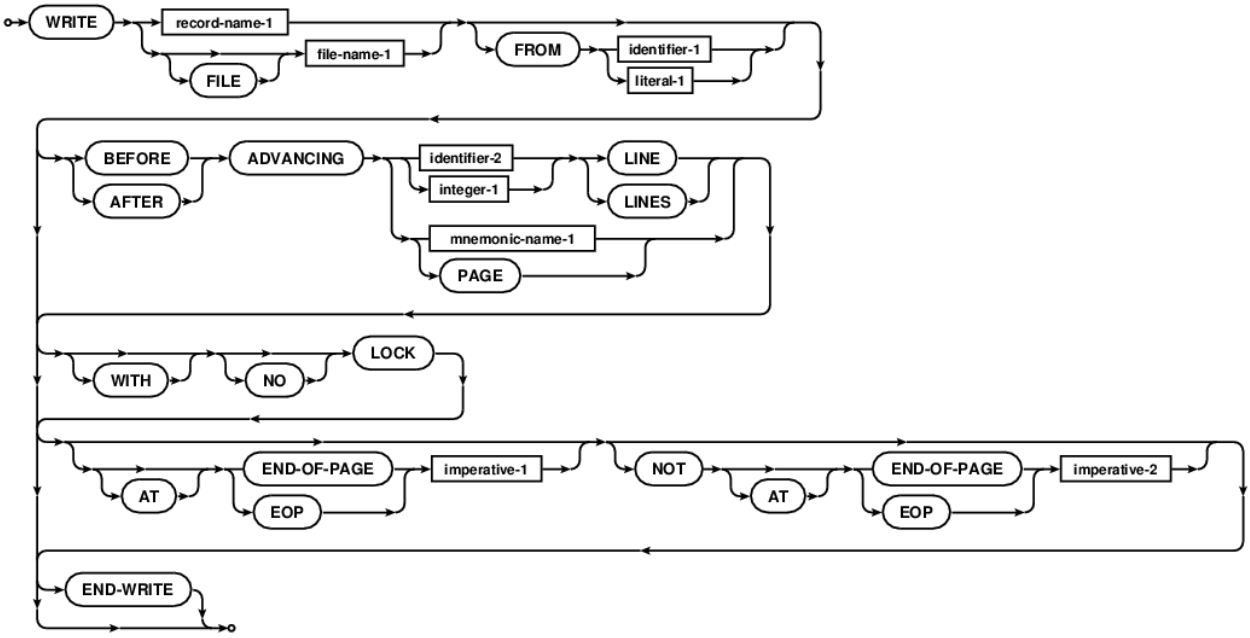
4.1.593 WORKING-STORAGE

A *DATA* (page 241) division section. Unless *BASED* (page 212), all fields are allocated and fixed in memory (for the running program within a module).

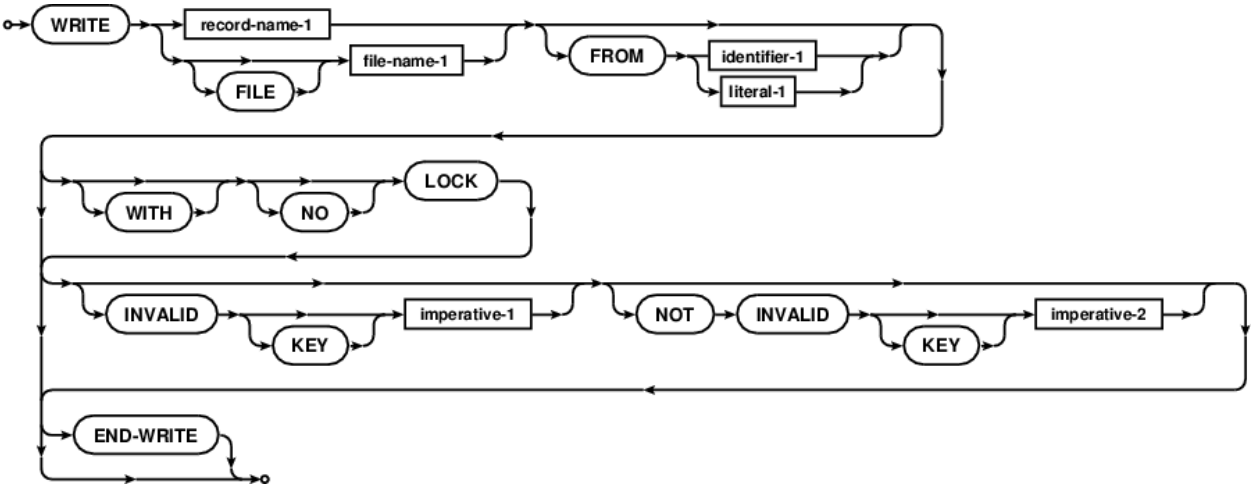
4.1.594 WRITE

Record write to file, with features for page control.

Write sequential:



Random file:



Unlike *READ* (page 359) that uses filenames syntax, WRITE uses record buffer syntax by default, which must be related to the file through the *FD* (page 260) file descriptor. GnuCOBOL supports *LINAGE* (page 314) and WRITE has support for 'report' paging and line control.

```
WRITE record-buff END-WRITE

WRITE indexed-record
    WITH LOCK
    ON INVALID KEY
        DISPLAY "Key exists, REWRITING..."
        PERFORM rewrite-key
END-WRITE
IF indexed-file-status NOT EQUAL ZERO THEN
    DISPLAY "Write problem: " indexed-file-status UPON SYSERR
    PERFORM evasive-manoeuvres
END-IF
```

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```
WRITE record-name-1 AFTER ADVANCING PAGE

WRITE record-name-1 FROM header-record-1
    AFTER ADVANCING 2 LINES
    AT END-OF-PAGE
        PERFORM write-page-header
        PERFORM write-last-detail-reminder
END-WRITE
```

4.1.595 YYYYDDD

Modifies ACCEPT var FROM *DAY* (page 242) to use full 4 digit year for the Julian date retrieval.

```
ACCEPT date-var FROM DAY YYYYDDD
```

4.1.596 YYYYMMDD

Modifies ACCEPT var FROM *DATE* (page 241) to use full 4 digit year.

```
#!/usr/local/bin/cobc -xj

      *> Modified: 2015-12-09/19:38-0500
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 date-var    pic 99999999.

       ==
       ==:CODEBOOK:== BY
       ==

       accept date-var from date
       display ":" date-var ":"

       accept date-var from date yyyymmdd
       display ":" date-var ":"

       ==
       .
```

Giving:

```
$ ./yyyymmdd-sample.cob
:00151213:
:20151213:
```

4.1.597 ZERO

Figurative and numeric constant for the value 0.

```
#!/usr/local/bin/cobc -xj

      *> Modified: 2015-12-13/00:28-0500
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 amount pic s9(8)v99 value zero.

       ==
       ==:CODEBOOK:== BY
       ==

       if amount equal zero then
           display zero
       else
           display amount
       end-if

       ==
       .
```

Giving:

```
prompt$ ./zero-sample.cob
0
```

As can be see here, the figurative constant is used to set the value, for testing the value, and as a display item. When used as a sending field (in MOVE or DISPLAY for example) figurative contants are limited by the receiving field length and/or type. If that length is indeterminant, a length of one is assumed.

See *Sample shortforms* (page 1433) for the `sample-template` listing.

4.1.598 ZERO-FILL

Not yet implemented. Extension.

4.1.599 ZEROES

Plural of *ZERO* (page 435).

```
#!/usr/local/bin/cobc -xj

      *> Modified: 2015-12-09/19:38-0500
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 amount pic s9(8)v99 value all zeroes.

       ==
       ==:CODEBOOK:== BY
       ==

       display amount
```

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```
       ==
       .
```

Giving:

```
prompt$ ./zeroes-sample.cob
+00000000.00
```

See *Sample shortforms* (page 1433) for the `sample-template` listing.

4.1.600 ZEROS

Alternate spelling for *ZEROES* (page 436).

```
#!/usr/local/bin/cobc -xj

      *> Modified: 2015-12-09/19:38-0500
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 amount      pic s9(8)v99.
          88 zilch                value zeros.
       01 show-amount pic $(8)9.99.

       ==
       ==:CODEBOOK:== BY
       ==

       move amount to show-amount
       if zilch then
           display " GOOSE EGGS "
       else
           display show-amount
       end-if

       ==
       .
```

Giving:

```
prompt$ ./zeros-sample.cob
 GOOSE EGGS
```

but that tongue in cheek sample is not something you'd put in a bank report. In school? Maybe a chuckle. At work? Probably sacked. In this FAQ? Go ahead, roll your eyes, *this is the last reserved word and it deserved a sample.*

See *Sample shortforms* (page 1433) for the `sample-template` listing.

4.2 Does GnuCOBOL implement any Intrinsic FUNCTIONs?

Yes. Most of the COBOL 2014 Standard is covered.

Intrinsic Function	Parameters
FUNCTION ABS (page 440)	1
FUNCTION ACOS (page 441)	1
FUNCTION ANNUITY (page 441)	2
FUNCTION ASIN (page 442)	1
FUNCTION ATAN (page 443)	1
FUNCTION BOOLEAN-OF-INTEGER (page 445)	2
FUNCTION BYTE-LENGTH (page 445)	1
FUNCTION CHAR (page 446)	1
FUNCTION CHAR-NATIONAL (page 447)	1
FUNCTION COMBINED-DATETIME (page 447)	2
FUNCTION CONCATENATE (page 447)	Variable
FUNCTION CONTENT-LENGTH (page 447)	1
FUNCTION CONTENT-OF (page 448)	1-or-2
FUNCTION COS (page 448)	1
FUNCTION CURRENCY-SYMBOL (page 450)	0
FUNCTION CURRENT-DATE (page 451)	0
FUNCTION DATE-OF-INTEGER (page 452)	1
FUNCTION DATE-TO-YYYYMMDD (page 453)	Variable
FUNCTION DAY-OF-INTEGER (page 453)	1
FUNCTION DAY-TO-YYYYDDD (page 453)	Variable
FUNCTION DISPLAY-OF (page 453)	Variable
FUNCTION E (page 454)	0
FUNCTION EXCEPTION-FILE (page 456)	0
FUNCTION EXCEPTION-FILE-N (page 456)	0
FUNCTION EXCEPTION-LOCATION (page 456)	0
FUNCTION EXCEPTION-LOCATION-N (page 457)	0
FUNCTION EXCEPTION-STATEMENT (page 457)	0
FUNCTION EXCEPTION-STATUS (page 457)	0
FUNCTION EXP (page 458)	1
FUNCTION EXP10 (page 458)	1
FUNCTION FACTORIAL (page 458)	1
FUNCTION FORMATTED-CURRENT-DATE (page 460)	1
FUNCTION FORMATTED-DATE (page 461)	2
FUNCTION FORMATTED-DATETIME (page 461)	Variable
FUNCTION FORMATTED-TIME (page 462)	Variable
FUNCTION FRACTION-PART (page 463)	1
FUNCTION HIGHEST-ALGEBRAIC (page 463)	1
FUNCTION INTEGER (page 464)	1
FUNCTION INTEGER-OF-BOOLEAN (page 464)	1
FUNCTION INTEGER-OF-DATE (page 465)	1
FUNCTION INTEGER-OF-DAY (page 465)	1
FUNCTION INTEGER-OF-FORMATTED-DATE (page 465)	2
FUNCTION INTEGER-PART (page 465)	1
FUNCTION LENGTH (page 466)	1
FUNCTION LENGTH-AN (page 466)	1
FUNCTION LOCALE-COMPARE (page 466)	Variable
FUNCTION LOCALE-DATE (page 466)	2
FUNCTION LOCALE-TIME (page 469)	2
FUNCTION LOCALE-TIME-FROM-SECONDS (page 469)	2
FUNCTION LOG (page 469)	1

Continued on next page

Table 2 – continued from previous page

Intrinsic Function	Parameters
FUNCTION LOG10 (page 470)	1
FUNCTION LOWER-CASE (page 470)	1
FUNCTION LOWEST-ALGEBRAIC (page 470)	1
FUNCTION MAX (page 470)	Variable
FUNCTION MEAN (page 470)	Variable
FUNCTION MEDIAN (page 470)	Variable
FUNCTION MIDRANGE (page 471)	Variable
FUNCTION MIN (page 471)	Variable
FUNCTION MOD (page 471)	2
FUNCTION MODULE-CALLER-ID (page 471)	0
FUNCTION MODULE-DATE (page 472)	0
FUNCTION MODULE-FORMATTED-DATE (page 472)	0
FUNCTION MODULE-ID (page 473)	0
FUNCTION MODULE-PATH (page 473)	0
FUNCTION MODULE-SOURCE (page 473)	0
FUNCTION MODULE-TIME (page 473)	0
FUNCTION MONETARY-DECIMAL-POINT (page 473)	0
FUNCTION MONETARY-THOUSANDS-SEPARATOR (page 474)	0
FUNCTION NATIONAL-OF (page 474)	Variable
FUNCTION NUMERIC-DECIMAL-POINT (page 475)	0
FUNCTION NUMERIC-THOUSANDS-SEPARATOR (page 475)	0
FUNCTION NUMVAL (page 475)	1
FUNCTION NUMVAL-C (page 475)	2
FUNCTION NUMVAL-F (page 476)	1
FUNCTION ORD (page 476)	1
FUNCTION ORD-MAX (page 476)	Variable
FUNCTION ORD-MIN (page 476)	Variable
FUNCTION PI (page 477)	0
FUNCTION PRESENT-VALUE (page 478)	Variable
FUNCTION PYTHON (page 480)	Variable
FUNCTION RANDOM (page 481)	Variable
FUNCTION RANGE (page 484)	Variable
FUNCTION REM (page 485)	2
FUNCTION REVERSE (page 485)	1
FUNCTION REXX (page 485)	Variable
FUNCTION REXX-UNRESTRICTED (page 486)	Variable
FUNCTION SECONDS-FROM-FORMATTED-TIME (page 486)	2
FUNCTION SECONDS-PAST-MIDNIGHT (page 486)	0
FUNCTION SIGN (page 487)	1
FUNCTION SIN (page 487)	1
FUNCTION SQRT (page 489)	1
FUNCTION STANDARD-COMPARE (page 490)	Variable
FUNCTION STANDARD-DEVIATION (page 490)	Variable
FUNCTION STORED-CHAR-LENGTH (page 490)	1
FUNCTION SUBSTITUTE (page 491)	Variable
FUNCTION SUBSTITUTE-CASE (page 492)	Variable
FUNCTION SUM (page 492)	Variable
FUNCTION TAN (page 493)	1
FUNCTION TEST-DATE-YYYYMMDD (page 494)	1

Continued on next page

Table 2 – continued from previous page

Intrinsic Function	Parameters
FUNCTION TEST-DAY-YYYYDDD (page 495)	1
FUNCTION TEST-FORMATTED-DATETIME (page 496)	2
FUNCTION TEST-NUMVAL (page 496)	1
FUNCTION TEST-NUMVAL-C (page 496)	2
FUNCTION TEST-NUMVAL-F (page 498)	1
FUNCTION TRIM (page 499)	2
FUNCTION UPPER-CASE (page 499)	1
FUNCTION VARIANCE (page 499)	Variable
FUNCTION WHEN-COMPILED (page 499)	0
FUNCTION YEAR-TO-YYYY (page 502)	Variable

4.2.1 FUNCTION ABS

Absolute value of numeric argument

```
#!/usr/local/bin/cobc -xj

       COPY template REPLACING
       ==:DATABOOK:== BY
       ==

       01 showing pic --9.99.
       01 absing  pic zz9.99.

       01 samples-table.
          05 sample-values.
             10 filler pic s99v99 value -42.42.
             10 filler pic s99v99 value -0.42.
             10 filler pic s99v99 value 42.42.
          05 filler redefines sample-values.
             10 sample pic s99v99 occurs 3 times indexed by lot.

       ==
       ==:CODEBOOK:== BY
       ==

       perform varying lot from 1 by 1 until lot > 3
           move sample(lot) to showing
           move abs(sample(lot)) to absing

           display "Abs of: " showing " is " absing
       end-perform

       ==
       .
```

With a run sample of:

```
$ ./abs-sample.cob
Abs of: -42.42 is  42.42
Abs of:  -0.42 is   0.42
Abs of:  42.42 is  42.42
```

See *Sample shortforms* (page 1433) for the `sample-template.cob` listing.

4.2.2 FUNCTION ACOS

The ACOS function returns a numeric value (in radians) that approximates the arccosine of the argument.

The domain of the arccosine function is -1 to +1. Domain errors return a result of 0. The inverse cosine function returns a range of 0 thru pi

```
#!/usr/local/bin/cobc -xj

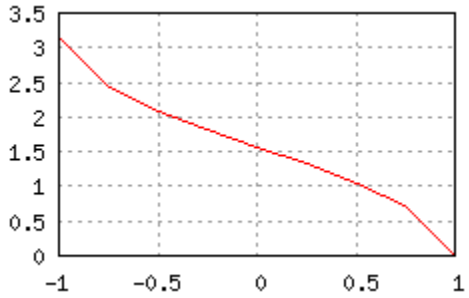
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 x            pic s9v99.
       01 degrees      pic s999v9.
       01 answer       pic s9v9(5).

       ==
       ==:CODEBOOK:== BY
       ==

       perform varying x from -1.0 by 0.25 until x > 1.0
           compute answer = acos(x)
           compute degrees rounded = answer * 180 / pi
           display "acos(" x ") ~= " answer " ~= " degrees "°"
       end-perform

       ==
       .
```




```
$ ./acos-sample.cob
acos(-1.00) ~= +3.14159 ~= +180.0°
acos(-0.75) ~= +2.41885 ~= +138.6°
acos(-0.50) ~= +2.09439 ~= +120.0°
acos(-0.25) ~= +1.82347 ~= +104.5°
acos(+0.00) ~= +1.57079 ~= +090.0°
acos(+0.25) ~= +1.31811 ~= +075.5°
acos(+0.50) ~= +1.04719 ~= +060.0°
acos(+0.75) ~= +0.72273 ~= +041.4°
acos(+1.00) ~= +0.00000 ~= +000.0°
```

See *Sample shortforms* (page 1433) for the `sample-template.cob` listing.

4.2.3 FUNCTION ANNUITY

Compute the ratio of an annuity paid based on arguments of interest and number of periods.

```
WORKING-STORAGE SECTION.
77  INTEREST       PIC S9V9999 VALUE 0.08.
77  MONTHLY        PIC S9V9999 VALUE ZERO.
77  PERIODS        PIC 99      VALUE 36.
77  ANNUITY-VALUE  PIC S9V9999 VALUE ZERO.
PROCEDURE DIVISION.
   COMPUTE MONTHLY ROUNDED = INTEREST / 12
   COMPUTE ANNUITY-VALUE ROUNDED =
       FUNCTION ANNUITY (MONTHLY PERIODS)
   DISPLAY "Monthly rate: " MONTHLY
       " Periods: " PERIODS
       " Annuity ratio: " ANNUITY-VALUE
   END-DISPLAY.
```

Outputs:

```
Monthly rate: +0.0067 Periods: 36 Annuity ratio: +0.0314
```

4.2.4 FUNCTION ASIN

The ASIN function returns a numeric value (in radians) that approximates the arcsine of the argument.

The domain of the arcsine function is -1 to +1. Domain errors return a result of 0. The inverse sine function returns a range of -pi/2 thru pi/2

```
#!/usr/local/bin/cobc -xj

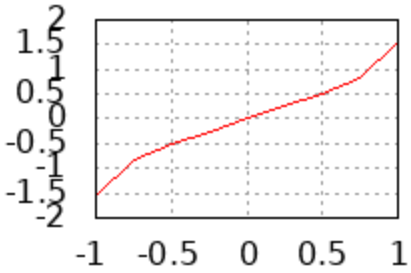
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 x            pic s9v99.
       01 degrees      pic s999v9.
       01 answer       pic s9v9(5).

       ==
       ==:CODEBOOK:== BY
       ==

       perform varying x from -1.0 by 0.25 until x > 1.0
           compute answer = asin(x)
           compute degrees rounded = answer * 180 / pi
           display "asin(" x ") ~= " answer " ~= " degrees "°"
       end-perform

       ==
       .
```




```
prompt$ ./asin-sample.cob
asin(-1.00) ~= -1.57079 ~= -090.0°
asin(-0.75) ~= -0.84806 ~= -048.6°
asin(-0.50) ~= -0.52359 ~= -030.0°
asin(-0.25) ~= -0.25268 ~= -014.5°
asin(+0.00) ~= +0.00000 ~= +000.0°
asin(+0.25) ~= +0.25268 ~= +014.5°
asin(+0.50) ~= +0.52359 ~= +030.0°
asin(+0.75) ~= +0.84806 ~= +048.6°
asin(+1.00) ~= +1.57079 ~= +090.0°
```

See *Sample shortforms* (page 1433) for the `sample-template.cob` listing.

4.2.5 FUNCTION ATAN

The ATAN function returns a numeric value (in radians) that approximates the arctangent of the argument.

The domain of the arctangent function is all real numbers. The inverse tangent function returns a range of -pi/2 thru pi/2

```
#!/usr/local/bin/cobc -xj

       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 answer       pic s9v9(5).
       01 degrees      pic s999v9.

       01 samples-table.
          05 sample-values.
             10 filler pic s9(2)v99 value -10.
             10 filler pic s9(2)v99 value -1.
             10 filler pic s9(2)v99 value -0.75.
             10 filler pic s9(2)v99 value -0.5.
             10 filler pic s9(2)v99 value -0.25.
             10 filler pic s9(2)v99 value 0.
             10 filler pic s9(2)v99 value +0.25.
             10 filler pic s9(2)v99 value +0.5.
             10 filler pic s9(2)v99 value +0.75.
             10 filler pic s9(2)v99 value +1.
             10 filler pic s9(2)v99 value +10.
          05 filler redefines sample-values.
             10 x      pic s9(2)v99 occurs 11 times indexed by lot.
       ==
```

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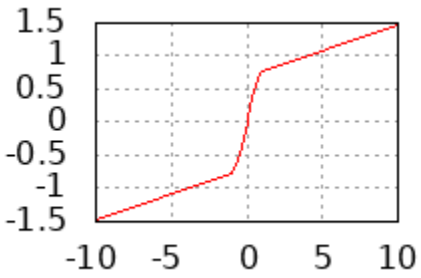
```
       ==:CODEBOOK:== BY
       ==

       perform varying lot from 1 by 1 until lot > 11
           compute answer = atan(x(lot))
           compute degrees rounded = answer * 180 / pi
           display "atan(" x(lot) ") ~= " answer " ~= " degrees "°"
       end-perform

       ==
       .

      *> Plot with
      *> gnuplot
      *>   set term png 256,160
      *>   set grid ; set tics scale 0
      *>   set output "atan-sample.png"
      *>   plot "atan-numbers.txt" using 1:2  with lines notitle
```




```
prompt$ ./atan-sample.cob
atan(-10.00) ~= -1.47112 ~= -084.3°
atan(-01.00) ~= -0.78539 ~= -045.0°
atan(-00.75) ~= -0.64350 ~= -036.9°
atan(-00.50) ~= -0.46364 ~= -026.6°
atan(-00.25) ~= -0.24497 ~= -014.0°
atan(+00.00) ~= +0.00000 ~= +000.0°
atan(+00.25) ~= +0.24497 ~= +014.0°
atan(+00.50) ~= +0.46364 ~= +026.6°
atan(+00.75) ~= +0.64350 ~= +036.9°
atan(+01.00) ~= +0.78539 ~= +045.0°
atan(+10.00) ~= +1.47112 ~= +084.3°
```

Plotting these values to a terminal, which can come in handy for command line COBOL programs.

```
prompt$ gnuplot
gnuplot> set term dumb
Terminal type set to 'dumb'
Options are 'feed  size 79, 24'
gnuplot> set grid ; set tics scale 0
gnuplot> plot "atan-numbers.txt" using 1:2  with lines notitle
```

Giving:

```
 1.5 +----------------+-----------------+----------------+-------------****
     |                :                 :                :       ******   |
```

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```
     |                 :                  :                 : ******          |
   1 +.................................................******.................+
     |                 :                  :      ******     :                 |
     |                 :                  : *****           :                 |
 0.5 +...................................*.................................+
     |                 :                  :*                :                 |
     |                 :                  *                 :                 |
   0 +...................................*.................................+
     |                 :                  *                 :                 |
     |                 :                 *:                 :                 |
     |                 :                * :                 :                 |
-0.5 +.................................*...................................+
     |                 :           *****  :                 :                 |
     |                 :    ******        :                 :                 |
  -1 +................******.................................................+
     |          ****** :                  :                 :                 |
     |   ******        :                  :                 :                 |
-1.5 ****-------------+-----------------+----------------+----------------+
    -10               -5                 0                 5                10
```

See *Sample shortforms* (page 1433) for the `sample-template.cob` listing.

4.2.6 FUNCTION BOOLEAN-OF-INTEGER

Not yet implemented.

Will return a USAGE BIT field given an integer argument and bit width.

4.2.7 FUNCTION BYTE-LENGTH

The BYTE-LENGTH function returns an integer that is the internal storage length of the given argument.

```
COBOL  >>SOURCE FORMAT IS FIXED
      ************************************************************************
      * Purpose:   demonstrate intrinsic FUNCTION BYTE-LENGTH
      ************************************************************************
       identification division.
       program-id. bytelength.

       data division.
       working-storage section.
       01 char-var           usage binary-char.
       01 short-var          usage binary-short.
       01 long-var           usage binary-long.
       01 double-var         usage binary-double.

       01 num1-var           pic 9.
       01 num4-var           pic 99v99.
       01 num9-var           pic s9(9).
       01 num18-var          pic s9(18).
       01 num18c-var         pic s9(18) usage comp.
       01 num18p-var         pic s9(18) usage comp-3.
       01 edit-var           pic $zzzz9.99.
```

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```
       01 string-var         pic x(10) value "abc".

       01 newline             pic x value x'0a'.

       procedure division.
       display
           "num1-var   len = " function byte-length(num1-var) newline
           "num4-var   len = " function byte-length(num4-var) newline
           "num9-var   len = " function byte-length(num9-var) newline
           "num18-var  len = " function byte-length(num18-var) newline
           "num18c-var len = " function byte-length(num18c-var) newline
           "num18p-var len = " function byte-length(num18p-var) newline
           "edit-var   len = " function byte-length(edit-var) newline

           "12         len = " function byte-length(12) newline
           "12.12      len = " function byte-length(12.12) newline
           "1234567890.123 = " function
               byte-length(1234567890.123) newline

           "string-var len = " function byte-length(string-var) newline
           "trim string    = " function
               byte-length(function trim(string-var)) newline

           "char-var   len = " function byte-length(char-var) newline
           "short-var  len = " function byte-length(short-var) newline
           "long-var   len = " function byte-length(long-var) newline
           "double-var len = " function byte-length(double-var)

       end-display
       goback.
       exit program.
```

Outputs:

```
num1-var   len = 1
num4-var   len = 4
num9-var   len = 9
num18-var  len = 18
num18c-var len = 8
num18p-var len = 10
edit-var   len = 9
12         len = 2
12.12      len = 4
1234567890.123 = 13
string-var len = 10
trim string    = 00000003
char-var   len = 1
short-var  len = 2
long-var   len = 4
double-var len = 8
```

4.2.8 FUNCTION CHAR

The CHAR function returns a ONE character alphanumeric field whose value is the character in the current collating sequence having the ordinal position equal to the value of the integer argument. The argument must be greater than 0

and less than or equal to the number of positions in the collating sequence. Errors in the argument range return 0 (the LOW-VALUE by default).

See *ASCII* (page 207) or *EBCDIC* (page 251) and details of the *ALPHABET* (page 196) clause.

DISPLAY FUNCTION CHAR(66).

Would output **A** in the ASCII character set. Note this may be different than what some expect. GnuCOBOL CHAR is 1 thru 128 not 0 thru 127 as a C programmer may be used to.

And to add a little confusion, most personal computers use an extended character set, usually erroneously called ASCII with a range of 0 to 255. A more appropriate name may be ISO-8859-1 Latin 1. See *ASCII* (page 207) for more accurate details. This author is often guilty of this misnomer of the use of the term ASCII.

4.2.9 FUNCTION CHAR-NATIONAL

Not yet implemented.

Will return a character from the national program collating sequence, given an integer argument representing the ordinal position in the sequence. From 1 to the length of the alphabet.

4.2.10 FUNCTION COMBINED-DATETIME

Returns a common datetime form from integer date (years and days from 1600 to 10000) and numeric time arguments (seconds in day). Date should be from 1 to 3067671 and time should be from 1 to 86400. The character string returned is in the form, 7 digits dot 5 digits.

```
DISPLAY FUNCTION COMBINED-DATETIME(1; 1)
```

Outputs:

```
0000001.00001
```

4.2.11 FUNCTION CONCATENATE

Concatenate the given fields. CONCATENATE is a GnuCOBOL extension.

```
MOVE "COBOL" TO stringvar
MOVE FUNCTION CONCATENATE("Gnu"; stringvar) TO goodsystem
DISPLAY goodsystem
```

Displays GnuCOBOL

4.2.12 FUNCTION CONTENT-LENGTH

Scans for a NUL byte delimiter of the data starting at address in given pointer, and returns the length. The NUL byte is not included in the count. An EC-DATA-PTR-NULL exception is set to exist if the pointer is NULL, and a zero length is returned.

CONTENT-LENGTH is a GnuCOBOL extension.

```
01 ptr USAGE POINTER.
01 str PIC x(4) VALUE z"abc".

SET ptr TO ADDRESS OF str
DISPLAY FUNCTION CONTENT-LENGTH(ptr)
```

Displays 3.

4.2.13 FUNCTION CONTENT-OF

Takes a pointer and optional length. Returns a character field of the data addressed by the pointer, either up to a NUL byte or to the given length.

The NUL byte is not included in the data when no optional length given. With an optional count the character field can hold any content including NUL bytes.

An EC-DATA-PTR-NULL exception is set to exist if the pointer is NULL, and a zero length space is returned. An EC-SIZE-TRUNCATION is set if the resulting field would exceed character field size limits and the data is truncated.

Reference modification allowed on resulting field.

CONTENT-OF is a GnuCOBOL extension.

```
01 ptr USAGE POINTER.
01 str PIC x(7) VALUE z"abcdef".

SET ptr TO ADDRESS OF str
DISPLAY FUNCTION CONTENT-OF(ptr)
DISPLAY FUNCTION CONTENT-OF(ptr, 2)
DISPLAY FUNCTION CONTENT-OF(ptr)(3:3)
```

Displays abcdef, ab, cde

4.2.14 FUNCTION COS

The COS function returns a numeric value that approximates the cosine of the argument (in radians).

The domain of the cosine function is all real numbers, with a nominal domain of 0 thru pi with a zero returned at pi/2. The cosine function returns a range of -1 thru +1.

```
#!/usr/local/bin/cobc -xj

       COPY line-sequential-template REPLACING
       ==:INPUT-NAME:== BY =="no-input"==
       ==:OUTPUT-NAME:== BY =="cos-plot.gp"==

       ==:DATABOOK:== BY
       ==

       01 gnuplot.
          05 value
          'set terminal dumb ; set grid ; set tics scale 0 ; ' &
          'set title "FUNCTION COS" ; plot "-" using 1:2 with lines'.

       01 x            pic s9v99.
       01 domain       pic s9v99.
```

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```
       01 degrees      pic s999v9.
       01 answer       pic s9(5)v9(5).

       01 output-data-line.
          05 x-out     pic -9.99.
          05           pic x value space.
          05 ans-out   pic -9(5).9(5).

       ==
       ==:CODEBOOK:== BY
       ==

       perform open-files

       move length(gnuplot) to output-actual
       move gnuplot to output-line
       perform write-output

       compute domain = pi * 3
       move length(output-data-line) to output-actual
       perform varying x from 0.0 by 0.25 until x > domain
           compute degrees rounded = x * 180 / pi
           move cos(x) to answer
           display "cos(" x ") ~= cos(" degrees "°) ~= " answer

           move x to x-out
           move answer to ans-out
           move output-data-line to output-line
           perform write-output
       end-perform

       perform close-files

       call "SYSTEM" using "gnuplot cos-plot.gp"

       perform delete-output
       ==
       .
```

And a run sample of:

```
prompt$ ./cos-sample.cob
cos(+0.00) ~= cos(+000.0°) ~= +00001.00000
cos(+0.25) ~= cos(+014.3°) ~= +00000.96891
cos(+0.50) ~= cos(+028.6°) ~= +00000.87758
cos(+0.75) ~= cos(+043.0°) ~= +00000.73168
cos(+1.00) ~= cos(+057.3°) ~= +00000.54030
cos(+1.25) ~= cos(+071.6°) ~= +00000.31532
cos(+1.50) ~= cos(+085.9°) ~= +00000.07073
cos(+1.75) ~= cos(+100.3°) ~= -00000.17824
cos(+2.00) ~= cos(+114.6°) ~= -00000.41614
cos(+2.25) ~= cos(+128.9°) ~= -00000.62817
cos(+2.50) ~= cos(+143.2°) ~= -00000.80114
cos(+2.75) ~= cos(+157.6°) ~= -00000.92430
cos(+3.00) ~= cos(+171.9°) ~= -00000.98999
cos(+3.25) ~= cos(+186.2°) ~= -00000.99412
cos(+3.50) ~= cos(+200.5°) ~= -00000.93645
```

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```
cos(+3.75) ~= cos(+214.9°) ~= -00000.82055
cos(+4.00) ~= cos(+229.2°) ~= -00000.65364
cos(+4.25) ~= cos(+243.5°) ~= -00000.44608
cos(+4.50) ~= cos(+257.8°) ~= -00000.21079
cos(+4.75) ~= cos(+272.2°) ~= +00000.03760
cos(+5.00) ~= cos(+286.5°) ~= +00000.28366
cos(+5.25) ~= cos(+300.8°) ~= +00000.51208
cos(+5.50) ~= cos(+315.1°) ~= +00000.70866
cos(+5.75) ~= cos(+329.5°) ~= +00000.86119
cos(+6.00) ~= cos(+343.8°) ~= +00000.96017
cos(+6.25) ~= cos(+358.1°) ~= +00000.99944
cos(+6.50) ~= cos(+372.4°) ~= +00000.97658
cos(+6.75) ~= cos(+386.7°) ~= +00000.89300
cos(+7.00) ~= cos(+401.1°) ~= +00000.75390
cos(+7.25) ~= cos(+415.4°) ~= +00000.56792
cos(+7.50) ~= cos(+429.7°) ~= +00000.34663
cos(+7.75) ~= cos(+444.0°) ~= +00000.10379
cos(+8.00) ~= cos(+458.4°) ~= -00000.14550
cos(+8.25) ~= cos(+472.7°) ~= -00000.38574
cos(+8.50) ~= cos(+487.0°) ~= -00000.60201
cos(+8.75) ~= cos(+501.3°) ~= -00000.78084
cos(+9.00) ~= cos(+515.7°) ~= -00000.91113
cos(+9.25) ~= cos(+530.0°) ~= -00000.98476


                                FUNCTION COS

    1 ***-----+------+------+------+------+-----******-+------+------+------+
      |  **  :      :      :      :      :    *:     *"-" using 1:2 ****** |
  0.8 +....*.....................................*........*.................+
      |     *:      :      :      :      : **  :      :*     :      :      |
  0.6 +.....*.............................*.............*................+
  0.4 +......*............................*.............*................+
      |      : *    :      :      :      *     :      :   *  :      :      |
  0.2 +.......*.......................*................*.............+
      |      :  *   :      :      :     *:     :      :    * :      :      |
    0 +.........*.....................*.....................*............+
      |      :   *  :      :      :   *  :     :      :      *      :      |
 -0.2 +..........*...................*.........................*...........+
      |      :     *:      :      : *    :     :      :      : *    :      |
 -0.4 +............*.............*.............................*.........+
 -0.6 +.............*............*.............................*........+
      |      :      : *    :     **      :     :      :      :    * :      |
 -0.8 +................**.....**.....................................**.....+
      |      :      :    **: **   :      :     :      :      :      **     |
   -1 +------+------+------**-----+------+-----+------+------+------+-*----+
      0      1      2      3      4      5     6      7      8      9      10
```

See *Sample shortforms* (page 1433) for the `line-sequential-template.cob` listing.

4.2.15 FUNCTION CURRENCY-SYMBOL

returns the current character symbol for monentary value picture clauses and outputs.

At time of testing this looked broken… cobc/parser.y has some support but if looks unfinished.

currency-symbol.cob

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *>************************************************
      *>****P* gcfaq/currency-symbol
      *> TECTONICS
      *>   cobc -x currency-symbol.cob
      *> SOURCE
       identification division.
       program-id. sample-currency-symbol.

       environment division.
       configuration section.
       special-names.
       currency sign is "&".   *> with picture symbol "@".
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 some-money              pic 9(5)9v99 value 4242.
       01 show-money              pic &zzzz9.99.

      *> ************************************************
       procedure division.
       display function currency-symbol

       move some-money to show-money
       display some-money
       display show-money

       goback.
       end program sample-currency-symbol.
      *>****
```

The above feels wrong and the following looks wrong.

```
$ cobc -x currency-symbol.cob
$ ./currency-symbol
```

giving:

```
$
004242.00
 &4242.00
```

I may have a misconfigured LOCALE and or misunderstanding of currency sign and symbol. There is code for WITH PICTURE SYMBOL "literal" but it is incomplete.

4.2.16 FUNCTION CURRENT-DATE

Returns an alphanumeric field of length 21 with the current date, time and timezone information in the form YYYYMMDDhhmmsscc±tznn

```
DISPLAY FUNCTION CURRENT-DATE.
```

Example Output:

```
2008080921243796-0400
```

See *FUNCTION FORMATTED-CURRENT-DATE* (page 460) for an easier to read form.

4.2.17 FUNCTION DATE-OF-INTEGER

Converts an integer date, (days on the Gregorian calendar, since December 31 1600) to YYYYMMDD form

```
#!/usr/local/bin/cobc -xj

      *> Modified: 2015-12-09/03:48-0500
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 showing pic zzz,zz9.
       01 dating  pic 9999/99/99.

       01 samples-table.
          05 sample-values.
             10 filler pic 9(6) value 1.
             10 filler pic 9(6) value 50000.
             10 filler pic 9(6) value 100000.
             10 filler pic 9(6) value 200000.
             10 filler pic 9(6) value 151550.
          05 filler redefines sample-values.
             10 sample pic 9(6) occurs 5 times indexed by lot.
       ==
       ==:CODEBOOK:== BY
       ==

       perform varying lot from 1 by 1 until lot > 5
           move sample(lot) to showing
           move date-of-integer(sample(lot)) to dating

           display "Day: " showing " is " dating
       end-perform

       ==
       .
```

Outputs:

```
prompt$ ./date-of-integer-sample
Day:       1 is 1601/01/01
Day:  50,000 is 1737/11/23
Day: 100,000 is 1874/10/16
Day: 200,000 is 2148/07/31
Day: 151,550 is 2015/12/06
```

50,000 days after December 31, 1600, being November 23rd, 1737.

See *Sample shortforms* (page 1433) for the `sample-template.cob` listing.

4.2.18 FUNCTION DATE-TO-YYYYMMDD

Converts a two digit year date format to four digit year form using a sliding window pivot of the optional second argument. The pivot defaults to 50.

The GnuCOBOL implementation of DATE-TO-YYYYMMDD also accepts an optional third argument, replacing the default century value of 1900 and is treated as the years added to the given year portion of the first argument and modified by the sliding 100 window pivot.

Domain errors occur for year values less than 1600 and greater than 999,999. There is no validation of the input date.

Because of the sliding window, this function is dependent on the date of evaluation

```
DISPLAY FUNCTION DATE-TO-YYYYMMDD(000101)
DISPLAY FUNCTION DATE-TO-YYYYMMDD(500101)
DISPLAY FUNCTION DATE-TO-YYYYMMDD(610101)
DISPLAY FUNCTION DATE-TO-YYYYMMDD(990101)

DISPLAY FUNCTION DATE-TO-YYYYMMDD(990101, 50, 1900)
DISPLAY FUNCTION DATE-TO-YYYYMMDD(990101, -10, 1900)
DISPLAY FUNCTION DATE-TO-YYYYMMDD(990101, 50, 2000)
DISPLAY FUNCTION DATE-TO-YYYYMMDD(990101, 50, 2100)
```

When run in August, 2008 produces:

```
20000101
20500101
19610101
19990101
18990101
17990101
19990101
20990101
```

4.2.19 FUNCTION DAY-OF-INTEGER

Converts a Gregorian integer date form to Julian date form (YYYDDD) based on days since December 31, 1600. Errors return 0

```
DISPLAY FUNCTION DAY-OF-INTEGER(97336).
1867182
```

97,336 days after 16001231 being the 182nd day of the year 1867. Canada's date of Confederation and recognized birthday.

4.2.20 FUNCTION DAY-TO-YYYYDDD

Converts a Julian 2 digit year and three digit day integer to a four digit year form. See *FUNCTION DATE-TO-YYYYMMDD* (page 453) for some of the details of the calculations involved.

4.2.21 FUNCTION DISPLAY-OF

Not yet implemented.

4.2.22 FUNCTION E

Returns Euler's number as an alphanumeric field to 34 digits of accuracy after the decimal. E forms the base of the natural logarithms. It has very unique and important properties such as:

- the derivative of e^x is e^x
- and the area below the curve of *y = 1/x* for *1 <= x <= e* is exactly 1.
- making it very useful in calculations of Future Value with compound interest.

```
DISPLAY FUNCTION E
```

outputs:

```
2.71828182845904523536028747135266 25
```

A small graph to show the magic area.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin
      *> Date:      29-May-2009, Modified 20110505 to add e tic mark
      *> Purpose:   Plot Euler's number (using integral of 1 over x)
      *> Tectonics: requires access to gnuplot. http://www.gnuplot.info
      *>            cobc -Wall -x ploteuler.cob
      *> OVERWRITES ocgenplot.gp, ocgpdata.txt and images/euler.png
      *> ****************************************************************
       identification division.
       program-id. ploteuler.

       environment division.
       input-output section.
       file-control.
           select scriptfile
               assign to "ocgenplot.gp"
               organization is line sequential.
           select outfile
               assign to "ocgpdata.txt"
               organization is line sequential.

       data division.
       file section.
       fd scriptfile.
          01 gnuplot-command pic x(82).

       fd outfile.
          01 outrec.
             03 x-value   pic -z9.999.
             03 filler    pic x.
             03 y-value   pic -z9.999.

       working-storage section.
       01 xstep   pic 9v99999.
       01 x       pic 9v99999.
       01 recip   pic 9v99999.

      *> The plot command is xrange 0:3, y 0:2 data col 1 for x 2 for y
       01 gpcmds  pic x(400) value is
```

(continues on next page)

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```
           "set style fill solid 1.0;                              " &
           "set grid;                                              " &
           "set xtics add ('e' 2.718281);                          " &
           "plot [0:3] [0:2] 'ocgpdata.txt' using 1:2 \            " &
           " with filledcurves below x1  title '1/x';              " &
           "set terminal png;                                      " &
           "set output 'images/euler.png';                         " &
           "replot                                                 ".
       01 line-cnt pic 999.
       01 gptable.
          05 gpcmd pic x(50) occurs 8 times.

       01 gplot   pic x(40) value is 'gnuplot -persist ocgenplot.gp'.
       01 result  pic s9(9).

      *> ****************************************************************
       procedure division.
       display function e

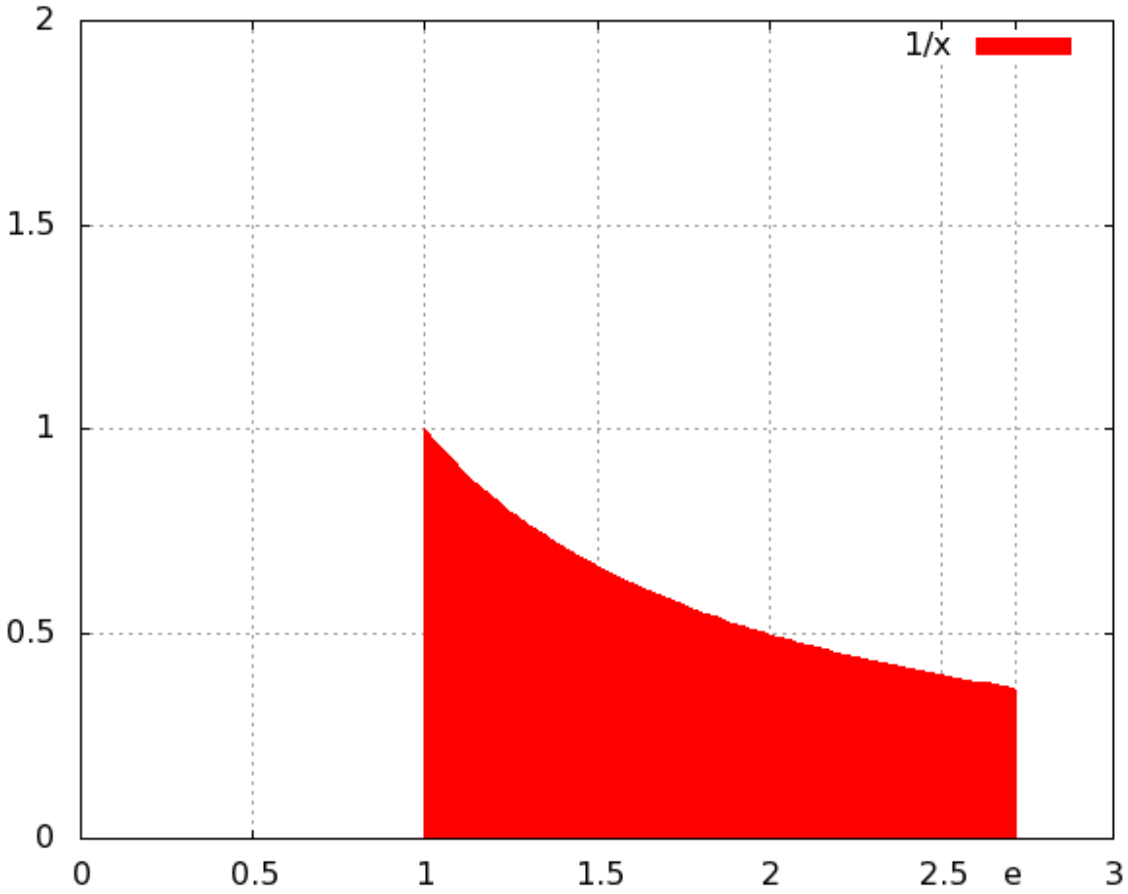
      *><* Create the script to plot the area of Euler's number
       open output scriptfile.
       move gpcmds to gptable
       perform varying line-cnt from 1 by 1 until line-cnt > 8
           move gpcmd(line-cnt) to gnuplot-command
           write gnuplot-command end-write
       end-perform
       close scriptfile

      *><* Create the reciprocal data
       open output outfile
       move spaces to outrec
       compute xstep = function e / 100 end-compute
       perform
           with test after
           varying x from 1 by xstep
           until x >= function e
               if x > function e
                   move function e to x-value
               else
                   move x to x-value
               end-if
               compute recip = 1 / x end-compute
               move recip to y-value
               write outrec end-write
       end-perform
       close outfile

      *><* Invoke gnuplot
       call "SYSTEM" using gplot returning result end-call
       if result not = 0
           display "Problem: " result
           stop run returning result
       end-if

       goback.
       end program ploteuler.
```

The area in red is exactly 1. *Well, not on this plot exactly, as it is somewhat sloppy with the xstep end case and the precisions.*



See *Can GnuCOBOL be used for plotting?* (page 801) for some details on plotting.

4.2.23 FUNCTION EXCEPTION-FILE

This special-register holds the error number and name of the source file that caused an input output exception. See *FUNCTION EXCEPTION-STATUS* (page 457) for an example.

4.2.24 FUNCTION EXCEPTION-FILE-N

Not yet implemented.

4.2.25 FUNCTION EXCEPTION-LOCATION

This special-register can be queried for the location of the last exception. See *FUNCTION EXCEPTION-STATUS* (page 457) for example source code. Note: This feature requires compilation with *-fsource-location* compiler switch. This option is also turned on with *-g* and *-debug* debugging info compiles. Information includes PROGRAM-ID, section and source line.

4.2.26 FUNCTION EXCEPTION-LOCATION-N

Not yet implemented.

4.2.27 FUNCTION EXCEPTION-STATEMENT

This special-register holds the statement that was executing when the latest exception was raised. See *FUNCTION EXCEPTION-STATUS* (page 457) for an example. Note: This feature requires compilation with *-fsource-location* compiler switch. This option is also turned on with *-g* debugging info compiles.

4.2.28 FUNCTION EXCEPTION-STATUS

This FUNCTION returns the current exception status. The example below is courtesy of Roger While, from a post he made announcing the *FUNCTION EXCEPTION-* features.

Source format is free, compile with *cobc -x -g -free except.cob*

```
IDENTIFICATION DIVISION.
PROGRAM-ID. MINIPROG.

ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER. LINUX.
OBJECT-COMPUTER. LINUX.
SPECIAL-NAMES.

INPUT-OUTPUT SECTION.
FILE-CONTROL.
SELECT PRINTFILE ASSIGN TO "XXRXWXX"
FILE STATUS RXWSTAT.

DATA DIVISION.
FILE SECTION.
FD PRINTFILE.
01 PRINTREC PIC X(132).

WORKING-STORAGE SECTION.
01 RXWSTAT PIC XX.

PROCEDURE DIVISION.
A00-MAIN SECTION.
001-MAIN-PROCEDURE.
OPEN INPUT PRINTFILE.
DISPLAY "File Status: " RXWSTAT.
DISPLAY "EXCEPTION-FILE: " FUNCTION EXCEPTION-FILE.
DISPLAY "Return Length: "
    FUNCTION LENGTH (FUNCTION EXCEPTION-FILE).
DISPLAY "EXCEPTION-STATUS: " FUNCTION EXCEPTION-STATUS.
DISPLAY "EXCEPTION-STATEMENT: " FUNCTION EXCEPTION-STATEMENT.
STRING "TOOLONG" DELIMITED SIZE INTO RXWSTAT.
DISPLAY "EXCEPTION-STATUS: " FUNCTION EXCEPTION-STATUS.
DISPLAY "EXCEPTION-STATEMENT: " FUNCTION EXCEPTION-STATEMENT.
DISPLAY "EXCEPTION-LOCATION: " FUNCTION EXCEPTION-LOCATION.

STOP RUN.
```

Example output:

```
File Status: 35
EXCEPTION-FILE: 35PRINTFILE
Return Length: 00000011
EXCEPTION-STATUS: EC-I-O-PERMANENT-ERROR
EXCEPTION-STATEMENT: OPEN
EXCEPTION-STATUS: EC-OVERFLOW-STRING
EXCEPTION-STATEMENT: STRING
EXCEPTION-LOCATION: MINIPROG; 001-MAIN-PROCEDURE OF A00-MAIN; 29
```

Tip: See the source file libcob/exception.def for a list of the plethora of run-time exceptions supported by GnuCOBOL.

4.2.29 FUNCTION EXP

Returns an approximation of Euler's number (see *FUNCTION E* (page 454)) raised to the power of the numeric argument.

```
DISPLAY FUNCTION EXP(1)
```

outputs:

```
2.718281828459045091
```

Note: Be aware that this approximation seems accurate to "only" 15 decimal places. Diligent programmers need to be aware of the foibles of floating point mathematics and take these issues into consideration.

4.2.30 FUNCTION EXP10

Returns an approximation of the value 10 raised to the power of the numeric argument.

```
DISPLAY FUNCTION EXP10(1.0)
DISPLAY FUNCTION EXP10(1.2)
DISPLAY FUNCTION EXP10(10)
```

Outputs:

```
10.000000000000000000
15.848931924611132871
10000000000.000000000000000000
```

4.2.31 FUNCTION FACTORIAL

Computes the factorial of the integral argument. Valid domain of 0 to 19 with a range of 1 to 121645100408832000.

```
GCobol*> ************************************************************
      *> Program to find range and domain of FUNCTION FACTORIAL
       identification division.
```

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```
       program-id. fact.

       data division.
       working-storage section.
       01 ind pic 999.
       01 result pic 9(18).

      *> ****************************************************************
       procedure division.
       perform varying ind from 0 by 1 until ind > 20
           add zero to function factorial(ind) giving result
               on size error
                   display "overflow at " ind
           end-add
           display ind " = " function factorial(ind)
       end-perform

       goback.
       end program fact.
```

Outputs:

```
000 = 000000000000000001
001 = 000000000000000001
002 = 000000000000000002
003 = 000000000000000006
004 = 000000000000000024
005 = 000000000000000120
006 = 000000000000000720
007 = 000000000000005040
008 = 000000000000040320
009 = 000000000000362880
010 = 000000000003628800
011 = 000000000039916800
012 = 000000000479001600
013 = 000000006227020800
014 = 000000087178291200
015 = 000001307674368000
016 = 000020922789888000
017 = 000355687428096000
018 = 006402373705728000
019 = 121645100408832000
overflow at 020
020 = 432902008176640000
```

Kind of the same thing, with some zero out formatting.

```
GCobol*> ****************************************************************
      *> Program to find range and domain of FUNCTION FACTORIAL
       identification division.
       program-id. fact.

       data division.
       working-storage section.
       01 ind                  pic 99.
       01 z-ind                pic z9.
       01 result               pic 9(18).
```

(continues on next page)

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```
       01 pretty-result        pic z(17)9.

      *> ************************************************************
       procedure division.
       perform varying ind from 0 by 1 until ind > 21
           add zero to function factorial(ind) giving result
               on size error
                   display
                       "overflow at " ind ", result undefined: "
                       function factorial(ind)
               not on size error
                   move ind to z-ind
                   move result to pretty-result
                   display "factorial(" z-ind ") = " pretty-result
           end-add
       end-perform

       goback.
       end program fact.
```

Which outputs:

```
factorial( 0) =                  1
factorial( 1) =                  1
factorial( 2) =                  2
factorial( 3) =                  6
factorial( 4) =                 24
factorial( 5) =                120
factorial( 6) =                720
factorial( 7) =               5040
factorial( 8) =              40320
factorial( 9) =             362880
factorial(10) =            3628800
factorial(11) =           39916800
factorial(12) =          479001600
factorial(13) =         6227020800
factorial(14) =        87178291200
factorial(15) =      1307674368000
factorial(16) =     20922789888000
factorial(17) =    355687428096000
factorial(18) =   6402373705728000
factorial(19) = 121645100408832000
overflow at 20, result undefined, 432902008176640000
overflow at 21, result undefined, 197454024290336768
```

4.2.32 FUNCTION FORMATTED-CURRENT-DATE

Returns the current date, formatted as per the given format specification, matching those of ISO 8601.

See *FUNCTION FORMATTED-DATETIME* (page 461) for the allowable format specifications.

```
display formatted-current-date("YYYY-Www-D")
2015-W49-3

display formatted-current-date("YYYY-MM-DD")
2015-12-02
```

On Wednesday, December 2nd 2015, the 49th week, 3rd day of the week.

```
display formatted-current-date("YYYY-MM-DDThh:mm:ss+hh:mm")
2015-12-02T03:47:05-05:00

display formatted-current-date("YYYY-MM-DDThh:mm:ssZ")
2015-12-02T08:47:05Z
```

The **Z spec** (*Zulu time*) displays the time field relative to UTC, not local time.

If the current time zone cannot be determined, the initial +/- symbol is displayed as a 0, so that would have been shown as:

```
display formatted-current-date("YYYY-MM-DDThh:mm:ss+hh:mm")
2015-12-02T03:47:05000:00
```

4.2.33 FUNCTION FORMATTED-DATE

Returns a formatted time given:

- an ISO 8601 format spec
- an integer date form
- an optional offset from UTC expressed in minutes.

See *FUNCTION FORMATTED-DATETIME* (page 461) for the allowable format specifications.

```
display formatted-date("YYYY-MM-DD",
          integer-of-date(numval(current-date(1:8))))
display formatted-date("YYYY-Www-D",
          integer-of-date(numval(current-date(1:8))))
```

On December 2nd, 2015 displayed:

```
2015-12-02
2015-W49-3
```

4.2.34 FUNCTION FORMATTED-DATETIME

Returns a formatted combined date and time, given

- an ISO 8601 specification
- an integer date form
- a time in numeric form
- an optional offset from UTC expressed in minutes.

The table below uses:

```
Wednesday, February 15, 1995, at 05:14:27.812479168304 Eastern Standard Time
```

for the example value illustrations.

Type of format	Format	Example Value
Basic calendar format	YYYYMMDD	19950215
Extended calendar date	YYYY-MM-DD	1995-02-15
Basic ordinal date	YYYYDDD	1995046
Extended ordinal date	YYYY-DDD	1995-046
Basic week date	YYYYWwwD	1995W063
Extended week date	YYYY-Www-D	1995-W06-3
Basic local time	hhmmss	051427
Extended local time	hh:mm:ss	05:14:27
Basic local time (fractional)	hhmmss.sssssssss	051427.812479168
Extended local time (fractional)	hh:mm:ss.sssssssss	05:14:27.812479168
Basic UTC time	hhmmssZ	101427Z
Extended UTC time	hh:mm:ssZ	10:14:27Z
Basic UTC time (fractional)	hhmmss.ssssssssZ	101427.812479168Z
Extended UTC time (fractional)	hh:mm:ss.ssssssssZ	10:14:27.812479168Z
Basic offset time	hhmmss+hhmm	051427-0500
Extended offset time	hh:mm:ss+hh:mm	05:14:27-05:00
Basic offset time (frac)	hhmmss.sssssssss+hhmm	051427.812479168-0500
Extended offset time (frac)	hh:mm:ss.sssssssss+hh:mm	05:14:27.812479168-05:00
Combined basic date and time	YYYYMMDDThhmmss	19950215T051427
Combined extended date time	YYYY-MM-DDThh:mm:ss+hh:mm	1995-02-15T05:14:27-05:00
Combined basic date time (frac)	YYYYMMDDThhmm.ss+hhmm	19950215T051427.81-0500

All valid date and time formats are allowed with the combined date and time specifications, and not all combinations are listed here.

Note: When DECIMAL POINT IS COMMA is in effect, any periods used for time format, must be commas when used. Be wary when requesting sub-seconds, and DPC mode.

4.2.35 FUNCTION FORMATTED-TIME

Returns a formatted time given:

- an ISO 8601 specification
- a time in numeric form as a number of seconds past midnight
- an optional offset from UTC, expressed in minutes.

See *FUNCTION FORMATTED-DATETIME* (page 461) for the allowable format specifications.

```
identification division.
program-id. formatted-time-sample.

environment division.
configuration section.
repository.
    function all intrinsic.

procedure division.
display current-date
display seconds-past-midnight
```

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```
display formatted-time("hh:mm:ss", seconds-past-midnight)
display
  formatted-time("hh:mm:ss+hh:mm", seconds-past-midnight, -300)

goback.
end program formatted-time-sample.
```

giving:

```
prompt$ cobc -xj formatted-time-sample
20151201225324740000
000082404
22:53:24
22:53:24-05:00
```

4.2.36 FUNCTION FRACTION-PART

Returns a numeric value that is the fraction part of the argument. Keeping the sign.

```
DISPLAY FUNCTION FRACTION-PART(FUNCTION E)
DISPLAY FUNCTION FRACTION-PART(-1.5)
DISPLAY FUNCTION FRACTION-PART(-1.0)
DISPLAY FUNCTION FRACTION-PART(1)
```

Outputs:

```
+.718281828459045235
-.500000000000000000
+.000000000000000000
+.000000000000000000
```

4.2.37 FUNCTION HIGHEST-ALGEBRAIC

Returns the highest value allowed in the argument's data type.

```
GNU    >>SOURCE FORMAT IS FIXED
Cobol *>************************************************
      *>****P* gcfaq/highest-algebraic
      *> TECTONICS
      *>   cobc -x highest-algebraic.cob
      *> SOURCE
       identification division.
       program-id. function-highest-algebraic.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 some-money              pic 9(5)9v99 value 4242.
       01 show-money              pic $zzzz9.99.
```

(continues on next page)

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```
       01 some-pennies            pic v99 value 0.06.

       01 newline                 pic x value x"0a".

      *> ********************************************
       procedure division.
       move some-money to show-money

       display
           some-money " : " highest-algebraic(some-money) newline
           show-money " : " highest-algebraic(show-money) newline
           some-pennies " : " highest-algebraic(some-pennies)

       goback.
       end program function-highest-algebraic.
```

giving:

```
./highest-algebraic
004242.00 : 0999999.99
 $4242.00 : 0099999.99
.06 : 0000000.99
```

4.2.38 FUNCTION INTEGER

Returns the greatest integer less than or equal to the numeric argument.

```
DISPLAY
    FUNCTION INTEGER (-3)       SPACE
    FUNCTION INTEGER (-3.141)
DISPLAY
    FUNCTION INTEGER (3)        SPACE
    FUNCTION INTEGER (3.141)
DISPLAY
    FUNCTION INTEGER (-0.3141) SPACE
    FUNCTION INTEGER (0.3141)  SPACE
    FUNCTION INTEGER (0)
```

Outputs:

```
-000000000000000003 -000000000000000004
+000000000000000003 +000000000000000003
-000000000000000001 +000000000000000000 +000000000000000000
```

Note the -4, greatest integer **less than or equal to** the argument.

4.2.39 FUNCTION INTEGER-OF-BOOLEAN

Not yet implemented.

4.2.40 FUNCTION INTEGER-OF-DATE

Converts a date in the Gregorian calender to an integer form. Expects a numeric argument in the form *YYYYMMDD* based on years greater than or equal to 1601 and less than 10000. Month values range from 1 to 12. Days range from 1 to 31 and should be valid for the specified month and year. Invalid input returns unpredictable results and sets the exception EC-ARGUMENT-FUNCTION to exist. See *FUNCTION DATE-OF-INTEGER* (page 452) for the converse function.

4.2.41 FUNCTION INTEGER-OF-DAY

Converts a Julian date of YYYYDDD to integer date form. See *FUNCTION DAY-OF-INTEGER* (page 453) for the converse intrinsic function. Invalid arguments return an undefined result and set the exception EC-ARGUMENT-FUNCTION to exist.

4.2.42 FUNCTION INTEGER-OF-FORMATTED-DATE

Returns an integer date form given

- an ISO 8601 format specification
- a date string appropriate for the spec

```
display integer-of-formatted-date("YYYY-Www-D", "2014-W01-1")
150844

display integer-of-formatted-date("YYYY-MM-DD", "2013-12-30")
150844

display integer-of-formatted-date("YYYY-DDD", "2013-364")
150844
```

The first day of the first week of 2014 was actually December 30th, 2013.

See *FUNCTION FORMATTED-DATETIME* (page 461) for a table of supported format specifications.

4.2.43 FUNCTION INTEGER-PART

Returns the integer part of the numeric argument. Similar to *FUNCTION INTEGER* (page 464) but returns different values for negative arguments.

```
DISPLAY
    FUNCTION INTEGER-PART (-3)       SPACE
    FUNCTION INTEGER-PART (-3.141)
DISPLAY
    FUNCTION INTEGER-PART (3)        SPACE
    FUNCTION INTEGER-PART (3.141)
DISPLAY
    FUNCTION INTEGER-PART (-0.3141) SPACE
    FUNCTION INTEGER-PART (0.3141)  SPACE
    FUNCTION INTEGER-PART (0)
```

Outputs:

```
-000000000000000003 -000000000000000003
+000000000000000003 +000000000000000003
+000000000000000000 +000000000000000000 +000000000000000000
```

4.2.44 FUNCTION LENGTH

Returns an integer that is the length in character positions of the given argument.

```
working storage.
01 nat      pic n(10).
01 cha      pic x(10).
01 bin      constant as h'ff'.

01 num      pic s9(8)v9(8).
01 form     pic $-z(7)9.9(8).

procedure division.
display
    function length(nat) space
    function length(cha) space
    function length(bin)
end-display
display
    function length(num) space
    function length(form)
end-display
```

Outputs:

```
20 10 3
16 19
```

4.2.45 FUNCTION LENGTH-AN

In GnuCOBOL 2.0 this is an alias for *FUNCTION BYTE-LENGTH* (page 445).

4.2.46 FUNCTION LOCALE-COMPARE

Not yet implemented.

4.2.47 FUNCTION LOCALE-DATE

Returns a culturally appropriate date given an alphanumeric of 8 character positions in the form "YYYYMMDD" and an optional locale name that has been associated with a locale in the SPECIAL-NAMES paragraph.

See https://en.wikipedia.org/wiki/Locale for a start at the very detail rich computational requirements of LOCALE.

Will set EC-ARGUMENT-FUNCTION to exist for invalid input.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
```

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```
      *> Date:      20120116
      *> Purpose:   Demonstrate locale functions
      *> Tectonics: cobc -x locales.cob
      *> ************************************************************
       identification division.
       program-id. locales.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

      *> -*********-*********-*********-*********-*********-*********-**
       procedure division.

      *> Display cultural norm date and times as set in environment.
      *>   Google LC_ALL.
      *> 20120622 represents June 22 2012
      *> 141516 represents 2pm (14th hour), 15 minutes, 16 seconds
      *> 39600 represents 11 hours in seconds

       display locale-date(20120622)
       display locale-time(141516)
       display locale-time-from-seconds(39600)

       goback.
       end program locales.
```

Which produced:

```
[btiffin@home cobol]$ cobc -x locales.cob
[btiffin@home cobol]$ ./locales
06/22/2012
02:15:16 PM
11:00:00 AM
```

I live in Canada, but usually run Fedora with LANG=en_US.utf8

and so

```
[btiffin@home cobol]$ export LANG='en_CA.utf8'
[btiffin@home cobol]$ ./locales
22/06/12
02:15:16 PM
11:00:00 AM
```

Boo, day month year form. Sad, 2 digit year? What kinda backwater land do I live in? Time to write strongly worded letters to some committees. :)

I just looked, and it seems Canada is listed as DD/MM/YY; I'm moving to Denmark.

```
[btiffin@home cobol]$ export LANG=en_DK.utf8
[btiffin@home cobol]$ ./locales
2012-06-22
14:15:16
11:00:00
```

Joy. year month day. Hmm, what about Hong Kong?

```
[btiffin@home cobol]$ LANG=en_HK.utf8 ./locales
Sunday, June 22, 2012
02:15:16 EST
11:00:00 EST
```

Nice.

If you want to run your system through its locales, try

```
$ locs=( $(locale -a) )
$ for l in ${locs[@]}; do echo $l; LANG=$l ./locales; done
```

and expect some unicode in the output.

Oh, and along with *FUNCTION EXCEPTION-STATUS* (page 457) you can detect invalid arguments.

```
000100 >>SOURCE FORMAT IS FIXED
000200*> ************************************************************
000300*> Author:    Brian Tiffin
000400*> Date:      20120116
000500*> Purpose:   Demonstrate locale function invalid arguments
000600*> Tectonics: cobc -x -g -debug locales.cob
000700*> ************************************************************
000800 identification division.
000900 program-id. locales.
001000
001100 environment division.
001200 configuration section.
001300 repository.
001400     function all intrinsic.
001500
001600*> -*********-*********-*********-*********-*********-*********-**
001700 procedure division.
001800
001900*> Display cultural norm date and times as set in environment.
002000*>   Google LC_ALL.
002100*> 20120622 represents June 22 2012
002200*> 141516 represents 2pm (14th hour), 15 minutes, 16 seconds
002300*> 39600 represents 11 hours in seconds
002400
002500 display locale-date(20120622)
002600 display locale-time(141516)
002700 display locale-time-from-seconds(39600)
002800
002900*> invalid arguments are detected through EXCEPTION-STATUS
003000 display locale-date(20120699)
003100 DISPLAY "EXCEPTION-STATUS: " EXCEPTION-STATUS
003200 DISPLAY "EXCEPTION-STATEMENT: " EXCEPTION-STATEMENT
003300 DISPLAY "EXCEPTION-LOCATION: " EXCEPTION-LOCATION
003400
003500 display locale-time(941516)
003600 DISPLAY "EXCEPTION-STATUS: " EXCEPTION-STATUS
003700 DISPLAY "EXCEPTION-STATEMENT: " EXCEPTION-STATEMENT
003800 DISPLAY "EXCEPTION-LOCATION: " EXCEPTION-LOCATION
003900
004000 display locale-time-from-seconds(-39600)
004100
004200 goback.
```

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```
004300 end program locales.
```

giving:

```
$ ./locales
06/22/2012
02:15:16 PM
11:00:00 AM

EXCEPTION-STATUS: EC-ARGUMENT-FUNCTION
EXCEPTION-STATEMENT: DISPLAY
EXCEPTION-LOCATION: locales; MAIN PARAGRAPH OF MAIN SECTION; 30

EXCEPTION-STATUS: EC-ARGUMENT-FUNCTION
EXCEPTION-STATEMENT: DISPLAY
EXCEPTION-LOCATION: locales; MAIN PARAGRAPH OF MAIN SECTION; 35
-11:00:00 AM
```

4.2.48 FUNCTION LOCALE-TIME

Returns a culturally appropriate date given an alphanumeric of 6 character positions in the form "HHMMSS" and an optional locale name that has been associated with a locale in the SPECIAL-NAMES paragraph. See https://en.wikipedia.org/wiki/Locale for a start at the very detail rich computational requirements of LOCALE.

Will set EC-ARGUMENT-FUNCTION to exist for invalid input.

See *FUNCTION LOCALE-DATE* (page 466).

4.2.49 FUNCTION LOCALE-TIME-FROM-SECONDS

Returns a culturally appropriate date given an alphanumeric number of seconds and an optional locale name that has been associated with a locale in the SPECIAL-NAMES paragraph.

See https://en.wikipedia.org/wiki/Locale for a start at the very detail rich computational requirements of LOCALE.

Will set EC-ARGUMENT-FUNCTION to exist for invalid input.

See *FUNCTION LOCALE-DATE* (page 466).

4.2.50 FUNCTION LOG

Returns an approximation of the natural logarithmic value of the given numeric argument. Uses a base of *FUNCTION E* (page 454).

```
DISPLAY FUNCTION LOG(100)
DISPLAY FUNCTION LOG(FUNCTION E)
```

gives:

```
4.60517018598809137
000000001
```

4.2.51 FUNCTION LOG10

Returns an approximation of the base-10 logarithmic value of the given numeric argument.

```
DISPLAY FUNCTION LOG10(100)
```

gives:

```
000000002
```

4.2.52 FUNCTION LOWER-CASE

Convert any uppercase character values (A-Z) in the argument to lowercase (a-z).

4.2.53 FUNCTION LOWEST-ALGEBRAIC

Returns the lowest value allowed in the argument's data type.

Basically, this will be 0 or the "largest" negative value that can be expressed by PICTURE or USAGE. `PIC S999` is lowest at `-999`, `PIC 999` is lowest at `0`.

See *FUNCTION HIGHEST-ALGEBRAIC* (page 463)

4.2.54 FUNCTION MAX

Returns the maximum value from the list of arguments.

```
DISPLAY FUNCTION MAX ( "def"; "abc"; )
DISPLAY FUNCTION MAX ( 123.1; 123.11; 123 )
```

Outputs:

```
def
123.11
```

4.2.55 FUNCTION MEAN

Returns the arithmetic mean (average) of the list of numeric arguments.

```
DISPLAY FUNCTION MEAN( 1; 2; 3; 4; 5; 6; 7; 8; 9 )
```

Outputs:

```
+5.00000000000000000
```

4.2.56 FUNCTION MEDIAN

Returns the middle value of the arguments formed by arranging the list in sorted order.

```
DISPLAY FUNCTION MEDIAN( 1; 2; 3; 4; 5; 6; 7; 8; 9 )
```

Outputs:

```
5
```

4.2.57 FUNCTION MIDRANGE

Returns the arithmetic mean (average) of the minimum and maximum argument from the list of numeric arguments.

```
DISPLAY FUNCTION MIDRANGE( 1; 2; 3; 4; 5; 6; 7; 8; 9 )
```

Outputs:

```
5.000000000000000000
```

4.2.58 FUNCTION MIN

Returns the minimum value from the list of arguments.

```
DISPLAY FUNCTION MIN ( "def"; "abc";)
DISPLAY FUNCTION MIN ( 123.1; 123.11; 123 )
```

Outputs:

```
abc
123
```

4.2.59 FUNCTION MOD

Returns an integer value of that is the first-argument modulo second-argument.

```
DISPLAY FUNCTION MOD( 123; 23 )
```

Outputs:

```
+000000000000000008
```

4.2.60 FUNCTION MODULE-CALLER-ID

Returns the PROGRAM-ID identifier (or FUNCTION-ID) of the calling program, if there is one.

```
GNU
COBOL
       IDENTIFICATION   DIVISION.
       PROGRAM-ID.      prog.
       ENVIRONMENT      DIVISION.
       DATA             DIVISION.
       WORKING-STORAGE SECTION.
       PROCEDURE        DIVISION.
           CALL "prog2"
           END-CALL.
           STOP RUN.
```

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```
       END PROGRAM prog.

       IDENTIFICATION   DIVISION.
       PROGRAM-ID.      prog2.
       ENVIRONMENT      DIVISION.
       DATA             DIVISION.
       WORKING-STORAGE SECTION.
       01 newline       pic x value x"0a".

       PROCEDURE        DIVISION.
           DISPLAY
               FUNCTION MODULE-CALLER-ID           newline
               FUNCTION MODULE-DATE                newline
               FUNCTION MODULE-FORMATTED-DATE      newline
               FUNCTION MODULE-ID                  newline
               FUNCTION MODULE-PATH                newline
               FUNCTION MODULE-SOURCE              newline
               FUNCTION MODULE-TIME
           END-DISPLAY.
           EXIT PROGRAM.
```

with a sample run of

```
prompt$ date
Thu Sep  4 04:01:32 EDT 2014

prompt$ cobc -xj module-dash.cob
prog
20140904
Sep 04 2014 04:01:34
prog2
/home/btiffin/lang/cobol/module-dash
module-dash.cob
040134
```

4.2.61 FUNCTION MODULE-DATE

Returns the date that the current module was compiled, in ccyymmdd form.

See *FUNCTION MODULE-CALLER-ID* (page 471) for an example program demonstrating the various MODULE-introspection functions.

4.2.62 FUNCTION MODULE-FORMATTED-DATE

Returns the formatted date of when the current module was compiled.

Default is Mon dd ccyy hh:mm:ss form. Where Mon is a month name shortform.

The format is dependent on the LC_CTYPE locale setting, see *Setting Locale* (page 1350) for more information.

See *FUNCTION MODULE-CALLER-ID* (page 471) for an example program demonstrating the various MODULE-introspection functions.

4.2.63 FUNCTION MODULE-ID

Returns the program name of the current module, taken from the PROGRAM-ID or FUNCTION-ID identifier.

See *FUNCTION MODULE-CALLER-ID* (page 471) for an example program demonstrating the various MODULE-introspection functions.

Invocation name

For the external name, as stored on a filesystem, use

```
display 0 upon argument-number
accept progname from argument-value
display "argument-value zero :" progname ":"
```

ARGUMENT-VALUE (with ARGUMENT-NUMBER at zero), returns the external invocation name of the program.

4.2.64 FUNCTION MODULE-PATH

Returns the source code path used when compiling module.

See *FUNCTION MODULE-CALLER-ID* (page 471) for an example program demonstrating the various MODULE-introspection functions.

4.2.65 FUNCTION MODULE-SOURCE

Returns the source file used when compiling module.

See *FUNCTION MODULE-CALLER-ID* (page 471) for an example program demonstrating the various MODULE-introspection functions.

4.2.66 FUNCTION MODULE-TIME

Returns the time the current module was compiled, in hh:mm:ss form by default.

The format is dependent on the LC_CTYPE locale setting, see *Setting Locale* (page 1350) for more information.

See *FUNCTION MODULE-CALLER-ID* (page 471) for an example program demonstrating the various MODULE-introspection functions.

4.2.67 FUNCTION MONETARY-DECIMAL-POINT

Returns the character representing the LOCALE based fiscal decimal point. Defaults to period, ".".

```
      *>
      *> monetary-decimal-point.cob
      *> Tectonics: cobc -xj monetary-decimal-point.cob
      *>
       >>SOURCE FORMAT IS FIXED
       identification division.
       program-id. monetary-decimal-point.

       procedure division.
```

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```
       demonstrate-intrinsic.

       display "FUNCTION MONETARY-DECIMAL-POINT is """
           function monetary-decimal-point """, character code "
           function ord(function monetary-decimal-point)
       end-display
       .

       goback.
       end program monetary-decimal-point.
```

Output:

```
prompt$ cobc -W -xj monetary-decimal-point.cob
FUNCTION MONETARY-DECIMAL-POINT is ".", character code 000000047
```

4.2.68 FUNCTION MONETARY-THOUSANDS-SEPARATOR

Returns the character representing the LOCALE based visual numeric grouping separator for fiscal data. Defaults to comma ",".

```
      *>
      *> monetary-thousands-separator.cob
      *> Tectonics: cobc -xj monetary-thousands-separator.cob
      *>
       >>SOURCE FORMAT IS FIXED
       identification division.
       program-id. monetary-thousands-separator.

       procedure division.
       demonstrate-intrinsic.

       display "FUNCTION MONETARY-THOUSANDS-SEPARATOR is """
           function monetary-thousands-separator """, character code "
           function ord(function monetary-thousands-separator)
       end-display
       .

       goback.
       end program monetary-thousands-separator.
```

Output:

```
prompt$ cobc -W -xj monetary-thousands-separator.cob
FUNCTION MONETARY-THOUSANDS-SEPARATOR is ",", character code 000000045
```

4.2.69 FUNCTION NATIONAL-OF

Not yet implemented.

Will return a national character string representing the characters in the argument.

4.2.70 FUNCTION NUMERIC-DECIMAL-POINT

Returns the character representing the LOCALE based decimal point.

4.2.71 FUNCTION NUMERIC-THOUSANDS-SEPARATOR

Returns the character representing the LOCALE based visual numeric grouping separator.

4.2.72 FUNCTION NUMVAL

Returns the numeric value represented by the character string argument.

```
GCobol IDENTIFICATION   DIVISION.
       PROGRAM-ID.      prog.
       DATA             DIVISION.
       WORKING-STORAGE  SECTION.
       01  X   PIC   X(12) VALUE " -9876.1234 ".
       01  F   PIC   X(12) VALUE "B-9876.1234 ".
       PROCEDURE        DIVISION.
           DISPLAY FUNCTION NUMVAL ( X )
           DISPLAY FUNCTION NUMVAL ( F )
           STOP RUN.
```

gives:

```
-09876.1234
000000000
```

The "B" in field F, breaks the numeric conversion. NUMVAL is actually fairly complicated and forgiving of inputs, but will return 0 on invalid numeric conversions.

GnuCOBOL 2 will also provide FUNCTION TEST-NUMVAL.

4.2.73 FUNCTION NUMVAL-C

Returns the numeric value represented by the culturally appropriate currency specification argument. With optional currency symbol.

See *FUNCTION CURRENCY-SYMBOL* (page 450).

```
GCobol IDENTIFICATION   DIVISION.
       PROGRAM-ID.      prog.
       DATA             DIVISION.
       WORKING-STORAGE  SECTION.
       01  X   PIC   X(14) VALUE " % -9876.1234 ".
       PROCEDURE        DIVISION.
           DISPLAY FUNCTION NUMVAL-C ( X , "%" )
           END-DISPLAY.
           STOP RUN.
```

gives:

```
-09876.1234
```

in a LOCALE that uses the percent sign as a currency symbol.

GnuCOBOL 2 will also provide FUNCTION TEST-NUMVAL-C.

4.2.74 FUNCTION NUMVAL-F

Returns the numeric value represented by the culturally appropriate floating point argument string.

```
GCobol IDENTIFICATION   DIVISION.
       PROGRAM-ID.      prog.
       DATA             DIVISION.
       WORKING-STORAGE  SECTION.
       01  X   PIC   X(12) VALUE " -0.1234E+4 ".
       PROCEDURE        DIVISION.
           DISPLAY FUNCTION NUMVAL-F ( X )
           END-DISPLAY.
           STOP RUN.
```

gives:

```
-000001234
```

GnuCOBOL 2 also provides *FUNCTION TEST-NUMVAL-C* (page 496) (as the NUMVAL- functions can cause run-time errors given invalid input).

4.2.75 FUNCTION ORD

Returns the integer value that is the ordinal position of the character argument in the program's collating sequence. COBOL uses 1 as the lowest ordinal for character sequencing.

```
DISPLAY FUNCTION ORD("J")
```

Outputs (on an ASCII system with no ALPHABET clause):

```
00000075
```

Note that COBOL uses 1 as the first value for collating. So ASCII 74 is ORD 75 for "J".

4.2.76 FUNCTION ORD-MAX

Returns the integer that is the ordinal position of the maximum value of the given argument list.

```
DISPLAY ORD-MAX( 9; 8; 7; 6; 5; 4; 3; 2; 1 )
DISPLAY ORD-MAX( 'abc'; 'def'; 'ghi' )
```

Outputs:

```
00000001
00000003
```

4.2.77 FUNCTION ORD-MIN

Returns the integer that is the ordinal position of the minimum value from the argument list.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20090531
      *> Purpose:   Demonstration of FUNCTION ORD-MIN and REPOSITORY
      *> Tectonics: cobc -x ordmin.cob
      *> ************************************************************
       identification division.
       program-id. ordmin.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 posmin               pic 9(8).

      *> ************************************************************
       procedure division.
       move ord-min ( 9; 8; 7; 6; 5; 4; 3; 2; 1; 2; 3; 4; 5 ) to posmin
       display posmin
       move ord-min ("abc"; "def"; "000"; "def"; "abc") to posmin
       display posmin
       goback.
       end program ordmin.
```

Outputs:

```
00000009
00000003
```

Notice how ord-min did not require FUNCTION, as the REPOSITORY entry allows this to be skipped in the source codes.

4.2.78 FUNCTION PI

Returns an approximation of the ratio of the circumference by the diameter of a circle. It returns an alphanumeric with 34 digits after the decimal. Please be aware of the limitations of using these types of approximated values in computations.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20101030
      *> Purpose:   Demonstrate PI
      *> Tectonics: cobc -x pi-demo.cob
      *> ************************************************************
       identification division.
       program-id. pi-demo.

       data division.
       working-storage section.
       01 args pic x(80).
       01 diameter pic 999 value 1.
```

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```
       01 show-diameter pic zz9.
       01 circumference usage float-long.
       01 plural pic xx.
       01 plural-length pic 9 value 1.
       01 newline pic x value x'0a'.

      *> ****************************************************************
       procedure division.
       accept args from command-line end-accept
       if args not equal spaces
           move args to diameter
       end-if

       if diameter not equal 1
           move "s " to plural
           move 2 to plural-length
       else
           move "  " to plural
           move 1 to plural-length
       end-if
       move diameter to show-diameter

       display "FUNCTION PI is " function pi newline

       compute circumference = function pi * diameter
       display
           "A wheel, " show-diameter " metre" plural(1:plural-length)
           "wide will roll, very close to but only approximately, "
           newline circumference " metres in ONE full rotation."
           newline

       goback.
       end program pi-demo.
```

Outputs:

```
$ cobc -x pi-demo.cob && ./pi-demo && ./pi-demo 42
FUNCTION PI is 3.14159265358979323846264338327950 29

A wheel,   1 metre wide will roll, very close to but only approximately,
3.14159265358979312 metres in ONE full rotation.

FUNCTION PI is 3.14159265358979323846264338327950 29

A wheel,  42 metres wide will roll, very close to but only approximately,
131.946891450771318 metres in ONE full rotation.
```

4.2.79 FUNCTION PRESENT-VALUE

Returns an approximation of the present value from a discount rate and list of future period end amounts. It attempts to reflect the future value of $1.00 given time, inflation and interest.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin
```

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```
      *> Date:      20101030
      *> Purpose:   Demo of PRESENT-VALUE
      *> Tectonics: cobc -x present-value-demo.cob
      *> ************************************************************
       identification division.
       program-id. present-value-demo.

       data division.
       working-storage section.
       01 args pic x(80).
       01 newline pic x value x'0a'.
       01 rate pic s9v9999 value 0.7000.
       01 the-value pic s9(6)v99.

      *> ************************************************************
       procedure division.
       accept args from command-line end-accept

       if args not equal to spaces
           move args to rate
       end-if

       compute the-value rounded =
           function present-value(rate; 1000, 1010, 1000, 1100)
       end-compute
       display
            "A discount rate of " rate " gives a PRESENT-VALUE of "
            the-value " given" newline
            "end-amounts of 1000, 1010, 1000 and 1100"

       compute the-value rounded =
           function present-value(rate; 1000, 1000, 1000, 1000)
       display
            "A discount rate of " rate " gives a PRESENT-VALUE of "
            the-value " given" newline
            "end-amounts of 1000, 1000, 1000 and 1000"

       goback.
       end program present-value-demo.
```

Outputs:

```
$ ./present-value-demo
A discount rate of +0.7000 gives a PRESENT-VALUE of +001272.96 given
end-amounts of 1000, 1010, 1000 and 1100
A discount rate of +0.7000 gives a PRESENT-VALUE of +001257.53 given
end-amounts of 1000, 1000, 1000 and 1000
$ ./present-value-demo 0.333
A discount rate of +0.3330 gives a PRESENT-VALUE of +002089.18 given
end-amounts of 1000, 1010, 1000 and 1100
A discount rate of +0.3330 gives a PRESENT-VALUE of +002051.88 given
end-amounts of 1000, 1000, 1000 and 1000
$ ./present-value-demo 0.935
A discount rate of +0.9350 gives a PRESENT-VALUE of +001003.03 given
end-amounts of 1000, 1010, 1000 and 1100
A discount rate of +0.9350 gives a PRESENT-VALUE of +000993.23 given
end-amounts of 1000, 1000, 1000 and 1000
```

For details, talk to a professional.

rant Any COBOL programmer using financial functions for use by others **HAS** to attain some level of *domain expertise* in the mathematics at work, as well as a level of *technical competence* to read through and defend both the COBOL source code and the generated C code that GnuCOBOL emits before compiling. *rant over*

4.2.80 FUNCTION PYTHON

An optional intrinsic function to evaluate Python source code.

Requires a build from source with:

```
./configure --with-python[=PYTHON]
```

The `=PYTHON` argument is a Python executable that will determine version information. Defaults to the first `python` found in the path.

For example `./configure --with-python=/usr/bin/python3`

Also requires a functioning Python install that matches the version chosen by `./configure`.

Accepts a script as character data, or a control code, and an optional number of arguments.

The control codes include:

```
- PYAPI-FINALIZE, finalize the Python instance
- PYAPI-REPORT, toggles printing of exception reports
```

These constants are defined in the system copy book, `pyapi.cpy`.

During initialization, the Python `__builtins__` values are pre-loaded.

Data to return to COBOL is pulled from the Python variable `result`, set by the script. When no `result` identifier is set, the `python()` function returns a zero length space. The Python instance is persistent across calls; all imported modules and variables remain in memory and accessible until `python(PYAPI-FINALIZE)` is called.

Before returning to COBOL, after setting the intrinsic value, the `result` variable is saved in _ (single underscore) and then `result` is cleared. This provides access to last result between invocations of the `python()` intrinsic.

Arguments are passed as `sys.argv` values. `sys.argv[0]` is fixed as "GnuCOBOL".

Reference modification of the function value is permitted.

Python examples

```
display function python("result = 'abcde' * 3")
```

```
abcdeabcdeabcde
```

```
display python("result = _ * 3")(26:5)
```

```
abcde
```

```
move function python(
    "import sys; result = 'Args: %s and %s' % sys.argv[0] + sys.argv[1]"
    "first argument")
  to answer
display trim(answer)
```

```
Args: GnuCOBOL and first argument
```

```
COPY pyapi.

...

move python(PYAPI-FINALIZE) to extraneous
move python(PYAPI-REPORT) to extraneous
move python("result = _") to answer
display SCRIPT-RETURN-CODE
display FUNCTION EXCEPTION-STATUS
display ":" answer ":"
```

```
Traceback (most recent call last):
  File "<string>", line 1, in <module>
NameError: name '_' is not defined
1
EC-IMP-SCRIPT
::
```

The Python instance was reset, and exception reporting toggled on. Then a Python exception occurs (no _ last result identifier found). The COBOL exception EC-IMP-SCRIPT is raised on the `python()` error and the special *EXTERNAL* (page 259) variable SCRIPT-RETURN-CODE (defined in `pyapi.cpy`) is set to 1. `answer` receives a zero length field.

No restrictions are placed on the Python script, so some care must be taken to screen for trusted programs, and for issues such as blocking IO. *There are many issues to think about when embedding Python in an application.*

For GUI scripting, Tkinter is available with most Python installs.

All stock Python modules and any local site modules that can be found in `sys.path`, `PYTHONPATH` and other site local search mechanisms may be imported. These will be persistent until the instance is finalized.

```
"You got chocolate in my peanut butter!"
"You got peanut butter on my chocolate!"
```

COBOL with Python, *so maybe it goes*:

```
"You got ketchup on my ice cream!"
"You got cake in my mustard!"
```

Or maybe it goes:

```
"Mmmm, pie."
```

4.2.81 FUNCTION RANDOM

Returns a pseudo-random number greater than or equal to 0.0 and less than 1.0, in a rectangular distribution.

`FUNCTION RANDOM` takes an optional numeric seed value for the generation of a sequence of pseudo-random numbers. The seed must be zero or a positive integer.

```
DISPLAY FUNCTION RANDOM(1)
DISPLAY FUNCTION RANDOM(1)
DISPLAY FUNCTION RANDOM()
```

Outputs:

```
+00000000.1804289383
+00000000.1804289383
+000000000.846930886
```

The random numbers are sequences, relative to the last given seed, and will be reproducible given the same seed value. For unpredictable random values, the seed will need to be from an unpredictable source; for instance the nano second hardware clock. For more true randomness, Linux has `/dev/random` and `/dev/urandom`. These are all **pseudo-random** values, not truly random.

To convert from `0.0 <= FUNCTION RANDOM() < 1.0` to a different range, some arithmetic is required. For example; to get a range from 1 to 10, multiply the result of `FUNCTION RANDOM()` by 10.0. This gives a range of 0.0 to almost 10.0 (but less than actual 10.0). Add 1.0 to get a range of 1.0 to almost 11.0, and move that to a two digit integer. Truncation will take care of the rest, giving a fairly even distribution of random values from 1 to 10, inclusive.

```
*> Modified: 2016-06-14/00:51-0400
 COPY sample-template REPLACING
 ==:DATABOOK:== BY
 ==

 01 random-float         usage float-long.
 01 random-integer       pic 99.

 01 results.
    05 hits              pic 9(9) occurs 10 times.
 01 first-ten            pic 99.

 ==
 ==:CODEBOOK:== BY
 ==

*> compute random-float = random(0)
 perform 1000000 times
     compute random-float = random() * 10.0
     compute random-integer = random-float + 1.0
     if random-integer < 1 or > 10 then
         display "anomaly: " random-integer upon syserr
     end-if
     add 1 to hits(random-integer)
     if first-ten < 10 then
         display random-integer space with no advancing
         add 1 to first-ten
     end-if
 end-perform
 display "..."

 perform varying tally from 1 by 1 until tally > 10
     display tally ": " hits(tally)
 end-perform

 ==
 .
```

See Sample shortforms (page 1433) *for the full* `sample-template` listing.

The sequence is reproducible. Use `random(new-seed)` to have different values for different runs of a program.

```
prompt$ cobc -xj random-sample.cob
09 04 08 08 10 02 04 08 03 06 ...
00001: 000100016
00002: 000099912
00003: 000099720
00004: 000100144
00005: 000100198
00006: 000100247
00007: 000099943
00008: 000099658
00009: 000100128
00010: 000100034

prompt$ ./random-sample
09 04 08 08 10 02 04 08 03 06 ...
00001: 000100016
00002: 000099912
00003: 000099720
00004: 000100144
00005: 000100198
00006: 000100247
00007: 000099943
00008: 000099658
00009: 000100128
00010: 000100034
```

With 1 million passes, each value from 1 to 10 occurred just about 100,000 times each, plus or minus a few tenths of a percent. Different initial seeds would give different counts.

Please note that these sequences are *predictable*. GnuCOBOL will generate the same sequence of random numbers (unless explicitly seeded) for every run of program. *As a matter of fact, GnuCOBOL will generate the same sequence of numbers for any given seed value.*

To create an initially less predictable sequence, you need to provide a somewhat random seed value. One common method is to use portions of the system clock as a first seed. Mickey White offered up this sequence, using bytes 8-16 of the datetime stamp:

```
GCOBOL identification division.

       program-id.             randomtest.

       environment division.

       configuration section.

       source-computer.

           cray-1
      *           with debugging mode
           .

       data division.

       working-storage section.

       01  answer-signed          pic S9(09).
       01  show-answer            pic z9999+.
       01  x                      pic s9.
```

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```
       01  num-ran    pic v9(9) value zeroes.
       01  re-num-ran pic 9.9(9) value zeroes.
       01  seed       pic s9(9) binary.
       01  j          pic s9(9) binary value zeroes.
       01  datetime21 pic x(21).

       procedure division.

            move function current-date to datetime21
            move datetime21(8:9) to seed
      *     display 'seed=' seed
           compute num-ran = function random (seed)
      *    display 'num-ran = ' num-ran

           perform 10000000 times
               move num-ran to re-num-ran
               move re-num-ran(3:9) to seed
      *        display 're-num-ran = ' re-num-ran
      *        display 'seed = ' seed
               compute num-ran = function random ()
      *        display 'num-ran = ' num-ran
               display  num-ran
           end-perform

           stop run
           .
```

One more, please note. This only creates *less predictable*, not *unpredictable* sequences. Due to the nature of pseudo-random number generators, these are not truly random. For applications that require a sequence that can outwit a determined guesser, more sophisticated methods are needed. The seed must be changed at unpredictable intervals to avoid known sequence patterns. Some form of unpredictable entropy needs to be used, such as relatively random network activity, hi-res timing of mouse movements or keyboard taps or other nondeterministic source.

The intrinsic `FUNCTION RANDOM()` in GnuCOBOL is **not** a cryptographically secure random number generator. At least not without surrounding code that ensures an initial (and ever changing) nondeterministic seeding algorithm.

Having said that, for most uses, `FUNCTION RANDOM` is random enough. You'll have to expend a great deal of effort to predict the next generated value, once seeded.

With the above listing, Simon Sobisch added

```
For a more secure seed: store the bytes 8-14 first in an alphanumeric
redefined variable, then move it with function REVERSE to another redefined
one, check which is greater, subtract the other one from it.  This was always
enough random for my cases.  If you want to run a casino take the result and
do a byte shift or some similar stuff of the result with the original value.
```

4.2.82 FUNCTION RANGE

Returns the value of the minimum argument subtracted from the maximum argument from the list of numeric arguments.

```
DISPLAY FUNCTION RANGE(1; 2; 3; 4; 5; 6; 7; 8; 9)
```

Outputs:

```
+000000000000000008
```

4.2.83 FUNCTION REM

Returns the numeric remainder of the first argument divided by the second.

```
DISPLAY FUNCTION REM(123; 23)
```

Outputs:

```
+000000000000000008
```

4.2.84 FUNCTION REVERSE

Returns the reverse of the given character string.

```
DISPLAY FUNCTION REVERSE("abc")
```

Outputs:

```
cba
```

4.2.85 FUNCTION REXX

This is an optional extension, built into GnuCOBOL with:

```
./configure --with-rexx
```

Requires Regina REXX.

Evaluates a REXX script with optional arguments. To promote safer scripting, the Regina RESTRICTED mode is set by default. This disables some of the features of REXX.

Restricted mode disables the following REXX features:

- LINEOUT, CHAROUT, POPEN, RXFUNCADD BIFs
- "OPEN WRITE", "OPEN BOTH" subcommands of STREAM BIF
- The "built-in" environments eg. SYSTEM, CMD or PATH of ADDRESS command
- Setting the value of a variable in the external environment with VALUE BIF.
- Calling external functions

First parameter is the REXX script text. Unlimited optional arguments follow. These arguments can be indexed in the script with `ARG(n)`.

Returns an ALPHANUMERIC field to COBOL. Reference modification is allowed.

```
MOVE FUNCTION REXX("return ARG(1) * ARG(2)", 6, 7)
  TO answer

DISPLAY FUNCTION REXX("abc = xyz; return abc || zy")
```

For use with computational verbs, wrap the REXX function with *FUNCTION NUMVAL* (page 475).

```
COMPUTE answer = FUNCTION NUMVAL(FUNCTION REXX("return 6")) * 7
```

See *Intrinsic REXX* (page 868) for more details.

4.2.86 FUNCTION REXX-UNRESTRICTED

This is an optional extension, built into GnuCOBOL with:

```
./configure --with-rexx
```

Requires Regina REXX.

Evaluates a REXX script with optional arguments with RESTRICTED mode disabled.

See *FUNCTION REXX* (page 485).

REXX-UNRESTRICTED enables the following REXX features:

- LINEOUT, CHAROUT, POPEN, RXFUNCADD BIFs
- "OPEN WRITE", "OPEN BOTH" subcommands of STREAM BIF
- The "built-in" environments eg. SYSTEM, CMD or PATH of ADDRESS command
- Setting the value of a variable in the external environment with VALUE BIF.
- Calling external functions

See *RESTRICTED mode REXX* (page 872) for more details.

4.2.87 FUNCTION SECONDS-FROM-FORMATTED-TIME

This function converts a time that is in a specified format to a numeric value representing the number of seconds after midnight.

```
GCobol IDENTIFICATION   DIVISION.
       PROGRAM-ID.      prog.
       DATA             DIVISION.
       WORKING-STORAGE  SECTION.
       01  X   PIC      X(6)   VALUE "hhmmss".
       01  Y   PIC      9(8)   COMP-5.
       01  Z   PIC      X(6)   VALUE "010203".
       PROCEDURE        DIVISION.
           MOVE FUNCTION SECONDS-FROM-FORMATTED-TIME (X, Z) TO Y.
           IF Y NOT = 3723
                   DISPLAY Y
                   END-DISPLAY
           END-IF.
           STOP RUN.
```

This test would fail if 01:02:03 was not returned as 3723 seconds past midnight.

Argument 1 takes the form *hhmmss* and expects argument 2 to be a matching length numeric item, or 0 is returned.

4.2.88 FUNCTION SECONDS-PAST-MIDNIGHT

Returns the seconds past the previous midnighti, from the current system time.

```
identification division.
program-id. second-past-midnight-sample.

environment division.
configuration section.
repository.
    function all intrinsic.

procedure division.
display current-date
display seconds-past-midnight
display formatted-time("hh:mm:ss", seconds-past-midnight)

goback.
end program second-past-midnight-sample.
```

giving:

```
prompt$ cobc -xj seconds-past-midnight-sample.cob
20151201225324740000
000082404
22:53:2
```

4.2.89 FUNCTION SIGN

Returns +1 for positive, 0 for zero and -1 for a negative numeric argument.

4.2.90 FUNCTION SIN

Returns an approximation for the trigonometric sine of the given numeric angle (expressed in radians) argument.

The domain of the sine function is all real numbers, with a nominal domain of 0 thru pi with a zero returned at n* pi and peaks at n* pi/2. The sine function returns a cyclic range of -1 thru +1.

```
#!/usr/local/bin/cobc -xj

       COPY line-sequential-template REPLACING
       ==:INPUT-NAME:== BY =="no-input"==
       ==:OUTPUT-NAME:== BY =="sin-plot.gp"==

       ==:DATABOOK:== BY
       ==

       01 gnuplot.
          05 value
          'set terminal dumb ; set grid ; set tics scale 0 ; ' &
          'set title "FUNCTION SIN" ; plot "-" using 1:2 with lines'.

       01 x            pic s9v99.
       01 domain       pic s9v99.
       01 degrees      pic s999v9.
       01 answer       pic s9(5)v9(5).

       01 output-data-line.
          05 x-out     pic -9.99.
```

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```
           05           pic x value space.
           05 ans-out    pic -9(5).9(5).

       ==
       ==:CODEBOOK:== BY
       ==

       perform open-files

       move length(gnuplot) to output-actual
       move gnuplot to output-line
       perform write-output

       compute domain = pi * 3
       move length(output-data-line) to output-actual
       perform varying x from 0.0 by 0.25 until x > domain
           compute degrees rounded = x * 180 / pi
           move sin(x) to answer
           display "sin(" x ") ~= sin(" degrees "°) ~= " answer

           move x to x-out
           move answer to ans-out
           move output-data-line to output-line
           perform write-output
       end-perform

       perform close-files

       call "SYSTEM" using "gnuplot sin-plot.gp"

       perform delete-output
       ==
       .
```

And a sample run of:

```
$ ./sin-sample.cob
sin(+0.00) ~= sin(+000.0°) ~= +00000.00000
sin(+0.25) ~= sin(+014.3°) ~= +00000.24740
sin(+0.50) ~= sin(+028.6°) ~= +00000.47942
sin(+0.75) ~= sin(+043.0°) ~= +00000.68163
sin(+1.00) ~= sin(+057.3°) ~= +00000.84147
sin(+1.25) ~= sin(+071.6°) ~= +00000.94898
sin(+1.50) ~= sin(+085.9°) ~= +00000.99749
sin(+1.75) ~= sin(+100.3°) ~= +00000.98398
sin(+2.00) ~= sin(+114.6°) ~= +00000.90929
sin(+2.25) ~= sin(+128.9°) ~= +00000.77807
sin(+2.50) ~= sin(+143.2°) ~= +00000.59847
sin(+2.75) ~= sin(+157.6°) ~= +00000.38166
sin(+3.00) ~= sin(+171.9°) ~= +00000.14112
sin(+3.25) ~= sin(+186.2°) ~= -00000.10819
sin(+3.50) ~= sin(+200.5°) ~= -00000.35078
sin(+3.75) ~= sin(+214.9°) ~= -00000.57156
sin(+4.00) ~= sin(+229.2°) ~= -00000.75680
sin(+4.25) ~= sin(+243.5°) ~= -00000.89498
sin(+4.50) ~= sin(+257.8°) ~= -00000.97753
sin(+4.75) ~= sin(+272.2°) ~= -00000.99929
```

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```
sin(+5.00) ~= sin(+286.5°) ~= -00000.95892
sin(+5.25) ~= sin(+300.8°) ~= -00000.85893
sin(+5.50) ~= sin(+315.1°) ~= -00000.70554
sin(+5.75) ~= sin(+329.5°) ~= -00000.50827
sin(+6.00) ~= sin(+343.8°) ~= -00000.27941
sin(+6.25) ~= sin(+358.1°) ~= -00000.03317
sin(+6.50) ~= sin(+372.4°) ~= +00000.21511
sin(+6.75) ~= sin(+386.7°) ~= +00000.45004
sin(+7.00) ~= sin(+401.1°) ~= +00000.65698
sin(+7.25) ~= sin(+415.4°) ~= +00000.82308
sin(+7.50) ~= sin(+429.7°) ~= +00000.93799
sin(+7.75) ~= sin(+444.0°) ~= +00000.99459
sin(+8.00) ~= sin(+458.4°) ~= +00000.98935
sin(+8.25) ~= sin(+472.7°) ~= +00000.92260
sin(+8.50) ~= sin(+487.0°) ~= +00000.79848
sin(+8.75) ~= sin(+501.3°) ~= +00000.62472
sin(+9.00) ~= sin(+515.7°) ~= +00000.41211
sin(+9.25) ~= sin(+530.0°) ~= +00000.17388


                                FUNCTION SIN

    1 +------+******+------+------+------+-----+------+----****-----+------+
      |      *      **     :      :      :     :      "-" using 1:2 ****** |
  0.8 +.....*.........*.....................................**........*.........+
      |    * :      :  *   :      :      :     :      *      :    * :       |
  0.6 +...*.............*.................................*.............*.......+
  0.4 +..*...............*...............................*...............*......+
      |  *   :      :    * :      :      :     :    * :      :       :*     |
  0.2 +.*...................*.........................*...................*....+
      |*     :      :      *      :      :     :  *   :      :       :      |
    0 *.......................*......................*........................+
      |      :      :      :*     :      :     :*     :      :       :      |
 -0.2 +.......................*...................*..........................+
      |      :      :      :  *   :      :     *      :      :       :      |
 -0.4 +.........................*................*............................+
 -0.6 +............................*.............**............................+
      |      :      :      :     *:      :  *  :      :      :       :      |
 -0.8 +............................*........*..................................+
      |      :      :      :      :**    :*    :      :      :       :      |
   -1 +------+------+------+------+--*****-----+------+------+------+------+
      0      1      2      3      4      5     6      7      8      9      10
```

See *Can GnuCOBOL be used for plotting?* (page 801) for another sample graph using gnuplot.

See *Sample shortforms* (page 1433) for the `line-sequential-template.cob` listing.

4.2.91 FUNCTION SQRT

Returns an approximation of the square root of the given numeric argument.

```
DISPLAY FUNCTION SQRT(-1)
CALL "perror" USING NULL RETURNING OMITTED
DISPLAY FUNCTION SQRT(2)
```

Outputs:

```
0.000000000000000000
Numerical argument out of domain
1.414213562373095145
```

Note: `CALL "perror"` exposes a bug in GnuCOBOL versions packaged before June 2009 where the stack may eventually underflow due to improper handling of `void` return C functions. Versions supporting `RETURNING OMITTED` fix this problem.

An actual application that needs to verify the results of square roots or other C library numerical functions might be better off placing a small C wrapper to set and get the global *errno* (page 1319) for testing in COBOL sources.

4.2.92 FUNCTION STANDARD-COMPARE

Not yet implemented.

4.2.93 FUNCTION STANDARD-DEVIATION

Returns an approximation of the standard deviation from the given list of numeric arguments.

```
DISPLAY
    FUNCTION STANDARD-DEVIATION(1 2 3 4 5 6 7 8 9 10) SPACE
    FUNCTION STANDARD-DEVIATION(1 2 3 4 5 6 7 8 9 100)
```

```
2.872281323269014308 28.605069480775604518
```

4.2.94 FUNCTION STORED-CHAR-LENGTH

Returns the numeric value of the internal storage length of the given argument, in bytes, not counting trailing spaces.

```
identification division.
program-id. stored-char-length-sample.

environment division.
configuration section.
repository.
    function all intrinsic.

data division.
working-storage section.
01 work-area pic x(20) value "default value".

procedure division.
display ":" work-area ": " stored-char-length(work-area)

move spaces to work-area
display ":" work-area ": " stored-char-length(work-area)

move "/usr/local/bin/" to work-area
display ":" work-area ": " stored-char-length(work-area)

inspect work-area(1:stored-char-length(work-area))
  replacing trailing "/" by " "
display ":" work-area ": " stored-char-length(work-area)
```

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```
goback.
end program stored-char-length-sample.
```

and:

```
prompt$ cobc -xj stored-char-length-sample.cob
:default value       : 000000013
:                    : 000000000
:/usr/local/bin/     : 000000015
:/usr/local/bin      : 000000014
```

Along with reference modification, FUNCTION STORED-CHAR-LENGTH can come in quite handy when dealing with statements that may or may not react well to trailing spaces in a field. In the short listing above, the INSPECT REPLACING TRAILING extension only replaces exact character matches, any trailing spaces would defeat some of the more useful features of this statement, as when removing a trailing slash from a directory name.

4.2.95 FUNCTION SUBSTITUTE

FUNCTION SUBSTITUTE is a GnuCOBOL extension to the suite of intrinsic functions.

```
DISPLAY
    FUNCTION SUBSTITUTE("this is a test",
        "this", "that",
        "is a", "was",
        "test", "very cool!")
```

Will display:

```
that was very cool!
```

having changed *this* for *that*, *is a* for *was*, and *test* with **very cool!**

The new intrinsic accepts:

```
SUBSTITUTE(subject, lit-pat-1, repl-1 [, litl-pat-2, repl-2, ...])
```

where lit-pat just means the scan is for literals, not that you have to use literal constants. WORKING-STORAGE identifiers are fine for any of the subject, the search patterns or the replacements.

As with all intrinsics, you receive a new field and the subject is untouched.

Note: The resulting field can be shorter, the same length or longer than the subject string.

This is literal character **global** find and replace, and there are no wildcards or other pattern expressions. Unlike INSPECT, this function **does not require same length** patterns and replacements. Each pattern replacement pair uses the original subject, not any intermediate in progress result.

As this is an alphanumeric operation, a reference modification is also allowed

```
MOVE FUNCTION SUBSTITUTE(subject, pat, repl)(2:4) TO xvar4
```

to result in 4 characters starting at the second position after the substitution.

4.2.96 FUNCTION SUBSTITUTE-CASE

Similar to SUBSTITUTE, but ignores upper and lower case of subject when matching patterns.

```
display substitute("ABCDEF-GHIJKL",
                   "abcdef-", "abc case ")

display substitute-case("ABCDEF-GHIJKL",
                        "abcdef-", "abc case ")
```

Outputs:

```
ABCDEF-GHIJKL
abc case GHIJKL
```

The pattern did not match in the first statement, but did with the *SUBSTITUTE-CASE* insensitive function.

4.2.97 FUNCTION SUM

Returns the numeric value that is the sum of the given list of numeric arguments.

One of the nice features of this function is that the result can be moved directly to an edited-numeric display item.

```
#!/usr/local/bin/cobc -xj

      *> Modified: 2015-12-10/22:47-0500
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 aggregate  pic s9(7).
       01 show-total pic -,---,--9.

       01 samples-table.
          05 sample-values.
             10 filler pic 9(6) value 1.
             10 filler pic 9(6) value 50000.
             10 filler pic 9(6) value 100000.
             10 filler pic 9(6) value 200000.
             10 filler pic 9(6) value 151550.
          05 filler redefines sample-values.
             10 s pic 9(6) occurs 5 times indexed by lot.
       ==
       ==:CODEBOOK:== BY
       ==

       move sum(s(1), s(2), s(3), s(4), s(5)) to aggregate show-total
       display show-total
       display aggregate

       move sum(-s(1), -s(2), -s(3), -s(4), -s(5)) to show-total
       display show-total

       ==
       .
```

With a run sample of:

```
prompt$ ./sum-sample.cob
  501,551
+0501551
 -501,551
```

See Sample shortforms (page 1433) *for the full* `sample-template.cob`.

4.2.98 FUNCTION TAN

Returns an approximation for the trigonometric tangent of the given numeric angle (expressed in radians). Returns ZERO if the argument would cause an infinity or other size error.

```
#!/usr/local/bin/cobc -xj

       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 x            pic s9v99.
       01 domain       pic s9v9(5).
       01 degrees      pic s999v9.
       01 answer       pic s9(5)v9(5).

       ==
       ==:CODEBOOK:== BY
       ==

       perform varying x from -1.0 by 0.25 until x > 1.0
           compute domain = pi * x
           compute degrees rounded = domain * 180 / pi
           move tan(domain) to answer
           display "tan(" domain ") ~= tan(" degrees "°) ~= " answer
       end-perform

       ==
       .
```

shows:

```
prompt$ cobc -xj tan-sample.cob
tan(-3.14159) ~= tan(-180.0°) ~= +00000.00000
tan(-2.35619) ~= tan(-135.0°) ~= +00001.00000
tan(-1.57079) ~= tan(-090.0°) ~= -58057.91341
tan(-0.78539) ~= tan(-045.0°) ~= -00000.99998
tan(+0.00000) ~= tan(+000.0°) ~= +00000.00000
tan(+0.78539) ~= tan(+045.0°) ~= +00000.99998
tan(+1.57079) ~= tan(+090.0°) ~= +58057.91341
tan(+2.35619) ~= tan(+135.0°) ~= -00001.00000
tan(+3.14159) ~= tan(+180.0°) ~= +00000.00000
```

Where "~=" denotes "approximately equals".

See Sample shortforms (page 1433) *for the full* `sample-template.cob`.

4.2.99 FUNCTION TEST-DATE-YYYYMMDD

Test for valid date in numeric yyyymmdd form.

Returns 0 for success, 1 if the year is not in range, 2 if the month is not in range and 3 if the day is not in range.

```
#!/usr/local/bin/cobc -xj

       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 result pic 9.

       01 sample-table.
          05 pic 9(8) value 0.
          05 pic 9(8) value 16000102.

          05 pic 9(8) value 16010101.
          05 pic 9(8) value 20151225.

          05 pic 9(8) value 20151325.
          05 pic 9(8) value 20151232.

          05 pic 9(8) value 20000229.
          05 pic 9(8) value 19000229.

       01 redefines sample-table.
          05 sample pic 9(8) occurs 8 times indexed by lot.

       ==
       ==:CODEBOOK:== BY
       ==

       perform varying lot from 1 by 1 until lot > 8
           move test-date-yyyymmdd(sample(lot)) to result
           display "test-date-yyyymmdd(" sample(lot) ") returns " result
              with no advancing
           if result greater than 0 then
               display " fail"
           else
               display " ok"
           end-if

       end-perform

       ==
       .
```

Giving:

```
prompt$ ./test-date-sample.cob
test-date-yyyymmdd(00000000) returns 1 fail
test-date-yyyymmdd(16000102) returns 1 fail
test-date-yyyymmdd(16010101) returns 0 ok
test-date-yyyymmdd(20151225) returns 0 ok
test-date-yyyymmdd(20151325) returns 2 fail
test-date-yyyymmdd(20151232) returns 3 fail
```

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```
test-date-yyyymmdd(20000229) returns 0 ok
test-date-yyyymmdd(19000229) returns 3 fail
```

The year 2000 was a leap year, 1900 was not.

See Sample shortforms (page 1433) *for the full* `sample-template.cob`.

4.2.100 FUNCTION TEST-DAY-YYYYDDD

Test for valid date in numeric yyyyddd form. Years from 1601 to 9999, days from 1 to 365/366.

Returns 0 for success, 1 if the year is not in range, 2 if the day of year is not in range.

```
#!/usr/local/bin/cobc -xj

       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 result pic 9.

       01 sample-table.
          05 pic 9(7) value 0.
          05 pic 9(7) value 1601000.

          05 pic 9(7) value 1601001.
          05 pic 9(7) value 2015350.

          05 pic 9(7) value 2000366.
          05 pic 9(7) value 1900366.

       01 redefines sample-table.
          05 sample pic 9(7) occurs 6 times indexed by lot.

       ==
       ==:CODEBOOK:== BY
       ==

       perform varying lot from 1 by 1 until lot > 6
           move test-day-yyyyddd(sample(lot)) to result
           display "test-day-yyyyddd(" sample(lot) ") returns " result
              with no advancing
           if result greater than 0 then
               display " fail"
           else
               display " ok"
           end-if

       end-perform

       ==
       .
```

With a sample run of:

```
prompt$ ./test-day-yyyyddd-sample.cob
test-day-yyyyddd(0000000) returns 1 fail
test-day-yyyyddd(1601000) returns 2 fail
test-day-yyyyddd(1601001) returns 0 ok
test-day-yyyyddd(2015350) returns 0 ok
test-day-yyyyddd(2000366) returns 0 ok
test-day-yyyyddd(1900366) returns 2 fail
```

1900 was not a leap year, while the year 2000 was.

See Sample shortforms (page 1433) *for the* `sample-template.cob` copybook.

4.2.101 FUNCTION TEST-FORMATTED-DATETIME

Returns 0 is the given date and/or time string matches the initial ISO 8601 datetime format specification. If the given date time does not conform to the spec, then TEST-FORMATTED-DATETIME returns the first character position within the string that caused an error.

```
display test-formatted-datetime("YYYYDDD", "1999001")
0
display test-formatted-datetime("YYYYDDD", "19A9001")
3
display test-formatted-datetime("hhmmss", "250101")
2
display test-formatted-datetime("hh:mm:ss+hh:mm", "232323-05:00")
0
```

See *FUNCTION FORMATTED-DATETIME* (page 461) for a table of supported format specifications.

4.2.102 FUNCTION TEST-NUMVAL

Tests the given string for conformance to the rules used by *FUNCTION NUMVAL* (page 475).

Returns 0 if the value conforms, a character position of the first non conforming charater, or the length plus one for other cases such as all spaces.

4.2.103 FUNCTION TEST-NUMVAL-C

Tests the given string for conformance to the rules used by *FUNCTION NUMVAL-C* (page 475) for items with currency symbols and debit/credit tags.

Returns 0 if the value conforms, a character position of the first non conforming character, or the length plus one for other, cases such as all spaces.

The `LOCALE` and `ANYCASE` options are not yet supported.

```
#!/usr/local/bin/cobc -xj

      *> Modified: 2015-12-10/23:34-0500
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 lots constant as 7.
```

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```
       01 samples-table.
          05 sample-values.
             10 value "$101.10 DB".
             10 value "$101.10 CR".
             10 value "$101.10 cr".
             10 value "#101010.10".
             10 value "#101.10 CR".
             10 value "-#10101.01".
             10 value "          ".
          05 filler redefines sample-values.
             10 sample pic x(10) occurs lots times indexed by lot.
       ==
       ==:CODEBOOK:== BY
       ==

       perform varying lot from 1 by 1 until lot > lots
           display "$: " sample(lot) " -> " test-numval-c(sample(lot))
           display "#: " sample(lot) " -> "
               test-numval-c(sample(lot), "#") with no advancing
           if test-numval-c(sample(lot), "#") equal 0 then
               display " = " numval-c(sample(lot), "#")
           else
               display space
           end-if
           display space

       end-perform

       ==
       .
```

With a run sample that tests default currency symbol (`$` in this case) and a `#` symbol:

```
prompt$ ./test-numval-c-sample.cob
$: $101.10 DB -> 000000000
#: $101.10 DB -> 000000001

$: $101.10 CR -> 000000000
#: $101.10 CR -> 000000001

$: $101.10 cr -> 000000009
#: $101.10 cr -> 000000001

$: #101010.10 -> 000000001
#: #101010.10 -> 000000000 = 00101010.1

$: #101.10 CR -> 000000001
#: #101.10 CR -> 000000000 = -00000101.1

$: -#10101.01 -> 000000002
#: -#10101.01 -> 000000000 = -0010101.01

$:            -> 000000011
#:            -> 000000011
```

See *Sample shortforms* (page 1433) for the `sample-template` listing.

4.2.104 FUNCTION TEST-NUMVAL-F

Tests the given string for conformance to the rules used by *FUNCTION NUMVAL-F* (page 476) with floating numbers in the COBOL view of scientific notation.

Returns 0 if the value conforms, a character position of the first non conforming character, or the length plus one for other cases, such as all spaces or empty strings.

```
#!/usr/local/bin/cobc -xj

      *> Modified: 2015-12-11/00:02-0500
       COPY sample-template REPLACING
       ==:DATABOOK:== BY
       ==

       01 lots constant as 5.
       01 samples-table.
          05 sample-values.
             10 value "101.99   ".
             10 value "101.99E01".
             10 value "101.99E+2".
             10 value "101.99E-2".
             10 value "          ".
          05 filler redefines sample-values.
             10 sample pic x(9) occurs lots times indexed by lot.

       ==
       ==:CODEBOOK:== BY
       ==

       perform varying lot from 1 by 1 until lot > lots
           display sample(lot) " -> " test-numval-f(sample(lot))
              with no advancing
           if test-numval-f(sample(lot)) equal 0 then
               display " = " numval-f(sample(lot))
           else
               display space
           end-if

       end-perform

       ==
       .
```

And a sample run of:

```
prompt$ ./test-numval-f-sample.cob
101.99    -> 000000000 = 0000101.99
101.99E01 -> 000000008
101.99E+2 -> 000000000 = 000010199
101.99E-2 -> 000000000 = 00001.0199
          -> 000000010
```

See *Sample shortforms* (page 1433) for the `sample-template` listing.

4.2.105 FUNCTION TRIM

Returns a character string that is the argument trimmed of spaces. Defaults to trimming both ends, but can be passed LEADING or TRAILING qualifier arguments.

```
DISPLAY '"' FUNCTION TRIM("   abc   ") '"'
DISPLAY '"' FUNCTION TRIM("   abc   " LEADING) '"'
DISPLAY '"' FUNCTION TRIM("   abc   " TRAILING) '"'
```

Outputs:

```
"abc"
"abc   "
"   abc"
```

4.2.106 FUNCTION UPPER-CASE

Returns a copy of the alphanumeric argument with any lower case letters replaced by upper case letters.

```
DISPLAY FUNCTION UPPER-CASE("# 123 abc DEF #")
```

Outputs:

```
# 123 ABC DEF #
```

4.2.107 FUNCTION VARIANCE

Returns the variance of a series of numbers. The variance is defined as the square of the *FUNCTION STANDARD-DEVIATION* (page 490)

```
DISPLAY FUNCTION VARIANCE(1 2 3 4 5 6 7 8 9 100)
```

```
+818.250000000000000
```

4.2.108 FUNCTION WHEN-COMPILED

Returns a 21 character alphanumeric field of the form YYYYMMDDhhmmsscc±zzzz e.g. 2008070505152000-0400 representing when a module or executable is compiled.

The *WHEN-COMPILED* (page 431) special register also reflects when an object module was compiled, but its use was deemed obsolete and discouraged in newer COBOL programming (newer, meaning anything after 1989).

```
program-id. whenpart1. procedure division.
display "First part :" FUNCTION WHEN-COMPILED.

program-id. whenpart2. procedure division.
display "Second part:" FUNCTION WHEN-COMPILED.

program-id. whenshow. procedure division.
call "whenpart1" end-call.
call "whenpart2" end-call.
display "Main part  :" FUNCTION WHEN-COMPILED.
```

For a test

```
$ cobc -c whenpart1.cob && sleep 15 && cobc -c whenpart2.cob &&
> sleep 15 && cobc -x whenshow.cob whenpart1.o whenpart2.o
$ ./whenshow
```

gives:

```
First part :2008082721391500-0400
Second part:2008082721393000-0400
Main part  :2008082721394500-0400
```

The value returned from `FUNCTION WHEN-COMPILED` is not an easy read, and there are some simple tricks to make this valuable information a little more pleasing to the eye.

One of the simplest:

```
01  ws-when-compiled PIC X(8)BX(8).
...
MOVE WHEN-COMPILED TO ws-when-compiled
DISPLAY "prognam " ws-when-compiled
```

To easily break up the field into date and time fragments.

Using *INSPECT* (page 304) is another handy way of making the result more human friendly. From the *GLOBAL* (page 285) reserved word code listing, for example.

```
01 built-on      PIC xxxx/xx/xxBxx/xx/xxBxxxxxxx GLOBAL.

...

    MOVE FUNCTION WHEN-COMPILED TO built-on
    INSPECT built-on REPLACING
        ALL "/" BY ":" AFTER INITIAL SPACE
        ALL " " BY "." AFTER INITIAL SPACE
        ALL "/" BY "-"
      FIRST " " BY "/"
    DISPLAY "Built on " built-on
```

Showing:

```
Built on 2015-10-27/23:32:46.00-0400
```

which is a bit easier to read than:

```
Built on 2015102723324600-0400
```

REDEFINES can also be used to good effect for this:

```
01 built-on             pic xxxxBxxBxx/xxBxxBxxBxxxxxxx.
01 REDEFINES built-on.
   05  PIC x(4).
   05  bo-dash-1 PIC X.
   05  PIC x(2).
   05  bo-dash-2 PIC X.
   05  PIC x(2).
   05  pic x.
   05  PIC x(2).
```

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```
   05  bo-colon-1 PIC X.
   05  PIC x(2).
   05  bo-colon-2 PIC X.
   05  PIC x(2).
   05  bo-dot PIC X.
   05  PIC x(7).
01 REDEFINES built-on.
   05  PIC x(4).
   05  PIC X.
       88  bo-setdash-1 value "-".
   05  PIC x(2).
   05  PIC X.
       88  bo-setdash-2 value "-".
   05  PIC x(2).
   05  pic x.
   05  PIC x(2).
   05  PIC X.
       88  bo-setcolon-1 value ":".
   05  PIC x(2).
   05  PIC X.
       88  bo-setcolon-2 value ":".
   05  PIC x(2).
   05  PIC X.
       88  bo-setdot value ".".
   05  PIC x(7).

   ....

move function when-compiled to built-on
move ":" to bo-colon-1 bo-colon-2
move "-" to bo-dash-1 bo-dash-2
move "." to bo-dot
DISPLAY built-on
move SPACE to built-on
set bo-setdash-1
       bo-setdash-2
       bo-setcolon-1
       bo-setcolon-2
       bo-setdot
    to true
```

The above code, posted to the GnuCOBOL project forums by Bill Woodger, an experienced developer with an eye for COBOL programming in the large, and techniques that can avoid mistakes before they happen, *(unlike many of the code samples in this FAQ that lean very much to programming in the small)*, came with a short explanation:

```
Why, when this is typically only going to be done once per program? Because,
someone is going to see it, and do something similar to a date-stamp field
in a DB table with hundreds of millions of rows.

A couple of copybooks, however, and no-one would copy the code blindly
anyway. Blind-copiers don't look at copybook contents :-)
```

COBOL source code has a tendency to be very long lived. The harder it is to use improperly, the better it is, for everyone involved.

4.2.109 FUNCTION YEAR-TO-YYYY

Converts a two digit year to a sliding window four digit year. The optional second argument (default 50) is added to the date at execution time to determine the ending year of a 100 year interval. Results are dependant on current year, as the window slides.

4.3 Can you clarify the use of FUNCTION in GnuCOBOL?

Yes. This information is from [Roger], posted to the opencobol forums.

```
Just to clarify the use of FUNCTION.
(Applies to 0.33)
FUNCTION (generally speaking, there are exceptions) can
be used anywhere where a source item is valid.
It always results in a new temporary field.
This will have the desired characteristics dependant
on the parameters.
eg. FUNCTION MIN (x, y, z)
with x PIC 99
     y PIC 9(8) COMP
     z PIC 9(6)V99
will result in returning a field that has
at least 8 positions before the (implied) decimal
point and 2 after.

It does NOT ever change the contents of parameters
to the function.

FUNCTION's are nestable.
eg.

DISPLAY FUNCTION REVERSE (FUNCTION UPPER-CASE (myfield)).
```

One clarification to the above quote was pointed out by Roger. The line:

```
be used anywhere where a source item is valid.
```

should be:

```
be used anywhere where a sending field is valid.
```

4.4 What is the difference between the LENGTH verb and FUNCTION LENGTH?

From [Roger]:

```
The standard only defines FUNCTION LENGTH.
The LENGTH OF phrase is an extension (from MF)
```

4.5 What STOCK CALL LIBRARY does GnuCOBOL offer?

GnuCOBOL 1.0 ships with quite a few callable features. Also termed "the system calls". See *CALL* (page 219). Looking through the source code, you'll find the current list of service calls in:

```
libcob/system.def
```

With the GnuCOBOL-2.0-rc3, Jan 31st, 2017 the list includes

```
/* COB_SYSTEM_GEN (external name, number of parameters, internal name) */

COB_SYSTEM_GEN ("SYSTEM",               1, cob_sys_system)

COB_SYSTEM_GEN ("CBL_AND",              3, cob_sys_and)
COB_SYSTEM_GEN ("CBL_CHANGE_DIR",       1, cob_sys_change_dir)
COB_SYSTEM_GEN ("CBL_CHECK_FILE_EXIST", 2, cob_sys_check_file_exist)
COB_SYSTEM_GEN ("CBL_CLOSE_FILE",       1, cob_sys_close_file)
COB_SYSTEM_GEN ("CBL_COPY_FILE",        2, cob_sys_copy_file)
COB_SYSTEM_GEN ("CBL_CREATE_DIR",       1, cob_sys_create_dir)
COB_SYSTEM_GEN ("CBL_CREATE_FILE",      5, cob_sys_create_file)
COB_SYSTEM_GEN ("CBL_DELETE_DIR",       1, cob_sys_delete_dir)
COB_SYSTEM_GEN ("CBL_DELETE_FILE",      1, cob_sys_delete_file)
COB_SYSTEM_GEN ("CBL_EQ",               3, cob_sys_eq)
COB_SYSTEM_GEN ("CBL_ERROR_PROC",       2, cob_sys_error_proc)
COB_SYSTEM_GEN ("CBL_EXIT_PROC",        2, cob_sys_exit_proc)
COB_SYSTEM_GEN ("CBL_FLUSH_FILE",       1, cob_sys_flush_file)
COB_SYSTEM_GEN ("CBL_GET_CURRENT_DIR",  3, cob_sys_get_current_dir)
COB_SYSTEM_GEN ("CBL_GET_CSR_POS",      1, cob_sys_get_csr_pos)
COB_SYSTEM_GEN ("CBL_GET_SCR_SIZE",     2, cob_sys_get_scr_size)
COB_SYSTEM_GEN ("CBL_IMP",              3, cob_sys_imp)
COB_SYSTEM_GEN ("CBL_NIMP",             3, cob_sys_nimp)
COB_SYSTEM_GEN ("CBL_NOR",              3, cob_sys_nor)
COB_SYSTEM_GEN ("CBL_NOT",              2, cob_sys_not)
COB_SYSTEM_GEN ("CBL_OPEN_FILE",        5, cob_sys_open_file)
COB_SYSTEM_GEN ("CBL_OR",               3, cob_sys_or)
COB_SYSTEM_GEN ("CBL_PUT_SCR_POS",      1, cob_sys_put_scr_pos)
COB_SYSTEM_GEN ("CBL_READ_FILE",        5, cob_sys_read_file)
COB_SYSTEM_GEN ("CBL_READ_KBD_CHAR",    1, cob_sys_get_char)
COB_SYSTEM_GEN ("CBL_RENAME_FILE",      2, cob_sys_rename_file)
COB_SYSTEM_GEN ("CBL_TOLOWER",          2, cob_sys_tolower)
COB_SYSTEM_GEN ("CBL_TOUPPER",          2, cob_sys_toupper)
COB_SYSTEM_GEN ("CBL_WRITE_FILE",       5, cob_sys_write_file)
COB_SYSTEM_GEN ("CBL_XOR",              3, cob_sys_xor)

COB_SYSTEM_GEN ("CBL_READ_CHANNEL",     3, cob_sys_read_channel)
COB_SYSTEM_GEN ("CBL_WRITE_CHANNEL",    3, cob_sys_write_channel)

COB_SYSTEM_GEN ("CBL_GC_FORK",          0, cob_sys_fork)
COB_SYSTEM_GEN ("CBL_GC_GETOPT",        6, cob_sys_getopt_long_long)
COB_SYSTEM_GEN ("CBL_GC_HOSTED",        2, cob_sys_hosted)
COB_SYSTEM_GEN ("CBL_GC_NANOSLEEP",     1, cob_sys_oc_nanosleep)
COB_SYSTEM_GEN ("CBL_GC_WAITPID",       1, cob_sys_waitpid)
COB_SYSTEM_GEN ("CBL_OC_GETOPT",        6, cob_sys_getopt_long_long)
COB_SYSTEM_GEN ("CBL_OC_HOSTED",        2, cob_sys_hosted)
COB_SYSTEM_GEN ("CBL_OC_NANOSLEEP",     1, cob_sys_oc_nanosleep)

COB_SYSTEM_GEN ("C$CALLEDBY",           1, cob_sys_calledby)
```

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```
COB_SYSTEM_GEN ("C$CHDIR",              2, cob_sys_chdir)
COB_SYSTEM_GEN ("C$COPY",               3, cob_sys_copyfile)
COB_SYSTEM_GEN ("C$DELETE",             2, cob_sys_file_delete)
COB_SYSTEM_GEN ("C$FILEINFO",           2, cob_sys_file_info)
COB_SYSTEM_GEN ("C$GETPID",             0, cob_sys_getpid)
COB_SYSTEM_GEN ("C$JUSTIFY",            1, cob_sys_justify)
COB_SYSTEM_GEN ("C$MAKEDIR",            1, cob_sys_mkdir)
COB_SYSTEM_GEN ("C$NARG",               1, cob_sys_return_args)
COB_SYSTEM_GEN ("C$PARAMSIZE",          1, cob_sys_parameter_size)
COB_SYSTEM_GEN ("C$PRINTABLE",          1, cob_sys_printable)
COB_SYSTEM_GEN ("C$SLEEP",              1, cob_sys_sleep)
COB_SYSTEM_GEN ("C$TOLOWER",            2, cob_sys_tolower)
COB_SYSTEM_GEN ("C$TOUPPER",            2, cob_sys_toupper)

COB_SYSTEM_GEN ("\x91",                 2, cob_sys_x91)
COB_SYSTEM_GEN ("\xE4",                 0, cob_sys_clear_screen)
COB_SYSTEM_GEN ("\xE5",                 0, cob_sys_sound_bell)
COB_SYSTEM_GEN ("\xF4",                 2, cob_sys_xf4)
COB_SYSTEM_GEN ("\xF5",                 2, cob_sys_xf5)
```

Note the "SYSTEM" at the very top. This CALL sends a command string to the shell. It acts as a wrapper to the standard C library `system` call. "SYSTEM" removes any trailing spaces from the argument and appends the null terminator required for the C library `system` function. While shell access opens yet another powerful door for the GnuCOBOL programmer, diligent developers will need to pay heed to cross platform issues when calling the operating system.

During the course of GnuCOBOL development, and rebranding from OpenCOBOL, a few of the stock library calls have been renamed. The old names were

```
COB_SYSTEM_GEN ("CBL_OC_GETOPT",            6, cob_sys_getopt_long_long)
COB_SYSTEM_GEN ("CBL_OC_HOSTED",            2, cob_sys_hosted)
COB_SYSTEM_GEN ("CBL_OC_NANOSLEEP",         1, cob_sys_oc_nanosleep)
```

The older `CBL_OC_` functions are aliased from `CBL_GC_` now, as can be seen in the above list.

4.5.1 list-system

GnuCOBOL 2 has a `cobc` option `--list-system` to get at the stock library list.

```
$ cobc --list-system

System routine                  Parameters

SYSTEM                          1
CBL_AND                         3
CBL_CHANGE_DIR                  1
CBL_CHECK_FILE_EXIST            2
CBL_CLOSE_FILE                  1
CBL_COPY_FILE                   2
CBL_CREATE_DIR                  1
CBL_CREATE_FILE                 5
CBL_DELETE_DIR                  1
CBL_DELETE_FILE                 1
CBL_EQ                          3
CBL_ERROR_PROC                  2
```

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```
CBL_EXIT_PROC                   2
CBL_FLUSH_FILE                  1
CBL_GET_CURRENT_DIR             3
CBL_GET_SCR_POS                 1
CBL_GET_SCR_SIZE                2
CBL_IMP                         3
CBL_NIMP                        3
CBL_NOR                         3
CBL_NOT                         2
CBL_OPEN_FILE                   5
CBL_OR                          3
CBL_PUT_SCR_POS                 1
CBL_READ_FILE                   5
CBL_READ_KBD_CHAR               1
CBL_RENAME_FILE                 2
CBL_TOLOWER                     2
CBL_TOUPPER                     2
CBL_WRITE_FILE                  5
CBL_XOR                         3
CBL_READ_CHANNEL                3
CBL_WRITE_CHANNEL               3
CBL_GC_FORK                     0
CBL_GC_GETOPT                   6
CBL_GC_HOSTED                   2
CBL_GC_NANOSLEEP                1
CBL_GC_WAITPID                  1
CBL_OC_GETOPT                   6
CBL_OC_HOSTED                   2
CBL_OC_NANOSLEEP                1
C$CALLEDBY                      1
C$CHDIR                         2
C$COPY                          3
C$DELETE                        2
C$FILEINFO                      2
C$GETPID                        0
C$JUSTIFY                       1
C$MAKEDIR                       1
C$NARG                          1
C$PARAMSIZE                     1
C$PRINTABLE                     1
C$SLEEP                         1
C$TOLOWER                       2
C$TOUPPER                       2
X"91"                           2
X"E4"                           0
X"E5"                           0
X"F4"                           2
X"F5"                           2
```

For reference:

- x”E4”, decimal 228, is clear screen, changes screen mode, best used with awareness of this extended terminal I/O behaviour
- x”E5”, decimal 229, is for ringing the terminal bell.

See *What are the XF4, XF5, and X91 routines?* (page 528) for some details on the other numerically coded stock library routines.

4.5.2 A CBL_ERROR_PROC example

```
GCobol >>SOURCE FORMAT IS FIXED
      *****************************************************************
      * GnuCOBOL demonstration
      * Author:  Brian Tiffin
      * Date:    26-Jun-2008
      * History:
      *     03-Jul-2008
      *     Updated to compile warning free according to standards
      * Purpose:
      *     CBL_ERROR_PROC and CBL_EXIT_PROC call example
      *     CBL_ERROR_PROC installs or removes run-time error procedures
      *     CBL_EXIT_PROC installs or removes exit handlers
      *     Also demonstrates the difference between Run time errors
      *     and raised exceptions.  Divide by zero is raises an
      *     exception, it does not cause a run time error.
      * NB:
      *     Please be advised that this example uses the functional
      *     but no longer standard ENTRY verb.  Compiling with -Wall
      *     will display a warning.  No warning will occur using
      *     -std=MF
      * Tectonics: cobc -x errorproc.cob
       identification division.
       program-id. error_exit_proc.

       data division.
       working-storage section.
      * entry point handlers are procedure addresses
       01  install-address   usage is procedure-pointer.
       01  install-flag      pic 9 comp-x value 0.
       01  status-code       pic s9(9) comp-5.

      * exit handler address and priority (prio is IGNORED with OC1.1)
       01  install-params.
           02 exit-addr      usage is procedure-pointer.
           02 handler-prio   pic 999 comp-x.

      * indexing variable for back scannning error message strings
       01  ind               pic s9(9) comp-5.

      * work variable to demonstrate raising exception, not RTE
       01  val               pic 9.

      * mocked up error procedure reentrancy control, global level
       01  once              pic 9 value 0.
           88 been-here             value 1.

      * mocked up non-reentrant value
       01  global-value      pic 99 value 99.

      * LOCAL-STORAGE SECTION comes into play for ERROR_PROCs that
      *   may themselves cause run-time errors, handling reentry.
       local-storage section.
       01  reenter-value     pic 99 value 11.

      * Linkage section for the error message argument passed to proc
```

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```
      * By definition, error messages are 325 alphanumeric
       linkage section.
       01  err-msg           pic x(325).

      * example of GnuCOBOL error and exit procedures
       procedure division.

      * Demonstrate problem installing procedure
      * get address of WRONG handler.  NOTE: Invalid address
       set exit-addr to entry "nogo-proc".

      * flag: 0 to install, 1 to remove
       call "CBL_EXIT_PROC" using install-flag
                                  install-params
                            returning status-code
       end-call.
      * status-code 0 on success, in this case expect error.
       if status-code not = 0
           display
               "Intentional problem installing EXIT PROC"
               ", Status: " status-code
       end-if.

      * Demonstrate install of an exit handler
      * get address of exit handler
       set exit-addr to entry "exit-proc".

      * flag: 0 to install, 1 to remove
       call "CBL_EXIT_PROC" using install-flag
                                  install-params
                            returning status-code
       end-call.
      * status-code 0 on success.
       if status-code not = 0
           display
               "Problem installing EXIT PROC"
               ", Status: " status-code
           stop run
       end-if.

      * Demonstrate installation of an error procedure
      * get the procedure entry address
       set install-address to entry "err-proc".

      * install error procedure. install-flag 0 installs, 1 removes
       call "CBL_ERROR_PROC" using install-flag
                                   install-address
                             returning status-code
       end-call.
      * status-code is 0 on success.
       if status-code not = 0
           display "Error installing ERROR PROC"
           stop run
       end-if.

      * example of error that raises exception, not a run-time error
       divide 10 by 0 giving val end-divide.
```

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```
      * val will be a junk value, use at own risk

       divide 10 by 0 giving val
           on size error display "DIVIDE BY ZERO Exception"
       end-divide.

      * intentional run-time error
       call "erroneous" end-call.           *> ** Intentional error **

      * won't get here.  RTS error handler will stop run
       display
           "procedure division, following run-time error"
       end-display.
       display
           "global-value: " global-value
           ", reenter-value: " reenter-value
       end-display.

       exit program.
      ******************************************************************

      ******************************************************************
      * Programmer controlled Exit Procedure:
       entry. "exit-proc".

       display
           "**Custom EXIT HANDLER (will pause 3 and 0.5 seconds)**"
       end-display.

      * sleep for 3 seconds
       call "C$SLEEP" using "3" end-call.
      * demonstrate nanosleep; argument in billionth's of seconds
      *   Note: also demonstrates GnuCOBOL's compile time
      *         string catenation using ampersand;
      *         500 million being one half second
       call "CBL_OC_NANOSLEEP" using "500" & "000000" end-call.

       exit program.

      ******************************************************************
      * Programmer controlled Error Procedure:
       entry "err-proc" using err-msg.

       display "**ENTER error procedure**".

      * These lines are to demonstrate local and working storage
       display
           "global-value: " global-value
           ", reenter-value: " reenter-value
       end-display.
      * As reenter-value is local-storage
      *  the 77 will NOT display on rentry, while the global 66 will
       move 66 to global-value.
       move 77 to reenter-value.

      * Process err-msg.
      * Determine Length of error message, looking for null terminator
```

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```
       perform varying ind from 1 by 1
           until (err-msg(ind:1) = x"00") or (ind = length of err-msg)
               continue
       end-perform.
       display err-msg(1:ind).

      * demonstrate trapping an error caused in error-proc
       if not been-here then
           set been-here to true
           display "Cause error while inside error-proc"
           call "very-erroneous" end-call        *> Intentional error
       end-if.

      * In GnuCOBOL 1.1, the return-code is local and does
      *   not influence further error handlers
      *move 1 to return-code.
       move 0 to return-code.

       display "**error procedure EXIT**".

       exit program.
       end program err-proc.
```

with tectonics:

```
$ cobc -x errorproc.cob
$ ./errorproc
Intentional problem installing EXIT PROC, Status: -000000001
DIVIDE BY ZERO Exception
**ENTER error procedure**
global-value: 99, reenter-value: 11
Cannot find module 'erroneous'
Cause error while inside error-proc
**ENTER error procedure**
global-value: 66, reenter-value: 11
Cannot find module 'very-erroneous'
**error procedure EXIT**
libcob: Cannot find module 'very-erroneous'
**Custom EXIT HANDLER (will pause 3 and 0.5 seconds)**
```

errorproc.cob update for GnuCOBOL 2. The ENTRY keyword, used to produce linker entry point symbols in this example, doesn't work properly with the new GnuCOBOL linkage. There is no way to force a STATIC entry, and the dynamic linker is missing an internal scan hook.

The sample above, will work for GNU Cobol 1.1, but NOT for GnuCOBOL 2.0. or later. At least not at time of writing, Dec 2014. The sample needs to be rewritten to use PROGAM-ID. entry points, instead of the shortcut ENTRY statements.

The listing below, should compile with GnuCOBOL, but it's wrong. ;-) Intermingled local and working-storage that hasn't been recoded. Making it a less useful example, being off kilter. And wrong.

```
GCobol >>SOURCE FORMAT IS FIXED
      ************************************************************
      * GnuCOBOL demonstration
      * Author:  Brian Tiffin
      * Date:    26-Jun-2008
      * History:
```

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```
      *     03-Jul-2008
      *     Updated to compile warning free according to standards
      * Purpose:
      *     CBL_ERROR_PROC and CBL_EXIT_PROC call example
      *     CBL_ERROR_PROC installs or removes run-time error procedures
      *     CBL_EXIT_PROC installs or removes exit handlers
      *     Also demonstrates the difference between Run time errors
      *     and raised exceptions.  Divide by zero is raises an
      *     exception, it does not cause a run time error.
      * NB:
      *     Please be advised that this example uses the functional
      *     but no longer standard ENTRY verb.  Compiling with -Wall
      *     will display a warning.  No warning will occur using
      *     -std=MF
      * Tectonics: cobc -x errorproc.cob
       identification division.
       program-id. error_exit_proc.

       data division.
       working-storage section.
      * entry point handlers are procedure addresses
       01  install-address   usage is procedure-pointer.
       01  install-flag      pic 9 comp-x value 0.
       01  status-code       pic s9(9) comp-5.

      * exit handler address and priority (prio is IGNORED with OC1.1)
       01  install-params.
           02 exit-addr      usage is procedure-pointer.
           02 handler-prio   pic 999 comp-x.

      * indexing variable for back scannning error message strings
       01  ind               pic s9(9) comp-5.

      * work variable to demonstrate raising exception, not RTE
       01  val               pic 9.

      * mocked up error procedure reentrancy control, global level
       01  once              pic 9 value 0 external.
           88 been-here             value 1.

      * mocked up non-reentrant value
       01  global-value      pic 99 value 99 external.
       01 glob-addr usage pointer.

      * LOCAL-STORAGE SECTION comes into play for ERROR_PROCs that
      *   may themselves cause run-time errors, handling reentry.
       local-storage section.
       01  reenter-value     pic 99 value 11.

      * Linkage section for the error message argument passed to proc
      * By definition, error messages are 325 alphanumeric
      *linkage section.
      *01  err-msg           pic x(325).

      * example of GnuCOBOL error and exit procedures
       procedure division.
       set glob-addr to address of global-value
```

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```
       display glob-addr

      * Demonstrate problem installing procedure
      * get address of WRONG handler.  NOTE: Invalid address
       set exit-addr to entry "nogo-proc".

      * flag: 0 to install, 1 to remove
       call "CBL_EXIT_PROC" using install-flag
                                  install-params
                            returning status-code
       end-call.
      * status-code 0 on success, in this case expect error.
       if status-code not = 0
           display
               "Intentional problem installing EXIT PROC"
               ", Status: " status-code
           end-display
       end-if.

      * Demonstrate install of an exit handler
      * get address of exit handler
       set exit-addr to entry "exit-proc".

      * flag: 0 to install, 1 to remove
       call "CBL_EXIT_PROC" using install-flag
                                  install-params
                            returning status-code
       end-call.
      * status-code 0 on success.
       if status-code not = 0
           display
               "Problem installing EXIT PROC"
               ", Status: " status-code
           end-display
           stop run
       end-if.

      * Demonstrate installation of an error procedure
      * get the procedure entry address
       set install-address to entry "err-proc".

      * install error procedure. install-flag 0 installs, 1 removes
       call "CBL_ERROR_PROC" using install-flag
                                   install-address
                             returning status-code
       end-call.
      * status-code is 0 on success.
       if status-code not = 0
           display "Error installing ERROR PROC" end-display
           stop run
       end-if.

      * example of error that raises exception, not a run-time error
       divide 10 by 0 giving val end-divide.
      * val will be a junk value, use at own risk

       divide 10 by 0 giving val
```

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```
           on size error display "DIVIDE BY ZERO Exception" end-display
       end-divide.

      * intentional run-time error
       call "erroneous" end-call.           *> ** Intentional error **

      * won't get here.  RTS error handler will stop run
       display
           "procedure division, following run-time error"
       end-display.
       display
           "global-value: " global-value
           ", reenter-value: " reenter-value
       end-display.

       exit program.
       end program error_exit_proc.
      ****************************************************************

      ****************************************************************
      * Programmer controlled Exit Procedure:
       identification division.
       program-id. exit-proc.
       procedure division.

       display "**Custom EXIT HANDLER**" end-display.

      * sleep for 3 seconds
       display "Call C$SLEEP using 3" end-display.
       call "C$SLEEP" using "3" end-call.

      * demonstrate nanosleep; argument in billionth's of seconds
      *   Note: also demonstrates GnuCOBOL's compile time
      *         string catenation using ampersand;
      *         500 million being one half second
       display "Call CBL_OC_NANOSLEEP using 500,000,000" end-display.
       call "CBL_OC_NANOSLEEP" using "500" & "000000" end-call.

       exit program.
       end program exit-proc.

      ****************************************************************
      * Programmer controlled Error Procedure:
       identification division.
       program-id. err-proc.
       data division.
       working-storage section.
       01  global-value      pic 99 external.

       01  ind               pic s9(9) comp-5.
       01  once              pic 9 external.
           88 been-here            value 1.

      * LOCAL-STORAGE SECTION comes into play for ERROR_PROCs that
      *   may themselves cause run-time errors, handling reentry.
       local-storage section.
       01  reenter-value     pic 99 value 11.
```

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```
       01 glob-addr usage pointer.

       linkage section.
       01  err-msg           pic x(325).

       procedure division using err-msg.
       set glob-addr to address of global-value
       display glob-addr end-display

       display "**ENTER error procedure**" end-display.

      * These lines are to demonstrate local and working storage
       display
           "global-value: " global-value
           ", reenter-value: " reenter-value
       end-display.
      * As reenter-value is local-storage
      *  the 77 will NOT display on rentry, while the global 66 will
       move 66 to global-value.
       move 77 to reenter-value.

      * Process err-msg.
      * Determine Length of error message, looking for null terminator
       perform varying ind from 1 by 1
           until (err-msg(ind:1) = x"00") or (ind = length of err-msg)
               continue
       end-perform.
       display err-msg(1:ind) end-display.

      * demonstrate trapping an error caused in error-proc
       if not been-here then
           set been-here to true
           display "Cause error while inside error-proc" end-display
           call "very-erroneous" end-call        *> Intentional error
       end-if.

      * In GnuCOBOL 1.1, the return-code is local and does
      *   not influence further error handlers
      *move 1 to return-code.
       move 0 to return-code.

       display "**error procedure EXIT**" end-display.

       exit program.
       end program err-proc.
```

4.5.3 byte access files

GnuCOBOL supports CBL_READ_FILE and CBL_WRITE_FILE, along with an open and close, and supporting file management functions, for byte offset and request length access to files.

Seekable streams are the assumed POSIX file access method, and the byte functions allow byte access to these files and streams. Most operating systems will support offset and length access.

The example below is a small marquee, reading 40 bytes of a file, with a incrementing offset, to slide characters across a screen section field at about 5.9 characters per second. Inefficiently, and expensively.

```
Sample >>SOURCE FORMAT IS FIXED
      * Author:    Brian Tiffin
      * Date:      25-July-2008
      * Modified:  2015-07-29 07:41 EDT, Wednesday
      * License:   Copyright 2008,2015 Brian Tiffin
      *            Public domain sample.  Zero warranty.
      * Purpose:   Demonstrate GnuCOBOL byte stream files
      *            and SCREEN SECTION features
      * Tectonics: cobc -x streams.cob
       identification division.
       program-id. streams.

       environment division.
       configuration section.
       special-names.
           crt status is user-control.

       data division.
       working-storage section.
       78 READ-ONLY            value 1.
       78 WRITE-ONLY           value 2.
       78 READ-WRITE           value 3.

       01 filehandle           usage is pointer.
       01 filename             pic x(40).
       01 cfile                pic x(41).
       01 access-mode          usage binary-long.
       01 file-lock            pic x.
       01 device               pic x.
       01 result               usage binary-long.

       01 file-offset          pic 9(18) comp.
       01 read-length          pic 9(8)  comp.
       01 file-flags           binary-char.
       01 read-buffer          pic x(40).
       01 marquee              pic x(40).
       01 marquee-limit        pic 9(4).

       01 scr-result           pic 9(5).
       01 scr-file-offset      pic 9(5).
       01 scr-read-length      pic 9(5).
       01 scr-file-length      pic 9(6).
       01 scr-pass             pic x(5) value "Pre  ".

       01 user-control         pic 9(4).
       01 exit-message         pic x(10) value "CRT STATUS".

       screen section.
       01 file-screen.
          05 blank screen.
          05 line 1 column 25 value "GnuCOBOL byte stream files"
              foreground-color 2.
          05 line 3 column 10 value "Enter filename and marquee count."
              foreground-color 3.
          05 line 3 column 44 value "Any function key to exit"
              foreground-color 4.
          05 line 4 column 10 value "File:".
```

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```
          05 line 4 column 19 using filename.
          05 line 5 column 10 value "limit:".
          05 line 5 column 19 using marquee-limit.
          05 line 5 column 30 value "<- limits marquee loop".
          05 line 7 column 19 from marquee reverse-video.
          05 line 9 column 10 from scr-pass.
          05 line 9 column 15 value "Result:".
          05 line 9 column 22 from scr-result.
          05 line 9 column 29 value "Length:".
          05 line 9 column 36 from scr-read-length.
          05 line 9 column 43 value "Offset:".
          05 line 9 column 50 from scr-file-offset.
          05 line 9 column 57 value "Total:".
          05 line 9 column 63 from scr-file-length.
          05 line 10 column 29 from exit-message.
          05 line 10 column 40 from user-control.

      ****************************************************************
       procedure division.

      * read screen with defaults
       move "streams.cob" to filename.
       move 64 to marquee-limit.
       accept file-screen end-accept.

      * tapping a function key will bail
       if user-control not = 0
           move "Bailing..." to exit-message
           display file-screen
           call "C$SLEEP" using "2"
           goback
       end-if.

      * open the file, name needs terminating null byte
       move READ-ONLY to access-mode.
       string filename delimited by space
              low-value delimited by size
              into cfile
       end-string.
       call "CBL_OPEN_FILE" using cfile
                                  access-mode
                                  file-lock
                                  device
                                  filehandle
                            returning result
       end-call.
       move result to scr-result

       display file-screen.

      * This section demonstrates the file-flags option
      * If 128 is in file-flags, CBL_READ_FILE will place
      * the actual file length into the file-offset field on
      * completion of the read.
       move result to scr-result
       move 0 to file-offset scr-file-offset.
       move 40 to read-length scr-read-length.
```

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```
       move 128 to file-flags.

       call "CBL_READ_FILE" using filehandle
                                  file-offset
                                  read-length
                                  file-flags
                                  read-buffer
                            returning result.

       move "Post " to scr-pass
       move result to scr-result
       move file-offset to scr-file-offset
                           scr-file-length
       move read-length to scr-read-length

       display file-screen.

      * display a sliding marquee, one character every
      * 170 million, one billionth's of a second; about 5.9cps
       move 0 to file-flags.
       move 40 to read-length.
       perform varying file-offset from 0 by 1
           until (result not = 0)
              or (file-offset > marquee-limit)
            call "CBL_READ_FILE" using filehandle
                                       file-offset
                                       read-length
                                       file-flags
                                       read-buffer
                                 returning result
            end-call

            move read-buffer to marquee
            inspect marquee replacing all x"0d0a" by "  "
            inspect marquee replacing all x"0a" by space

            move file-offset to scr-file-offset
            move result to scr-result
            display file-screen

            call "CBL_OC_NANOSLEEP" using 170000000 end-call
       end-perform

       call "CBL_CLOSE_FILE" using filehandle
                             returning result.

       move "Leaving..." to exit-message.
       display file-screen.
       call "C$SLEEP" using "2" end-call.

       goback.
       exit program.
```

showing:

```
               GnuCOBOL byte stream files

```

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```
Enter filename and marquee count. Any function key to exit
File:    streams.cob_____________________________
limit:   0064       <- limits marquee loop

               * Date:      25-July-2008        *

Post Result:00000  Length:00040  Offset:00064  Total:006207
                   Leaving... 0000
```

with characters from the source file used as the sliding message.

4.5.4 Some stock library explanations

This small gem of a help file was written up by Vincent Coen, included here for our benefit.

Note: The code below is a work in progress. If you see this attention box; the file is not yet deemed complete.

```
System Calls v1.1.0 for OC v1.1  Author: Vincent B Coen  dated 12/01/2009

COB_SYSTEM_GEN ("CBL_ERROR_PROC", 2, CBL_ERROR_PROC):        Register error proc in Linux??? needs checking Roger?
   call using      install-flag   pic x comp-x    Indicates operation to be performed
                                                  (0 = install error procedure)
                                                  (1 = un-install error procedure)
                   install-addrs  Usage procedure pointer  Create by 'set install-addr to entry entry-name'
                                                  (the address of error procedure to install or un-install)

COB_SYSTEM_GEN ("CBL_EXIT_PROC", 2, CBL_EXIT_PROC)           Register closedown proc
   call using      install-flag   pic x comp-x    Indicate operation to be performed
                                                  (0 = install closedown proc. with default priority of 64)
                                                  (1 = un=install closedown proc.)
                                                  (2 = query priority of installed proc.)
                                                  (3 = install closedown proc. with given priority)
                   install-param  group item defined as:
                     install-addr  USAGE PROCEDURE POINTER (addr of closedown proc to install, uninstall or query)
                     install-prty  pic x comp-x    (when install-flag = 3, priority of proc. being installed 0 - 127)
      returning     status-code    (See section key).
   on exit           install-prty                  (when install-flag = 2, returns priority of selected proc.)

COB_SYSTEM_GEN ("CBL_OPEN_FILE", 5, CBL_OPEN_FILE)           Open byte stream file
    call using     file-name      pic x(n)      space or null terminated
                   access-mode    pic x comp-5   (1 = read only, 2 = write only [deny must = 0]
                                                  3 = read / write)
                   deny-mode      pic x comp-5   (0 = deny both, 1 = deny write, 2 = deny read
                                                  3 = deny neither read nor write)
                   device         pic x comp-5   (must be zero)
                   file-handle    pic x(4)       (Returns a file handle for a successful open)
        returning  status-code    (See section key)

COB_SYSTEM_GEN ("CBL_CREATE_FILE", 5, CBL_CREATE_FILE)       Create byte stream file
    call using     file-name      pic x(n)      (space or null terminated)
                   access-mode    pic x comp-x  (1 = read only)
                                                (2 = write only (deny must be 0)
                                                (3 = read / write)
                   deny-mode      pic x comp-x  (0 = deny both read & write exclusive)
                                                (1 = deny write)
                                                (2 = deny read)
                                                (3 = deny neither read nor write)
                   device         pic x comp-x  (must be zero) (reserved for future use)
                   file-handle    pic x(4)      (Returns a file handle for a successful open)
         returning status-code     (See section key)

COB_SYSTEM_GEN ("CBL_READ_FILE", 5, CBL_READ_FILE)           Read byte stream file
    call using  file-handle     pic x(4)         (File handke returned when file opened)
                file-offset     pic x(8) comp-x  (offset in the file at which to read) (Max limit X"00FFFFFFFF") ??
                byte-count      pic x(4) comp-x  (number of bytes to read. Poss limit x"00FFFF")
                flags           pic x comp-x     (0 = standard read, 128 = current file size returned in the
                                                      file-offset field)
```

```
               buffer          pic x(n)
     returning status-code     (See section key)
      on exit:  file-offset                    (Current file size on return if flags = 128 on entry)
               buffer          pic x(n)        (Buffer into which bytes are read. IT IS YOUR RESPONSIBILITY
                                                TO ENSURE THAT THE BUFFER IS LARGE ENOUGH TO HOLD ALL BYTES TO BE
                                                READ)
     Remarks:                 See Introduction to Byte Stream Routines as well as example code taken
                              from old version of CobXref

COB_SYSTEM_GEN ("CBL_WRITE_FILE", 5, CBL_WRITE_FILE)         Write byte stream file
    call using  file-handle     pic x(4)         (File handke returned when file opened)
                file-offset     pic x(8) comp-x  (offset in the file at which to write) (Max limit X"00FFFFFFFF") ??
                byte-count      pic x(4) comp-x  (number of bytes to write. Poss limit x"00FFFF")
                                                 Putting a value of zero here causes file to be trancated or extended
                                                 to the size specified in file-offset)
                flags           pic x comp-x     (0 = standard write)
                buffer          pic x(n)         (Buffer into which bytes are writen from)
     returning status-code     (See section key)

     Remarks:                 See Introduction to Byte Stream Routines as well as example code taken
                              from old version of CobXref

COB_SYSTEM_GEN ("CBL_CLOSE_FILE", 1, CBL_CLOSE_FILE)         Close byte stream file
    call using file-handle       pic x(4)     on entry the file handle returned when file opened
         returning status-code   (see section key)

COB_SYSTEM_GEN ("CBL_FLUSH_FILE", 1, CBL_FLUSH_FILE)         ?????????????
    call using   ???????         pic ????       No Idea

COB_SYSTEM_GEN ("CBL_DELETE_FILE", 1, CBL_DELETE_FILE)       Delete File
    call using file-name         pic x(n)   file to delete terminated by space can contain path.
     returning status-code

COB_SYSTEM_GEN ("CBL_COPY_FILE", 2, CBL_COPY_FILE)           Copy file
      call using file-name1     (pic x(n)       File to copy, can contain path terniated by space
                  file-name2     (pic x(n)       File name of new file, can contain path termiated by space.
                                                 For both, if no path current directory is assumed.
       returning status-code    (see section key)

COB_SYSTEM_GEN ("CBL_CHECK_FILE_EXIST", 2, CBL_CHECK_FILE_EXIST)     Check if file exists & return details if it does
     Call using     file-name
                    file-details
       returning status-code

    file-name  pic x(n)
    file-details       Group item defined as:
       file-size        pic x(8) comp-x
     file-date
       day              pic x comp-x
       month            pic x comp-x
       year             pic xx comp-x

     file-time
       hours            pic x comp-x
       minutes          pic x comp-x
       seconds          pic x comp-x
       hundredths       pic x comp-x
     status-code    see section key

On entry: file-name     The file to look for. name can contain path and is terminated by a space
                        If no path given current directory is assumed.
On Exit:  file-size     Size if file in bytes
          file-date     Date the file was created
          file-time     Time file created

COB_SYSTEM_GEN ("CBL_RENAME_FILE", 2, CBL_RENAME_FILE)        Rename file
    call using      old-file-name    pic x(n)     (file to rename can contain path terminated by space)
                    new-file-name    pic x(n)     (new file name  as above path must be same)
     returning status-code     (see section key)

COB_SYSTEM_GEN ("CBL_GET_CURRENT_DIR", 3, CBL_GET_CURRENT_DIR) Get details of current directory
     call using      ???        pic x(n)  ???
                     ???        pic x(n)  ???
      returning  status-code (see section key)

COB_SYSTEM_GEN ("CBL_CHANGE_DIR", 1, CBL_CHANGE_DIR)          Change current directory
     Call using     path-name   pic x(n) (relative or absolute terminated by x"00")
       returning  status-code (see section key)

COB_SYSTEM_GEN ("CBL_CREATE_DIR", 1, CBL_CREATE_DIR)          Create directory
     Call using     path-name   pic x(n)  (relative or absolute path-name terminate by x"00")
```

```
       returning  status-code  (see section key)

COB_SYSTEM_GEN ("CBL_DELETE_DIR", 1, CBL_DELETE_DIR)          Delete directory
     Call using path-name       pic x(n)  (relative or absolute name terminated by space or null [x"00"])
       returning status-code    (see section key)

COB_SYSTEM_GEN ("CBL_AND", 3, CBL_AND)                        logical AND
     Call using  source      (Any data item)
                 target      (Any data item)
        by value length      (numeric literal or pic x(4) comp-5
       returning status-code  (see section key)

COB_SYSTEM_GEN ("CBL_OR", 3, CBL_OR)                          logical OR
   call using    source      (Any data item)
                 target      (Any data item)
        by value length      (numeric literal or pic x(4) comp-5
       returning status-code  (see section key)

COB_SYSTEM_GEN ("CBL_NOR", 3, CBL_NOR)                        Logial Not OR ?
     Call using  source      (Any data item)
                 target      (Any data item)
        by value length      (numeric literal or pic x(4) comp-5
       returning status-code  (see section key)

COB_SYSTEM_GEN ("CBL_XOR", 3, CBL_XOR)                        logical eXclusive OR
     Call using  source      (Any data item)
                 target      (Any data item)
        by value length      (numeric literal or pic x(4) comp-5
       returning status-code  (see section key)


COB_SYSTEM_GEN ("CBL_IMP", 3, CBL_IMP)                        Logical IMPlies
    call using source        Any data item
               target        Any data Item
          by value length    Nuneric literal or pic x(4) comp-5
     returning status-code    (see section key)

COB_SYSTEM_GEN ("CBL_NIMP", 3, CBL_NIMP)                       Logical Not IMPlies
    call using source        Any data item
               target        Any data Item
          by value length    Nuneric literal or pic x(4) comp-5
     returning status-code    (see section key)

COB_SYSTEM_GEN ("CBL_EQ", 3, CBL_EQ)                          Logical EQUIVALENCE between bits of both items
     Call using  source      (Any data item)
                 target      (Any data item)
        by value length      (numeric literal or pic x(4) comp-5
       returning status-code  (see section key)

COB_SYSTEM_GEN ("CBL_NOT", 2, CBL_NOT)                        Logical NOT
   Call using target         Any data item
      by value length        numeric lit or pic x(4) comp-5

COB_SYSTEM_GEN ("CBL_TOUPPER", 2, CBL_TOUPPER)                Convert a string to Upper case
    Call using    string      pic x(n)          (The string to convert)
        by value  length      pic x(4) comp-5   (Number of bytes to change)
       returning status-code  (see section key)

COB_SYSTEM_GEN ("CBL_TOLOWER", 2, CBL_TOLOWER)                Convert a string to Lower case
    Call using    string      pic x(n)          (The string to convert)
        by value  length      pic x(4) comp-5   (Number of bytes to change)
       returning status-code  (see section key)

COB_SYSTEM_GEN ("\364", 2, CBL_XF4)
COB_SYSTEM_GEN ("\365", 2, CBL_XF5)
COB_SYSTEM_GEN ("\221", 2, CBL_X91)
COB_SYSTEM_GEN ("C$NARG", 1, cob_return_args)
COB_SYSTEM_GEN ("C$PARAMSIZE", 1, cob_parameter_size)
COB_SYSTEM_GEN ("C$MAKEDIR", 1, cob_acuw_mkdir)
COB_SYSTEM_GEN ("C$CHDIR", 2, cob_acuw_chdir)
COB_SYSTEM_GEN ("C$SLEEP", 1, cob_acuw_sleep)
COB_SYSTEM_GEN ("C$COPY", 3, cob_acuw_copyfile)
COB_SYSTEM_GEN ("C$FILEINFO", 2, cob_acuw_file_info)
COB_SYSTEM_GEN ("C$DELETE", 2, cob_acuw_file_delete)

COB_SYSTEM_GEN ("C$TOUPPER", 2, CBL_TOUPPER)                  Convert string to upper case
    see cbl_toupper  ???

COB_SYSTEM_GEN ("C$TOLOWER", 2, CBL_TOLOWER)                  Convert string to lower case
    see cbl_tolower  ???
COB_SYSTEM_GEN ("C$JUSTIFY", 1, cob_acuw_justify)
```

```
COB_SYSTEM_GEN ("CBL_OC_NANOSLEEP", 1, CBL_OC_NANOSLEEP)

Key:
  Option Returning clause will allow all routine to return a value showing result of the operation.
  Zero = success and nonzero failure. If this field is omitted the value should be returned in the
  special register RETURN-CODE..       Note that status-code must be capable of holding positive
                                       values from 0 to 65535 ie, pic xx comp-5.

And a sample program too::

Introduction to Byte Streaming Routines.

The byte stream file routines enable you to read, write data files without the need to adhere to
Cobol record definitions.

For all of these routines, if the routine is successful the RETURN-CODE register is set to zero. If
it fails, the RETURN-CODE register contains a file status value which indicates the failure. This
file status  is always the standard ASNI '74 file status value. If no ANSI '74 file status is defined
for the error, an extended error status is returned (9/nnn) where nnn is the runtime error number).
          MAYBE need to speak to Roger. <<<<<<<<<<<<<<<<<<<<

An extract of a example of working Cobol code that shows usage of byte stream file handling
```

```
000100 Identification division.
000200 program-id.           cobxref.
...
...
104000 01  File-Handle-Tables.
104100     03  filler          occurs 0 to 99
104200                                 depending on Fht-Table-Size.
104300       05 Fht-File-Handle  pic x(4).
104400       05 Fht-File-OffSet  pic x(8)       comp-x  value zero.
104500       05 Fht-File-Size    pic x(8)       comp-x  value zero.
104600       05 Fht-Block-OffSet pic x(8)       comp-x  value zero.
104700       05 Fht-Byte-Count   pic x(4)       comp-x  value 4096.
104800       05 Fht-CopyRefNo2   pic 9(6)               value zero.
104900       05 Fht-Pointer      pic s9(5)      comp    value zero.
105000       05 Fht-Copy-Line-End pic s9(5)     comp    value zero.
105100       05 Fht-Copy-Words   pic s9(5)      comp    value zero.
105200       05 Fht-sw-Eof       pic 9                  value zero.
105300        88 Fht-Eof                               value 1.
105400       05 Fht-Current-Rec  pic x(160)             value spaces.
105500       05 Fht-File-Name    pic x(256).
105600       05 Fht-Buffer       pic x(4097).
105700       05 filler           pic x                  value x"FF".
105800 01  Fht-Table-Size        pic s9(5) comp value zero.
105900*
106000 01  Cbl-File-Fields.
106100     03  Cbl-File-name     pic x(256).
106200     03  Cbl-Access-Mode   pic x          comp-x  value 1.
106300     03  Cbl-Deny-Mode     pic x          comp-x  value 3.
106400     03  Cbl-Device        pic x          comp-x  value zero.
106500     03  Cbl-Flags         pic x          comp-x  value zero.
106600     03  Cbl-File-Handle   pic x(4)               value zero.
106700     03  Cbl-File-OffSet   pic x(8)       comp-x  value zero.
106800*
106900 01  Cbl-File-Details.
107000     03  Cbl-File-Size     pic x(8)       comp-x  value zero.
107100     03  Cbl-File-Date.
107200         05  Cbl-File-Day  pic x          comp-x  value zero.
107300         05  Cbl-File-Mth  pic x          comp-x  value zero.
107400         05  Cbl-File-Year pic x          comp-x  value zero.
```

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```
107500     03  Cbl-File-time.
107600         05  Cbl-File-Hour pic x          comp-x  value zero.
107700         05  Cbl-File-Min  pic x          comp-x  value zero.
107800         05  Cbl-File-Sec  pic x          comp-x  value zero.
107900         05  Cbl-File-Hund pic x          comp-x  value zero.
...
...
      *****************************************************************
      *
      * zz300, zz400, zz500 & zz600 all relate to copy files/libraries
      *   via the COPY verb
      *  As it is hoped to only use the filename.i via Open-Cobol
      * then this lot can be killed off as well as all the other related
      * code.
      * NOTE that the COPY verb is implemented in a very basic way despite
      *  the fact that this code allows for 99 levels of COPY, eg, there is
      *  NO replacing so hopefully I can remove it all after primary testing
      *  When it is built into cobc
      *
356400 zz300-Open-File.
356500****************
356600* Open a Copy file using CBL-OPEN-File
356700*  filename is using Cbl-File-name
356800*
356900     move     zero to Return-Code.
357000     if       Fht-Table-Size > 99
357100              move 24 to Return-Code
357200              display Msg11
357300              go to zz300-Exit.
357400*
357500* set up New entry in File Table
357600*
357700     add      1 to Fht-Table-Size.
357800     move     Fht-Table-Size to e.
357900     move     zeroes to Fht-File-OffSet (e) Fht-File-Size (e)
358000                        Fht-File-Handle (e) Fht-Block-OffSet (e)
358100                        Fht-CopyRefNo2 (e)  Fht-sw-Eof (e)
358200                        Fht-Copy-Line-End (e) Fht-Copy-Words (e).
358300     move     4096 to   Fht-Byte-Count (e).
358400     move     spaces to Fht-Current-Rec (e).
358500     move     1      to Fht-pointer (e).
358600*
358700     perform  zz400-Check-File-Exists thru zz400-Exit.
358800     if       Return-Code not = zero
358900              subtract 1 from Fht-Table-Size
359000              go to zz300-Exit.
359100*
359200     move     Fht-Table-Size to e.
359300     move     Cbl-File-Size to Fht-File-Size (e).
359400     move     Cbl-File-name to Fht-File-Name (e).
359500     move     1    to Cbl-Access-Mode
359600                      Cbl-Deny-Mode.
359700     move     zero to Cbl-Device
359800                      Cbl-File-Handle.
359900     move     zero to Return-Code.
360000     call     "CBL_OPEN_FILE" using
360100              Cbl-File-name
```

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```
360200              Cbl-Access-Mode
360300              Cbl-Deny-Mode
360400              Cbl-Device
360500              Cbl-File-Handle.
360600     if       Return-Code not = zero
360700              display Msg12 cbl-File-name
360800              display "       This should not happen here"
360900              subtract 1 from Fht-Table-Size
361000              go to zz300-exit.
361100*
361200     move     Cbl-File-Handle to Fht-File-Handle (e).
361300     add      1 to Copy-Depth.
361400     move     1 to sw-Copy.
361500     move     zero to Fht-CopyRefNo2 (e)
361600                     Return-Code.
362000 zz300-Exit.
362100     exit.
362200/
362300 zz400-Check-File-Exists.
362400*
362500* check for correct filename and extention taken from COPY verb
362600*
362700*  input : wsFoundNewWord2
362800* Output : Return-Code = 0  : Cbl-File-Details & Cbl-File-name
362900*          Return-Code = 25 : failed fn in wsFoundNewWord2
363000*
363100     move     zero to e.
363200     inspect  wsFoundNewWord2 tallying e for all ".".
363300     if       e not zero
363400              go to zz400-Try1.
363500     perform  varying a from 1 by 1 until Return-Code = zero
363600              move   1 to e
363700              move   spaces to Cbl-File-name
363800              string wsFoundNewWord2 delimited by space
363900                                     into Cbl-File-name pointer e
364000              string File-Ext (a) delimited by size
364100                                     into Cbl-File-name pointer e
364200              move   zero to Return-Code
364300              call   "CBL_CHECK_FILE_EXIST" using
364400                     Cbl-File-name
364500                     Cbl-File-Details
364600              end-call
364700              if   Return-Code not = zero
364800               and a = 7
364900                     exit perform
365000              end-if
365100     end-perform
365200     if       Return-Code not = zero
365300              display "zz400A Check File exist err=" Return-Code
365400              display Msg13 wsFoundNewWord2
365500              move 25 to Return-Code
365600              go to zz400-Exit.
365700* ok file now found
365900     go       to zz400-Exit.
366000*
366100 zz400-Try1.
366200     move     wsFoundNewWord2 to Cbl-File-name.
```

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```
366300     move      zero to Return-Code.
366400     call      "CBL_CHECK_FILE_EXIST" using
366500               Cbl-File-name
366600               Cbl-File-Details.
366700     if        Return-Code not = zero
366800               move function lower-case (wsFoundNewWord2) to
366900                     Cbl-File-name
367000               go to zz400-Try2.
367100* ok file now found
367200     go        to zz400-exit.
367300*
367400 zz400-Try2.
367500     move      zero to Return-Code.
367600     call      "CBL_CHECK_FILE_EXIST" using
367700               Cbl-File-name
367800               Cbl-File-Details.
367900     if        Return-Code not = zero
368000               display "zz400C Check File exist err=" Return-Code
368100               display Msg13 wsFoundNewWord2 " or " Cbl-File-name
368200               move 25 to Return-Code
368300               go to zz400-Exit.
368400*
368500* ok file now found
368600*
368700 zz400-Exit.
368800     exit.
368900/
369000 zz500-Close-File.
369100     call      "CBL_CLOSE_FILE" using
369200               Fht-File-Handle (Fht-Table-Size).
369300     if        Return-Code not = zero
369400               display Msg14
369500                       Cbl-File-name.
369800     subtract 1 from Fht-Table-Size.
369900*
370000     if        Fht-Table-Size = zero
370100               move zero to sw-Copy.
370200     subtract 1 from Copy-Depth.
370300     move      zero to Return-Code.
370400     go        to zz500-Exit.
370500*
370600 zz500-Exit.
370700     exit.
370800/
370900 zz600-Read-File.
371000****************
371100* called using file-handle
371200*  returning   CopySourceRecin1  size 160 chars
371300* If buffer enpty read a block
371400*    and regardless, move record terminated by x"0a"
371500* to Fht-Current-Rec (Fht-Table-Size)
371600*
371700     if        Fht-Eof (Fht-Table-Size)
371800               perform zz500-Close-File
371900               go to zz600-Exit.
372000*
372100     if        Fht-File-OffSet (Fht-Table-Size) = zero
```

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```
372200         and  Fht-Block-OffSet (Fht-Table-Size) = zero
372300              perform zz600-Read-A-Block
372400              go to zz600-Get-A-Record.
372500*
372600 zz600-Get-A-Record.
372700*******************
372800* Now to extract a record from buffer and if needed read a block
372900*         then extract
373000*
373100     move     spaces to Fht-Current-Rec (Fht-Table-Size).
373200     add      1 to Fht-Block-OffSet (Fht-Table-Size) giving g.
373300*
373400* note size is buffer size + 2
373500*
373600     unstring Fht-Buffer (Fht-Table-Size) (1:4097)
373700                delimited by x"0A" or x"FF"
373800                into         Fht-Current-Rec (Fht-Table-Size)
373900                delimiter    Word-Delimit3
374000                pointer      g.
374100*
374200* Get next Block of data ?
374300*
374400     if       Word-Delimit3 = x"FF"
374500          and g not < 4097
374600              add Fht-Block-OffSet (Fht-Table-Size)
374700                                to Fht-File-OffSet (Fht-Table-Size)
374800              perform zz600-Read-A-Block
374900              go to zz600-Get-A-Record.
375000* EOF?
375100     move     1 to Fht-Pointer (Fht-Table-Size).
375200     if       Word-Delimit3 = x"FF"
375300              move 1 to Fht-sw-Eof (Fht-Table-Size)
375400              go to zz600-Exit.
375500* Now so tidy up
375600     subtract 1 from g giving Fht-Block-OffSet (Fht-Table-Size).
375700     go       to zz600-exit.
375800*
375900 zz600-Read-A-Block.
      *******************
376000     move     all x"FF" to Fht-Buffer (Fht-Table-Size).
376100*     if       Fht-File-Size (Fht-Table-Size) < 4096 and not = zero
376200*              move Fht-File-Size (Fht-Table-Size)
376300*                                to Fht-Byte-Count (Fht-Table-Size).
376400     call     "CBL_READ_FILE" using
376500              Fht-File-Handle (Fht-Table-Size)
376600              Fht-File-OffSet (Fht-Table-Size)
376700              Fht-Byte-Count (Fht-Table-Size)
376800              Cbl-Flags
376900              Fht-Buffer (Fht-Table-Size).
377000     if       Return-Code not = zero
377100              display Msg15 Return-Code
377200              go to zz600-Exit.
377300* just in case all ff does not work
377400     move     x"FF" to Fht-Buffer (Fht-Table-Size) (4097:1).
377500     move     zero to Fht-Block-OffSet (Fht-Table-Size).
377600     subtract Fht-Byte-Count (Fht-Table-Size)
377700                              from Fht-File-Size (Fht-Table-Size).
```

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```
377800 zz600-Exit.
377900     exit.
```

4.5.5 CBL_GC_FORK

At first, `fork` is a heady concept to understand. In *POSIX* (page 1361), `fork()` is a system level call that creates a new entry in the operating system process table by creating a clone copy of the currently executing program. In GNU/Linux this is a very fast operation, a small entry is made in a Linux kernel table along with some minimal paperwork. Other operating systems do more work in the background and actually spawn a new process space, but `fork()` is fast. The code and data is a clone, and most operating systems set up `copy on write` memory pages. No extra work is required until the new process modifies something, at which point a new memory page is added to the pool.

It gets heady because forking creates a new process that is executing an exact duplicate of the current code stream. When looking at source code it might be hard to remember that two separate programs are running exactly the same code, right at the trailing end of a `fork()` call. The only way to distinguish which copy of the program is running is the return value from `fork()`

PID is Process ID. The return from `CBL_GC_FORK` is either a PID (returned to the parent, representing the ID of the new child process), a zero (inside the new child) or an error code (-2 unsupported, -1 something went wrong with the fork (possibly out of memory or other resource exhaustion)).

```
parent --> parent (same process id, fork() returns PID of child)
             |
           child1 (new process id, fork() returns 0)
```

If you were to call two forks in a row you end up with four processes:

```
parent --> parent
             |
           child1 --> child1
             .          |
             .        child2
           parent --> parent
                        |
                      child3
```

This would happen because both processes would execute the second fork, having identical code streams.

Three forks in a row, and you get eight processes running:

```
fork1 (p splits into p and c1)

fork2 (p splits into p and c2, c1 splits into c1 and c3)

fork3 (p splits into p and c4, c1 splits into c1 and c5,
       c2 splits in c2 and c6, c3 splits into c3 and c7)
```

Fork bombs kill operating systems by exhausting resources, really fast. Blinky fast. `fork()` needs extreme care and attention to controlling details.

GnuCOBOL supports a cross platform version of forking, and it will work on GNU/Linux, Cygwin and other *POSIX* (page 1361) like operating systems. Native Windows™ is not yet included, as that operating system does not clone via fork, but requires a separate spawn sequence.

The common idiom is an `if` immediately after the fork. Being identical code, both parent and child evaluate the `if` (unless the return in less than 0, which is an error state and there is no child process):

```
if rpid < 0 then error occurred.

if rpid = 0 then "I'm the child", and that will usually exec a brand new
process space or jump to a completely separate part of the program. Don't
think this is a thread though, it is not, it is a separate copy of the
same program.

if rpid > 0 then "I'm the original", and I'll do my thing and eventually
wait on the child pid to ensure no orphan zombie reaping occurs.
```

This is not creating a thread, this is brand new process. The operating system will send a signal to the parent when the child exits. It is proper etiquette for a parent process to wait on the PID that is returned from fork before exiting to the operating system. Otherwise the operating system will terminate the child at its leisure as part of "zombie orphan reaping". When the master process exits, all child processes are also marked for removal from the process table, well actually they are reparented to PID 1, the `init` process.

As an example, when you are running a terminal shell and then close the window, any programs that were running in that shell are terminated as well. This is a good and needful behaviour for the operating system, otherwise processes would hang around forever, until manually killed.

A small example. Note the copied-value is separate as the child process is a clone of the parent, and once executing is a completely different process space.

```
      *>
      *> forking.cob, CBL_GC_FORK example
      *>
      *> Tectonics:
      *>   cobc -xj forking.cob
      *>
       identification division.
       program-id. forking.

       data division.
       working-storage section.
       01 return-pid           usage binary-long.
       01 wait-status          usage binary-long.

       01 copied-value         pic 9   value 7.

       procedure division.
       display "Forking"

      *> When the process forks, two processes will be running, at a
      *> point of execution of the "returning return-pid" part.
       call "CBL_GC_FORK" returning return-pid

      *> all code from now on is being executed by two processes
      *> unless an error occurred and there is no child

      *> unlike fork(), GnuCOBOL uses -2 to mean not supported and
      *>                               -1 when fork() fails
       if return-pid < zero then
           display "forking error: " return-pid upon syserr
       else
           display "**Both processes evaluate this line ", return-pid
```

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```
       end-if

       if return-pid equal zero then
      *> child will now branch off from the main control flow
           go to child-task
       end-if

      *> When the parent process exits, the child will be reaped as well
       display "This is still the original process: " return-pid
       display "Parent: copied value is: " copied-value
       add 1 to copied-value
       display "Parent: copied-value is now: " copied-value

      *> To ensure the child gets a chance to finish, waitpid is used
       call "CBL_GC_WAITPID" using return-pid returning wait-status
       display "Parent: status value from child: " wait-status
       display "Parent: copied-value is still: " copied-value
       display "Parent: leaves the building"
      *> libcob internals also set the parent return-code field
      *> during the call to CBL_GC_WAITPID (reset it to zero).
       move 0 to return-code
       goback.

      *> ********
      *> NOTE: this is not a thread, but is a separate process
      *>       evaluating an identical copy of the code as the parent
       child-task.
       display "    This is a new process space, a child"
       display "    Child: copied value is: " copied-value
       subtract 1 from copied-value
       display "    Child: copied-value is now: " copied-value

      *> exit the child process with a status value of 42
       display "    Child: leaves the building, setting return-code"
       move 42 to return-code
       goback.
       end program forking.
```

And a sample run capture:

```
prompt$ cobc -xj forking.cob
Forking
**Both processes evaluate this line +0000005148
This is still the original process: +0000005148
Parent: copied value is: 7
Parent: copied-value is now: 8
**Both processes evaluate this line +0000000000
    This is a new process space, a child
    Child: copied value is: 7
    Child: copied-value is now: 6
    Child: leaves the building, setting return-code
Parent: status value from child: +0000000042
Parent: copied-value is still: 8
Parent: leaves the building
```

4.6 What are the XF4, XF5, and X91 routines?

From opencobol.org

```
The CALL's X"F4", X"F5", X"91" are from MF.
You can find them in the online MF doc under
Library Routines.

F4/F5 are for packing/unpacking bits from/to bytes.
91 is a multi-use call. Implemented are the subfunctions
get/set cobol switches (11, 12) and get number of call params (16).

Roger
```

Use

```
CALL X"F4" USING
               BYTE-VAR
               ARRAY-VAR
           RETURNING STATUS-VAR
```

to pack the last bit of each byte in the 8 byte ARRAY-VAR into corresponding bits of the 1 byte BYTE-VAR.

The X"F5" routine takes the eight bits of byte and moves them to the corresponding occurrence within array.

X"91" is a multi-function routine.

```
CALL X"91" USING
               RESULT-VAR
               FUNCTION-NUM
               PARAMETER-VAR
           RETURNING STATUS-VAR
```

As mentioned by Roger, GnuCOBOL supports FUNCTION-NUM of 11, 12 and 16.

11 and 12 get and set the on off status of the 8 (eight) run-time GnuCOBOL switches definable in the *SPECIAL-NAMES* (page 410) paragraph. 16 returns the number of call parameters given to the current module.

GnuCOBOL 2 adds:

- X"E4" for clearing the screen.
- X"E5" for ringing the terminal bell.

4.7 What is CBL_OC_NANOSLEEP?

CBL_OC_NANOSLEEP allows (upto) nanosecond sleep timing. It accepts a 64 bit integer value which may be in character or numeric data forms.

```
CALL "CBL_OC_NANOSLEEP" USING 500000000
                        RETURNING STATUS
END-CALL
```

Would wait one-half second. *It may be easier to grok if the source code uses string catenation; "500" & "000000" for example.*

Nanosecond timing support is a hardware and platform dependency issue.

4.8 How do you use C$JUSTIFY?

The C$JUSTIFY sub program can centre, or justify strings left or right.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      01-Jul-2008
      *> Purpose:   Demonstrate the usage of GnuCOBOL call library
      *>            C$JUSTIFY, C$TOUPPER, C$TOLOWER
      *> Tectonics: Using OC1.1 post 02-Jul-2008, cobc -x -Wall
      *> History:   02-Jul-2008, updated to remove warnings
      *> ************************************************************
       identification division.
       program-id. justify.

       environment division.
       configuration section.
       source-computer. IBMPC.
       object-computer. IBMPC.

       data division.
       WORKING-STORAGE section.
       01 source-str           pic x(80)
           value "    this is a test of the internal voice communication
      - " system".
       01 just-str             pic x(80).
       01 justification        pic x.
       01 result               pic s9(9) comp-5.

       procedure division.
       move source-str to just-str.

      *> Left justification
       move "L" to justification.
       perform demonstrate-justification.

      *> case change to upper, demonstrate LENGTH verb
       call "C$TOUPPER" using just-str
                        by value function length( just-str )
                        returning result
       end-call.

      *> Centre
       move "C" to justification.
       perform demonstrate-justification.

      *> case change to lower
       call "C$TOLOWER" using just-str
                            by value 80
                        returning result
       end-call.

      *> Right, default if no second argument
       call "C$JUSTIFY" using just-str
                        returning result
       end-call.
```

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```
       move "R" to justification.
       perform show-justification.

       exit program.
       stop run.

      *> ****************************************************************
       demonstrate-justification.
       call "C$JUSTIFY" using just-str
                              justification
                        returning result
       end-call
       if result not equal 0 then
           display "Problem: " result
           stop run
       end-if
       perform show-justification
       .

      *> ****************************************************************
       show-justification.
       evaluate justification
           when "L"   display "Left justify"
           when "C"   display "Centred (in UPPERCASE)"
           when other display "Right justify"
       end-evaluate
       display "Source:    |" source-str "|"
       display "Justified: |" just-str "|"
       display space
       .
```

Producing

```
$ ./justify
Left justify
Source:    |    this is a test of the internal voice communication system                  |
Justified: |this is a test of the internal voice communication system                      |

Centred (in UPPERCASE)
Source:    |    this is a test of the internal voice communication system                  |
Justified: |           THIS IS A TEST OF THE INTERNAL VOICE COMMUNICATION SYSTEM           |

Right justify
Source:    |    this is a test of the internal voice communication system                  |
Justified: |                       this is a test of the internal voice communication system|
```

4.9 What preprocessor directives are supported by GnuCOBOL?

GnuCOBOL 1.1 supports a limited number of **directives**.

- >>D for conditional debug line compilation
- >>SOURCE for changing fixed and free format preprocessing modes
- *> for inline comments, column 1+ in free form, column 7+ in fixed

GnuCOBOL 2.0 supports a much wider subset of standard directives and existent extensions. Some are only recognized and will be ignored with a warning until implemented.

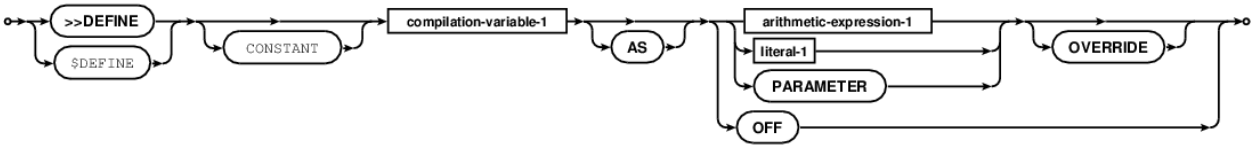
- >>D
- >>DEFINE
- >>DISPLAY
- >>IF
- >>ELSE
- >>ELIF
- >>ELSE-IF
- >>END-IF
- >>LEAP-SECOND
- >>SET
- >>SOURCE
- >>TURN

4.9.1 >>D

Debug line control. GnuCOBOL only compiles these lines if the **-fdebugging-line** command line option is set.

4.9.2 >>DEFINE

Define a compile time symbol.



- >>DEFINE identifier AS literal
- >>DEFINE identifier AS literal OVERRIDE
- >>DEFINE identifier OFF
- >>DEFINE identifier PARAMETER
- >>DEFINE CONSTANT identifier

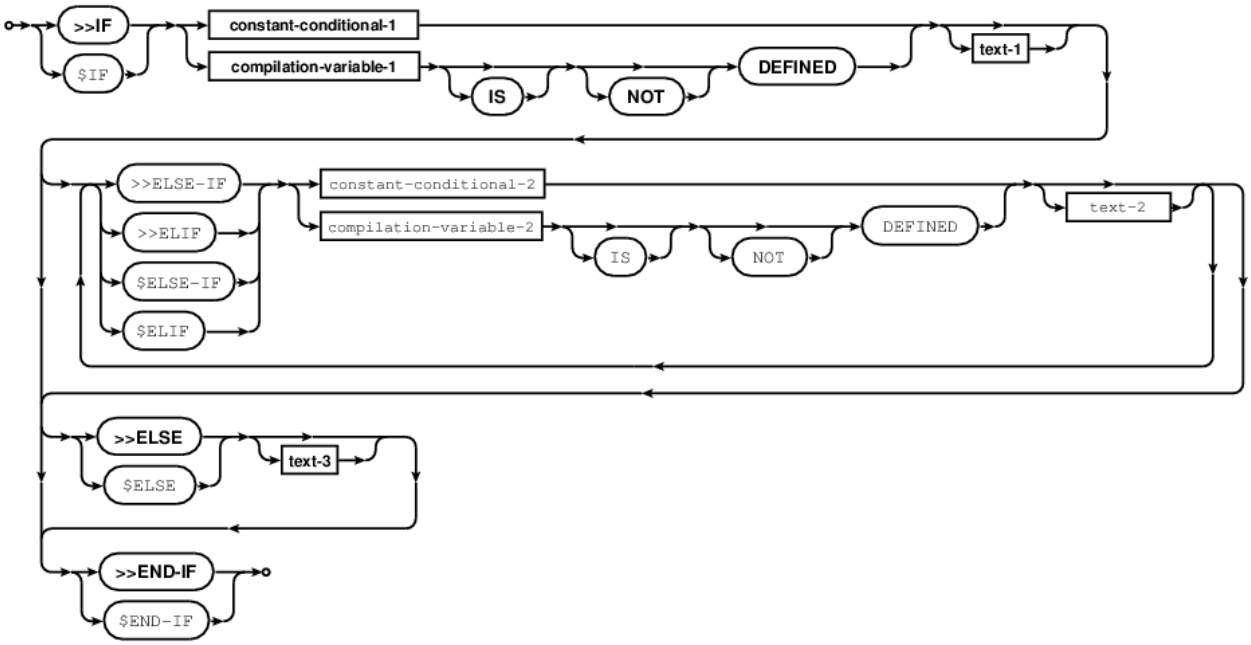
The -D command line option can be used to define symbols.

4.9.3 >>DISPLAY

Display the literal text following the directive, during compile time. Can be placed inside conditional compile directives. Quoting not required, text ends at newline.

4.9.4 >>IF

Conditional compile directive. Will include source lines upto >>END-IF, an >>ELSE-IF or >>ELSE clause if condition is true.



- >>IF identifier DEFINED
- >>IF conditional-expression

Predefined symbols

The GnuCOBOL compiler, predefines a set of compile time option tests.

In C, the definition is set at compile time, if the expression is true.

```
/* CB_PARSE_DEF (name, return value if true) */

CB_PARSE_DEF ("OPENCOBOL",              1U)
CB_PARSE_DEF ("GNUCOBOL",               1U)
CB_PARSE_DEF ("P64",                    sizeof (void *) > 4U)
CB_PARSE_DEF ("EXECUTABLE",             cb_flag_main != 0)
CB_PARSE_DEF ("MODULE",                 cb_flag_main == 0)
CB_PARSE_DEF ("TRUNC",                  cb_binary_truncate != 0)
CB_PARSE_DEF ("NOTRUNC",                cb_binary_truncate == 0)
CB_PARSE_DEF ("DEBUG",                  cobc_wants_debug != 0)
CB_PARSE_DEF ("STICKY-LINKAGE",         cb_sticky_linkage != 0)
CB_PARSE_DEF ("NOSTICKY-LINKAGE",       cb_sticky_linkage == 0)
CB_PARSE_DEF ("HOSTSIGNS",              cb_host_sign != 0)
CB_PARSE_DEF ("NOHOSTSIGNS",            cb_host_sign == 0)
CB_PARSE_DEF ("IBMCOMP",                cb_binary_size == CB_BINARY_SIZE_2_4_8)
CB_PARSE_DEF ("OCCOMP",                 cb_binary_size == CB_BINARY_SIZE_1_2_4_8)
CB_PARSE_DEF ("NOIBMCOMP",              cb_binary_size != CB_BINARY_SIZE_2_4_8)
```

Depending on configuration, some optional symbols are also defined:

```
CB_PARSE_DEF ("INTRINSIC-JVM",          1U)
CB_PARSE_DEF ("INTRINSIC-LUA",          1U)
CB_PARSE_DEF ("INTRINSIC-PYTHON",       1U)
CB_PARSE_DEF ("INTRINSIC-REXX",         1U)
CB_PARSE_DEF ("INTRINSIC-TCL",          1U)
```

This can be used for handy things like bit size assumptions (with the given `cobc` configuration, at time of the preprocessing phase of a COBOL compile sequence; that means these are *compile time values*).

```
>>IF P64 IS SET
    display "binary built assuming 8 byte pointers"
>>END-IF

>>IF OPENCOBOL IS SET
   display "free COBOL is pretty cool"
>>END-IF

>>IF INTRINSIC-TCL IS SET
    display tcl("expr {6 * 7}")
>>ELSE
    display "Intrinsic Tcl not available"
>>END-IF
```

Currently the C++ branch sets GNUCOBOL and not OPENCOBOL. *That will change soon after this writing.*

There will be OPENCOBOL, GNUCOBOL, GNUCOBCPP (or other C++ tag), soon, as of March 7, 2015.

There are also some testable values for native endian byte order, and character set:

```
>>IF ENDIAN = "BIG"
>>IF ENDIAN = "LITTLE"

>>IF CHARSET = "ASCII"
>>IF CHARSET = "EBCDIC"
>>IF CHARSET = "UNKNOWN"
```

4.9.5 >>ELSE-IF

Allows for multiple conditions in a conditional compile sequence.

4.9.6 >>ELIF

Alias for >>ELSE-IF.

4.9.7 >>ELSE

Compiles in source lines upto an >>END-IF if the previous >>IF or >>ELSE-IF conditions test false.

4.9.8 >>END-IF

Terminates a conditional compile block.

4.9.9 >>LEAP-SECOND

Ignored.

4.9.10 >>SET

Allows modification of compiler source text handling behaviour.

- >>SET CONSTANT
- >>SET SOURCEFORMAT
- >>SET FOLDCOPYNAME | FOLD-COPY-NAME
- >>SET NOFOLDCOPYNAME | NOFOLD-COPY-NAME
- >>SET AS
- >>SET literal
- >>SET {SET_PAREN_LIT}
- >>SET working-store-var

4.9.11 >>SOURCE

GnuCOBOL fully supports FREE and FIXED format source. The compiler defaults FIXED form sources, so this directive is usually placed at column 8 or beyond. The command line arguments **-free** and **-fixed** controls the default for the *first line* of source.

See *What source formats are accepted by GnuCOBOL?* (page 786) for more details.

4.9.12 >>TURN

Will allow modification of exception code handling, when implemented.

4.9.13 Example of compiler directives

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol  *> ************************************************************
       *> Author:    Brian Tiffin
       *> Date:      20131020
       *> License:   Public Domain
       *> Purpose:   Demonstrate GnuCOBOL conditional compile directives
       *> Tectonics: cobc -D PATHONE -x gnucobol-directives.cob
       *>   export GCOB_TESTVAR=42
       *>   cobc -D PATHTWO -x gnucobol-directives.cob
       *> ************************************************************

        >>DEFINE internal-define 7

        identification division.
        program-id. gnucobol-directives.

        data division.
```

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```
       working-storage section.
       01 working-var          pic x(32).

      *> ****************************************************************
       procedure division.

       >>IF PATHONE IS DEFINED
           move "First path conditional compile" to working-var
       >>ELSE
           >>IF PATHTWO IS DEFINED
               >>DEFINE internal-define AS 11 OVERRIDE
               move "Second path conditional compile" to working-var
           >>ELSE
               move "No PATHONE or PATHTWO symbols" to working-var
           >>END-IF
       >>END-IF

       display working-var

      *> Turns out that DEFINE directives don't nest in IF directive
       >>IF internal-define is > 10
           display "Hey, big define there"
       >>ELSE
           display "internal-define 10 or less, it won't be"
       >>END-IF

      *> This is how you pull conditional values from the environment
       >>DEFINE GCOB_TESTVAR PARAMETER
       >>IF GCOB_TESTVAR IS DEFINED
           display "Hey, cool, DEFINE with PARAMETER environment"
       >>END-IF

       >>IF GCOB_TESTVAR is > 10
           display "Nice.  PARAMETER and expressions"
       >>END-IF

       goback.
       end program gnucobol-directives.
```

Testing with:

```
$ unset GCOB_TESTVAR

$ cobc -E -D PATHONE gnucobol-directives.cob
$ cat gnucobol-directives.i | grep -v '^$'
#line 1 "gnucobol-directives.cob"
```

```
identification division.
program-id. gnucobol-directives.
data division.
working-storage section.
01 working-var pic x(32).
procedure division.
move "First path conditional compile" to working-var
display working-var
display "Hey, big define there"
```

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```
goback.
end program gnucobol-directives.
```

```
$ GCOB_TESTVAR=42 cobc -E -D PATHTWO gnucobol-directives.cob
$ cat gnucobol-directives.i | grep -v '^$'
#line 1 "gnucobol-directives.cob"
```

```
identification division.
program-id. gnucobol-directives.
data division.
working-storage section.
01 working-var pic x(32).
procedure division.
move "Second path conditional compile" to working-var
display working-var
display "Hey, big define there"
display "Hey, cool, DEFINE with PARAMETER environment"
display "Nice.  PARAMETER and expressions"
goback.
end program gnucobol-directives.
```

4.10 What are the GnuCOBOL mnemonics?

```
$ cobc --list-mnemonics
```

```
Mnemonic names
SYSIN           Device name
SYSIPT          Device name
STDIN           Device name
SYSOUT          Device name
SYSLIST         Device name
SYSLST          Device name
STDOUT          Device name
PRINTER         Device name
SYSERR          Device name
STDERR          Device name
CONSOLE         Device name
C01             Feature name
C02 .. C12      Feature name
CSP             Feature name
FORMFEED        Feature name
CALL-CONVENTION Feature name
SWITCH-0        Switch name
SWITCH-1 .. 36  Switch name

Extended mnemonic names (with -fsyntax-extension)
SW0             Switch name
SW1 .. SW-36    Switch name
```

Hmm, that doesn't list KEYBOARD or DISPLAY, two handy device names.

4.11 What are the GnuCOBOL DATA DIVISION level numbers?

COBOL is defined with separate DATA and PROCEDURE divisions. This was purposeful in the original design of the language, from the earliest days.

GnuCOBOL supports the full gamut of data grouping allowed by COBOL, and many of the existing extensions that have been developed by various vendors.

Basically, level numbers allow for hierarchical field grouping within records. Some special numbers are reserved for other other purposes.

For historical, and readability reasons, two digits are used when mentioning level numbers throughout this documentation. 01 is 1, GnuCOBOL doesn't really care, but people have gotten used to the leading zero. It's just a thing.

01 is the base level, and all records must start here, *or be non-hierarchical level 77 fields*.

02 through 49 are for sub-groups and hierarchical structuring. Aside from higher values being included in lower numbered groups, a programmer is free to skip level numbers.

```
01 record-def.
   05 sub-group-1.
      10 field-a pic x.
      10 field-b pic x.
   05 sub-group-2.
      10 field-c pic x.
         15 sub-group-3.
            20 field-d pic x.
            20 field-e pic x.
```

is the same structure as

```
01 record-def.
   25 sub-group-1.
      33 field-a pic x.
      33 field-b pic x.
   25 sub-group-2.
      44 field-c pic x.
         45 sub-group-3.
            46 field-d pic x.
            46 field-e pic x.
```

and

```
01 record-def.
   02 sub-group-1.
      03 field-a pic x.
      03 field-b pic x.
   02 sub-group-2.
      03 field-c pic x.
         04 sub-group-3.
            05 field-d pic x.
            05 field-e pic x.
```

Note how, in the second example, 25 contains 33 and the next 25 contains 44. In memory this is still an equivalent layout.

Early COBOL developers found that *wedging* new sub-fields into record layouts was easier when the groups skipped a few numbers, allowing for a 03 and 04 between a 01 and 05, instead of needing to bump all the level numbers up by

one, and risking mistakes. So, it is more common to see 01, 05, 10, 15 or other skipped groupings instead of a strict 01, 02, 03, 04. After a few years of maintenance, you'll probably see 03, 07, 08 (and more) mixed in.

COBOL requires that elementary fields have types and sizes, and groups do not, *but they may have attributes, such as GLOBAL* (page 285), *BASED* (page 212) and *USAGE* (page 427) specifiers. The size of a group is the size of the constituent parts.

4.11.1 Special Data Levels

GnuCOBOL also supports the common COBOL special data level numbers.

- 66 is for renaming fields, groups and sub-groupings. See *RENAMES* (page 367)
- **77 for single entry, not subdivided or part of any subdivision, elementary** data fields.
- **78 for constants, but COBOL 2002 has a new *CONSTANT* (page 235) keyword that may be** preferred to the 78 non standard extension.
- **88 for conditionals, where the values listed do not take up space in** accessible working store, but return true if the previously listed field (at any level number from 01 to 49, or 77) contains any of the values listed.

The 66 level groups allow subdividing working storage record structures.

```
data division.
working-storage section.
01 master.
   05 field-1 pic s9(9).
   05 field-2 pic x(16).
   05 field-3 pic x(4).
   05 field-4 pic s9(9).
66 sixtysix renames field-2.
66 group-66 renames field-2 through field-4.
```

Conditional 88 level fields create data dependent true false user defined words:

```
01 cli-group
   05 cli-text     pic x(16).
      88 helping     values "help", "-help", "-h"
                     when set to false is "rude".
   05 cli-flags    usage binary-long.
```

The `helping` conditional is dependent on the `cli-text` storage field. 88 level tests are "attached" to the preceding field, as positioned in the source code, whatever its level number may be (01-49 or 77). Indentation helps the human reader, but COBOL does not care about indentation, it is strictly by closest previous position in the source file when determining which field an 88 level conditional is dependent on.

Although 88 level conditionals do not take up space in working store, they can be retrieved (at least some of them can) using `SET`.

```
set helping to true
```

That line would set the `cli-text` field, listed above, to `"help"` (sans the quotes), overwriting any previous contents as if a `move` had occurred. The first value in any `values` list is chosen.

Setting `to false` only allows one field (no range is allowed) when defining `when set to false is` in the 88 definition.

In the example above:

```
set helping to false
```

would be the equivalent of

```
move "rude" to cli-text
```

CHAPTER

FIVE

FEATURES AND EXTENSIONS

5.1 How do I use GnuCOBOL for CGI?

GnuCOBOL is more than capable of being a web server backend tool.

- One of the tricks is assigning an input stream to KEYBOARD when you need to get at POST data.
- Another is using the ACCEPT var FROM ENVIRONMENT feature.

Modern day web programming requires security considerations, even for simple samples. Defensive programming is a mainstay of COBOL development, and developers should always keep in mind that the network is an actively hostile environment. In the sample below, all form and environment data is stripped of all less-than, greater-than and ampersand symbols. Ruthless, but much safer.

Full confession, an early binary of this code was publicly hosted for too many years, for people to try; it simply echoes some web form and environment data. It did not have the `inspect converting`, and I have no idea if anyone ever thought of using it to launch cross site scripting attacks. An insecure tiny piece of how-to might well have caused someone else some grief. (I looked, through log archives after realizing, and found no trace of any shenanigans, but still). When it comes to network facing applications:

```
caveat amplificator, *developer beware*
```

Here is gnucobolcgi.cob, a sample of simple GET and POST handling. Far more sophisticated browser friendly applications can be written in GnuCOBOL in surprisingly few lines of source code.

```
GNU    >>SOURCE FORMAT IS FIXED
Cobol *> ************************************************************
CGI   *> Author:    Brian Tiffin, Francois Hiniger
      *> Date:      30-Aug-2008, 02-Oct-2013
      *> License:   Public Domain
      *> Purpose:   Display some GnuCOBOL CGI environment space
      *> Tectonics: cobc -x gnucobolcgi.cob
      *>  Move gnucobolcgi to the cgi-bin directory as gnucobol.cgi
      *>  browse http://localhost/cgi-bin/gnucobol.cgi
      *>      or http://localhost/gnucgiform.html
      *> ************************************************************
       identification division.
       program-id. gnucobolcgi.

       environment division.
       input-output section.
       file-control.
           select webinput assign to KEYBOARD
           file status is in-status.
```

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```
       data division.
       file section.
       fd webinput.
          01 chunk-of-post     pic x(1024).

       working-storage section.
       01 in-status            pic 9999.
       01 newline              pic x     value x'0a'.

       01 name-count           constant  as 25.
       01 name-index           pic 99    usage comp-5.
       01 value-string         pic x(256).
          88 IS-POST                     value 'POST'.
       01 environment-names.
          02 name-strings.
             03 filler         pic x(20) value 'DOCUMENT_ROOT'.
             03 filler         pic x(20) value 'GATEWAY_INTERFACE'.
             03 filler         pic x(20) value 'HTTP_ACCEPT'.
             03 filler         pic x(20) value 'HTTP_ACCEPT_CHARSET'.
             03 filler         pic x(20) value 'HTTP_ACCEPT_ENCODING'.
             03 filler         pic x(20) value 'HTTP_ACCEPT_LANGUAGE'.
             03 filler         pic x(20) value 'HTTP_CONNECTION'.
             03 filler         pic x(20) value 'HTTP_HOST'.
             03 filler         pic x(20) value 'HTTP_USER_AGENT'.
             03 filler         pic x(20) value 'LIB_PATH'.
             03 filler         pic x(20) value 'PATH'.
             03 filler         pic x(20) value 'QUERY_STRING'.
             03 filler         pic x(20) value 'REMOTE_ADDR'.
             03 filler         pic x(20) value 'REMOTE_PORT'.
             03 filler         pic x(20) value 'REQUEST_METHOD'.
             03 filler         pic x(20) value 'REQUEST_URI'.
             03 filler         pic x(20) value 'SCRIPT_FILENAME'.
             03 filler         pic x(20) value 'SCRIPT_NAME'.
             03 filler         pic x(20) value 'SERVER_ADDR'.
             03 filler         pic x(20) value 'SERVER_ADMIN'.
             03 filler         pic x(20) value 'SERVER_NAME'.
             03 filler         pic x(20) value 'SERVER_PORT'.
             03 filler         pic x(20) value 'SERVER_PROTOCOL'.
             03 filler         pic x(20) value 'SERVER_SIGNATURE'.
             03 filler         pic x(20) value 'SERVER_SOFTWARE'.
          02 filler redefines name-strings.
             03 name-string    pic x(20) occurs name-count times.
             88 IS-REQUEST-METHOD        value 'REQUEST_METHOD'.

      *> ****************************************************************
       procedure division.

      *> Always send out the Content-type before any other IO
       display
           "Content-type: text/html"
           newline
       end-display

       display
           "<html><head>"
           "<style>"
```

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```
           "  table"
           "  { background-color:#e0ffff; border-collapse:collapse; }"
           "  table, th, td"
           "  { border: 1px solid black; }"
           "</style>"
           "</head><body>"
           newline
           "<h3>CGI environment with GnuCOBOL</h3>"
           newline "<p>"
           'To <a href="gnucgiform.html">GnuCOBOL CGI form</a>,'
           ' or <a href="gnuajaxform.html">GnuCOBOL AJAX form</a>'
           newline "</p><p>"
           "<i>All values of &lt;, &gt;, and &amp;"
           " replaced by space</i>"
           "</p><p><table>"
       end-display

      *> Display some of the known CGI environment values
       perform varying name-index from 1 by 1
           until name-index > name-count

               accept value-string from environment
                   name-string(name-index)
               end-accept

              *> cleanse any potential danger, thoughtlessly
               inspect value-string converting "<>&" to "   "

               display
                   "<tr><td>"
                   name-string(name-index)
                   ": </td><td>"
                   function trim (value-string trailing)
                   "</td></tr>"
               end-display

               *> Demonstration of POST handling
               if IS-REQUEST-METHOD(name-index) and IS-POST

                      *> open a channel to the POST data, KEYBOARD
                      *> read what's there, in a loop normally
                      *> and close. For real world, this would
                      *> have more intelligent defensive programming
                      *>   and likely fatter buffers

                      open input webinput
                      if in-status < 10 then
                          read webinput end-read
                          if in-status > 9 then
                              move spaces to chunk-of-post
                          end-if
                      end-if
                      close webinput

                      *> cleanse any potential danger, thoughtlessly
                      inspect chunk-of-post converting "<>&" to "   "
```

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```
                    display
                        '<tr><td align="right">'
                        "First chunk of POST: "
                        "</td><td>" chunk-of-post(1:72) "</td></tr>"
                    end-display
                end-if
            end-perform

           *> end the table, and being free software, link to the source
            display
                "</table></p>"
                '<a href="gnucobolcgi.cob">GnuCOBOL CGI Source Code</a>'
                "</body></html>" end-display
            goback.

            end program gnucobolcgi.
```

Once compiled and placed in an appropriate cgi-bin directory of your web server, a simple form can be used to try the example.

cgienvform.html

```
<html><head><title>GnuCOBOL sample CGI form</title></head>
<body>
<h3>GnuCOBOL sample CGI form</h3>
<p>Welcome to <a href="http://savannah.gnu.org/projects/gnucobol">GnuCOBOL</a>, and
a small demonstration of CGI progamming.</p>
<form action="http://opencobol.add1tocobol.com/gnucobolcgi/gnucobol.cgi" method="post
↪">
    <p>
    Text: <input type="text" name="text"><br>
    Pass: <input type="password" name="pass"><br>
    Checkbox: <input type="checkbox" name="checkbox"><br>
    <input type="radio" name="radio" value="ONE"> One<br>
    <input type="radio" name="radio" value="TWO"> Two<br>
    <input type="submit" value="Send"> <input type="reset">
    </p>
</form>
Pressing <b>Send</b> will cause a GnuCOBOL program to run on the server, with
the Common Gateway Interface results displayed in the browser.
</body>
</html>
```

5.1.1 AJAX

From a post on opencobol.org by DamonH:

```
As promised, here is the html for AJAX to use the cgenv.cgi example from the FAQ.
You need not change anything with the cobol code.
```

ajax.html

```
<html>
<head>
<title>Simple AJAX Example with GnuCOBOL</title>
```

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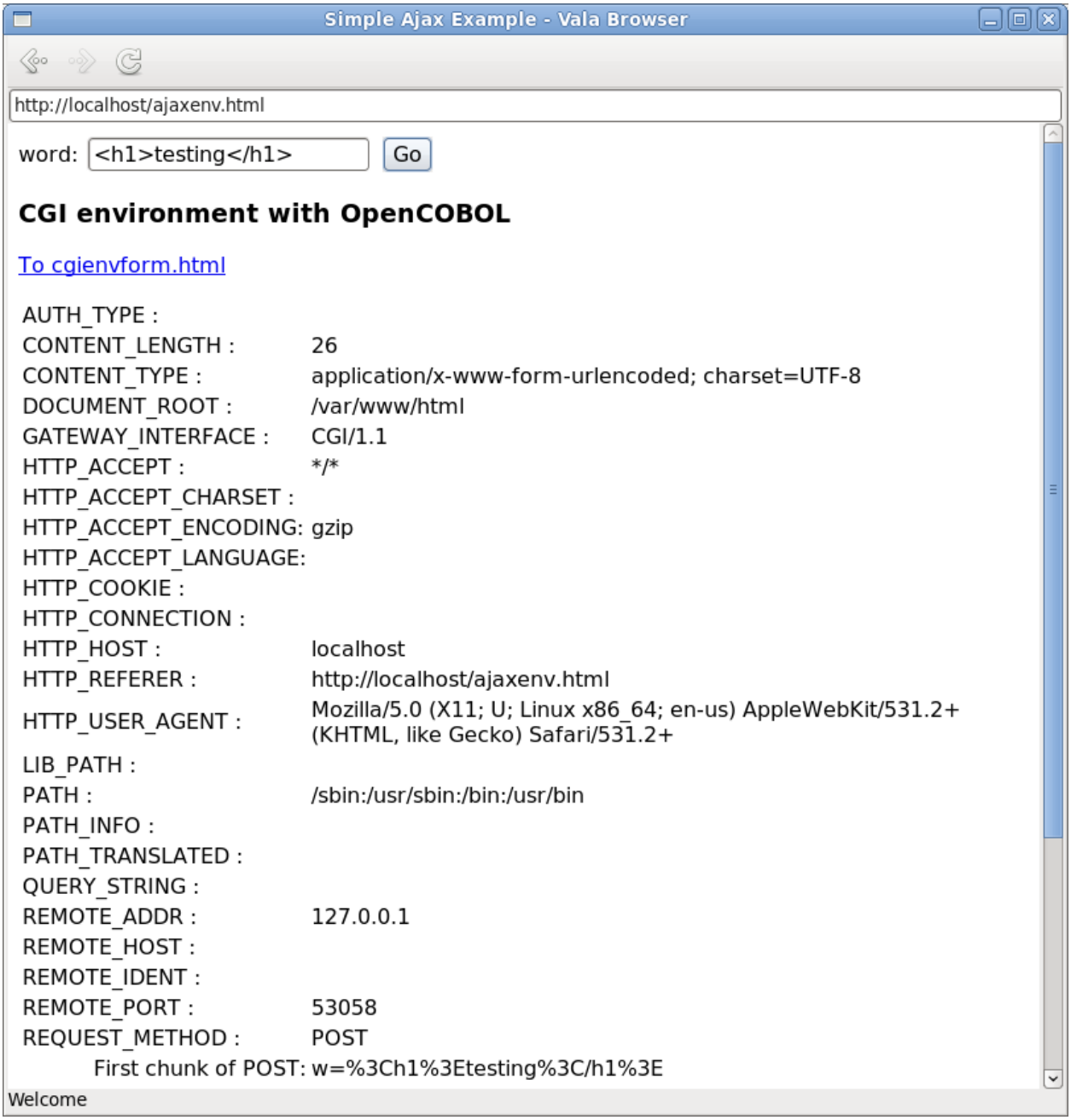
```
<script language="Javascript">
function xmlhttpPost(strURL) {
    var xmlHttpReq = false;
    var self = this;
    // Mozilla/Safari
    if (window.XMLHttpRequest) {
        self.xmlHttpReq = new XMLHttpRequest();
    }
    // IE
    else if (window.ActiveXObject) {
        self.xmlHttpReq = new ActiveXObject("Microsoft.XMLHTTP");
    }
    self.xmlHttpReq.open('POST', strURL, true);
    self.xmlHttpReq.setRequestHeader('Content-Type',
        'application/x-www-form-urlencoded');
    self.xmlHttpReq.onreadystatechange = function() {
        if (self.xmlHttpReq.readyState == 4) {
            updatepage(self.xmlHttpReq.responseText);
        }
    }
    self.xmlHttpReq.send(getquerystring());
}

function getquerystring() {
    var form     = document.forms['f1'];
    var word = form.word.value;
    qstr = 'word=' + escape(word);  // NOTE: no '?' before querystring
    return qstr;
}

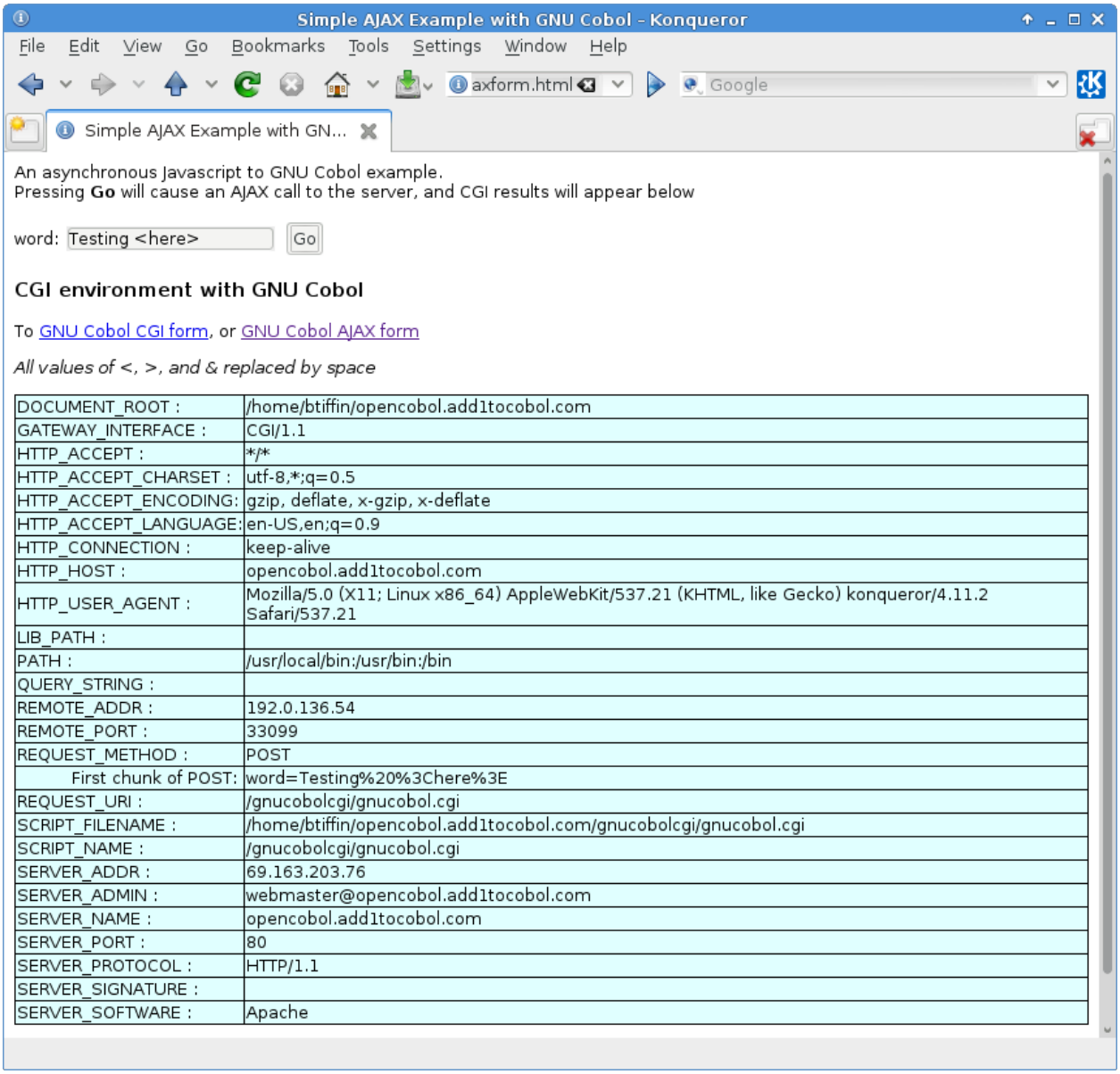
function updatepage(str){
    document.getElementById("result").innerHTML = str;
}
</script>
</head>
<body>
An asynchronous Javascript to GnuCOBOL example.<br>
Pressing <b>Go</b> will cause an AJAX call to the server,
and CGI results will appear below
<form name="f1">
  <p>word: <input name="word" type="text">
  <input value="Go" type="button" onclick='javascript:xmlhttpPost("gnucobol.cgi")'></
↪p>
  <div id="result"></div>
</form>
</body>
</html>
```

An old screenshot from Vala WebKit embedded in OpenCobol sample. *To be clear, this is a screenshot of a COBOL application, that includes an embedded brower, displaying AJAX invoked COBOL CGI binaries; (installed on shared host without superuser access).* Take this one step further, and the browser application could utilize libSOUP and be its own webserver.

Sometimes, just wow. Ok, feel the need for marketing speak. “Moving beyond COBOL? Why? Move COBOL beyond.”



and the current GnuCOBOL copy from the Konqueror web browser.



DOCUMENT_ROOT :	/home/btiffin/opencobol.add1tocobol.com
GATEWAY_INTERFACE :	CGI/1.1
HTTP_ACCEPT :	*/*
HTTP_ACCEPT_CHARSET :	utf-8,*;q=0.5
HTTP_ACCEPT_ENCODING:	gzip, deflate, x-gzip, x-deflate
HTTP_ACCEPT_LANGUAGE:	en-US,en;q=0.9
HTTP_CONNECTION :	keep-alive
HTTP_HOST :	opencobol.add1tocobol.com
HTTP_USER_AGENT :	Mozilla/5.0 (X11; Linux x86_64) AppleWebKit/537.21 (KHTML, like Gecko) konqueror/4.11.2 Safari/537.21
LIB_PATH :	
PATH :	/usr/local/bin:/usr/bin:/bin
QUERY_STRING :	
REMOTE_ADDR :	192.0.136.54
REMOTE_PORT :	33099
REQUEST_METHOD :	POST
First chunk of POST:	word=Testing%20%3Chere%3E
REQUEST_URI :	/gnucobolcgi/gnucobol.cgi
SCRIPT_FILENAME :	/home/btiffin/opencobol.add1tocobol.com/gnucobolcgi/gnucobol.cgi
SCRIPT_NAME :	/gnucobolcgi/gnucobol.cgi
SERVER_ADDR :	69.163.203.76
SERVER_ADMIN :	webmaster@opencobol.add1tocobol.com
SERVER_NAME :	opencobol.add1tocobol.com
SERVER_PORT :	80
SERVER_PROTOCOL :	HTTP/1.1
SERVER_SIGNATURE :	
SERVER_SOFTWARE :	Apache

For those developers looking to serve GnuCOBOL applications on hosted systems and no super user privileges, see *How do I use LD_RUN_PATH with GnuCOBOL?* (page 135) for some pointers on local library linkage.

5.1.2 jQuery

Umm, this gets a LOT easier to read with jQuery. The above AJAX listing is reduced to:

The HTML part

```
<script type="text/javascript" src="/js/jquery.js"></script>
```

And the AJAX with jQuery

```
$.ajax({
    url: "/gnucobol-cobweb/gnucobol-sample/default.cgi",
```

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```
        data: {
            report: "RWEX06"
        },
    success: function( data ) {
        $( "#gnucobol-sample" ).html( "<pre>" + data + "</pre>" );
    }
});
```

which would fill an element on a web page, tagged `gnucobol-sample` with the output of Jay Moseley's Report Writer tutorial sample 6, all nicely wrapped in a pre block. Later triggers can refill the named div (or other element) with more exciting blocks of ancient COBOL lore. *Valuable lore, lifted to the web in a few lines of script and some recompiles.*

5.1.3 CGIFORM

And now, for a larger scale full application that demontrates handling form fields, URI percent decoding, and mulitpart File Upload capabilities. This is a much longer listing than normally included in the FAQ, but is much more comprehensive, and more pratical for any developers looking to include server side GnuCOBOL handling in their application suites.

Jump to *What is ocdoc?* (page 588) to skip past these listings, if you are simply scrolling down through the document at this time.

All this code goodness is a Contributions entry along with the GnuCOBOL project, get it with

```
svn checkout svn://svn.code.sf.net/p/gnucobol/contrib/ gnucobol-contrib
cd gnucobol-contrib/trunk/samples/cgiform
```

First up, László's readme file and some hints on customization.

```
CGI form and file upload example.

The program usage is described in the program header.

Files:

cgiform.cob            - CGI COBOL program
cgiform.html           - demo HTML form
cygwin_apache_start.sh - start apache under cygwin
cygwin_apache_stop.sh  - stop apache under cygwin
makefile               - compile the CGI COBOL program under cygwin
readme.txt             - this file

The CGI Program was tested in these environment:
- 64 bit windows, 64 bit cygwin, GnuCOBOL 2.0,
  apache web server under cygwin,
  Firefox 39.0.3.
```

and from a post on SourceForge

```
This parses automatically GET, POST and POST with file upload requests. The
parsed information (field names, values, length) will be saved in an internal
table. After it you can get the values with the function COB2CGI-POST:

MOVE COB2CGI-POST(FIRSTNAME) TO FNAME
```

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```
It's very easy to extend or change this program. Please search for these lines:

* begin user defined content *
* end user defined content *

Between these lines you can define your variables in WORKING-STORAGE section,
or you can write your HTML reply in COB2CGI-MAIN section, or you can write your
own sections.
```

And now the HTML control form:

```
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01 Transitional//EN"
       "http://www.w3.org/TR/html4/loose.dtd">
<html>
<head>
<title>CGI form test with post</title>
<meta http-equiv="content-type" content="text/html;charset=utf-8" />
<meta http-equiv="Content-Style-Type" content="text/css" />
</head>
<body>

<h2>CGI form test with post</h2>
<p>
<form action="/cgi-bin/cgiform" method="post" accept-charset="UTF-8">
  <table border="0" cellpadding="0" cellspacing="4">
    <tr>
      <td align="right">First name:</td>
      <td><input name="firstname" type="text" size="30" maxlength="30"></td>
    </tr>
    <tr>
      <td align="right">Last name:</td>
      <td><input name="lastname" type="text" size="30" maxlength="30"></textarea></td>
    </tr>
  </table>
  <br>
  <input type="submit" value="Send"> <input type="reset">
</form>
</p>

<h2>CGI file upload test</h2>

File upload uses enctype="multipart/form-data".
<br><br>

<p>
<form action="/cgi-bin/cgiform" method="post" accept-charset="UTF-8"
     enctype="multipart/form-data">

  <table border="0" cellpadding="0" cellspacing="4">
    <tr>
      <td align="right">First name:</td>
      <td><input name="firstname" type="text" size="30" maxlength="30"></td>
    </tr>
    <tr>
      <td align="right">Last name:</td>
      <td><input name="lastname" type="text" size="30" maxlength="30"></textarea></td>
```

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```
    </tr>
    <tr>
      <td align="right">upload1:</td>
      <td><input type="file" name="upload1" /></td>
    </tr>
  </table>

<br>
<input type="submit" value="Upload form data" />

</form>
</p>

</body>
</html>
```

The main server side GnuCOBOL code, **cgiform.cob**:

(This is a lot of code, skip past by clicking *What is ocdoc?* (page 588) if you aren't looking for GnuCOBOL CGI assistance at this time).

```
*>*****************************************************************************
*>  cgiform is free software: you can redistribute it and/or modify it
*>  under the terms of the GNU General Public License as published by the Free
*>  Software Foundation, either version 3 of the License, or (at your option)
*>  any later version.
*>
*>  cgiform is distributed in the hope that it will be useful, but
*>  WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY
*>  or FITNESS FOR A PARTICULAR PURPOSE.
*>  See the GNU General Public License for more details.
*>
*>  You should have received a copy of the GNU General Public License along
*>  with cgiform.
*>  If not, see <http://www.gnu.org/licenses/>.
*>*****************************************************************************

*>*****************************************************************************
*> Program:      cgiform.cob
*>
*> Purpose:      CGI form and file upload example
*>
*> Author:       Laszlo Erdos - https://www.facebook.com/wortfee
*>
*> Date-Written: 2015.08.21
*>
*> Tectonics:    cobc -x -free cgiform.cob
*>
*>               Compile for Windows with this define "OS=WINDOWS"
*>               (GnuCOBOL with MS Visual Studio):
*>
*>               cobc -x -free cgiform.cob -D OS=WINDOWS
*>
*> Usage:        Compile this program and copy the runnable code to your web
*>               servers cgi-bin directory. Create a HTML file, and copy it in
*>               the htdocs directory. If you want to upload a file, you
*>               have to use enctype="multipart/form-data" in your HTML form.
```

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```
*>
*>               This program processes every field in a HTML form, not only
*>               input type="file". The processed data will be written in an
*>               internal table: COB2CGI-TABLE. The field values will be saved
*>               in COB2CGI-DATA-VALUE variable. After the parsing you can get
*>               all values with the COB2CGI-POST function.
*>
*>               The uploaded files will be created in your cgi-bin directory.
*>               You can simply change this if you add a file path to the file
*>               at the function "CBL_CREATE_FILE".
*>
*>               The file type and content will be checked. For this demo
*>               only images (BMP, GIF, JPG, PNG, TIFF) are allowed. See the
*>               definition COB2CGI-CHECK-FILE-TYPE and the section
*>               COB2CGI-CHECK-FILE-DATA.
*>
*>               It's very easy to extend or change this program. Please search
*>               for these lines:
*>               ********* begin user defined content *********
*>               ********* end user defined content   *********
*>               Between these lines you can define your variables in
*>               WORKING-STORAGE section, or you can write your HTML reply in
*>               COB2CGI-MAIN section, or you can write your own section.
*>
*>*****************************************************************************
*> Date       Change description
*> ========== ================================================================
*> 2015.08.21 First version.
*>
*>*****************************************************************************

 IDENTIFICATION DIVISION.
 PROGRAM-ID. cgiform.

 ENVIRONMENT DIVISION.
 CONFIGURATION SECTION.
 REPOSITORY.
    FUNCTION COB2CGI-POST
    FUNCTION COB2CGI-DECODE
    FUNCTION COB2CGI-ENV
    FUNCTION COB2CGI-NUM2HEX
    FUNCTION ALL INTRINSIC.

 DATA DIVISION.

 WORKING-STORAGE SECTION.
*> end of line char
 78 COB2CGI-LF                          VALUE X"0A".
 78 COB2CGI-CRLF                        VALUE X"0D0A".

*> flags
 01 COB2CGI-ERROR-FLAG                  PIC 9.
    88 V-COB2CGI-ERROR-NO               VALUE 0.
    88 V-COB2CGI-ERROR-YES              VALUE 1.
 01 COB2CGI-REQUEST-METHOD-FLAG         PIC 9.
    88 V-COB2CGI-REQUEST-METHOD-GET     VALUE 0.
    88 V-COB2CGI-REQUEST-METHOD-POST    VALUE 1.
```

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```
 01 COB2CGI-MULTIPART-FLAG             PIC 9.
    88 V-COB2CGI-MULTIPART-NO          VALUE 0.
    88 V-COB2CGI-MULTIPART-YES         VALUE 1.
 01 COB2CGI-POST-FIELD-VALUE-FLAG      PIC 9.
    88 V-COB2CGI-POST-FIELD            VALUE 0.
    88 V-COB2CGI-POST-VALUE            VALUE 1.
 01 COB2CGI-EOF-FLAG                   PIC 9.
    88 V-COB2CGI-EOF-NO                VALUE 0.
    88 V-COB2CGI-EOF-YES               VALUE 1.

*> for environment variables
 01 COB2CGI-ENV-VALUE                  PIC X(256).

*> for GET data in query string
 78 COB2CGI-QUERY-STR-MAX-LEN          VALUE 65536.
 01 COB2CGI-QUERY-STR                  PIC X(COB2CGI-QUERY-STR-MAX-LEN)
                                            VALUE LOW-VALUE.
 01 COB2CGI-QUERY-STR-LEN              PIC 9(9) COMP.
 01 COB2CGI-QUERY-STR-IND              PIC 9(9) COMP.

*> for POST data together with UPLOAD file
 78 COB2CGI-CONTENT-MAX-LEN            VALUE 1000000.
 01 COB2CGI-CONTENT-LEN                PIC 9(9) COMP.

*> counts all received chars
 01 COB2CGI-CHAR-COUNT                 PIC S9(9) COMP.

*> for the C function getchar()
 01 COB2CGI-GETCHAR                    BINARY-INT.

*> !!!this is only for windows, GnuCOBOL with MS Visual Studio!!!
*> we have to switch stdin in binary mode
>>IF OS = "WINDOWS"
 01 COB2CGI-RET                        BINARY-INT.
*> file mode is binary (untranslated) x"8000"
 01 COB2CGI-MODE-BINARY                BINARY-INT VALUE 32768.
>>END-IF

*> character conversion
 01 COB2CGI-CHAR                       PIC X(1).
 01 COB2CGI-CHAR-R REDEFINES COB2CGI-CHAR PIC S9(2) COMP-5.

 01 COB2CGI-UTF8-STR                   PIC X(3).

*> max field length in the table
 78 COB2CGI-TAB-FIELD-MAX-LEN          VALUE 40.
*> max number of lines in the table
 78 COB2CGI-TAB-MAX-LINE               VALUE 1000.
 01 COB2CGI-TAB-IND                    PIC 9(9) COMP.
*> saved number of lines in the table
 01 COB2CGI-TAB-NR                     EXTERNAL PIC 9(9) COMP.
*> length of one COB2CGI-TAB-LINE = 161,
*> therefore the size of table = 161 * COB2CGI-TAB-MAX-LINE
 01 COB2CGI-TABLE-R                    EXTERNAL PIC X(161000).
 01 COB2CGI-TABLE REDEFINES COB2CGI-TABLE-R.
   02 COB2CGI-TAB.
     03 COB2CGI-TAB-LINE              OCCURS 1 TO COB2CGI-TAB-MAX-LINE TIMES.
```

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```
       *> there are only the name of fields in the internal table,
       *> all values will be saved in the field COB2CGI-DATA-VALUE
       04 COB2CGI-TAB-FIELD            PIC X(40).
       04 COB2CGI-TAB-FIELD-LEN        PIC 9(9) COMP.
       04 COB2CGI-TAB-VALUE-PTR        PIC 9(9) COMP.
       04 COB2CGI-TAB-VALUE-LEN        PIC 9(9) COMP.
       04 COB2CGI-TAB-FILE-FLAG        PIC 9.
          88 V-COB2CGI-TAB-FILE-NO     VALUE 0.
          88 V-COB2CGI-TAB-FILE-YES    VALUE 1.
       04 COB2CGI-TAB-FILE-NAME        PIC X(60).
       04 COB2CGI-TAB-FILE-NAME-LEN    PIC 9(9) COMP.
       04 COB2CGI-TAB-FILE-TYPE        PIC X(40).
       04 COB2CGI-TAB-FILE-DATA-LEN    PIC 9(9) COMP.

*> max value length
 78 COB2CGI-DATA-VALUE-MAX-LEN         VALUE 500000.
*> we can save memory, if we use one field for all values
 01 COB2CGI-DATA-VALUE        EXTERNAL PIC X(COB2CGI-DATA-VALUE-MAX-LEN).

*> indices for cycles
 01 COB2CGI-IND-1                      PIC 9(9) COMP.
 01 COB2CGI-IND-2                      PIC 9(9) COMP.

*> for POST UPLOAD processing ------------------------------------------------

*> flags
 01 COB2CGI-EOL-FLAG                   PIC 9.
    88 V-COB2CGI-EOL-NO                VALUE 0.
    88 V-COB2CGI-EOL-YES               VALUE 1.
 01 COB2CGI-BOUNDARY-FLAG              PIC 9.
    88 V-COB2CGI-BOUNDARY-NO           VALUE 0.
    88 V-COB2CGI-BOUNDARY-YES          VALUE 1.
 01 COB2CGI-BOUNDARY-EOF-FLAG          PIC 9.
    88 V-COB2CGI-BOUNDARY-EOF-NO       VALUE 0.
    88 V-COB2CGI-BOUNDARY-EOF-YES      VALUE 1.
 01 COB2CGI-CONTENT-DISP-FLAG          PIC 9.
    88 V-COB2CGI-CONTENT-DISP-ERROR    VALUE 0.
    88 V-COB2CGI-CONTENT-DISP-FIELD    VALUE 1.
    88 V-COB2CGI-CONTENT-DISP-FILE     VALUE 2.
 01 COB2CGI-FIRST-LINE-FLAG            PIC 9.
    88 V-COB2CGI-FIRST-LINE-NO         VALUE 0.
    88 V-COB2CGI-FIRST-LINE-YES        VALUE 1.

*> boundary string in CONTENT_TYPE
*> example: "---------------------------5276231769132"
*> this boundary string splits the form fields and uploaded files
 01 COB2CGI-BOUNDARY                   PIC X(256).
 01 COB2CGI-BOUNDARY-LEN               PIC S9(9) COMP.
*> boundary string plus "--", this is the last boundary string
*> example: "---------------------------5276231769132--"
 01 COB2CGI-BOUNDARY-EOF               PIC X(256).

*> input buffer
 78 COB2CGI-INPUT-BUF-MAX-LEN          VALUE 1024.
 01 COB2CGI-INPUT-BUF                  PIC X(COB2CGI-INPUT-BUF-MAX-LEN).
 01 COB2CGI-INPUT-BUF-IND              PIC S9(09) COMP.
 01 COB2CGI-INPUT-BUF-SAVE             PIC X(COB2CGI-INPUT-BUF-MAX-LEN).
```

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```
 01 COB2CGI-INPUT-BUF-SAVE-IND         PIC S9(09) COMP.

*> counter for COBOL inspect
 01 COB2CGI-INSPECT-COUNT              PIC S9(09) COMP.

*> max. uploaded file size
 78 COB2CGI-UPLOAD-FILE-MAX-SIZE      VALUE 300000.

*> check uploaded file type
 01 COB2CGI-CHECK-FILE-TYPE           PIC X(40).
    88 V-COB2CGI-FILE-TYPE-TXT         VALUE "text/plain".
    *> application
    88 V-COB2CGI-FILE-TYPE-EXE         VALUE "application/octet-stream".
    88 V-COB2CGI-FILE-TYPE-PDF         VALUE "application/pdf".
    88 V-COB2CGI-FILE-TYPE-ZIP         VALUE "application/zip".
    *> image
    88 V-COB2CGI-FILE-TYPE-BMP         VALUE "image/bmp".
    88 V-COB2CGI-FILE-TYPE-GIF         VALUE "image/gif".
    88 V-COB2CGI-FILE-TYPE-JPG         VALUE "image/jpeg".
    88 V-COB2CGI-FILE-TYPE-PNG         VALUE "image/png".
    88 V-COB2CGI-FILE-TYPE-TIF         VALUE "image/tiff".
    *> only images allowed
    88 V-COB2CGI-FILE-TYPE-ALLOWED     VALUE "image/bmp",  "image/gif"
                                             "image/jpeg", "image/png"
                                             "image/tiff".

*> temp file name
 01 COB2CGI-TMP-FILE-NAME              PIC X(COB2CGI-INPUT-BUF-MAX-LEN).
 01 COB2CGI-TMP-FILE-NAME-LEN          PIC 9(9) COMP.
 01 COB2CGI-TMP-FILE-PATH-LEN          PIC 9(9) COMP.

*> create and write the uploaded file
 01 COB2CGI-FILE-HANDLE                PIC X(4) USAGE COMP-X.
 01 COB2CGI-FILE-OFFSET                PIC X(8) USAGE COMP-X.
 01 COB2CGI-FILE-NBYTES                PIC X(4) USAGE COMP-X.
 01 COB2CGI-FILE-BUF                   PIC X(COB2CGI-INPUT-BUF-MAX-LEN).

*> ********* begin user defined content *********

 01 FIRSTNAME                 PIC X(40) VALUE "firstname".
 01 LASTNAME                  PIC X(40) VALUE "lastname".

 01 FNAME.
   02 LEN                    PIC 9(9) COMP.
   02 VAL                    PIC X(100).
 01 LNAME.
   02 LEN                    PIC 9(9) COMP.
   02 VAL                    PIC X(100).

*> ********* end user defined content   *********

 PROCEDURE DIVISION.

*>------------------------------------------------------------------------------
 COB2CGI-MAIN SECTION.
*>------------------------------------------------------------------------------
```

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```
    *> Always send out the Content-type before any other IO
    DISPLAY "Content-Type: text/html; charset=utf-8"
            COB2CGI-LF
    END-DISPLAY

*>  Test cookie
*>  DISPLAY
*>     "Content-Type: text/html; charset=utf-8"
*>     "Set-Cookie: testcookie=first"
*>     "Set-Cookie: sessionToken=abc123; Expires=Wed, 19 Jun 2015 10:18:14 GMT"
*>     COB2CGI-LF
*>  END-DISPLAY

    PERFORM COB2CGI-PROCESS-DATA
    IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
    THEN
       GOBACK
    END-IF

*> ********* begin user defined content *********

    DISPLAY "<!DOCTYPE HTML PUBLIC ""-//W3C//DTD HTML 4.01 Transitional//EN""" END-
↪DISPLAY
    DISPLAY "       ""http://www.w3.org/TR/html4/loose.dtd"">" END-DISPLAY
    DISPLAY "<html>" END-DISPLAY
    DISPLAY "<head>" END-DISPLAY
    DISPLAY "<title>Hello GnuCOBOL world!</title>" END-DISPLAY
    DISPLAY "<meta http-equiv=""content-type"" content=""text/html;charset=utf-8"" />
↪" END-DISPLAY
    DISPLAY "<meta http-equiv=""Content-Style-Type"" content=""text/css"" />" END-
↪DISPLAY
    DISPLAY "</head>" END-DISPLAY
    DISPLAY "<body>" END-DISPLAY

    MOVE COB2CGI-POST(FIRSTNAME) TO FNAME
    MOVE COB2CGI-POST(LASTNAME)  TO LNAME

    DISPLAY "<br><br>" END-DISPLAY
    DISPLAY "Hello GnuCOBOL world!" END-DISPLAY

    DISPLAY "<p>" END-DISPLAY
    DISPLAY "First name: " END-DISPLAY

    DISPLAY VAL OF FNAME(1:LEN OF FNAME) END-DISPLAY

    DISPLAY "<br>" END-DISPLAY
    DISPLAY "Last name : " END-DISPLAY

    DISPLAY VAL OF LNAME(1:LEN OF LNAME) END-DISPLAY

    DISPLAY "<br>" END-DISPLAY
    DISPLAY "</p>" END-DISPLAY
    DISPLAY "</body>" END-DISPLAY
    DISPLAY "</html>" END-DISPLAY

*> ********* end user defined content   *********
```

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```
    GOBACK

    .
 COB2CGI-MAIN-EX.
    EXIT.

*> ********* begin user defined content *********

*> here you can write your own sections

*> ********* end user defined content   *********

*>-----------------------------------------------------------------------------
 COB2CGI-PROCESS-DATA SECTION.
*>-----------------------------------------------------------------------------

    SET V-COB2CGI-ERROR-NO OF COB2CGI-ERROR-FLAG TO TRUE

*> !!!this is only for windows, GnuCOBOL with MS Visual Studio!!!
*> we have to switch stdin in binary mode
>>IF OS = "WINDOWS"
    PERFORM COB2CGI-SET-BINARY-MODE
    IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
    THEN
       DISPLAY "<BR>Error in SET-BINARY-MODE <BR>" END-DISPLAY
       EXIT SECTION
    END-IF
>>END-IF

    *> check REQUEST_METHOD
    MOVE COB2CGI-ENV("REQUEST_METHOD")
      TO COB2CGI-ENV-VALUE

    IF  COB2CGI-ENV-VALUE NOT = "GET"
    AND COB2CGI-ENV-VALUE NOT = "POST"
    THEN
       DISPLAY "<BR>Error: wrong REQUEST_METHOD: " COB2CGI-ENV-VALUE " <BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       EXIT SECTION
    END-IF

    IF COB2CGI-ENV-VALUE = "GET"
    THEN
       SET V-COB2CGI-REQUEST-METHOD-GET  OF COB2CGI-REQUEST-METHOD-FLAG TO TRUE
       PERFORM COB2CGI-PROCESS-GET
       IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
       THEN
          DISPLAY "<BR>Error in PROCESS-GET <BR>" END-DISPLAY
          EXIT SECTION
       END-IF
    ELSE
       SET V-COB2CGI-REQUEST-METHOD-POST OF COB2CGI-REQUEST-METHOD-FLAG TO TRUE
       PERFORM COB2CGI-PROCESS-POST
       IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
       THEN
          DISPLAY "<BR>Error in PROCESS-POST <BR>" END-DISPLAY
```

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```
           EXIT SECTION
        END-IF
     END-IF

     .
 COB2CGI-PROCESS-DATA-EX.
     EXIT.

*> !!!this is only for windows, GnuCOBOL with MS Visual Studio!!!
*> we have to switch stdin in binary mode
>>IF OS = "WINDOWS"
*>-----------------------------------------------------------------------------
 COB2CGI-SET-BINARY-MODE SECTION.
*>-----------------------------------------------------------------------------

     CALL STATIC "_setmode"
          USING BY VALUE 0
                BY VALUE COB2CGI-MODE-BINARY
          RETURNING COB2CGI-RET
     END-CALL

     *> if cannot set binary mode, then result = -1
     IF COB2CGI-RET = -1
     THEN
        SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
        DISPLAY "Error: cannot set binary mode"
                "<BR>"
        END-DISPLAY
     END-IF

     .
 COB2CGI-SET-BINARY-MODE-EX.
     EXIT.
>>END-IF

*>-----------------------------------------------------------------------------
 COB2CGI-PROCESS-GET SECTION.
*>-----------------------------------------------------------------------------

     *> QUERY_STRING is the URL-encoded information
     *> that is sent with GET method request.
     MOVE COB2CGI-ENV("QUERY_STRING")
       TO COB2CGI-QUERY-STR
     MOVE FUNCTION STORED-CHAR-LENGTH(COB2CGI-ENV("QUERY_STRING"))
       TO COB2CGI-QUERY-STR-LEN

     *> no data
     IF COB2CGI-QUERY-STR-LEN = ZEROES
     THEN
        EXIT SECTION
     END-IF

     *> check QUERY_STRING data length
     IF COB2CGI-QUERY-STR-LEN > COB2CGI-QUERY-STR-MAX-LEN
     THEN
        DISPLAY "<BR>Error: QUERY_STRING length " COB2CGI-QUERY-STR-LEN
                " greater than " COB2CGI-QUERY-STR-MAX-LEN " max. length <BR>"
```

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```
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       EXIT SECTION
    END-IF

    *> parse GET data
    PERFORM COB2CGI-PARSE-GET-POST
    IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
    THEN
       DISPLAY "<BR>Error in PARSE-GET-POST <BR>" END-DISPLAY
       EXIT SECTION
    END-IF

    .
 COB2CGI-PROCESS-GET-EX.
    EXIT.

*>-------------------------------------------------------------------------------
 COB2CGI-PROCESS-POST SECTION.
*>-------------------------------------------------------------------------------

    *> check CONTENT_LENGTH
    MOVE COB2CGI-ENV("CONTENT_LENGTH")
      TO COB2CGI-ENV-VALUE

    MOVE NUMVAL(COB2CGI-ENV-VALUE)
      TO COB2CGI-CONTENT-LEN

    IF COB2CGI-CONTENT-LEN > COB2CGI-CONTENT-MAX-LEN
    THEN
       DISPLAY "<BR>Error: CONTENT_LENGTH " COB2CGI-CONTENT-LEN
               " greater than " COB2CGI-CONTENT-MAX-LEN " max. length <BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       EXIT SECTION
    END-IF

    *> no data
    IF COB2CGI-CONTENT-LEN = ZEROES
    THEN
       EXIT SECTION
    END-IF

    *> check CONTENT_TYPE
    MOVE COB2CGI-ENV("CONTENT_TYPE")
      TO COB2CGI-ENV-VALUE

    EVALUATE TRUE
       *> this is only a POST
       WHEN COB2CGI-ENV-VALUE(1:33) = "application/x-www-form-urlencoded"
          SET V-COB2CGI-MULTIPART-NO OF COB2CGI-MULTIPART-FLAG TO TRUE

          *> parse POST data
          PERFORM COB2CGI-PARSE-GET-POST
          IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
          THEN
             DISPLAY "<BR>Error in PARSE-GET-POST <BR>" END-DISPLAY
```

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```
            EXIT SECTION
         END-IF

      *> this is a POST with file UPLOAD
      WHEN COB2CGI-ENV-VALUE(1:29) = "multipart/form-data; boundary"
         SET V-COB2CGI-MULTIPART-YES OF COB2CGI-MULTIPART-FLAG TO TRUE
         *> parse multipart POST data, save UPLOAD
         PERFORM COB2CGI-PARSE-UPLOAD
         IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
         THEN
            DISPLAY "<BR>Error in PARSE-UPLOAD <BR>" END-DISPLAY
            EXIT SECTION
         END-IF

      WHEN OTHER
         DISPLAY "<BR>Error: wrong CONTENT_TYPE: " COB2CGI-ENV-VALUE "<BR>"
         END-DISPLAY
         SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
         EXIT SECTION
   END-EVALUATE

   .
COB2CGI-PROCESS-POST-EX.
   EXIT.

*>-----------------------------------------------------------------------------
 COB2CGI-PARSE-GET-POST SECTION.
*>-----------------------------------------------------------------------------

   MOVE ZEROES TO COB2CGI-QUERY-STR-IND
   MOVE ZEROES TO COB2CGI-CHAR-COUNT
   MOVE ZEROES TO COB2CGI-GETCHAR
   SET V-COB2CGI-EOF-NO OF COB2CGI-EOF-FLAG TO TRUE

   *> field name comes first
   SET V-COB2CGI-POST-FIELD OF COB2CGI-POST-FIELD-VALUE-FLAG TO TRUE
   MOVE 1 TO COB2CGI-TAB-IND
   MOVE 1 TO COB2CGI-TAB-NR
   INITIALIZE COB2CGI-TAB-LINE(COB2CGI-TAB-IND)
   MOVE 1 TO COB2CGI-IND-1
   MOVE 1 TO COB2CGI-IND-2

   PERFORM UNTIL V-COB2CGI-EOF-YES   OF COB2CGI-EOF-FLAG
           OR    V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
      *> read next char from CGI input stream
      PERFORM COB2CGI-READ-NEXT-CHAR
      IF V-COB2CGI-EOF-YES OF COB2CGI-EOF-FLAG
      THEN
         EXIT PERFORM
      END-IF

      EVALUATE TRUE
         *> end of field name
         WHEN COB2CGI-CHAR = "="
            SET V-COB2CGI-POST-VALUE OF COB2CGI-POST-FIELD-VALUE-FLAG TO TRUE
            COMPUTE COB2CGI-TAB-FIELD-LEN(COB2CGI-TAB-IND)
                  = COB2CGI-IND-1 - 1
```

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```
               END-COMPUTE
               MOVE 1 TO COB2CGI-IND-1
               MOVE COB2CGI-IND-2
                 TO COB2CGI-TAB-VALUE-PTR(COB2CGI-TAB-IND)

            *> end of value, start a field name
            WHEN COB2CGI-CHAR = "&"
               SET V-COB2CGI-POST-FIELD OF COB2CGI-POST-FIELD-VALUE-FLAG TO TRUE
               IF COB2CGI-TAB-IND = 1
               THEN
                  COMPUTE COB2CGI-TAB-VALUE-LEN(COB2CGI-TAB-IND)
                        = COB2CGI-IND-2 - 1
                  END-COMPUTE
               ELSE
                  COMPUTE COB2CGI-TAB-VALUE-LEN(COB2CGI-TAB-IND)
                        = COB2CGI-IND-2 - COB2CGI-TAB-VALUE-PTR(COB2CGI-TAB-IND)
                  END-COMPUTE
               END-IF

               ADD 1 TO COB2CGI-TAB-IND
               ADD 1 TO COB2CGI-TAB-NR

               *> check table limit
               IF COB2CGI-TAB-IND > COB2CGI-TAB-MAX-LINE
               OR COB2CGI-TAB-NR  > COB2CGI-TAB-MAX-LINE
               THEN
                  DISPLAY "<BR>Error: DATA-TAB-NR " COB2CGI-TAB-NR
                          " greater than " COB2CGI-TAB-MAX-LINE
                          " DATA-TAB-MAX-LINE <BR>"
                  END-DISPLAY
                  SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
                  EXIT SECTION
               END-IF
               *> init next line in the table
               INITIALIZE COB2CGI-TAB-LINE(COB2CGI-TAB-IND)

            *> UTF8 special char in hexa code
            WHEN COB2CGI-CHAR = "%"
               MOVE COB2CGI-CHAR TO COB2CGI-UTF8-STR(1:1)
               *> read next char from CGI input stream
               PERFORM COB2CGI-READ-NEXT-CHAR
               IF V-COB2CGI-EOF-YES OF COB2CGI-EOF-FLAG
               THEN
                  EXIT PERFORM
               END-IF
               MOVE COB2CGI-CHAR TO COB2CGI-UTF8-STR(2:1)

               *> read next char from CGI input stream
               PERFORM COB2CGI-READ-NEXT-CHAR
               IF V-COB2CGI-EOF-YES OF COB2CGI-EOF-FLAG
               THEN
                  EXIT PERFORM
               END-IF
               MOVE COB2CGI-CHAR TO COB2CGI-UTF8-STR(3:1)

               *> convert UTF8 string
               MOVE COB2CGI-DECODE(COB2CGI-UTF8-STR)
```

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```
              TO COB2CGI-DATA-VALUE(COB2CGI-IND-2:1)

           *> check value limit
           ADD 1 TO COB2CGI-IND-2
           IF COB2CGI-IND-2 > COB2CGI-DATA-VALUE-MAX-LEN
           THEN
              DISPLAY "<BR>Error: DATA-VALUE-LEN " COB2CGI-IND-2
                      " greater than " COB2CGI-DATA-VALUE-MAX-LEN
                      " DATA-VALUE-MAX-LEN <BR>"
              END-DISPLAY
              SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
              EXIT SECTION
           END-IF

        *> a SPACE char
        WHEN COB2CGI-CHAR = "+"
           MOVE SPACES
             TO COB2CGI-DATA-VALUE(COB2CGI-IND-2:1)

           *> check value limit
           ADD 1 TO COB2CGI-IND-2
           IF COB2CGI-IND-2 > COB2CGI-DATA-VALUE-MAX-LEN
           THEN
              DISPLAY "<BR>Error: DATA-VALUE-LEN " COB2CGI-IND-2
                      " greater than " COB2CGI-DATA-VALUE-MAX-LEN
                      " DATA-VALUE-MAX-LEN <BR>"
              END-DISPLAY
              SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
              EXIT SECTION
           END-IF

        *> other chars
        WHEN OTHER
           IF V-COB2CGI-POST-FIELD OF COB2CGI-POST-FIELD-VALUE-FLAG
           THEN
              MOVE COB2CGI-CHAR
                TO COB2CGI-TAB-FIELD(COB2CGI-TAB-IND)
                                     (COB2CGI-IND-1:1)

              *> check field limit
              ADD 1 TO COB2CGI-IND-1
              IF COB2CGI-IND-1 > COB2CGI-TAB-FIELD-MAX-LEN
              THEN
                 DISPLAY "<BR>Error: FIELD-LEN " COB2CGI-IND-1
                         " greater than " COB2CGI-TAB-FIELD-MAX-LEN
                         " DATA-TAB-FIELD-MAX-LEN <BR>"
                 END-DISPLAY
                 SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
                 EXIT SECTION
              END-IF
           ELSE
              MOVE COB2CGI-CHAR
                TO COB2CGI-DATA-VALUE(COB2CGI-IND-2:1)

              *> check value limit
              ADD 1 TO COB2CGI-IND-2
              IF COB2CGI-IND-2 > COB2CGI-DATA-VALUE-MAX-LEN
```

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```
                THEN
                   DISPLAY "<BR>Error: DATA-VALUE-LEN " COB2CGI-IND-2
                           " greater than " COB2CGI-DATA-VALUE-MAX-LEN
                           " DATA-VALUE-MAX-LEN <BR>"
                   END-DISPLAY
                   SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
                   EXIT SECTION
                END-IF
             END-IF
       END-EVALUATE
    END-PERFORM

    IF COB2CGI-TAB-IND = 1
    THEN
       COMPUTE COB2CGI-TAB-VALUE-LEN(COB2CGI-TAB-IND)
             = COB2CGI-IND-2 - 1
       END-COMPUTE
    ELSE
       COMPUTE COB2CGI-TAB-VALUE-LEN(COB2CGI-TAB-IND)
             = COB2CGI-IND-2 - COB2CGI-TAB-VALUE-PTR(COB2CGI-TAB-IND)
       END-COMPUTE
    END-IF

    .
 COB2CGI-PARSE-GET-POST-EX.
    EXIT.

*>------------------------------------------------------------------------------
 COB2CGI-READ-NEXT-CHAR SECTION.
*>------------------------------------------------------------------------------

    ADD 1 TO COB2CGI-CHAR-COUNT

    IF COB2CGI-CHAR-COUNT > COB2CGI-CONTENT-LEN + 1
    THEN
       DISPLAY "<BR>Error: CHAR-COUNT " COB2CGI-CHAR-COUNT
               " greater than " COB2CGI-CONTENT-LEN " CONTENT-LEN <BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       EXIT SECTION
    END-IF

    IF V-COB2CGI-REQUEST-METHOD-GET OF COB2CGI-REQUEST-METHOD-FLAG
    THEN
       *> data with GET
       ADD 1 TO COB2CGI-QUERY-STR-IND

       IF COB2CGI-QUERY-STR-IND > COB2CGI-QUERY-STR-MAX-LEN
       THEN
          DISPLAY "<BR>Error: QUERY-STR-IND " COB2CGI-QUERY-STR-IND
                  " greater than " COB2CGI-QUERY-STR-MAX-LEN
                  " QUERY-STR-MAX-LEN <BR>"
          END-DISPLAY
          SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
          EXIT SECTION
       END-IF
```

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```
       IF COB2CGI-QUERY-STR-IND > COB2CGI-QUERY-STR-LEN
       THEN
          SET V-COB2CGI-EOF-YES OF COB2CGI-EOF-FLAG TO TRUE
          EXIT SECTION
       END-IF

       MOVE COB2CGI-QUERY-STR(COB2CGI-QUERY-STR-IND:1)
         TO COB2CGI-CHAR
    ELSE
       *> data with POST
       CALL STATIC "getchar" RETURNING COB2CGI-GETCHAR END-CALL

       IF COB2CGI-GETCHAR < ZEROES
       THEN
          SET V-COB2CGI-EOF-YES OF COB2CGI-EOF-FLAG TO TRUE
          EXIT SECTION
       END-IF

       MOVE COB2CGI-GETCHAR TO COB2CGI-CHAR-R
    END-IF

    *> !!!only for test!!!
    *> DISPLAY COB2CGI-CHAR WITH NO ADVANCING END-DISPLAY

    .
 COB2CGI-READ-NEXT-CHAR-EX.
    EXIT.

*>------------------------------------------------------------------------------
 COB2CGI-PARSE-UPLOAD SECTION.
*>------------------------------------------------------------------------------

    PERFORM COB2CGI-UPL-GET-BOUNDARY
    IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
    THEN
       DISPLAY "<BR>Error in UPL-GET-BOUNDARY <BR>" END-DISPLAY
       EXIT SECTION
    END-IF

    *> !!!only for test, display boundary data!!!
    *> DISPLAY "BOUNDARY: " COB2CGI-BOUNDARY "<BR>" END-DISPLAY
    *> DISPLAY "BOUNDARY-LEN: " COB2CGI-BOUNDARY-LEN "<BR>" END-DISPLAY
    *> DISPLAY "BOUNDARY-EOF: " COB2CGI-BOUNDARY-EOF "<BR>" "<BR>"  END-DISPLAY

    PERFORM COB2CGI-UPL-READ-POST

    *> !!!only for test!!!
    *> success, if boundary EOF string found, without any error
    *> IF  V-COB2CGI-ERROR-NO OF COB2CGI-ERROR-FLAG
    *> AND V-COB2CGI-BOUNDARY-EOF-YES OF COB2CGI-BOUNDARY-EOF-FLAG
    *> THEN
    *>    DISPLAY "<BR>" "<BR>"
    *>            "BOUNDARY-EOF found, CGI post processed successfully"
    *>            "<BR>" "<BR>"
    *>    END-DISPLAY
    *> END-IF
```

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```
    .
 COB2CGI-PARSE-UPLOAD-EX.
    EXIT.

*>------------------------------------------------------------------------------
 COB2CGI-UPL-GET-BOUNDARY SECTION.
*>------------------------------------------------------------------------------

    IF COB2CGI-ENV-VALUE(1:30) = "multipart/form-data; boundary="
    THEN
       MOVE COB2CGI-ENV-VALUE(31:) TO COB2CGI-BOUNDARY
       MOVE FUNCTION STORED-CHAR-LENGTH(COB2CGI-BOUNDARY)
         TO COB2CGI-BOUNDARY-LEN

       MOVE SPACES TO COB2CGI-BOUNDARY-EOF
       STRING COB2CGI-BOUNDARY(1:COB2CGI-BOUNDARY-LEN)
              "--"
         INTO COB2CGI-BOUNDARY-EOF
       END-STRING
    ELSE
       DISPLAY "Error: can not find boundary string: "
               COB2CGI-ENV-VALUE
               "<BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       EXIT SECTION
    END-IF

    .
 COB2CGI-UPL-GET-BOUNDARY-EX.
    EXIT.

*>------------------------------------------------------------------------------
 COB2CGI-UPL-READ-POST SECTION.
*>------------------------------------------------------------------------------

    MOVE ZEROES TO COB2CGI-CHAR-COUNT
    MOVE ZEROES TO COB2CGI-GETCHAR
    MOVE 1 TO COB2CGI-IND-2

    *> read a "boundary" line with EOL
    PERFORM COB2CGI-READ-NEXT-LINE
    IF V-COB2CGI-EOL-YES OF COB2CGI-EOL-FLAG
    THEN
       PERFORM COB2CGI-CHECK-BOUNDARY

       *> this must be a "boundary" line
       IF V-COB2CGI-BOUNDARY-NO OF COB2CGI-BOUNDARY-FLAG
       THEN
          DISPLAY "Error: boundary line not found"
                  "<BR>"
          END-DISPLAY
          SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
          EXIT SECTION
       END-IF
    ELSE
       DISPLAY "Error: end of line not found"
```

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```
                "<BR>"
      END-DISPLAY
      SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
      EXIT SECTION
   END-IF

   PERFORM UNTIL COB2CGI-CHAR-COUNT > COB2CGI-CONTENT-LEN
           OR    COB2CGI-GETCHAR < ZEROES
           OR    V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
           OR    V-COB2CGI-BOUNDARY-EOF-YES OF COB2CGI-BOUNDARY-EOF-FLAG

      *> read a "Content-Disposition" line with EOL
      PERFORM COB2CGI-READ-NEXT-LINE

      *> this must have an EOL
      IF V-COB2CGI-EOL-YES OF COB2CGI-EOL-FLAG
      THEN
         PERFORM COB2CGI-CHECK-CONTENT-DISP
         IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
         THEN
            EXIT SECTION
         END-IF

         *> this must be a "Content-Disposition" line
         EVALUATE TRUE
         WHEN V-COB2CGI-CONTENT-DISP-FIELD OF COB2CGI-CONTENT-DISP-FLAG
            *> read and save field value
            PERFORM COB2CGI-PARSE-FIELD-VALUE

         WHEN V-COB2CGI-CONTENT-DISP-FILE  OF COB2CGI-CONTENT-DISP-FLAG
            *> read and save the uploaded file
            PERFORM COB2CGI-PARSE-FILE-UPLOAD

         WHEN OTHER
            DISPLAY "Error: Content-Disposition not found"
                    "<BR>"
            END-DISPLAY
            SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
            EXIT SECTION
         END-EVALUATE
      ELSE
         DISPLAY "Error: end of line not found"
                 "<BR>"
         END-DISPLAY
         SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
         EXIT SECTION
      END-IF
   END-PERFORM

   .
COB2CGI-UPL-READ-POST-EX.
   EXIT.
```

```
*>------------------------------------------------------------------------
 COB2CGI-READ-NEXT-LINE SECTION.
*>------------------------------------------------------------------------
```

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```
    MOVE ZEROES    TO COB2CGI-INPUT-BUF-IND
    MOVE LOW-VALUE TO COB2CGI-INPUT-BUF

    SET V-COB2CGI-EOL-NO OF COB2CGI-EOL-FLAG TO TRUE
    SET V-COB2CGI-EOF-NO OF COB2CGI-EOF-FLAG TO TRUE

    PERFORM UNTIL COB2CGI-CHAR-COUNT > COB2CGI-CONTENT-LEN
            OR    COB2CGI-INPUT-BUF-IND > COB2CGI-INPUT-BUF-MAX-LEN
            OR    COB2CGI-GETCHAR < ZEROES

       CALL STATIC "getchar" RETURNING COB2CGI-GETCHAR END-CALL

       IF COB2CGI-CHAR-COUNT > COB2CGI-CONTENT-LEN
       OR COB2CGI-GETCHAR < ZEROES
       THEN
          SET V-COB2CGI-EOF-YES OF COB2CGI-EOF-FLAG TO TRUE
          EXIT SECTION
       END-IF

       ADD 1 TO COB2CGI-CHAR-COUNT
       ADD 1 TO COB2CGI-INPUT-BUF-IND

       IF COB2CGI-INPUT-BUF-IND <= COB2CGI-INPUT-BUF-MAX-LEN
       THEN
          MOVE COB2CGI-GETCHAR TO COB2CGI-CHAR-R
          MOVE COB2CGI-CHAR    TO COB2CGI-INPUT-BUF(COB2CGI-INPUT-BUF-IND:1)

          *> !!!only for test!!!
          *> received chars
          *> DISPLAY COB2CGI-CHAR WITH NO ADVANCING END-DISPLAY
          *> received chars with num values
          *> DISPLAY "(" COB2CGI-GETCHAR ")" END-DISPLAY
          *> IF COB2CGI-GETCHAR = 10
          *> THEN
          *>    DISPLAY "<BR>" END-DISPLAY
          *> END-IF

          *> check end of line X"0A" or X"0D0A"
          IF COB2CGI-GETCHAR = 10
          OR COB2CGI-INPUT-BUF-IND = COB2CGI-INPUT-BUF-MAX-LEN
          THEN
             SET V-COB2CGI-EOL-YES OF COB2CGI-EOL-FLAG TO TRUE
             EXIT SECTION
          END-IF
       ELSE
          *> input buffer full
          EXIT SECTION
       END-IF
    END-PERFORM

    .
 COB2CGI-READ-NEXT-LINE-EX.
    EXIT.

*>------------------------------------------------------------------------------
 COB2CGI-CHECK-BOUNDARY SECTION.
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*>-------------------------------------------------------------------------

    SET V-COB2CGI-BOUNDARY-NO     OF COB2CGI-BOUNDARY-FLAG     TO TRUE
    SET V-COB2CGI-BOUNDARY-EOF-NO OF COB2CGI-BOUNDARY-EOF-FLAG TO TRUE

    *> search boundary string
    MOVE ZEROES TO COB2CGI-INSPECT-COUNT
    INSPECT COB2CGI-INPUT-BUF(1:COB2CGI-INPUT-BUF-IND)
       TALLYING COB2CGI-INSPECT-COUNT
       FOR ALL  COB2CGI-BOUNDARY(1:COB2CGI-BOUNDARY-LEN)

    IF COB2CGI-INSPECT-COUNT > ZEROES
    THEN
       SET V-COB2CGI-BOUNDARY-YES OF COB2CGI-BOUNDARY-FLAG TO TRUE

       *> search boundary EOF string
       MOVE ZEROES TO COB2CGI-INSPECT-COUNT
       INSPECT COB2CGI-INPUT-BUF(1:COB2CGI-INPUT-BUF-IND)
          TALLYING COB2CGI-INSPECT-COUNT
          FOR ALL  COB2CGI-BOUNDARY-EOF(1:COB2CGI-BOUNDARY-LEN + 2)

       IF COB2CGI-INSPECT-COUNT > ZEROES
       THEN
          SET V-COB2CGI-BOUNDARY-EOF-YES OF COB2CGI-BOUNDARY-EOF-FLAG TO TRUE
       END-IF
    END-IF

    .
 COB2CGI-CHECK-BOUNDARY-EX.
    EXIT.

*>-------------------------------------------------------------------------------
 COB2CGI-CHECK-CONTENT-DISP SECTION.
*>-------------------------------------------------------------------------------

    SET V-COB2CGI-CONTENT-DISP-ERROR OF COB2CGI-CONTENT-DISP-FLAG TO TRUE

    IF COB2CGI-INPUT-BUF(1:38) NOT = "Content-Disposition: form-data; name="""
    THEN
       EXIT SECTION
    END-IF

    *> for every Content-Disposition there is a line in the internal table
    ADD 1 TO COB2CGI-TAB-IND
    MOVE COB2CGI-TAB-IND TO COB2CGI-TAB-NR

    IF COB2CGI-TAB-IND > COB2CGI-TAB-MAX-LINE
    THEN
       DISPLAY "Error: internal table full"
               "<BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       EXIT SECTION
    END-IF

    *> get length of field name
    MOVE ZEROES TO COB2CGI-INSPECT-COUNT
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```
    INSPECT COB2CGI-INPUT-BUF(39:)
       TALLYING COB2CGI-INSPECT-COUNT
       FOR CHARACTERS BEFORE INITIAL """"

    *> save length of field name
    MOVE COB2CGI-INSPECT-COUNT
      TO COB2CGI-TAB-FIELD-LEN(COB2CGI-TAB-IND)

    *> save field name
    MOVE COB2CGI-INPUT-BUF(39:COB2CGI-INSPECT-COUNT)
      TO COB2CGI-TAB-FIELD(COB2CGI-TAB-IND)

    *> search number of fields
    MOVE ZEROES TO COB2CGI-INSPECT-COUNT
    INSPECT COB2CGI-INPUT-BUF(39:)
       TALLYING COB2CGI-INSPECT-COUNT
       FOR ALL """"

    *> this is only one field --> exit section
    IF COB2CGI-INSPECT-COUNT = 1
    THEN
       SET V-COB2CGI-CONTENT-DISP-FIELD OF COB2CGI-CONTENT-DISP-FLAG TO TRUE
       SET V-COB2CGI-TAB-FILE-NO OF COB2CGI-TAB-FILE-FLAG(COB2CGI-TAB-IND)
                                                                  TO TRUE
       EXIT SECTION
    END-IF

    *> search file name
    MOVE ZEROES TO COB2CGI-INSPECT-COUNT
    INSPECT COB2CGI-INPUT-BUF(39 + COB2CGI-TAB-FIELD-LEN(COB2CGI-TAB-IND):)
       TALLYING COB2CGI-INSPECT-COUNT
       FOR CHARACTERS BEFORE INITIAL "filename="""

    IF COB2CGI-INSPECT-COUNT = 3
    THEN
       SET V-COB2CGI-CONTENT-DISP-FILE OF COB2CGI-CONTENT-DISP-FLAG TO TRUE
       SET V-COB2CGI-TAB-FILE-YES OF COB2CGI-TAB-FILE-FLAG(COB2CGI-TAB-IND)
                                                                  TO TRUE

       *> get length of file name
       MOVE ZEROES TO COB2CGI-INSPECT-COUNT
       INSPECT COB2CGI-INPUT-BUF(39 + COB2CGI-TAB-FIELD-LEN(COB2CGI-TAB-IND)
                                    + 13:)
          TALLYING COB2CGI-INSPECT-COUNT
          FOR CHARACTERS BEFORE INITIAL """"

       *> save length of file name in temp
       MOVE COB2CGI-INSPECT-COUNT
         TO COB2CGI-TMP-FILE-NAME-LEN

       *> save file name in temp
       MOVE COB2CGI-INPUT-BUF(39 + COB2CGI-TAB-FIELD-LEN(COB2CGI-TAB-IND)
                              + 13:COB2CGI-INSPECT-COUNT)
         TO COB2CGI-TMP-FILE-NAME

       *> Check file name. Internet Explorer sends a file name with full
       *> file path, but Firefox sends only a file name.
```

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```
       MOVE ZEROES TO COB2CGI-INSPECT-COUNT
       INSPECT COB2CGI-TMP-FILE-NAME
          TALLYING COB2CGI-INSPECT-COUNT
          FOR ALL "\" "/"

       IF COB2CGI-INSPECT-COUNT = ZEROES
       THEN
          *> this is only a file name without file path
          *> save length of file name
          MOVE COB2CGI-TMP-FILE-NAME-LEN
            TO COB2CGI-TAB-FILE-NAME-LEN(COB2CGI-TAB-IND)
          *> save file name
          MOVE COB2CGI-TMP-FILE-NAME
            TO COB2CGI-TAB-FILE-NAME(COB2CGI-TAB-IND)
       ELSE
          *> this is a file name with full file path, get file name from it
          MOVE ZEROES TO COB2CGI-INSPECT-COUNT

          INSPECT FUNCTION REVERSE(COB2CGI-TMP-FILE-NAME)
             TALLYING COB2CGI-INSPECT-COUNT
             FOR CHARACTERS BEFORE INITIAL "\"
                            BEFORE INITIAL "/"

          COMPUTE COB2CGI-TMP-FILE-PATH-LEN
                = FUNCTION LENGTH(COB2CGI-TMP-FILE-NAME)
                - COB2CGI-INSPECT-COUNT + 1
          END-COMPUTE

          *> save length of file name
          COMPUTE COB2CGI-TAB-FILE-NAME-LEN(COB2CGI-TAB-IND)
                = COB2CGI-TMP-FILE-NAME-LEN
                - COB2CGI-TMP-FILE-PATH-LEN + 1
          END-COMPUTE

          *> save file name
          MOVE COB2CGI-TMP-FILE-NAME(COB2CGI-TMP-FILE-PATH-LEN:
                                     COB2CGI-TAB-FILE-NAME-LEN(COB2CGI-TAB-IND))
            TO COB2CGI-TAB-FILE-NAME(COB2CGI-TAB-IND)
       END-IF
    ELSE
       DISPLAY "Error: filename not found in Content-Disposition"
               "<BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       EXIT SECTION
    END-IF

    .
 COB2CGI-CHECK-CONTENT-DISP-EX.
    EXIT.

*>------------------------------------------------------------------------------
 COB2CGI-PARSE-FIELD-VALUE SECTION.
*>------------------------------------------------------------------------------

    *> this must be an empty line
    PERFORM COB2CGI-READ-NEXT-LINE
```

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```
    IF V-COB2CGI-EOL-NO OF COB2CGI-EOL-FLAG
    OR COB2CGI-INPUT-BUF(1:2) NOT = COB2CGI-CRLF
    THEN
       DISPLAY "Error: end of line not found"
               "<BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       EXIT SECTION
    END-IF

    *> init char counter
    MOVE ZEROES TO COB2CGI-IND-1

    SET V-COB2CGI-FIRST-LINE-YES OF COB2CGI-FIRST-LINE-FLAG TO TRUE
    MOVE SPACES TO COB2CGI-INPUT-BUF-SAVE
    MOVE ZEROES TO COB2CGI-INPUT-BUF-SAVE-IND

    *> set value pointer in the table
    MOVE COB2CGI-IND-2
      TO COB2CGI-TAB-VALUE-PTR(COB2CGI-TAB-IND)

    PERFORM TEST AFTER
      UNTIL V-COB2CGI-BOUNDARY-YES     OF COB2CGI-BOUNDARY-FLAG
      OR    V-COB2CGI-BOUNDARY-EOF-YES OF COB2CGI-BOUNDARY-EOF-FLAG

       *> read a line
       PERFORM COB2CGI-READ-NEXT-LINE
       IF V-COB2CGI-EOF-YES OF COB2CGI-EOF-FLAG
       THEN
          DISPLAY "Error: boundary line not found"
                  "<BR>"
          END-DISPLAY
          SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
          EXIT SECTION
       END-IF

       PERFORM COB2CGI-CHECK-BOUNDARY

       IF V-COB2CGI-BOUNDARY-YES     OF COB2CGI-BOUNDARY-FLAG
       OR V-COB2CGI-BOUNDARY-EOF-YES OF COB2CGI-BOUNDARY-EOF-FLAG
       THEN
          *> end of field reached
          *> write last line without CRLF
          IF COB2CGI-INPUT-BUF-SAVE-IND > 2
          THEN
             IF COB2CGI-IND-2 < COB2CGI-DATA-VALUE-MAX-LEN
             THEN
                MOVE COB2CGI-INPUT-BUF-SAVE(1:COB2CGI-INPUT-BUF-SAVE-IND - 2)
                  TO COB2CGI-DATA-VALUE(COB2CGI-IND-2:)
                COMPUTE COB2CGI-IND-1 = COB2CGI-IND-1
                                      + COB2CGI-INPUT-BUF-SAVE-IND - 2
                END-COMPUTE
                MOVE COB2CGI-IND-1
                  TO COB2CGI-TAB-VALUE-LEN(COB2CGI-TAB-IND)
                ADD COB2CGI-IND-1 TO COB2CGI-IND-2
             ELSE
                DISPLAY "Error: value is too long"
```

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```
                        "<BR>"
                END-DISPLAY
                SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
                EXIT SECTION
             END-IF
          END-IF

          EXIT PERFORM
       ELSE
          IF V-COB2CGI-FIRST-LINE-NO OF COB2CGI-FIRST-LINE-FLAG
          THEN
             *> this was only a CRLF, we have to write it in the internal table
             IF COB2CGI-IND-2 < COB2CGI-DATA-VALUE-MAX-LEN
             THEN
                MOVE COB2CGI-INPUT-BUF-SAVE(1:COB2CGI-INPUT-BUF-SAVE-IND)
                  TO COB2CGI-DATA-VALUE(COB2CGI-IND-2:)
                ADD COB2CGI-INPUT-BUF-SAVE-IND TO COB2CGI-IND-1
                MOVE COB2CGI-IND-1
                  TO COB2CGI-TAB-VALUE-LEN(COB2CGI-TAB-IND)
                ADD COB2CGI-IND-1 TO COB2CGI-IND-2
             ELSE
                DISPLAY "Error: value is too long"
                        "<BR>"
                END-DISPLAY
                SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
                EXIT SECTION
             END-IF
          END-IF

          *> save line
          SET V-COB2CGI-FIRST-LINE-NO OF COB2CGI-FIRST-LINE-FLAG TO TRUE
          MOVE COB2CGI-INPUT-BUF     TO COB2CGI-INPUT-BUF-SAVE
          MOVE COB2CGI-INPUT-BUF-IND TO COB2CGI-INPUT-BUF-SAVE-IND
       END-IF
    END-PERFORM

    .
 COB2CGI-PARSE-FIELD-VALUE-EX.
    EXIT.

*>------------------------------------------------------------------------------
 COB2CGI-PARSE-FILE-UPLOAD SECTION.
*>------------------------------------------------------------------------------

    *> this must be a Content-Type
    PERFORM COB2CGI-READ-NEXT-LINE
    IF V-COB2CGI-EOL-NO OF COB2CGI-EOL-FLAG
    OR COB2CGI-INPUT-BUF(1:14) NOT = "Content-Type: "
    THEN
       DISPLAY "Error: Content-Type not found"
               "<BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       EXIT SECTION
    END-IF

    *> save Content-Type as file type
```

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```
    MOVE ZEROES TO COB2CGI-INSPECT-COUNT
    INSPECT COB2CGI-INPUT-BUF(15:)
       TALLYING COB2CGI-INSPECT-COUNT
       FOR CHARACTERS BEFORE INITIAL COB2CGI-CRLF
    MOVE COB2CGI-INPUT-BUF(15:COB2CGI-INSPECT-COUNT)
      TO COB2CGI-TAB-FILE-TYPE(COB2CGI-TAB-IND)

    *> if not empty file
    IF COB2CGI-TAB-FILE-NAME-LEN(COB2CGI-TAB-IND) NOT = ZEROES
    THEN
       *> check file type
       MOVE COB2CGI-TAB-FILE-TYPE(COB2CGI-TAB-IND) TO COB2CGI-CHECK-FILE-TYPE
       IF  NOT V-COB2CGI-FILE-TYPE-ALLOWED OF COB2CGI-CHECK-FILE-TYPE
       THEN
          DISPLAY "Error: File-Type not allowed"
                  "<BR>"
          END-DISPLAY
          SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
          EXIT SECTION
       END-IF
    END-IF

    *> this must be an empty line
    PERFORM COB2CGI-READ-NEXT-LINE
    IF V-COB2CGI-EOL-NO OF COB2CGI-EOL-FLAG
    OR COB2CGI-INPUT-BUF(1:2) NOT = COB2CGI-CRLF
    THEN
       DISPLAY "Error: end of line not found"
               "<BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       EXIT SECTION
    END-IF

    *> if not empty file
    IF COB2CGI-TAB-FILE-NAME-LEN(COB2CGI-TAB-IND) NOT = ZEROES
    THEN
       *> create uploaded file
       PERFORM COB2CGI-FILE-CREATE
       IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
       THEN
          EXIT SECTION
       END-IF
    END-IF

    *> init offset
    MOVE ZEROES TO COB2CGI-FILE-OFFSET

    SET V-COB2CGI-FIRST-LINE-YES OF COB2CGI-FIRST-LINE-FLAG TO TRUE
    MOVE SPACES TO COB2CGI-INPUT-BUF-SAVE
    MOVE ZEROES TO COB2CGI-INPUT-BUF-SAVE-IND

    PERFORM TEST AFTER
      UNTIL V-COB2CGI-BOUNDARY-YES     OF COB2CGI-BOUNDARY-FLAG
      OR    V-COB2CGI-BOUNDARY-EOF-YES OF COB2CGI-BOUNDARY-EOF-FLAG

       *> read a line
```

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```
       PERFORM COB2CGI-READ-NEXT-LINE
       IF V-COB2CGI-EOF-YES OF COB2CGI-EOF-FLAG
       THEN
          DISPLAY "Error: boundary line not found"
                  "<BR>"
          END-DISPLAY
          SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
          EXIT PERFORM
       END-IF

       PERFORM COB2CGI-CHECK-BOUNDARY

       IF V-COB2CGI-BOUNDARY-YES     OF COB2CGI-BOUNDARY-FLAG
       OR V-COB2CGI-BOUNDARY-EOF-YES OF COB2CGI-BOUNDARY-EOF-FLAG
       THEN
          *> end of uploaded file reached
          *> write last line without CRLF
          IF COB2CGI-INPUT-BUF-SAVE-IND > 2
          THEN
             MOVE COB2CGI-INPUT-BUF-SAVE(1:COB2CGI-INPUT-BUF-SAVE-IND - 2)
               TO COB2CGI-FILE-BUF
             COMPUTE COB2CGI-FILE-NBYTES = COB2CGI-INPUT-BUF-SAVE-IND - 2
             END-COMPUTE

             PERFORM COB2CGI-FILE-WRITE
             IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
             THEN
                EXIT PERFORM
             END-IF
          END-IF

          EXIT PERFORM
       ELSE
          IF V-COB2CGI-FIRST-LINE-NO OF COB2CGI-FIRST-LINE-FLAG
          THEN
             *> this was only a CRLF, we have to write it in the file
             MOVE COB2CGI-INPUT-BUF-SAVE(1:COB2CGI-INPUT-BUF-SAVE-IND)
               TO COB2CGI-FILE-BUF
             MOVE COB2CGI-INPUT-BUF-SAVE-IND TO COB2CGI-FILE-NBYTES

             PERFORM COB2CGI-FILE-WRITE
             IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
             THEN
                EXIT PERFORM
             END-IF
          ELSE
             *> if not empty file
             IF COB2CGI-TAB-FILE-NAME-LEN(COB2CGI-TAB-IND) NOT = ZEROES
             THEN
                *> this is the first line, we can check here the file data
                PERFORM COB2CGI-CHECK-FILE-DATA
                IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
                THEN
                   EXIT PERFORM
                END-IF
             END-IF
          END-IF
```

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```
            *> save line
            SET V-COB2CGI-FIRST-LINE-NO OF COB2CGI-FIRST-LINE-FLAG TO TRUE
            MOVE COB2CGI-INPUT-BUF     TO COB2CGI-INPUT-BUF-SAVE
            MOVE COB2CGI-INPUT-BUF-IND TO COB2CGI-INPUT-BUF-SAVE-IND
         END-IF
      END-PERFORM

      *> if not empty file
      IF COB2CGI-TAB-FILE-NAME-LEN(COB2CGI-TAB-IND) NOT = ZEROES
      THEN
         PERFORM COB2CGI-FILE-CLOSE
         IF V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG
         THEN
            EXIT SECTION
         END-IF
      END-IF

      .
 COB2CGI-PARSE-FILE-UPLOAD-EX.
      EXIT.

*>------------------------------------------------------------------------------
 COB2CGI-CHECK-FILE-DATA SECTION.
*>------------------------------------------------------------------------------

      *> check uploaded file data
      EVALUATE TRUE
      WHEN V-COB2CGI-FILE-TYPE-BMP OF COB2CGI-CHECK-FILE-TYPE
         IF COB2CGI-INPUT-BUF(1:2) NOT = "BM"
         THEN
            DISPLAY "Error: Image content not BMP"
                    "<BR>"
            END-DISPLAY
            SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
         END-IF

      WHEN V-COB2CGI-FILE-TYPE-GIF OF COB2CGI-CHECK-FILE-TYPE
         IF COB2CGI-INPUT-BUF(1:3) NOT = "GIF"
         THEN
            DISPLAY "Error: Image content not GIF"
                    "<BR>"
            END-DISPLAY
            SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
         END-IF

      WHEN V-COB2CGI-FILE-TYPE-JPG OF COB2CGI-CHECK-FILE-TYPE
         IF  COB2CGI-INPUT-BUF(1:4) NOT = X"FFD8FFE0"
         AND COB2CGI-INPUT-BUF(1:4) NOT = X"FFD8FFE1"
         THEN
            DISPLAY "Error: Image content not JPG"
                    "<BR>"
            END-DISPLAY
            SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
         END-IF

      WHEN V-COB2CGI-FILE-TYPE-PNG OF COB2CGI-CHECK-FILE-TYPE
```

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```
       IF COB2CGI-INPUT-BUF(1:4) NOT = X"89504E47"
       THEN
          DISPLAY "Error: Image content not PNG"
                  "<BR>"
          END-DISPLAY
          SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       END-IF

    WHEN V-COB2CGI-FILE-TYPE-TIF OF COB2CGI-CHECK-FILE-TYPE
       IF  COB2CGI-INPUT-BUF(1:3) NOT = X"49492A"
       AND COB2CGI-INPUT-BUF(1:3) NOT = X"4D4D2A"
       THEN
          DISPLAY "Error: Image content not TIF"
                  "<BR>"
          END-DISPLAY
          SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       END-IF

    WHEN OTHER
       DISPLAY "Error: File-Type not allowed"
               "<BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
    END-EVALUATE

    .
 COB2CGI-CHECK-FILE-DATA-EX.
    EXIT.

*>------------------------------------------------------------------------------
 COB2CGI-FILE-CREATE SECTION.
*>------------------------------------------------------------------------------

    CALL "CBL_CREATE_FILE"
         USING COB2CGI-TAB-FILE-NAME(COB2CGI-TAB-IND)
             , 2
             , 0
             , 0
             , COB2CGI-FILE-HANDLE
    END-CALL

    IF RETURN-CODE NOT = ZEROES
    THEN
       DISPLAY "Error: CBL_CREATE_FILE, "
               "FILE: " COB2CGI-TAB-FILE-NAME(COB2CGI-TAB-IND)
               "<BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
    END-IF

    .
 COB2CGI-FILE-CREATE-EX.
    EXIT.

*>------------------------------------------------------------------------------
 COB2CGI-FILE-WRITE SECTION.
*>------------------------------------------------------------------------------
```

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```
    CALL "CBL_WRITE_FILE"
         USING COB2CGI-FILE-HANDLE
       , COB2CGI-FILE-OFFSET
       , COB2CGI-FILE-NBYTES
       , 0
       , COB2CGI-FILE-BUF(1:COB2CGI-INPUT-BUF-IND)
    END-CALL

    IF RETURN-CODE NOT = ZEROES
    THEN
       DISPLAY "Error: CBL_WRITE_FILE, "
               "FILE: " COB2CGI-TAB-FILE-NAME(COB2CGI-TAB-IND)
               "<BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
    END-IF

    ADD  COB2CGI-FILE-NBYTES TO COB2CGI-FILE-OFFSET
    *> update uploaded file size
    MOVE COB2CGI-FILE-OFFSET TO COB2CGI-TAB-FILE-DATA-LEN(COB2CGI-TAB-IND)

    *> check max. allowed file size
    IF COB2CGI-UPLOAD-FILE-MAX-SIZE < COB2CGI-TAB-FILE-DATA-LEN(COB2CGI-TAB-IND)
    THEN
       DISPLAY "Error: " COB2CGI-TAB-FILE-NAME(COB2CGI-TAB-IND) " file size"
               " > " COB2CGI-UPLOAD-FILE-MAX-SIZE " max. allowed size" "<BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
       EXIT SECTION
    END-IF

    .
 COB2CGI-FILE-WRITE-EX.
    EXIT.

*>------------------------------------------------------------------------------
 COB2CGI-FILE-CLOSE SECTION.
*>------------------------------------------------------------------------------

    CALL "CBL_CLOSE_FILE"
         USING COB2CGI-FILE-HANDLE
    END-CALL

    IF RETURN-CODE NOT = ZEROES
    THEN
       DISPLAY "Error: CBL_CLOSE_FILE, "
               "FILE: " COB2CGI-TAB-FILE-NAME(COB2CGI-TAB-IND)
               "<BR>"
       END-DISPLAY
       SET V-COB2CGI-ERROR-YES OF COB2CGI-ERROR-FLAG TO TRUE
    END-IF

    .
 COB2CGI-FILE-CLOSE-EX.
    EXIT.
```

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```
 END PROGRAM cgiform.
```

```
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*>*****************************************************************************

*>*****************************************************************************
*> Function:     COB2CGI-POST.cob
*>
*> Purpose:      Get saved cgi values
*>
*> Author:       Laszlo Erdos - https://www.facebook.com/wortfee
*>
*> Date-Written: 2015.08.21
*>
*> Usage:        To use this function, simply CALL it as follows:
*>               COB2CGI-POST(<cgi-field-name>)
*>               Fields in COB2CGI-POST linkage:
*>                 <cgi-field-name>  - input
*>                 <cgi-field-value> - output
*>*****************************************************************************

 IDENTIFICATION DIVISION.
 FUNCTION-ID. COB2CGI-POST.
 AUTHOR.      Laszlo Erdos.

 ENVIRONMENT DIVISION.
 DATA DIVISION.
 WORKING-STORAGE SECTION.

*> there are only the name of fields in the internal table
 01 COB2CGI-TAB-IND                    PIC 9(9) COMP.
 78 COB2CGI-TAB-MAX-LINE               VALUE 1000.
 01 COB2CGI-TAB-NR            EXTERNAL PIC 9(9) COMP.
 01 COB2CGI-TABLE-R           EXTERNAL PIC X(161000).
 01 COB2CGI-TABLE REDEFINES COB2CGI-TABLE-R.
   02 COB2CGI-DATA-TAB.
     03 COB2CGI-TAB-LINE               OCCURS 1 TO COB2CGI-TAB-MAX-LINE TIMES.
       04 COB2CGI-TAB-FIELD            PIC X(40).
       04 COB2CGI-TAB-FIELD-LEN        PIC 9(9) COMP.
       04 COB2CGI-TAB-VALUE-PTR        PIC 9(9) COMP.
       04 COB2CGI-TAB-VALUE-LEN        PIC 9(9) COMP.
       04 COB2CGI-TAB-FILE-FLAG        PIC 9.
          88 V-COB2CGI-TAB-FILE-NO     VALUE 0.
```

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```
          88 V-COB2CGI-TAB-FILE-YES    VALUE 1.
       04 COB2CGI-TAB-FILE-NAME        PIC X(60).
       04 COB2CGI-TAB-FILE-NAME-LEN    PIC 9(9) COMP.
       04 COB2CGI-TAB-FILE-TYPE        PIC X(40).
       04 COB2CGI-TAB-FILE-DATA-LEN    PIC 9(9) COMP.

*> we can save memory, if we use one field for all values
 01 COB2CGI-DATA-VALUE        EXTERNAL PIC X(500000).

 01 COB2CGI-IND-1                      PIC 9(9) COMP.

 LINKAGE SECTION.
 01 LNK-CGI-FIELD-NAME                 PIC X(40).
 01 LNK-CGI-FIELD-VALUE.
   02 LEN                             PIC 9(9) COMP.
   02 VAL                             PIC X(500000).

 PROCEDURE DIVISION USING     BY VALUE LNK-CGI-FIELD-NAME
                   RETURNING          LNK-CGI-FIELD-VALUE.

 COB2CGI-POST-MAIN SECTION.

    PERFORM VARYING COB2CGI-IND-1 FROM 1 BY 1
      UNTIL COB2CGI-IND-1 > COB2CGI-TAB-NR
      OR    COB2CGI-IND-1 > COB2CGI-TAB-MAX-LINE

       IF COB2CGI-TAB-FIELD(COB2CGI-IND-1) = LNK-CGI-FIELD-NAME
       THEN
          IF COB2CGI-TAB-VALUE-LEN(COB2CGI-IND-1) = ZEROES
          THEN
             MOVE ZEROES
               TO LEN OF LNK-CGI-FIELD-VALUE
             MOVE SPACES
               TO VAL OF LNK-CGI-FIELD-VALUE
          ELSE
             MOVE COB2CGI-TAB-VALUE-LEN(COB2CGI-IND-1)
               TO LEN OF LNK-CGI-FIELD-VALUE
             MOVE COB2CGI-DATA-VALUE
                  (COB2CGI-TAB-VALUE-PTR(COB2CGI-IND-1):
                   COB2CGI-TAB-VALUE-LEN(COB2CGI-IND-1))
               TO VAL OF LNK-CGI-FIELD-VALUE
          END-IF

          EXIT PERFORM
       END-IF
    END-PERFORM

    IF COB2CGI-IND-1 > COB2CGI-TAB-NR
    OR COB2CGI-IND-1 > COB2CGI-TAB-MAX-LINE
    THEN
       MOVE ZEROES
         TO LEN OF LNK-CGI-FIELD-VALUE
       MOVE SPACES
         TO VAL OF LNK-CGI-FIELD-VALUE
    END-IF

    GOBACK
```

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```
    .
 COB2CGI-POST-MAIN-EX.
    EXIT.
 END FUNCTION COB2CGI-POST.

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*>*****************************************************************************

*>*****************************************************************************
*> Function:     COB2CGI-ENV.cob
*>
*> Purpose:      Get cgi environment variables
*>
*> Author:       Laszlo Erdos - https://www.facebook.com/wortfee
*>
*> Date-Written: 2015.08.21
*>
*> Usage:        To use this function, simply CALL it as follows:
*>               COB2CGI-ENV(<env-name>)
*>               Fields in COB2CGI-ENV linkage:
*>                 <env-name>  - input
*>                 <env-value> - output
*>*****************************************************************************

 IDENTIFICATION DIVISION.
 FUNCTION-ID. COB2CGI-ENV.
 AUTHOR.      Laszlo Erdos.

 ENVIRONMENT DIVISION.
 DATA DIVISION.
 WORKING-STORAGE SECTION.

 LINKAGE SECTION.
 01 LNK-ENV-NAME                      PIC X(256).
 01 LNK-ENV-VALUE                     PIC X(256).

 PROCEDURE DIVISION USING     BY VALUE LNK-ENV-NAME
                   RETURNING          LNK-ENV-VALUE.

 COB2CGI-ENV-MAIN SECTION.

    ACCEPT LNK-ENV-VALUE FROM ENVIRONMENT
           LNK-ENV-NAME
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```
    END-ACCEPT

    GOBACK

    .
 COB2CGI-ENV-MAIN-EX.
    EXIT.
 END FUNCTION COB2CGI-ENV.

*>*****************************************************************************
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*>*****************************************************************************

*>*****************************************************************************
*> Function:     COB2CGI-DECODE.cob
*>
*> Purpose:      Decode UTF-8 chars
*>
*> Author:       Laszlo Erdos - https://www.facebook.com/wortfee
*>
*> Date-Written: 2015.08.21
*>
*> Usage:        To use this function, simply CALL it as follows:
*>               COB2CGI-DECODE(<UTF8-string>)
*>               Fields in COB2CGI-DECODE linkage:
*>                 <UTF8-string>  - input
*>                 <UTF8-value>   - output
*>*****************************************************************************

 IDENTIFICATION DIVISION.
 FUNCTION-ID. COB2CGI-DECODE.
 AUTHOR.      Laszlo Erdos.

 ENVIRONMENT DIVISION.
 DATA DIVISION.
 WORKING-STORAGE SECTION.

 01 WS-DECODE-TABLE.
   02 FILLER                          PIC X(4) VALUE "%00" & X"00".
   02 FILLER                          PIC X(4) VALUE "%01" & X"01".
   02 FILLER                          PIC X(4) VALUE "%02" & X"02".
   02 FILLER                          PIC X(4) VALUE "%03" & X"03".
   02 FILLER                          PIC X(4) VALUE "%04" & X"04".
   02 FILLER                          PIC X(4) VALUE "%05" & X"05".
   02 FILLER                          PIC X(4) VALUE "%06" & X"06".
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   02 FILLER                          PIC X(4) VALUE "%07" & X"07".
   02 FILLER                          PIC X(4) VALUE "%08" & X"08".
   02 FILLER                          PIC X(4) VALUE "%09" & X"09".
   02 FILLER                          PIC X(4) VALUE "%0A" & X"0A".
   02 FILLER                          PIC X(4) VALUE "%0B" & X"0B".
   02 FILLER                          PIC X(4) VALUE "%0C" & X"0C".
   02 FILLER                          PIC X(4) VALUE "%0D" & X"0D".
   02 FILLER                          PIC X(4) VALUE "%0E" & X"0E".
   02 FILLER                          PIC X(4) VALUE "%0F" & X"0F".

   02 FILLER                          PIC X(4) VALUE "%10" & X"10".
   02 FILLER                          PIC X(4) VALUE "%11" & X"11".
   02 FILLER                          PIC X(4) VALUE "%12" & X"12".
   02 FILLER                          PIC X(4) VALUE "%13" & X"13".
   02 FILLER                          PIC X(4) VALUE "%14" & X"14".
   02 FILLER                          PIC X(4) VALUE "%15" & X"15".
   02 FILLER                          PIC X(4) VALUE "%16" & X"16".
   02 FILLER                          PIC X(4) VALUE "%17" & X"17".
   02 FILLER                          PIC X(4) VALUE "%18" & X"18".
   02 FILLER                          PIC X(4) VALUE "%19" & X"19".
   02 FILLER                          PIC X(4) VALUE "%1A" & X"1A".
   02 FILLER                          PIC X(4) VALUE "%1B" & X"1B".
   02 FILLER                          PIC X(4) VALUE "%1C" & X"1C".
   02 FILLER                          PIC X(4) VALUE "%1D" & X"1D".
   02 FILLER                          PIC X(4) VALUE "%1E" & X"1E".
   02 FILLER                          PIC X(4) VALUE "%1F" & X"1F".

   02 FILLER                          PIC X(4) VALUE "%20" & X"20".
   02 FILLER                          PIC X(4) VALUE "%21" & X"21".
   02 FILLER                          PIC X(4) VALUE "%22" & X"22".
   02 FILLER                          PIC X(4) VALUE "%23" & X"23".
   02 FILLER                          PIC X(4) VALUE "%24" & X"24".
   02 FILLER                          PIC X(4) VALUE "%25" & X"25".
   02 FILLER                          PIC X(4) VALUE "%26" & X"26".
   02 FILLER                          PIC X(4) VALUE "%27" & X"27".
   02 FILLER                          PIC X(4) VALUE "%28" & X"28".
   02 FILLER                          PIC X(4) VALUE "%29" & X"29".
   02 FILLER                          PIC X(4) VALUE "%2A" & X"2A".
   02 FILLER                          PIC X(4) VALUE "%2B" & X"2B".
   02 FILLER                          PIC X(4) VALUE "%2C" & X"2C".
   02 FILLER                          PIC X(4) VALUE "%2D" & X"2D".
   02 FILLER                          PIC X(4) VALUE "%2E" & X"2E".
   02 FILLER                          PIC X(4) VALUE "%2F" & X"2F".

   02 FILLER                          PIC X(4) VALUE "%30" & X"30".
   02 FILLER                          PIC X(4) VALUE "%31" & X"31".
   02 FILLER                          PIC X(4) VALUE "%32" & X"32".
   02 FILLER                          PIC X(4) VALUE "%33" & X"33".
   02 FILLER                          PIC X(4) VALUE "%34" & X"34".
   02 FILLER                          PIC X(4) VALUE "%35" & X"35".
   02 FILLER                          PIC X(4) VALUE "%36" & X"36".
   02 FILLER                          PIC X(4) VALUE "%37" & X"37".
   02 FILLER                          PIC X(4) VALUE "%38" & X"38".
   02 FILLER                          PIC X(4) VALUE "%39" & X"39".
   02 FILLER                          PIC X(4) VALUE "%3A" & X"3A".
   02 FILLER                          PIC X(4) VALUE "%3B" & X"3B".
   02 FILLER                          PIC X(4) VALUE "%3C" & X"3C".
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   02 FILLER                       PIC X(4) VALUE "%3D" & X"3D".
   02 FILLER                       PIC X(4) VALUE "%3E" & X"3E".
   02 FILLER                       PIC X(4) VALUE "%3F" & X"3F".

   02 FILLER                       PIC X(4) VALUE "%40" & X"40".
   02 FILLER                       PIC X(4) VALUE "%41" & X"41".
   02 FILLER                       PIC X(4) VALUE "%42" & X"42".
   02 FILLER                       PIC X(4) VALUE "%43" & X"43".
   02 FILLER                       PIC X(4) VALUE "%44" & X"44".
   02 FILLER                       PIC X(4) VALUE "%45" & X"45".
   02 FILLER                       PIC X(4) VALUE "%46" & X"46".
   02 FILLER                       PIC X(4) VALUE "%47" & X"47".
   02 FILLER                       PIC X(4) VALUE "%48" & X"48".
   02 FILLER                       PIC X(4) VALUE "%49" & X"49".
   02 FILLER                       PIC X(4) VALUE "%4A" & X"4A".
   02 FILLER                       PIC X(4) VALUE "%4B" & X"4B".
   02 FILLER                       PIC X(4) VALUE "%4C" & X"4C".
   02 FILLER                       PIC X(4) VALUE "%4D" & X"4D".
   02 FILLER                       PIC X(4) VALUE "%4E" & X"4E".
   02 FILLER                       PIC X(4) VALUE "%4F" & X"4F".

   02 FILLER                       PIC X(4) VALUE "%50" & X"50".
   02 FILLER                       PIC X(4) VALUE "%51" & X"51".
   02 FILLER                       PIC X(4) VALUE "%52" & X"52".
   02 FILLER                       PIC X(4) VALUE "%53" & X"53".
   02 FILLER                       PIC X(4) VALUE "%54" & X"54".
   02 FILLER                       PIC X(4) VALUE "%55" & X"55".
   02 FILLER                       PIC X(4) VALUE "%56" & X"56".
   02 FILLER                       PIC X(4) VALUE "%57" & X"57".
   02 FILLER                       PIC X(4) VALUE "%58" & X"58".
   02 FILLER                       PIC X(4) VALUE "%59" & X"59".
   02 FILLER                       PIC X(4) VALUE "%5A" & X"5A".
   02 FILLER                       PIC X(4) VALUE "%5B" & X"5B".
   02 FILLER                       PIC X(4) VALUE "%5C" & X"5C".
   02 FILLER                       PIC X(4) VALUE "%5D" & X"5D".
   02 FILLER                       PIC X(4) VALUE "%5E" & X"5E".
   02 FILLER                       PIC X(4) VALUE "%5F" & X"5F".

   02 FILLER                       PIC X(4) VALUE "%60" & X"60".
   02 FILLER                       PIC X(4) VALUE "%61" & X"61".
   02 FILLER                       PIC X(4) VALUE "%62" & X"62".
   02 FILLER                       PIC X(4) VALUE "%63" & X"63".
   02 FILLER                       PIC X(4) VALUE "%64" & X"64".
   02 FILLER                       PIC X(4) VALUE "%65" & X"65".
   02 FILLER                       PIC X(4) VALUE "%66" & X"66".
   02 FILLER                       PIC X(4) VALUE "%67" & X"67".
   02 FILLER                       PIC X(4) VALUE "%68" & X"68".
   02 FILLER                       PIC X(4) VALUE "%69" & X"69".
   02 FILLER                       PIC X(4) VALUE "%6A" & X"6A".
   02 FILLER                       PIC X(4) VALUE "%6B" & X"6B".
   02 FILLER                       PIC X(4) VALUE "%6C" & X"6C".
   02 FILLER                       PIC X(4) VALUE "%6D" & X"6D".
   02 FILLER                       PIC X(4) VALUE "%6E" & X"6E".
   02 FILLER                       PIC X(4) VALUE "%6F" & X"6F".

   02 FILLER                       PIC X(4) VALUE "%70" & X"70".
   02 FILLER                       PIC X(4) VALUE "%71" & X"71".
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   02 FILLER                          PIC X(4) VALUE "%72" & X"72".
   02 FILLER                          PIC X(4) VALUE "%73" & X"73".
   02 FILLER                          PIC X(4) VALUE "%74" & X"74".
   02 FILLER                          PIC X(4) VALUE "%75" & X"75".
   02 FILLER                          PIC X(4) VALUE "%76" & X"76".
   02 FILLER                          PIC X(4) VALUE "%77" & X"77".
   02 FILLER                          PIC X(4) VALUE "%78" & X"78".
   02 FILLER                          PIC X(4) VALUE "%79" & X"79".
   02 FILLER                          PIC X(4) VALUE "%7A" & X"7A".
   02 FILLER                          PIC X(4) VALUE "%7B" & X"7B".
   02 FILLER                          PIC X(4) VALUE "%7C" & X"7C".
   02 FILLER                          PIC X(4) VALUE "%7D" & X"7D".
   02 FILLER                          PIC X(4) VALUE "%7E" & X"7E".
   02 FILLER                          PIC X(4) VALUE "%7F" & X"7F".

   02 FILLER                          PIC X(4) VALUE "%80" & X"80".
   02 FILLER                          PIC X(4) VALUE "%81" & X"81".
   02 FILLER                          PIC X(4) VALUE "%82" & X"82".
   02 FILLER                          PIC X(4) VALUE "%83" & X"83".
   02 FILLER                          PIC X(4) VALUE "%84" & X"84".
   02 FILLER                          PIC X(4) VALUE "%85" & X"85".
   02 FILLER                          PIC X(4) VALUE "%86" & X"86".
   02 FILLER                          PIC X(4) VALUE "%87" & X"87".
   02 FILLER                          PIC X(4) VALUE "%88" & X"88".
   02 FILLER                          PIC X(4) VALUE "%89" & X"89".
   02 FILLER                          PIC X(4) VALUE "%8A" & X"8A".
   02 FILLER                          PIC X(4) VALUE "%8B" & X"8B".
   02 FILLER                          PIC X(4) VALUE "%8C" & X"8C".
   02 FILLER                          PIC X(4) VALUE "%8D" & X"8D".
   02 FILLER                          PIC X(4) VALUE "%8E" & X"8E".
   02 FILLER                          PIC X(4) VALUE "%8F" & X"8F".

   02 FILLER                          PIC X(4) VALUE "%90" & X"90".
   02 FILLER                          PIC X(4) VALUE "%91" & X"91".
   02 FILLER                          PIC X(4) VALUE "%92" & X"92".
   02 FILLER                          PIC X(4) VALUE "%93" & X"93".
   02 FILLER                          PIC X(4) VALUE "%94" & X"94".
   02 FILLER                          PIC X(4) VALUE "%95" & X"95".
   02 FILLER                          PIC X(4) VALUE "%96" & X"96".
   02 FILLER                          PIC X(4) VALUE "%97" & X"97".
   02 FILLER                          PIC X(4) VALUE "%98" & X"98".
   02 FILLER                          PIC X(4) VALUE "%99" & X"99".
   02 FILLER                          PIC X(4) VALUE "%9A" & X"9A".
   02 FILLER                          PIC X(4) VALUE "%9B" & X"9B".
   02 FILLER                          PIC X(4) VALUE "%9C" & X"9C".
   02 FILLER                          PIC X(4) VALUE "%9D" & X"9D".
   02 FILLER                          PIC X(4) VALUE "%9E" & X"9E".
   02 FILLER                          PIC X(4) VALUE "%9F" & X"9F".

   02 FILLER                          PIC X(4) VALUE "%A0" & X"A0".
   02 FILLER                          PIC X(4) VALUE "%A1" & X"A1".
   02 FILLER                          PIC X(4) VALUE "%A2" & X"A2".
   02 FILLER                          PIC X(4) VALUE "%A3" & X"A3".
   02 FILLER                          PIC X(4) VALUE "%A4" & X"A4".
   02 FILLER                          PIC X(4) VALUE "%A5" & X"A5".
   02 FILLER                          PIC X(4) VALUE "%A6" & X"A6".
   02 FILLER                          PIC X(4) VALUE "%A7" & X"A7".
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   02 FILLER                          PIC X(4) VALUE "%A8" & X"A8".
   02 FILLER                          PIC X(4) VALUE "%A9" & X"A9".
   02 FILLER                          PIC X(4) VALUE "%AA" & X"AA".
   02 FILLER                          PIC X(4) VALUE "%AB" & X"AB".
   02 FILLER                          PIC X(4) VALUE "%AC" & X"AC".
   02 FILLER                          PIC X(4) VALUE "%AD" & X"AD".
   02 FILLER                          PIC X(4) VALUE "%AE" & X"AE".
   02 FILLER                          PIC X(4) VALUE "%AF" & X"AF".

   02 FILLER                          PIC X(4) VALUE "%B0" & X"B0".
   02 FILLER                          PIC X(4) VALUE "%B1" & X"B1".
   02 FILLER                          PIC X(4) VALUE "%B2" & X"B2".
   02 FILLER                          PIC X(4) VALUE "%B3" & X"B3".
   02 FILLER                          PIC X(4) VALUE "%B4" & X"B4".
   02 FILLER                          PIC X(4) VALUE "%B5" & X"B5".
   02 FILLER                          PIC X(4) VALUE "%B6" & X"B6".
   02 FILLER                          PIC X(4) VALUE "%B7" & X"B7".
   02 FILLER                          PIC X(4) VALUE "%B8" & X"B8".
   02 FILLER                          PIC X(4) VALUE "%B9" & X"B9".
   02 FILLER                          PIC X(4) VALUE "%BA" & X"BA".
   02 FILLER                          PIC X(4) VALUE "%BB" & X"BB".
   02 FILLER                          PIC X(4) VALUE "%BC" & X"BC".
   02 FILLER                          PIC X(4) VALUE "%BD" & X"BD".
   02 FILLER                          PIC X(4) VALUE "%BE" & X"BE".
   02 FILLER                          PIC X(4) VALUE "%BF" & X"BF".

   02 FILLER                          PIC X(4) VALUE "%C0" & X"C0".
   02 FILLER                          PIC X(4) VALUE "%C1" & X"C1".
   02 FILLER                          PIC X(4) VALUE "%C2" & X"C2".
   02 FILLER                          PIC X(4) VALUE "%C3" & X"C3".
   02 FILLER                          PIC X(4) VALUE "%C4" & X"C4".
   02 FILLER                          PIC X(4) VALUE "%C5" & X"C5".
   02 FILLER                          PIC X(4) VALUE "%C6" & X"C6".
   02 FILLER                          PIC X(4) VALUE "%C7" & X"C7".
   02 FILLER                          PIC X(4) VALUE "%C8" & X"C8".
   02 FILLER                          PIC X(4) VALUE "%C9" & X"C9".
   02 FILLER                          PIC X(4) VALUE "%CA" & X"CA".
   02 FILLER                          PIC X(4) VALUE "%CB" & X"CB".
   02 FILLER                          PIC X(4) VALUE "%CC" & X"CC".
   02 FILLER                          PIC X(4) VALUE "%CD" & X"CD".
   02 FILLER                          PIC X(4) VALUE "%CE" & X"CE".
   02 FILLER                          PIC X(4) VALUE "%CF" & X"CF".

   02 FILLER                          PIC X(4) VALUE "%D0" & X"D0".
   02 FILLER                          PIC X(4) VALUE "%D1" & X"D1".
   02 FILLER                          PIC X(4) VALUE "%D2" & X"D2".
   02 FILLER                          PIC X(4) VALUE "%D3" & X"D3".
   02 FILLER                          PIC X(4) VALUE "%D4" & X"D4".
   02 FILLER                          PIC X(4) VALUE "%D5" & X"D5".
   02 FILLER                          PIC X(4) VALUE "%D6" & X"D6".
   02 FILLER                          PIC X(4) VALUE "%D7" & X"D7".
   02 FILLER                          PIC X(4) VALUE "%D8" & X"D8".
   02 FILLER                          PIC X(4) VALUE "%D9" & X"D9".
   02 FILLER                          PIC X(4) VALUE "%DA" & X"DA".
   02 FILLER                          PIC X(4) VALUE "%DB" & X"DB".
   02 FILLER                          PIC X(4) VALUE "%DC" & X"DC".
   02 FILLER                          PIC X(4) VALUE "%DD" & X"DD".
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```
  02 FILLER                           PIC X(4) VALUE "%DE" & X"DE".
  02 FILLER                           PIC X(4) VALUE "%DF" & X"DF".

  02 FILLER                           PIC X(4) VALUE "%E0" & X"E0".
  02 FILLER                           PIC X(4) VALUE "%E1" & X"E1".
  02 FILLER                           PIC X(4) VALUE "%E2" & X"E2".
  02 FILLER                           PIC X(4) VALUE "%E3" & X"E3".
  02 FILLER                           PIC X(4) VALUE "%E4" & X"E4".
  02 FILLER                           PIC X(4) VALUE "%E5" & X"E5".
  02 FILLER                           PIC X(4) VALUE "%E6" & X"E6".
  02 FILLER                           PIC X(4) VALUE "%E7" & X"E7".
  02 FILLER                           PIC X(4) VALUE "%E8" & X"E8".
  02 FILLER                           PIC X(4) VALUE "%E9" & X"E9".
  02 FILLER                           PIC X(4) VALUE "%EA" & X"EA".
  02 FILLER                           PIC X(4) VALUE "%EB" & X"EB".
  02 FILLER                           PIC X(4) VALUE "%EC" & X"EC".
  02 FILLER                           PIC X(4) VALUE "%ED" & X"ED".
  02 FILLER                           PIC X(4) VALUE "%EE" & X"EE".
  02 FILLER                           PIC X(4) VALUE "%EF" & X"EF".

  02 FILLER                           PIC X(4) VALUE "%F0" & X"F0".
  02 FILLER                           PIC X(4) VALUE "%F1" & X"F1".
  02 FILLER                           PIC X(4) VALUE "%F2" & X"F2".
  02 FILLER                           PIC X(4) VALUE "%F3" & X"F3".
  02 FILLER                           PIC X(4) VALUE "%F4" & X"F4".
  02 FILLER                           PIC X(4) VALUE "%F5" & X"F5".
  02 FILLER                           PIC X(4) VALUE "%F6" & X"F6".
  02 FILLER                           PIC X(4) VALUE "%F7" & X"F7".
  02 FILLER                           PIC X(4) VALUE "%F8" & X"F8".
  02 FILLER                           PIC X(4) VALUE "%F9" & X"F9".
  02 FILLER                           PIC X(4) VALUE "%FA" & X"FA".
  02 FILLER                           PIC X(4) VALUE "%FB" & X"FB".
  02 FILLER                           PIC X(4) VALUE "%FC" & X"FC".
  02 FILLER                           PIC X(4) VALUE "%FD" & X"FD".
  02 FILLER                           PIC X(4) VALUE "%FE" & X"FE".
  02 FILLER                           PIC X(4) VALUE "%FF" & X"FF".

01 WS-DECODE-TAB REDEFINES WS-DECODE-TABLE.
  02 WS-DECODE-TAB-LINE               OCCURS 1 TO 256 TIMES
                                      ASCENDING KEY IS WS-DECODE-TAB-UTF8-STR
                                      INDEXED BY WS-DECODE-TAB-INDEX.
    03 WS-DECODE-TAB-UTF8-STR         PIC X(3).
    03 WS-DECODE-TAB-UTF8-VAL         PIC X(1).

LINKAGE SECTION.
01 LNK-UTF8-STR                       PIC X(3).
01 LNK-UTF8-VAL                       PIC X(1).

PROCEDURE DIVISION USING     BY VALUE LNK-UTF8-STR
                  RETURNING          LNK-UTF8-VAL.

COB2CGI-DECODE-MAIN SECTION.

   SET WS-DECODE-TAB-INDEX TO 1
   SEARCH ALL WS-DECODE-TAB-LINE
      AT END
         *> not found --> gives space back
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```
           MOVE X"20"
             TO LNK-UTF8-VAL

       WHEN WS-DECODE-TAB-UTF8-STR(WS-DECODE-TAB-INDEX) = LNK-UTF8-STR
           MOVE WS-DECODE-TAB-UTF8-VAL(WS-DECODE-TAB-INDEX)
             TO LNK-UTF8-VAL
    END-SEARCH

    GOBACK

    .
 COB2CGI-DECODE-MAIN-EX.
    EXIT.
 END FUNCTION COB2CGI-DECODE.

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*>*****************************************************************************

*>*****************************************************************************
*> Function:     COB2CGI-NUM2HEX.cob
*>
*> Purpose:      Convert a number in hexa
*>
*> Author:       Laszlo Erdos - https://www.facebook.com/wortfee
*>
*> Date-Written: 2015.08.21
*>
*> Usage:        To use this function, simply CALL it as follows:
*>               COB2CGI-NUM2HEX(<number>)
*>               Fields in COB2CGI-NUM2HEX linkage:
*>                 <number>      - input
*>                 <hexa string> - output
*>*****************************************************************************

 IDENTIFICATION DIVISION.
 FUNCTION-ID. COB2CGI-NUM2HEX.
 AUTHOR.      Laszlo Erdos.

 ENVIRONMENT DIVISION.
 DATA DIVISION.
 WORKING-STORAGE SECTION.

 01 COB2CGI-NUM2HEX-IN                    PIC 9(2) COMP-5.
 01 COB2CGI-NUM2HEX-OUT                   PIC X(2).
```

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```
 01 COB2CGI-NUM2HEX-QUOTIENT               PIC 9(2) COMP-5.
 01 COB2CGI-NUM2HEX-REMAINDER              PIC 9(2) COMP-5.
 01 COB2CGI-HEX-CHAR                       PIC X(16)
                                           VALUE "0123456789ABCDEF".
 01 COB2CGI-IND-1                          PIC 9(2) COMP-5.

 LINKAGE SECTION.
 01 LNK-NUM-DATA                          PIC X(1).
 01 LNK-NUM-DATA-R REDEFINES LNK-NUM-DATA PIC 9(2) COMP-5.
 01 LNK-HEX-DATA                          PIC X(2).

 PROCEDURE DIVISION USING     BY VALUE LNK-NUM-DATA
                   RETURNING          LNK-HEX-DATA.

 COB2CGI-NUM2HEX-MAIN SECTION.

    INITIALIZE LNK-HEX-DATA

    MOVE LNK-NUM-DATA-R TO COB2CGI-NUM2HEX-IN

    INITIALIZE COB2CGI-NUM2HEX-OUT

    PERFORM VARYING COB2CGI-IND-1 FROM 2 BY -1
            UNTIL   COB2CGI-IND-1 < 1

       DIVIDE COB2CGI-NUM2HEX-IN BY 16
          GIVING    COB2CGI-NUM2HEX-QUOTIENT
          REMAINDER COB2CGI-NUM2HEX-REMAINDER
       END-DIVIDE

       ADD 1 TO COB2CGI-NUM2HEX-REMAINDER

       MOVE COB2CGI-HEX-CHAR(COB2CGI-NUM2HEX-REMAINDER:1)
         TO COB2CGI-NUM2HEX-OUT(COB2CGI-IND-1:1)

       MOVE COB2CGI-NUM2HEX-QUOTIENT
         TO COB2CGI-NUM2HEX-IN
    END-PERFORM

    MOVE COB2CGI-NUM2HEX-OUT  TO LNK-HEX-DATA

    GOBACK

    .
 COB2CGI-NUM2HEX-MAIN-EX.
    EXIT.
 END FUNCTION COB2CGI-NUM2HEX.
```

As with all of László's contributions, there is also a sample `Makefile`, to get you up and rolling quickly.

```
cgibin=/srv/www/cgi-bin
htdocs=/srv/www/htdocs

all:    cgiform.exe

# compile
cgiform.exe:    cgiform.cob
```

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```
        cobc -x -free cgiform.cob -o cgiform.exe
        cp cgiform.exe $(cgibin)/cgiform
        cp cgiform.html $(htdocs)/cgiform.html

clean:
        rm cgiform.exe
        rm $(cgibin)/cgiform
        rm $(htdocs)/cgiform.html
```

And some small Cygwin starter scripts.

`cygwin_apache_start.sh`

```
# Before you start Apache, you have to install cygserver
# as a Windows Service. Check this file: /bin/cygserver-config.
#
# Important File Locations
# - httpd.conf:
# c:/cygwin/etc/apache2/httpd.conf
#
# - HTML files:
# c:/cygwin/srv/www/htdocs/index.html
#
# Verifying that Apache is running
# In a browser try the following URL.
# http://localhost
# You should be happy to see a page that says "It Works"
#
# Issues:
# - Installed as Service but doesn't start.
#
#   Check that you installed Cygwin for All Users.
#   Just run Cygwin's setup program again and click "All Users"
#   and you should be all set.

# Running Apache2
/usr/sbin/apachectl2 start
```

and finally, `cygwin_apache_stop.sh`

```
# Stop Apache2
/usr/sbin/apachectl2 stop
```

With that example, you should now be ready to take on the web with GnuCOBOL programming. Many thanks to László Erdős for sharing his creations and hard work.

Click *CGIFORM* (page 548) to skip to the top of the listings.

5.2 What is ocdoc?

ocdoc is a small utility used to annotate sample programs and to support generation of Usage Documentation using COBOL sourced ReStructuredText extract lines.

ocdoc.cob

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *><* ====================
      *><* ocdoc.cob usage guide
      *><* ====================
      *><* .. sidebar:: Table of Contents
      *><*
      *><*     .. contents:: :local:
      *><*
      *><* :Author:    Brian Tiffin
      *><* :Date:      30-Sep-2008
      *><* :Rights:    Copyright (c) 2008, Brian Tiffin.
      *><*             GNU FDL License.
      *><* :Purpose:   Extract usage document lines from COBOL sources.
      *><*             Using GnuCOBOL 1.1pr.  GnuCOBOL is tasty.
      *><* :Tectonics: cobc -x ocdoc.cob
      *><* :Docgen:    $ ./ocdoc ocdoc.cob ocdoc.rst ocdoc.html skin.css
      *> ************************************************************
      *><*
      *><* ------------
      *><* Command line
      *><* ------------
      *><* *ocdoc* runs in two forms.
      *><*
      *><* Without arguments, *ocdoc* will act as a pipe filter.
      *><* Reading from standard in and writing the extract to standard
      *><+  out.
      *><*
      *><* The *ocdoc* command also takes an input file, an extract
      *><+  filename, an optional result file (with optional
      *><+  stylesheet) and a verbosity option *-v* or a
      *><+  special *-fixed* flag (to force skipping sequence numbers).
      *><* If a result file is given, ocdoc will automatically
      *><* run an *rst2html* command using the SYSTEM service.
      *><*
      *><* Due to an overly simplistic argument handler, you can only
      *><+  turn on verbosity or -fixed when using all four filenames.
      *><*
      *><* Examples::
      *><*
      *><*   $ cat ocdoc.cob | ocdoc >ocdoc.rst
      *><*   $ ./ocdoc ocdoc.cob ocdoc.rst
      *><*   $ ./ocdoc ocdoc.cob ocdoc.rst
      *><+  ocdoc.html skin.css -fixed
      *><*   ...
      *><*   Input  : ocdoc.cob
      *><*   Output : ocdoc.rst
      *><*   Command: rst2html --stylesheet=skin.css
      *><+  ocdoc.rst ocdoc.html
      *><*
      *><* -----------------
      *><* What is extracted
      *><* -----------------
      *><* - Lines that begin with \*><\* *ignoring spaces*, are
      *><+  extracted.
      *><*
      *><* - Lines that begin with \*><+ are appended to the
```

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```
      *><+  previous output line.  As lines are trimmed of trailing
      *><+  spaces, and *ocdoc* removes the space following the
      *><+  extract triggers, you may need two spaces after an
      *><+  ocdoc append.
      *><*
      *><* - Lines that begin with \*><[ begin a here document
      *><+  with lines that follow extracted as is.
      *><*
      *><* - Lines that begin with \*><] close a here document.
      *><+  Here document start and end lines are excluded from the
      *><+  extract.
      *><*
      *><* -----------
      *><* Source code
      *><* -----------
      *><* `Download ocdoc.cob
      *><+  <http://opencobol.add1tocobol.com/ocdoc.cob>`_
      *><* `See ocdocseq.cob
      *><+  <http://opencobol.add1tocobol.com/ocdocseq.html>`_
      *><*
      *><! This is not extracted. Reminder of how to include source
      *><! .. include:: ocdoc.cob
      *><!    :literal:
      *><*
      *><* ------------------------
      *><* identification division
      *><* ------------------------
      *><*
      *><* ::
      *><*
      *><[
       identification division.
       program-id. OCDOC.

       environment division.
       input-output section.
       file-control.
           select standard-input assign to KEYBOARD.
           select standard-output assign to DISPLAY.

           select source-input
           assign to source-name
           organization is line sequential
           .
           select doc-output
           assign to doc-name
           organization is line sequential
           .
      *><]
      *><*
      *><* -------------
      *><* data division
      *><* -------------
      *><*
      *><* ::
      *><*
      *><[
```

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```
       data division.
       file section.
       fd standard-input.
          01 stdin-record      pic x(256).
       fd standard-output.
          01 stdout-record     pic x(256).

       fd source-input.
          01 source-record     pic x(256).
       fd doc-output.
          01 doc-record        pic x(256).

       working-storage section.
       01 arguments            pic x(256).
       01 source-name          pic x(256).
       01 doc-name             pic x(256).
       01 result-name          pic x(256).
       01 style-name           pic x(256).
       01 verbosity            pic x(9).
          88 verbose           values "-v" "--v" "-verbose" "--verbose".
          88 skipseqnum        values "-fix" "-fixed" "--fix" "--fixed".
       01 usagehelp            pic x(6).
          88 helping           values "-h" "--h" "-help" "--help".
       01 filter-flag          pic x value low-value.
          88 filtering         value high-value.

       01 line-count           usage binary-long.
       01 line-display         pic z(8)9.

      *><]
      *><*
      *><* Note the conditional test for end of here doc
      *><*
      *><* ::
      *><*
      *><[
       01 trimmed              pic x(256).
          88 herestart         value "*><[".
          88 hereend           value "*><]".

       01 hereflag             pic x value low-value.
          88 heredoc           value high-value.
          88 herenone          value low-value.

      *><]
      *><*
      *><* Note the here-record adds an ocdoc extract to lines that
      *><+  follow.
      *><*
      *><* ::
      *><*
      *><[
       01 here-record.
          02 filler            pic x(5) value "*><* ".
          02 here-data         pic x(251).

       01 seq-record.
```

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```
           02 filler            pic x(7) value "       ".
           02 seq-data          pic x(249).

        01 doc-buffer           pic x(256).
        01 buffer-offset        pic 999 usage comp-5 value 1.
        01 buffer-flag          pic x value low-value.
           88 buffer-empty      value low-value.
           88 buffered-output   value high-value.

        01 counter              pic 999 usage comp-5.
        01 len-of-comment       pic 999 usage comp-5.

        01 first-part           pic x(8).
           88 special           values "*><*" "*><+".
           88 autodoc           value "*><*".
           88 autoappend        value "*><+".

        01 rst-command          pic x(256).
        01 result               usage binary-long.
      *><]
      *><*
      *><* ------------------
      *><* procedure division
      *><* ------------------
      *><*
      *><* ::
      *><*
      *><[
      *> ****************************************************************
       procedure division.

      *><]
      *><*
      *><* Accept command line arguments.  See if help requested.
      *><*
      *><* ::
      *><*
      *><[
       accept arguments from command-line end-accept

       move arguments to usagehelp
       if helping
           display
               "$ ./ocdoc source markover [output [skin [--fixed]]]"
           end-display
           display "$ ./ocdoc" end-display
           display
               "    without arguments extracts stdin to stdout"
           end-display
           goback
       end-if

      *><]
      *><*
      *><* Either run as filter or open given files.  Two filenames
      *><+  will generate an extract.  Three will run the extract
      *><+  through *rst2html* using an optional fourth filename
```

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```
      *><+  as a stylesheet.
      *><*
      *><* ::
      *><*
      *><[
      *> Determine if this is running as a filter
       if arguments not equal spaces
           unstring arguments delimited by all spaces
               into source-name doc-name
                    result-name style-name
                    verbosity
           end-unstring

           open input source-input
           open output doc-output
       else
           set filtering to true

           open input standard-input
           open output standard-output
       end-if

      *><]
      *><*
      *><* Initialize the output buffer, and line count.
      *><*
      *><* ::
      *><*
      *><[
       set buffer-empty to true
       move 1 to buffer-offset
       move spaces to doc-record
       move 0 to line-count

      *><]
      *><*
      *><* The read is either from file or stdin.  Start with the
      *><+  first record.
      *><*
      *><* ::
      *><*
      *><[
      *> filtering requires different reader loop
       if filtering
           read standard-input
               at end move high-values to stdin-record
           end-read
           move stdin-record to source-record
       else
           read source-input
               at end move high-values to source-record
           end-read
       end-if

      *><]
      *><*
      *><* The main loop starts here, having done a pre-read to start
```

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```
      *><+  things off.
      *><*
      *><* ::
      *><*
      *><[
       perform until source-record = high-values
           add 1 to line-count

      *><]
      *><*
      *><* Small wrinkle if processing fixed form with sequence numbers,
      *><+  as the heredoc end marker needs to be recognized
      *><+  but we still want the sequence numbers in the heredoc.
      *><*
      *><* So files processed --fixed play some data shuffling games.
      *><*
      *><* ::
      *><*
      *><[
           if skipseqnum
               if heredoc
                   move source-record(7 : 248) to trimmed
                   move source-record to seq-data
                   move seq-record to source-record
               else
                   move source-record(7 : 248) to source-record
                   move source-record to trimmed
               end-if
           else
               move function trim(source-record leading) to trimmed
           end-if

      *><]
      *><*
      *><* First to check for here doc start and end, setting flag
      *><+  if trimmed conditional the heredoc start or heredoc end
      *><+  strings.
      *><*
      *><* ::
      *><*
      *><[
           if herestart
               set heredoc to true
           end-if

           if hereend
               set herenone to true
           end-if

      *><]
      *><*
      *><* Inside the loop, we skip over heredoc entries.
      *><+  If it is normal, than check for heredoc and include
      *><+  source lines that follow, by prepending the extract tag
      *><*
      *><* ::
      *><*
```

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```
      *><[
           if (not herestart) and (not hereend)
               if heredoc
                   move source-record to here-data
                   move here-record to trimmed
               end-if

      *><]
      *><*
      *><* Unstring the line, looking for special tags in the first
      *><+  part.
      *><*
      *><* ::
      *><*
      *><[
               unstring trimmed delimited by all spaces
                   into first-part
                       count in counter
               end-unstring

      *><]
      *><*
      *><* If special, we either buffer or append to buffer
      *><*
      *><* ::
      *><*
      *><[
               evaluate true when special
                   if autoappend and buffer-empty
                       move spaces to doc-record
                       move 1 to buffer-offset
                   end-if

                   if autodoc and buffered-output
                       if filtering
                           move doc-record to stdout-record
                           write stdout-record end-write
                       else
                           write doc-record end-write
                       end-if
                       if verbose
                           display
                               function trim(doc-record trailing)
                           end-display
                       end-if
                       move spaces to doc-record
                       set buffer-empty to true
                       move 1 to buffer-offset
                   end-if

      *><]
      *><*
      *><* Skip over where the tag was found plus an extra space.
      *><* Adding 2 skips over the assumed space after a special tag
      *><*
      *><* ::
      *><*
```

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```
      *><[
                  add 2 to counter
                  compute len-of-comment =
                      function length(trimmed) - counter
                  end-compute

                  if len-of-comment > 0
                      move trimmed(counter : len-of-comment)
                          to doc-buffer
                  else
                      move spaces to doc-buffer
                  end-if

      *><]
      *><*
      *><* Buffer the line, either to position 1 or appending to last.
      *><*
      *><* ::
      *><*
      *><[
                  string
                      function trim(doc-buffer trailing)
                          delimited by size
                      into doc-record
                      with pointer buffer-offset
                      on overflow
                          move line-count to line-display
                          display
                              "*** truncation *** reading line "
                              line-display
                          end-display
                  end-string
                  set buffered-output to true
              end-evaluate
          end-if

      *><]
      *><*
      *><* Again, we either read the next record from file or stdin.
      *><*
      *><* ::
      *><*
      *><[
          if filtering
              read standard-input
                  at end move high-values to stdin-record
              end-read
              move stdin-record to source-record
          else
              read source-input
                  at end move high-values to source-record
              end-read
          end-if
       end-perform

      *><]
      *><*
```

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```
      *><* We may or may not end up with buffered data
      *><*
      *><* ::
      *><*
      *><[
       if buffered-output
           set buffer-empty to true
           move 1 to buffer-offset
           if filtering
               move doc-record to stdout-record
               write stdout-record end-write
           else
               write doc-record end-write
           end-if
           if verbose
                display
                   function trim(doc-record trailing)
                end-display
           end-if
           move spaces to doc-record
       end-if

      *><]
      *><*
      *><* Close the GnuCOBOL files
      *><*
      *><* ::
      *><*
      *><[
       if filtering
           close standard-output
           close standard-input
       else
           close doc-output
           close source-input
       end-if

       if verbose
           display "Input  : " function trim(source-name) end-display
           display "Output : " function trim(doc-name) end-display
       end-if

      *><]
      *><*
      *><* If we have a result file, use the SYSTEM service to
      *><+  generate an HTML file, possibly with stylesheet.
      *><*
      *><* ::
      *><*
      *><[
      *> pass the extract through a markover, in this case ReST
       move spaces to rst-command
       if result-name not equal spaces
           if style-name equal spaces
               string
                   "rst2html " delimited by size
                   doc-name delimited by space
```

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```
                    " " delimited by size
                    result-name delimited by space
                    into rst-command
                end-string
            else
                string
                    "rst2html --stylesheet=" delimited by size
                    style-name delimited by space
                    " " delimited by size
                    doc-name delimited by space
                    " " delimited by size
                    result-name delimited by space
                    into rst-command
                end-string
            end-if

            if verbose
                display
                    "Command: "
                    function trim(rst-command trailing)
                end-display
            end-if

            call "SYSTEM"
                using rst-command
                returning result
            end-call

            if result not equal zero
                display "HTML generate failed: " result end-display
            end-if
        end-if

      *><]
      *><*
      *><* And before you know it, we are done.
      *><*
      *><* ::
      *><*
      *><[
       goback.

       end program OCDOC.
      *><]
      *><*
      *><* Don't forget to visit http://opencobol.org
      *><*
      *><* Cheers
      *><*
      *><* *Last edit:* 03-Oct-2008
```

5.2.1 ocdoc generated ocdoc documentation

See ocdoc.html for the output from processing *ocdoc.cob* with **ocdoc** using the tectonics listed in the source. skin.css ends up embedded in the html.

```
$ cobc -x ocdoc.cob
$ ./ocdoc ocdoc.cob ocdoc.rst ocdoc.html skin.css
```

5.3 What is CBL_OC_DUMP?

CBL_OC_DUMP is somewhat of a community challenge application to allow for runtime data dumps. Multiple postings to opencobol.org has refined the hex display callable to:

```
GCobol >>SOURCE FORMAT IS FIXED
      *-----------------------------------------------------------------
      * Authors:   Brian Tiffin, Asger Kjelstrup, human
      * Date:      27-Jan-2010
      * Purpose:   Hex Dump display
      * Tectonics: cobc -c CBL_OC_DUMP.cob
      *     Usage: cobc -x program.cob -o CBL_OC_DUMP
      *            export OC_DUMP_EXT=1 for explanatory text on dumps
      *            (memory address and dump length)
      *            export OC_DUMP_EXT=Y for extended explanatory text
      *            (architecture   and endian-order)
      *-----------------------------------------------------------------
       identification division.
       program-id. CBL_OC_DUMP.
      *
       ENVIRONMENT      DIVISION.
       CONFIGURATION    SECTION.
      *
       data division.
       working-storage section.
       77  addr                              usage pointer.
       77  addr2addr                         usage pointer.
       77  counter               pic 999999 usage comp-5.
       77  byline                pic 999    usage comp-5.
       77  offset                pic 999999.
       01  some                  pic 999    usage comp-5.
           88 some-is-printable-iso88591
              values 32 thru 126, 160 thru 255.
           88 some-is-printable-ebcdic
              values 64, 65, 74 thru 80, 90 thru 97,
                     106 thru 111, 121 thru 127, 129 thru 137, 143,
                     145 thru 153, 159, 161 thru 169, 176,
                     186 thru 188, 192 thru 201, 208 thru 217, 224,
                     226 thru 233, 240 thru 249.
       77  high-var              pic 99     usage comp-5.
       77  low-var               pic 99     usage comp-5.
      *
       01  char-set              pic x(06).
           88 is-ascii           value 'ASCII'.
           88 is-ebdic           value 'EBCDIC'.
           88 is-unknown         value '?'.
       01  architecture          pic x(06).
           88 is-32-bit          value '32-bit'.
           88 is-64-bit          value '64-bit'.
       01  endian-order          pic x(10).
           88 is-big-endian-no   value 'Little-Big'.
           88 is-big-endian-yes  value 'Big-Little'.
```

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```
      *
       77  hex-line              pic x(48).
       77  hex-line-pointer      pic 9(02) value 1.
      *
       77  show                  pic x(16).
       77  dots                  pic x value '.'.
       77  dump-dots             pic x.
      *
       77  hex-digit             pic x(16)  value '0123456789abcdef'.
       01  extended-infos        pic x.
           88 show-extended-infos      values '1', '2', 'Y', 'y'.
           88 show-very-extended-infos values '2', 'Y', 'y'.
      *
       77  len                   pic 999999 usage comp-5.
       77  len-display           pic 999999.
      *
       linkage section.
       01  buffer                pic x       any length.
       77  byte                  pic x.
      * ----------------------------------------------------------------
       procedure division using buffer.
      *
       MAIN SECTION.
       00.
           perform starting-address
      *
           perform varying counter from 0 by 16
                   until   counter  >=   len
              move counter to offset
              move spaces  to hex-line, show
              move '-'     to hex-line (24:01)
              move 1       to hex-line-pointer
              perform varying byline from 1 by 1
                      until   byline  >  16
                 if (counter + byline) > len
                    if byline < 9
                       move space to hex-line (24:01)
                    end-if
                    inspect show (byline:) replacing all spaces by dots
                    exit perform
                 else
                    move buffer (counter + byline : 1) to byte
                    perform calc-hex-value
                    if ((some-is-printable-iso88591 and is-ascii) or
                        (some-is-printable-ebcdic   and is-ebdic)   )
                       move byte to show (byline:1)
                    else
                       move dots to show (byline:1)
                    end-if
                 end-if
              end-perform
              display offset '  ' hex-line '  ' show
              end-display
           end-perform
           display ' '
           end-display
      *
```

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```
           continue.
       ex. exit program.
      *-----------------------------------------------------------------
       CALC-HEX-VALUE SECTION.
       00.
           subtract 1 from function ord(byte) giving some
           end-subtract
           divide   some by 16 giving high-var remainder low-var
           end-divide
           string hex-digit (high-var + 1:1)
                  hex-digit (low-var  + 1:1)
                  space
                  delimited by size
                  into hex-line
                  with pointer hex-line-pointer
           end-string
      *
           continue.
       ex. exit.
      *-----------------------------------------------------------------
       STARTING-ADDRESS SECTION.
       00.
      * Get the length of the transmitted buffer
           CALL 'C$PARAMSIZE' USING 1
              GIVING len
           END-CALL
      * If wanted, change the dots to something different than points
           accept dump-dots from environment 'OC_DUMP_DOTS'
             not on exception
                 move dump-dots to dots
           end-accept
      *
           perform TEST-ASCII
           perform TEST-ENDIAN
           set addr      to address of buffer
           set addr2addr to address of addr
      *
           if len > 0
      * To show hex-address, reverse if Big-Little Endian
              if is-big-endian-yes
                 set addr2addr up   by LENGTH OF addr
                 set addr2addr down by 1
              end-if
              move 1 to hex-line-pointer
              perform varying byline from 1 by 1
                      until byline > LENGTH OF addr
                 set address of byte to addr2addr
                 perform calc-hex-value
                 if is-big-endian-yes
                    set addr2addr down by 1
                 else
                    set addr2addr up   by 1
                 end-if
              end-perform
           end-if
      *
      * Get and display characteristics and headline
```

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```
           accept extended-infos from environment 'OC_DUMP_EXT'
           end-accept
           if show-extended-infos
              display ' '
              end-display
              if len > 0
                 end-display
                 display 'Dump of memory beginning at Hex-address: '
                          hex-line (1 : 3 * (byline - 1) )
                 end-display
              end-if
              move len to len-display
              display 'Length of memory dump is: ' len-display
              end-display
              if show-very-extended-infos
                 perform TEST-64bit
                 display 'Program runs in '
                         architecture ' architecture. '
                         'Char-set is '
                         function trim (char-set) '.'
                 end-display
                 display 'Byte order is ' endian-order
                         ' endian.'
                 end-display
              end-if
           end-if
      *
      * Do we have anything to dump?
           if len > 0
      * Ensure that the passed size is not too big
              if len > 999998
                 move 999998 to len, len-display
                 display 'Warning, only the first '
                         len-display  ' Bytes are shown!'
                 end-display
              end-if
              display ' '
              end-display
              display 'Offset  '
                      'HEX-- -- -- -5 -- -- -- -- 10 '
                      '-- -- -- -- 15 -- '
                      '  '
                      'CHARS----1----5-'
              end-display
           else
              display ' '
              end-display
              display 'Nothing to dump.'
              end-display
           end-if
      *
           continue.
       ex. exit.
      *-----------------------------------------------------------------
       TEST-ASCII SECTION.
      *Function: Discover if running Ascii or Ebcdic
       00.
```

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```
           evaluate space
              when x'20'
                 set  is-ascii   to true
              when x'40'
                 set  is-ebdic   to true
              when other
                 set  is-unknown to true
           end-evaluate
      *
           continue.
       ex. exit.
      *-----------------------------------------------------------------
       TEST-64BIT SECTION.
      *Function: Discover if running 32/64 bit
       00.
      *    Longer pointers in 64-bit architecture
           if function length (addr) <= 4
              set  is-32-bit to true
           else
              set  is-64-bit to true
           end-if
      *
           continue.
       ex. exit.
      *-----------------------------------------------------------------
       TEST-ENDIAN SECTION.
       00.
      *    Number-bytes are shuffled in Big-Little endian
           move 128 to byline
           set address of byte to address of byline
           if function ord(byte) > 0
              set  is-big-endian-yes to true
           else
              set  is-big-endian-no  to true
           end-if
      *
           continue.
       ex. exit.
      *-----------------------------------------------------------------
       end program CBL_OC_DUMP.
```

Example displays:

```
Alpha literal Dump

Offs  HEX-- -- -- 5- -- -- -- -- 10 -- -- -- -- 15 -- CHARS----1----5-
0000  61 62 63 64 65 66 67 68 69 6a 6b 6c 6d 6f 70 71 abcdefghijklmopq
0016  72                                              r...............

Integer Dump: +0000000123

Offs  HEX-- -- -- 5- -- -- -- -- 10 -- -- -- -- 15 -- CHARS----1----5-
0000  7b 00 00 00                                     {...............
```

Or with OC_DUMP_EXT environment variable set to Y:

```
Numeric Literal Dump: 0

Dump of memory beginning at Hex-address: bf 80 fc e4
Program runs in 32-bit architecture. Char-set is ASCII .
Byte order is Big-Little endian.

Offs  HEX-- -- -- 5- -- -- -- -- 10 -- -- -- -- 15 -- CHARS----1----5-
0000  00                                              ................
```

5.3.1 Update to OC_CBL_DUMP

human posted a new version that displays the dump upon SYSERR. Goes to show the activity that can spring forth from a keen and engaged community.

Edit 19-Oct-2010: Put all dump-outputs to syserr. Removed unused paragraphs and minor beauty changes.

```
GCobol >>SOURCE FORMAT IS FIXED
      *-----------------------------------------------------------------
      * Authors:   Brian Tiffin, Asger Kjelstrup, Simon Sobisch
      * Date:      19-Oct-2010
      * Purpose:   Hex Dump display
      * Tectonics: cobc -c CBL_OC_DUMP.cob
      *     Usage: export OC_DUMP_EXT=1 for explanatory text on dumps
      *            (memory address and dump length)
      *            export OC_DUMP_EXT=Y for extended explanatory text
      *            (architecture   and endian-order)
      *-----------------------------------------------------------------
       IDENTIFICATION DIVISION.
       PROGRAM-ID. CBL_OC_DUMP.
      *
       ENVIRONMENT      DIVISION.
       CONFIGURATION    SECTION.
      *
       DATA DIVISION.
       WORKING-STORAGE SECTION.
       77  addr                              usage pointer.
       77  addr2addr                         usage pointer.
       77  counter               pic 999999 usage comp-5.
       77  byline                pic 999    usage comp-5.
       77  offset                pic 999999.
       01  some                  pic 999    usage comp-5.
           88 some-is-printable-iso88591
              values 32 thru 126, 160 thru 255.
           88 some-is-printable-ebcdic
              values 64, 65, 74 thru 80, 90 thru 97,
                     106 thru 111, 121 thru 127, 129 thru 137, 143,
                     145 thru 153, 159, 161 thru 169, 176,
                     186 thru 188, 192 thru 201, 208 thru 217, 224,
                     226 thru 233, 240 thru 249.
       77  high-var              pic 99     usage comp-5.
       77  low-var               pic 99     usage comp-5.
      *
       01  char-set              pic x(06).
           88 is-ascii           value 'ASCII'.
           88 is-ebdic           value 'EBCDIC'.
           88 is-unknown         value '?'.
```

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```
       01  architecture          pic x(06).
           88 is-32-bit          value '32-bit'.
           88 is-64-bit          value '64-bit'.
       01  endian-order          pic x(10).
           88 is-big-endian-no    value 'Little-Big'.
           88 is-big-endian-yes   value 'Big-Little'.
      *
       77  hex-line              pic x(48).
       77  hex-line-pointer      pic 9(02) value 1.
      *
       77  show                  pic x(16).
       77  dots                  pic x value '.'.
       77  dump-dots             pic x.
      *
       77  hex-digit             pic x(16)  value '0123456789abcdef'.
       01  extended-infos        pic x.
           88 show-extended-infos      values '1', '2', 'Y', 'y'.
           88 show-very-extended-infos values '2', 'Y', 'y'.
      *
       77  len                   pic 999999 usage comp-5.
       77  len-display           pic 999999.
      *
       LINKAGE SECTION.
       01  buffer                pic x       any length.
       77  byte                  pic x.
      *-----------------------------------------------------------------
       PROCEDURE DIVISION USING buffer.
      *
      *MAIN SECTION.
      *00.
           perform starting-address
      *
           perform varying counter from 0 by 16
                   until   counter  >=   len
              move counter to offset
              move spaces  to hex-line, show
              move '-'     to hex-line (24:01)
              move 1       to hex-line-pointer
              perform varying byline from 1 by 1
                      until   byline  >  16
                 if (counter + byline) > len
                    if byline < 9
                       move space to hex-line (24:01)
                    end-if
                    inspect show (byline:) replacing all spaces by dots
                    exit perform
                 else
                    move buffer (counter + byline : 1) to byte
                    perform calc-hex-value
                    if ((some-is-printable-iso88591 and is-ascii) or
                        (some-is-printable-ebcdic   and is-ebdic)   )
                       move byte to show (byline:1)
                    else
                       move dots to show (byline:1)
                    end-if
                 end-if
              end-perform
```

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```
               display offset '  ' hex-line '  ' show
                       upon SYSERR
               end-display
           end-perform
           display ' '
                   upon SYSERR
           end-display
      *
           exit program.
      *-----------------------------------------------------------------
       CALC-HEX-VALUE SECTION.
      *00.
           subtract 1 from function ord(byte) giving some
           end-subtract
           divide   some by 16 giving high-var remainder low-var
           end-divide
           string hex-digit (high-var + 1:1)
                  hex-digit (low-var  + 1:1)
                  space
                  delimited by size
                  into hex-line
                  with pointer hex-line-pointer
           end-string
      *
           exit section.
      *-----------------------------------------------------------------
       STARTING-ADDRESS SECTION.
      *00.
      * Get the length of the transmitted buffer
           CALL 'C$PARAMSIZE' USING 1
              GIVING len
           END-CALL
      * If wanted, change the dots to something different than points
           accept dump-dots from environment 'OC_DUMP_DOTS'
             not on exception
                 move dump-dots to dots
           end-accept
      *
           perform TEST-ASCII
           perform TEST-ENDIAN
           set addr      to address of buffer
           set addr2addr to address of addr
      *
           if len > 0
      * To show hex-address, reverse if Big-Little Endian
              if is-big-endian-yes
                 set addr2addr up   by LENGTH OF addr
                 set addr2addr down by 1
              end-if
              move 1 to hex-line-pointer
              perform varying byline from 1 by 1
                      until byline > LENGTH OF addr
                 set address of byte to addr2addr
                 perform calc-hex-value
                 if is-big-endian-yes
                    set addr2addr down by 1
                 else
```

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```
                set addr2addr up   by 1
             end-if
          end-perform
       end-if
      *
      * Get and display characteristics and headline
       accept extended-infos from environment 'OC_DUMP_EXT'
       end-accept
       if show-extended-infos
          display ' '
                  upon SYSERR
          end-display
          if len > 0
             display 'Dump of memory beginning at Hex-address: '
                      hex-line (1 : 3 * (byline - 1) )
                      upon SYSERR
             end-display
          end-if
          move len to len-display
          display 'Length of memory dump is: ' len-display
                   upon SYSERR
          end-display
          if show-very-extended-infos
             perform TEST-64bit
             display 'Program runs in '
                     architecture ' architecture. '
                     'Char-set is '
                     function trim (char-set) '.'
                     upon SYSERR
             end-display
             display 'Byte order is ' endian-order
                     ' endian.'
                     upon SYSERR
             end-display
          end-if
       end-if
      *
      * Do we have anything to dump?
       if len > 0
      * Ensure that the passed size is not too big
          if len > 999998
             move 999998 to len, len-display
             display 'Warning, only the first '
                     len-display  ' Bytes are shown!'
                     upon SYSERR
             end-display
          end-if
          display ' '
                  upon SYSERR
          end-display
          display 'Offset  '
                  'HEX-- -- -- -5 -- -- -- -- 10 '
                  '-- -- -- -- 15 -- '
                  '  '
                  'CHARS----1----5-'
                  upon SYSERR
          end-display
```

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```
           else
              display ' '
                      upon SYSERR
              end-display
              display 'Nothing to dump.'
                      upon SYSERR
              end-display
           end-if
      *
           exit section.
      *-----------------------------------------------------------------
       TEST-ASCII SECTION.
      *Function: Discover if running Ascii or Ebcdic
      *00.
           evaluate space
              when x'20'
                 set  is-ascii   to true
              when x'40'
                 set  is-ebdic   to true
              when other
                 set  is-unknown to true
           end-evaluate
      *
           exit section.
      *-----------------------------------------------------------------
       TEST-64BIT SECTION.
      *Function: Discover if running 32/64 bit
      *00.
      *    Longer pointers in 64-bit architecture
           if function length (addr) <= 4
              set  is-32-bit to true
           else
              set  is-64-bit to true
           end-if
      *
           exit section.
      *-----------------------------------------------------------------
       TEST-ENDIAN SECTION.
      *00.
      *    Number-bytes are shuffled in Big-Little endian
           move 128 to byline
           set  address of byte to address of byline
           if function ord(byte) > 0
              set  is-big-endian-yes to true
           else
              set  is-big-endian-no  to true
           end-if
      *
           exit section.
      *-----------------------------------------------------------------*
       end program CBL_OC_DUMP.
```

5.4 Does GnuCOBOL support any SQL databases?

Yes. There are embedded SQL engines for GnuCOBOL and PostgreSQL, Oracle, and Firebird. There has also been efforts made for accessing DB2.

5.4.1 OCESQL

Brought to us by the developers behind the Open Source COBOL Consortium in Japan. It may require a pass through Google Translate, but see

http://www.osscons.jp/osscobol/download/

and look to **DB interface tool (Open COBOL ESQL) v1.1.0**

Or, if you prefer:

https://github.com/opensourcecobol/Open-COBOL-ESQL

Coded for `./configure; make; make check && sudo make install`

Will require PostgreSQL as well as the PostgreSQL development headers.

While you are on the osscons site, you may want to look at the UTF-8 and SJIS character set versions of the GnuCOBOL compiler.

Running ocesql

What follows is from the `sample/` directory that ships with ocesql-1.0.0.tar.gz.

Please note: for the FAQ, some lines have been deleted, that are commented out in the sample, as they are for use in Japan. The ocesql preprocessor is Unicode ready, but the data entries in Japanese have been removed from the listings here.

Remote network access is via *database@host:port* syntax in the `CONNECT ... USING :DBNAME` shown in the samples below.

First, inserting and populating a sample table, **EMP**, the employees. Fields include (test) employee number, sample name, and sample salary.

`INSERTTBL.cbl`

```
*****************************************************************
*  Open Cobol ESQL (Ocesql) Sample Program
*
*  INSERTTBL -- demonstrates CONNECT, DROP TABLE, CREATE TABLE,
*               INSERT rows, COMMIT, ROLLBACK, DISCONNECT
*
*  Copyright 2013 Tokyo System House Co., Ltd.
*****************************************************************
 IDENTIFICATION              DIVISION.
*****************************************************************
 PROGRAM-ID.                 INSERTTBL.
 AUTHOR.                     TSH.
 DATE-WRITTEN.               2013-06-28.

*****************************************************************
 DATA                        DIVISION.
*****************************************************************
```

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```
 WORKING-STORAGE             SECTION.
 01  TEST-DATA.
                                *>"---+++++++++++++++++++++++----"
   03 FILLER       PIC X(28) VALUE "0001HOKKAI TARO         0400".
   03 FILLER       PIC X(28) VALUE "0002AOMORI JIRO         0350".
   03 FILLER       PIC X(28) VALUE "0003AKITA SABURO        0300".
   03 FILLER       PIC X(28) VALUE "0004IWATE SHIRO         025p".
   03 FILLER       PIC X(28) VALUE "0005MIYAGI GORO         020p".
   03 FILLER       PIC X(28) VALUE "0006FUKUSHIMA RIKURO    0150".
   03 FILLER       PIC X(28) VALUE "0007TOCHIGI SHICHIRO    010p".
   03 FILLER       PIC X(28) VALUE "0008IBARAKI HACHIRO     0050".
   03 FILLER       PIC X(28) VALUE "0009GUMMA KURO          020p".
   03 FILLER       PIC X(28) VALUE "0010SAITAMA JURO        0350".
 01  TEST-DATA-R   REDEFINES TEST-DATA.
   03  TEST-TBL    OCCURS  10.
     05  TEST-NO              PIC S9(04).
     05  TEST-NAME            PIC  X(20) .
     05  TEST-SALARY          PIC S9(04).
 01  IDX                      PIC  9(02).
 01  SYS-TIME                 PIC  9(08).

 EXEC SQL BEGIN DECLARE SECTION END-EXEC.
 01  DBNAME                   PIC  X(30) VALUE SPACE.
 01  USERNAME                 PIC  X(30) VALUE SPACE.
 01  PASSWD                   PIC  X(10) VALUE SPACE.
 01  EMP-REC-VARS.
   03  EMP-NO                 PIC S9(04) VALUE ZERO.
   03  EMP-NAME               PIC  X(20) .
   03  EMP-SALARY             PIC S9(04) VALUE ZERO.
 EXEC SQL END DECLARE SECTION END-EXEC.

 EXEC SQL INCLUDE SQLCA END-EXEC.
******************************************************************
 PROCEDURE                   DIVISION.
******************************************************************
 MAIN-RTN.
     DISPLAY "*** INSERTTBL STARTED ***".

*    WHENEVER IS NOT YET SUPPORTED :(
*      EXEC SQL WHENEVER SQLERROR PERFORM ERROR-RTN END-EXEC.

*    CONNECT
     MOVE  "ocesql"          TO   DBNAME.
     MOVE  "postgres"        TO   USERNAME.
     MOVE  SPACES            TO   PASSWD.
     EXEC SQL
         CONNECT :USERNAME IDENTIFIED BY :PASSWD USING :DBNAME
     END-EXEC.
     IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN STOP RUN.

*    DROP TABLE
     EXEC SQL
         DROP TABLE EMP
     END-EXEC.
     IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN.

*    CREATE TABLE
```

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```
     EXEC SQL
          CREATE TABLE EMP
          (
              EMP_NO     NUMERIC(4,0) NOT NULL,
              EMP_NAME   CHAR(20),
              EMP_SALARY NUMERIC(4,0),
              CONSTRAINT IEMP_0 PRIMARY KEY (EMP_NO)
          )
     END-EXEC.
     IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN STOP RUN.

*    INSERT ROWS USING LITERAL
     EXEC SQL
          INSERT INTO EMP VALUES (46, 'KAGOSHIMA ROKURO', -320)
     END-EXEC.
     IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN.

     EXEC SQL
          INSERT INTO EMP VALUES (47, 'OKINAWA SHICHIRO', 480)
     END-EXEC.
     IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN.

*    INSERT ROWS USING HOST VARIABLE
     PERFORM VARYING IDX FROM 1 BY 1 UNTIL IDX > 10
        MOVE TEST-NO(IDX)      TO  EMP-NO
        MOVE TEST-NAME(IDX)    TO  EMP-NAME
        MOVE TEST-SALARY(IDX) TO  EMP-SALARY
        EXEC SQL
           INSERT INTO EMP VALUES
                  (:EMP-NO,:EMP-NAME,:EMP-SALARY)
        END-EXEC
        IF  SQLSTATE NOT = ZERO
            PERFORM ERROR-RTN
            EXIT PERFORM
        END-IF
     END-PERFORM.

*    COMMIT
     EXEC SQL COMMIT WORK END-EXEC.

*    DISCONNECT
     EXEC SQL
         DISCONNECT ALL
     END-EXEC.

*    END
     DISPLAY "*** INSERTTBL FINISHED ***".
     STOP RUN.

*****************************************************************
 ERROR-RTN.
*****************************************************************
     DISPLAY "*** SQL ERROR ***".
     DISPLAY "SQLSTATE: " SQLSTATE.
     EVALUATE SQLSTATE
        WHEN  "02000"
           DISPLAY "Record not found"
```

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```
        WHEN  "08003"
        WHEN  "08001"
           DISPLAY "Connection falied"
        WHEN  SPACE
           DISPLAY "Undefined error"
        WHEN  OTHER
           DISPLAY "SQLCODE: "   SQLCODE
           DISPLAY "SQLERRMC: "  SQLERRMC
        *> TO RESTART TRANSACTION, DO ROLLBACK.
           EXEC SQL
               ROLLBACK
           END-EXEC
     END-EVALUATE.
*****************************************************************
```

Running the oceqsl preprocessor:

```
prompt$ ocesql INSERTTBL.cbl inserttbl.cob
```

Gives

```
      *****************************************************************
      *  Open Cobol ESQL (Ocesql) Sample Program
      *
      *  INSERTTBL -- demonstrates CONNECT, DROP TABLE, CREATE TABLE,
      *               INSERT rows, COMMIT, ROLLBACK, DISCONNECT
      *
      *  Copyright 2013 Tokyo System House Co., Ltd.
      *****************************************************************
       IDENTIFICATION              DIVISION.
      *****************************************************************
       PROGRAM-ID.                 INSERTTBL.
       AUTHOR.                     TSH.
       DATE-WRITTEN.               2013-06-28.

      *****************************************************************
       DATA                        DIVISION.
      *****************************************************************
       WORKING-STORAGE             SECTION.
       01  TEST-DATA.
                                       *>"---+++++++++++++++++++++----"
         03 FILLER       PIC X(28) VALUE "0001HOKKAI TARO         0400".
         03 FILLER       PIC X(28) VALUE "0002AOMORI JIRO         0350".
         03 FILLER       PIC X(28) VALUE "0003AKITA SABURO        0300".
         03 FILLER       PIC X(28) VALUE "0004IWATE SHIRO         025p".
         03 FILLER       PIC X(28) VALUE "0005MIYAGI GORO         020p".
         03 FILLER       PIC X(28) VALUE "0006FUKUSHIMA RIKURO    0150".
         03 FILLER       PIC X(28) VALUE "0007TOCHIGI SHICHIRO    010p".
         03 FILLER       PIC X(28) VALUE "0008IBARAKI HACHIRO     0050".
         03 FILLER       PIC X(28) VALUE "0009GUMMA KURO          020p".
         03 FILLER       PIC X(28) VALUE "0010SAITAMA JURO        0350".
       01  TEST-DATA-R   REDEFINES TEST-DATA.
         03  TEST-TBL    OCCURS  10.
           05  TEST-NO             PIC S9(04).
           05  TEST-NAME           PIC  X(20) .
           05  TEST-SALARY         PIC S9(04).
       01  IDX                     PIC  9(02).
```

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```
       01  SYS-TIME                PIC  9(08).

OCESQL*EXEC SQL BEGIN DECLARE SECTION END-EXEC.
       01  DBNAME                  PIC  X(30) VALUE SPACE.
       01  USERNAME                PIC  X(30) VALUE SPACE.
       01  PASSWD                  PIC  X(10) VALUE SPACE.
       01  EMP-REC-VARS.
         03  EMP-NO                PIC S9(04) VALUE ZERO.
         03  EMP-NAME              PIC  X(20) .
         03  EMP-SALARY            PIC S9(04) VALUE ZERO.
OCESQL*EXEC SQL END DECLARE SECTION END-EXEC.

OCESQL*EXEC SQL INCLUDE SQLCA END-EXEC.
OCESQL     copy "sqlca.cbl".
      *****************************************************************
OCESQL*
OCESQL 01  SQ0001.
OCESQL     02  FILLER PIC X(014) VALUE "DROP TABLE EMP".
OCESQL     02  FILLER PIC X(1) VALUE X"00".
OCESQL*
OCESQL 01  SQ0002.
OCESQL     02  FILLER PIC X(135) VALUE "CREATE TABLE EMP ( EMP_NO NUME"
OCESQL  &  "RIC(4, 0) NOT NULL, EMP_NAME CHAR(20), EMP_SALARY NUMERIC("
OCESQL  &  "4, 0), CONSTRAINT IEMP_0 PRIMARY KEY (EMP_NO) )".
OCESQL     02  FILLER PIC X(1) VALUE X"00".
OCESQL*
OCESQL 01  SQ0003.
OCESQL     02  FILLER PIC X(053) VALUE "INSERT INTO EMP VALUES (46, 'K"
OCESQL  &  "AGOSHIMA ROKURO', -320)".
OCESQL     02  FILLER PIC X(1) VALUE X"00".
OCESQL*
OCESQL 01  SQ0004.
OCESQL     02  FILLER PIC X(052) VALUE "INSERT INTO EMP VALUES (47, 'O"
OCESQL  &  "KINAWA SHICHIRO', 480)".
OCESQL     02  FILLER PIC X(1) VALUE X"00".
OCESQL*
OCESQL 01  SQ0005.
OCESQL     02  FILLER PIC X(037) VALUE "INSERT INTO EMP VALUES ( $1, $"
OCESQL  &  "2, $3 )".
OCESQL     02  FILLER PIC X(1) VALUE X"00".
OCESQL*
OCESQL 01  SQ0006.
OCESQL     02  FILLER PIC X(014) VALUE "DISCONNECT ALL".
OCESQL     02  FILLER PIC X(1) VALUE X"00".
OCESQL*
       PROCEDURE                   DIVISION.
      *****************************************************************
       MAIN-RTN.
           DISPLAY "*** INSERTTBL STARTED ***".

      *    WHENEVER IS NOT YET SUPPORTED :(
      *      EXEC SQL WHENEVER SQLERROR PERFORM ERROR-RTN END-EXEC.

      *    CONNECT
           MOVE  "ocesql"           TO   DBNAME.
           MOVE  "postgres"         TO   USERNAME.
           MOVE  SPACES             TO   PASSWD.
```

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```
OCESQL*     EXEC SQL
OCESQL*         CONNECT :USERNAME IDENTIFIED BY :PASSWD USING :DBNAME
OCESQL*     END-EXEC.
OCESQL      CALL "OCESQLConnect" USING
OCESQL           BY REFERENCE SQLCA
OCESQL           BY REFERENCE USERNAME
OCESQL           BY VALUE 30
OCESQL           BY REFERENCE PASSWD
OCESQL           BY VALUE 10
OCESQL           BY REFERENCE DBNAME
OCESQL           BY VALUE 30
OCESQL      END-CALL.
            IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN STOP RUN.

      *     DROP TABLE
OCESQL*     EXEC SQL
OCESQL*         DROP TABLE EMP
OCESQL*     END-EXEC.
OCESQL      CALL "OCESQLExec" USING
OCESQL           BY REFERENCE SQLCA
OCESQL           BY REFERENCE SQ0001
OCESQL      END-CALL.
            IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN.

      *     CREATE TABLE
OCESQL*     EXEC SQL
OCESQL*          CREATE TABLE EMP
OCESQL*          (
OCESQL*              EMP_NO     NUMERIC(4,0) NOT NULL,
OCESQL*              EMP_NAME   CHAR(20),
OCESQL*              EMP_SALARY NUMERIC(4,0),
OCESQL*              CONSTRAINT IEMP_0 PRIMARY KEY (EMP_NO)
OCESQL*          )
OCESQL*     END-EXEC.
OCESQL      CALL "OCESQLExec" USING
OCESQL           BY REFERENCE SQLCA
OCESQL           BY REFERENCE SQ0002
OCESQL      END-CALL.
            IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN STOP RUN.

      *     INSERT ROWS USING LITERAL
OCESQL*     EXEC SQL
OCESQL*          INSERT INTO EMP VALUES (46, 'KAGOSHIMA ROKURO', -320)
OCESQL*     END-EXEC.
OCESQL      CALL "OCESQLExec" USING
OCESQL           BY REFERENCE SQLCA
OCESQL           BY REFERENCE SQ0003
OCESQL      END-CALL.
            IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN.

OCESQL*     EXEC SQL
OCESQL*          INSERT INTO EMP VALUES (47, 'OKINAWA SHICHIRO', 480)
OCESQL*     END-EXEC.
OCESQL      CALL "OCESQLExec" USING
OCESQL           BY REFERENCE SQLCA
OCESQL           BY REFERENCE SQ0004
OCESQL      END-CALL.
```

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```
            IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN.

      *     INSERT ROWS USING HOST VARIABLE
            PERFORM VARYING IDX FROM 1 BY 1 UNTIL IDX > 10
               MOVE TEST-NO(IDX)     TO  EMP-NO
               MOVE TEST-NAME(IDX)   TO  EMP-NAME
               MOVE TEST-SALARY(IDX) TO  EMP-SALARY
OCESQL*        EXEC SQL
OCESQL*           INSERT INTO EMP VALUES
OCESQL*                   (:EMP-NO,:EMP-NAME,:EMP-SALARY)
OCESQL*        END-EXEC
OCESQL      CALL "OCESQLStartSQL"
OCESQL      END-CALL
OCESQL      CALL "OCESQLSetSQLParams" USING
OCESQL           BY VALUE 3
OCESQL           BY VALUE 4
OCESQL           BY VALUE 0
OCESQL           BY REFERENCE EMP-NO
OCESQL      END-CALL
OCESQL      CALL "OCESQLSetSQLParams" USING
OCESQL           BY VALUE 16
OCESQL           BY VALUE 20
OCESQL           BY VALUE 0
OCESQL           BY REFERENCE EMP-NAME
OCESQL      END-CALL
OCESQL      CALL "OCESQLSetSQLParams" USING
OCESQL           BY VALUE 3
OCESQL           BY VALUE 4
OCESQL           BY VALUE 0
OCESQL           BY REFERENCE EMP-SALARY
OCESQL      END-CALL
OCESQL      CALL "OCESQLExecParams" USING
OCESQL           BY REFERENCE SQLCA
OCESQL           BY REFERENCE SQ0005
OCESQL           BY VALUE 3
OCESQL      END-CALL
OCESQL      CALL "OCESQLEndSQL"
OCESQL      END-CALL
               IF  SQLSTATE NOT = ZERO
                   PERFORM ERROR-RTN
                   EXIT PERFORM
               END-IF
            END-PERFORM.

      *     COMMIT
OCESQL*     EXEC SQL COMMIT WORK END-EXEC.
OCESQL      CALL "OCESQLStartSQL"
OCESQL      END-CALL
OCESQL      CALL "OCESQLExec" USING
OCESQL           BY REFERENCE SQLCA
OCESQL           BY REFERENCE "COMMIT" & x"00"
OCESQL      END-CALL
OCESQL      CALL "OCESQLEndSQL"
OCESQL      END-CALL.

      *     DISCONNECT
OCESQL*     EXEC SQL
```

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```
OCESQL*        DISCONNECT ALL
OCESQL*    END-EXEC.
OCESQL     CALL "OCESQLDisconnect" USING
OCESQL          BY REFERENCE SQLCA
OCESQL     END-CALL.

      *    END
           DISPLAY "*** INSERTTBL FINISHED ***".
           STOP RUN.

      ****************************************************************
       ERROR-RTN.
      ****************************************************************
           DISPLAY "*** SQL ERROR ***".
           DISPLAY "SQLSTATE: " SQLSTATE.
           EVALUATE SQLSTATE
              WHEN  "02000"
                 DISPLAY "Record not found"
              WHEN  "08003"
              WHEN  "08001"
                 DISPLAY "Connection falied"
              WHEN  SPACE
                 DISPLAY "Undefined error"
              WHEN  OTHER
                 DISPLAY "SQLCODE: "   SQLCODE
                 DISPLAY "SQLERRMC: "  SQLERRMC
              *> TO RESTART TRANSACTION, DO ROLLBACK.
OCESQL*           EXEC SQL
OCESQL*               ROLLBACK
OCESQL*           END-EXEC
OCESQL     CALL "OCESQLStartSQL"
OCESQL     END-CALL
OCESQL     CALL "OCESQLExec" USING
OCESQL          BY REFERENCE SQLCA
OCESQL          BY REFERENCE "ROLLBACK" & x"00"
OCESQL     END-CALL
OCESQL     CALL "OCESQLEndSQL"
OCESQL     END-CALL
           END-EVALUATE.
      ****************************************************************
```

Giving:

```
prompt$ cobc -x inserttbl.cob -locesql
prompt$ ./inserttbl
*** INSERTTBL STARTED ***
*** SQL ERROR ***
SQLSTATE: 01
SQLCODE: -0000000402
SQLERRMC:
```

Which is a pretty good indication that the PostgreSQL server is NOT running. So (on a Fedora 22 box, with PostgreSQL 9.4 installed):

```
prompt$ systemctl start postgresql
```

And another intial run of:

```
prompt$ ./inserttbl
*** INSERTTBL STARTED ***
*** SQL ERROR ***
SQLSTATE: 42P01
SQLCODE: -000000400
SQLERRMC: ERROR:  table "emp" does not exist
```

And during the initial run, the table did not exist and `drop table` reported an error, but that first run has now created it, so one more run to get a clean listing:

```
prompt$ ./inserttbl
*** INSERTTBL STARTED ***
*** INSERTTBL FINISHED ***
```

And the sample data is now in place. *If you look closely, the sample data has negative salaries, for testing purposes. These hard coded values use a sign field of 'p' in the numerics.* This is pretty low level stuff, and would not be something you would normally be faced with. But, it's a good thing to know about if the situation ever does come up.

Now to test the newly created table.

`FETCHTBL.cbl`

```
*****************************************************************
*  Open Cobol ESQL (Ocesql) Sample Program
*
*  FETCHTBL --- demonstrates CONNECT, SELECT COUNT(*),
*               DECLARE cursor, FETCH cursor, COMMIT,
*               ROLLBACK, DISCONNECT
*
*  Copyright 2013 Tokyo System House Co., Ltd.
*****************************************************************
 IDENTIFICATION              DIVISION.
*****************************************************************
 PROGRAM-ID.                 FETCHTBL.
 AUTHOR.                     TSH.
 DATE-WRITTEN.               2013-06-28.

*****************************************************************
 DATA                        DIVISION.
*****************************************************************
 WORKING-STORAGE             SECTION.
 01  D-EMP-REC.
     05  D-EMP-NO            PIC  9(04).
     05  FILLER              PIC  X.
     05  D-EMP-NAME          PIC  X(20).
     05  FILLER              PIC  X.
     05  D-EMP-SALARY        PIC  --,--9.

 EXEC SQL BEGIN DECLARE SECTION END-EXEC.
 01  DBNAME                  PIC  X(30) VALUE SPACE.
 01  USERNAME                PIC  X(30) VALUE SPACE.
 01  PASSWD                  PIC  X(10) VALUE SPACE.
 01  EMP-REC-VARS.
     05  EMP-NO              PIC S9(04).
     05  EMP-NAME            PIC  X(20) .
     05  EMP-SALARY          PIC S9(04).
 01  EMP-CNT                 PIC  9(04).
 EXEC SQL END DECLARE SECTION END-EXEC.
```

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```
 EXEC SQL INCLUDE SQLCA END-EXEC.
*****************************************************************
 PROCEDURE                   DIVISION.
*****************************************************************
 MAIN-RTN.
     DISPLAY "*** FETCHTBL STARTED ***".

*    WHENEVER IS NOT YET SUPPORTED :(
*      EXEC SQL WHENEVER SQLERROR PERFORM ERROR-RTN END-EXEC.

*    CONNECT
     MOVE  "ocesql"          TO   DBNAME.
     MOVE  "postgres"        TO   USERNAME.
     MOVE  SPACE             TO   PASSWD.
     EXEC SQL
         CONNECT :USERNAME IDENTIFIED BY :PASSWD USING :DBNAME
     END-EXEC.
     IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN STOP RUN.

*    SELECT COUNT(*) INTO HOST-VARIABLE
     EXEC SQL
         SELECT COUNT(*) INTO :EMP-CNT FROM EMP
     END-EXEC.
     IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN.
     DISPLAY "TOTAL RECORD: " EMP-CNT.

*    DECLARE CURSOR
     EXEC SQL
         DECLARE C1 CURSOR FOR
         SELECT EMP_NO, EMP_NAME, EMP_SALARY
                FROM EMP
                ORDER BY EMP_NO
     END-EXEC.
     EXEC SQL
         OPEN C1
     END-EXEC.
     IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN STOP RUN.

*    FETCH
     DISPLAY "---- -------------------- ------".
     DISPLAY "NO   NAME                 SALARY".
     DISPLAY "---- -------------------- ------".
     EXEC SQL
         FETCH C1 INTO :EMP-NO, :EMP-NAME, :EMP-SALARY
     END-EXEC.
     PERFORM UNTIL SQLSTATE NOT = ZERO
        MOVE  EMP-NO         TO    D-EMP-NO
        MOVE  EMP-NAME       TO    D-EMP-NAME
        MOVE  EMP-SALARY     TO    D-EMP-SALARY
        DISPLAY D-EMP-REC
        EXEC SQL
            FETCH C1 INTO :EMP-NO, :EMP-NAME, :EMP-SALARY
        END-EXEC
     END-PERFORM.
     IF  SQLSTATE NOT = "02000" PERFORM ERROR-RTN STOP RUN.
```

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```
*    CLOSE CURSOR
     EXEC SQL
         CLOSE C1
     END-EXEC.

*    COMMIT
     EXEC SQL
         COMMIT WORK
     END-EXEC.

*    DISCONNECT
     EXEC SQL
         DISCONNECT ALL
     END-EXEC.

*    END
     DISPLAY "*** FETCHTBL FINISHED ***".
     STOP RUN.

************************************************************************
 ERROR-RTN.
************************************************************************
     DISPLAY "*** SQL ERROR ***".
     DISPLAY "SQLSTATE: " SQLSTATE.
     EVALUATE SQLSTATE
        WHEN  "02000"
           DISPLAY "Record not found"
        WHEN  "08003"
        WHEN  "08001"
           DISPLAY "Connection falied"
        WHEN  SPACE
           DISPLAY "Undefined error"
        WHEN  OTHER
           DISPLAY "SQLCODE: "   SQLCODE
           DISPLAY "SQLERRMC: "  SQLERRMC
        *> TO RESTART TRANSACTION, DO ROLLBACK.
           EXEC SQL
               ROLLBACK
           END-EXEC
     END-EVALUATE.
************************************************************************
```

After processing with:

```
$ ocesql FETCHTBL.cbl fetchtbl.cob
precompile start: FETCHTBL.cbl
=====================================================
              LIST OF CALLED DB Library API
=====================================================
Generate:OCESQLConnect
Generate:OCESQLExecSelectIntoOne
Generate:OCESQLCursorDeclare
Generate:OCESQLCursorOpen
Generate:OCESQLCursorFetchOne
Generate:OCESQLCursorFetchOne
Generate:OCESQLCursorClose
Generate:COMMIT
```

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```
Generate:OCESQLDisconnect
Generate:ROLLBACK
==========================================================
```

The input for the `cobc` compiler looks like

```
      ************************************************************************
      *  Open Cobol ESQL (Ocesql) Sample Program
      *
      *  FETCHTBL --- demonstrates CONNECT, SELECT COUNT(*),
      *               DECLARE cursor, FETCH cursor, COMMIT,
      *               ROLLBACK, DISCONNECT
      *
      *  Copyright 2013 Tokyo System House Co., Ltd.
      ************************************************************************
       IDENTIFICATION              DIVISION.
      ************************************************************************
       PROGRAM-ID.                 FETCHTBL.
       AUTHOR.                     TSH.
       DATE-WRITTEN.               2013-06-28.

      ************************************************************************
       DATA                        DIVISION.
      ************************************************************************
       WORKING-STORAGE             SECTION.
       01  D-EMP-REC.
           05  D-EMP-NO            PIC  9(04).
           05  FILLER              PIC  X.
           05  D-EMP-NAME          PIC  X(20).
           05  FILLER              PIC  X.
           05  D-EMP-SALARY        PIC  --,--9.

OCESQL*EXEC SQL BEGIN DECLARE SECTION END-EXEC.
       01  DBNAME                  PIC  X(30) VALUE SPACE.
       01  USERNAME                PIC  X(30) VALUE SPACE.
       01  PASSWD                  PIC  X(10) VALUE SPACE.
       01  EMP-REC-VARS.
           05  EMP-NO              PIC S9(04).
           05  EMP-NAME            PIC  X(20) .
           05  EMP-SALARY          PIC S9(04).
       01  EMP-CNT                 PIC  9(04).
OCESQL*EXEC SQL END DECLARE SECTION END-EXEC.

OCESQL*EXEC SQL INCLUDE SQLCA END-EXEC.
OCESQL     copy "sqlca.cbl".
      ************************************************************************
OCESQL*
OCESQL 01  SQ0001.
OCESQL     02  FILLER PIC X(026) VALUE "SELECT COUNT( * ) FROM EMP".
OCESQL     02  FILLER PIC X(1) VALUE X"00".
OCESQL*
OCESQL 01  SQ0002.
OCESQL     02  FILLER PIC X(060) VALUE "SELECT EMP_NO, EMP_NAME, EMP_S"
OCESQL  &  "ALARY FROM EMP ORDER BY EMP_NO".
OCESQL     02  FILLER PIC X(1) VALUE X"00".
OCESQL*
OCESQL 01  SQ0003.
```

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```
OCESQL     02  FILLER PIC X(014) VALUE "DISCONNECT ALL".
OCESQL     02  FILLER PIC X(1) VALUE X"00".
OCESQL*
       PROCEDURE                   DIVISION.
      ****************************************************************
       MAIN-RTN.
           DISPLAY "*** FETCHTBL STARTED ***".

      *    WHENEVER IS NOT YET SUPPORTED :(
      *      EXEC SQL WHENEVER SQLERROR PERFORM ERROR-RTN END-EXEC.

      *    CONNECT
           MOVE  "ocesql"          TO   DBNAME.
           MOVE  "postgres"        TO   USERNAME.
           MOVE  SPACE             TO   PASSWD.
OCESQL*    EXEC SQL
OCESQL*        CONNECT :USERNAME IDENTIFIED BY :PASSWD USING :DBNAME
OCESQL*    END-EXEC.
OCESQL     CALL "OCESQLConnect" USING
OCESQL          BY REFERENCE SQLCA
OCESQL          BY REFERENCE USERNAME
OCESQL          BY VALUE 30
OCESQL          BY REFERENCE PASSWD
OCESQL          BY VALUE 10
OCESQL          BY REFERENCE DBNAME
OCESQL          BY VALUE 30
OCESQL     END-CALL.
           IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN STOP RUN.

      *    SELECT COUNT(*) INTO HOST-VARIABLE
OCESQL*    EXEC SQL
OCESQL*        SELECT COUNT(*) INTO :EMP-CNT FROM EMP
OCESQL*    END-EXEC.
OCESQL     CALL "OCESQLStartSQL"
OCESQL     END-CALL
OCESQL     CALL "OCESQLSetResultParams" USING
OCESQL          BY VALUE 1
OCESQL          BY VALUE 4
OCESQL          BY VALUE 0
OCESQL          BY REFERENCE EMP-CNT
OCESQL     END-CALL
OCESQL     CALL "OCESQLExecSelectIntoOne" USING
OCESQL          BY REFERENCE SQLCA
OCESQL          BY REFERENCE SQ0001
OCESQL          BY VALUE 0
OCESQL          BY VALUE 1
OCESQL     END-CALL
OCESQL     CALL "OCESQLEndSQL"
OCESQL     END-CALL.
           IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN.
           DISPLAY "TOTAL RECORD: " EMP-CNT.

      *    DECLARE CURSOR
OCESQL*    EXEC SQL
OCESQL*        DECLARE C1 CURSOR FOR
OCESQL*        SELECT EMP_NO, EMP_NAME, EMP_SALARY
OCESQL*               FROM EMP
```

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```
OCESQL*               ORDER BY EMP_NO
OCESQL*     END-EXEC.
OCESQL      CALL "OCESQLCursorDeclare" USING
OCESQL           BY REFERENCE SQLCA
OCESQL           BY REFERENCE "FETCHTBL_C1" & x"00"
OCESQL           BY REFERENCE SQ0002
OCESQL      END-CALL.
OCESQL*     EXEC SQL
OCESQL*         OPEN C1
OCESQL*     END-EXEC.
OCESQL      CALL "OCESQLCursorOpen" USING
OCESQL           BY REFERENCE SQLCA
OCESQL           BY REFERENCE "FETCHTBL_C1" & x"00"
OCESQL      END-CALL.
            IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN STOP RUN.

      *     FETCH
            DISPLAY "---- -------------------- ------".
            DISPLAY "NO   NAME                 SALARY".
            DISPLAY "---- -------------------- ------".
OCESQL*     EXEC SQL
OCESQL*         FETCH C1 INTO :EMP-NO, :EMP-NAME, :EMP-SALARY
OCESQL*     END-EXEC.
OCESQL      CALL "OCESQLStartSQL"
OCESQL      END-CALL
OCESQL      CALL "OCESQLSetResultParams" USING
OCESQL           BY VALUE 3
OCESQL           BY VALUE 4
OCESQL           BY VALUE 0
OCESQL           BY REFERENCE EMP-NO
OCESQL      END-CALL
OCESQL      CALL "OCESQLSetResultParams" USING
OCESQL           BY VALUE 16
OCESQL           BY VALUE 20
OCESQL           BY VALUE 0
OCESQL           BY REFERENCE EMP-NAME
OCESQL      END-CALL
OCESQL      CALL "OCESQLSetResultParams" USING
OCESQL           BY VALUE 3
OCESQL           BY VALUE 4
OCESQL           BY VALUE 0
OCESQL           BY REFERENCE EMP-SALARY
OCESQL      END-CALL
OCESQL      CALL "OCESQLCursorFetchOne" USING
OCESQL           BY REFERENCE SQLCA
OCESQL           BY REFERENCE "FETCHTBL_C1" & x"00"
OCESQL      END-CALL
OCESQL      CALL "OCESQLEndSQL"
OCESQL      END-CALL.
            PERFORM UNTIL SQLSTATE NOT = ZERO
               MOVE  EMP-NO        TO    D-EMP-NO
               MOVE  EMP-NAME      TO    D-EMP-NAME
               MOVE  EMP-SALARY    TO    D-EMP-SALARY
               DISPLAY D-EMP-REC
OCESQL*        EXEC SQL
OCESQL*            FETCH C1 INTO :EMP-NO, :EMP-NAME, :EMP-SALARY
OCESQL*        END-EXEC
```

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```
OCESQL     CALL "OCESQLStartSQL"
OCESQL     END-CALL
OCESQL     CALL "OCESQLSetResultParams" USING
OCESQL          BY VALUE 3
OCESQL          BY VALUE 4
OCESQL          BY VALUE 0
OCESQL          BY REFERENCE EMP-NO
OCESQL     END-CALL
OCESQL     CALL "OCESQLSetResultParams" USING
OCESQL          BY VALUE 16
OCESQL          BY VALUE 20
OCESQL          BY VALUE 0
OCESQL          BY REFERENCE EMP-NAME
OCESQL     END-CALL
OCESQL     CALL "OCESQLSetResultParams" USING
OCESQL          BY VALUE 3
OCESQL          BY VALUE 4
OCESQL          BY VALUE 0
OCESQL          BY REFERENCE EMP-SALARY
OCESQL     END-CALL
OCESQL     CALL "OCESQLCursorFetchOne" USING
OCESQL          BY REFERENCE SQLCA
OCESQL          BY REFERENCE "FETCHTBL_C1" & x"00"
OCESQL     END-CALL
OCESQL     CALL "OCESQLEndSQL"
OCESQL     END-CALL
           END-PERFORM.
           IF  SQLSTATE NOT = "02000" PERFORM ERROR-RTN STOP RUN.

      *    CLOSE CURSOR
OCESQL*    EXEC SQL
OCESQL*        CLOSE C1
OCESQL*    END-EXEC.
OCESQL     CALL "OCESQLCursorClose"  USING
OCESQL          BY REFERENCE SQLCA
OCESQL          BY REFERENCE "FETCHTBL_C1" & x"00"
OCESQL     END-CALL
OCESQL    .

      *    COMMIT
OCESQL*    EXEC SQL
OCESQL*        COMMIT WORK
OCESQL*    END-EXEC.
OCESQL     CALL "OCESQLStartSQL"
OCESQL     END-CALL
OCESQL     CALL "OCESQLExec" USING
OCESQL          BY REFERENCE SQLCA
OCESQL          BY REFERENCE "COMMIT" & x"00"
OCESQL     END-CALL
OCESQL     CALL "OCESQLEndSQL"
OCESQL     END-CALL.

      *    DISCONNECT
OCESQL*    EXEC SQL
OCESQL*        DISCONNECT ALL
OCESQL*    END-EXEC.
OCESQL     CALL "OCESQLDisconnect" USING
```

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```
OCESQL          BY REFERENCE SQLCA
OCESQL     END-CALL.

      *    END
           DISPLAY "*** FETCHTBL FINISHED ***".
           STOP RUN.

      ****************************************************************
       ERROR-RTN.
      ****************************************************************
           DISPLAY "*** SQL ERROR ***".
           DISPLAY "SQLSTATE: " SQLSTATE.
           EVALUATE SQLSTATE
              WHEN  "02000"
                 DISPLAY "Record not found"
              WHEN  "08003"
              WHEN  "08001"
                 DISPLAY "Connection falied"
              WHEN  SPACE
                 DISPLAY "Undefined error"
              WHEN  OTHER
                 DISPLAY "SQLCODE: "   SQLCODE
                 DISPLAY "SQLERRMC: "  SQLERRMC
              *> TO RESTART TRANSACTION, DO ROLLBACK.
OCESQL*            EXEC SQL
OCESQL*                ROLLBACK
OCESQL*            END-EXEC
OCESQL     CALL "OCESQLStartSQL"
OCESQL     END-CALL
OCESQL     CALL "OCESQLExec" USING
OCESQL          BY REFERENCE SQLCA
OCESQL          BY REFERENCE "ROLLBACK" & x"00"
OCESQL     END-CALL
OCESQL     CALL "OCESQLEndSQL"
OCESQL     END-CALL
           END-EVALUATE.
      ****************************************************************
```

Each of the generated lines prefixed with an easy to spot sequence value.

Compile with:

```
prompt$ cobc -x fetchtbl.cob -locesql
prompt$ ./fetchtbl
*** FETCHTBL STARTED ***
TOTAL RECORD: 0012
---- -------------------- ------
NO   NAME                 SALARY
---- -------------------- ------
0001 HOKKAI TARO             400
0002 AOMORI JIRO             350
0003 AKITA SABURO            300
0004 IWATE SHIRO            -250
0005 MIYAGI GORO            -200
0006 FUKUSHIMA RIKURO        150
0007 TOCHIGI SHICHIRO       -100
0008 IBARAKI HACHIRO          50
```

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```
0009 GUMMA KURO             -200
0010 SAITAMA JURO            350
0046 KAGOSHIMA ROKURO       -320
0047 OKINAWA SHICHIRO        480
*** FETCHTBL FINISHED ***
```

And repeating: Some of the example salaries listed above are negative, on purpose, as part of the test head, and work as expected. *(Although it would not be the nicest of pay days if this was production data).*

GnuCOBOL and PostgreSQL go great together. Many thanks to the team in Japan for a job well done.

PostgreSQL is one of the world's preeminent free software projects. It is a very well documented, very well written SQL database engine, more than capable of handling the largest work loads. And GnuCOBOL can now benefit with a very comprehensive ESQL preprocessor.

Oh, and one point. The `sqlca.cbl` copybook that ships with `ocesql` is NOT the same as the generic `sqlca.cpy` that ships with GnuCOBOL. Take care to ensure that your programs use the correct file when compiling. `ocesql` includes a command line option to help keep things straight for your installation, but you still want to be mindful of the difference:

```
prompt$ ocesql

Open Cobol ESQL (Ocesql)
Version 1.0.0
June 28, 2013
Tokyo System House Co., Ltd. <opencobol@tsh-world.co.jp>

Usage: ocesql [--inc=include_dir] SOURCE [DESTFILE] [LOGFILE]
```

`ocesql/copy/sqlca.cbl`

```
******************************************************************
*       SQLCA: SQL Communications Area for Ocesql                *
******************************************************************
 01  SQLCA GLOBAL.
     05  SQLCAID               PIC X(8).
     05  SQLCABC               PIC S9(9) COMP-5.
     05  SQLCODE               PIC S9(9) COMP-5.
     05  SQLERRM.
     49  SQLERRML              PIC S9(4) COMP-5.
     49  SQLERRMC              PIC X(70).
     05  SQLERRP               PIC X(8).               *> not used
     05  SQLERRD OCCURS 6 TIMES                        *> used only ERRD(3)
                               PIC S9(9) COMP-5.
     05  SQLWARN.                                     *> not used
         10 SQLWARN0           PIC X(1).
         10 SQLWARN1           PIC X(1).
         10 SQLWARN2           PIC X(1).
         10 SQLWARN3           PIC X(1).
         10 SQLWARN4           PIC X(1).
         10 SQLWARN5           PIC X(1).
         10 SQLWARN6           PIC X(1).
         10 SQLWARN7           PIC X(1).
     05  SQLSTATE              PIC X(5).
******************************************************************
```

versus the file that ships with GnuCOBOL:

```
01  SQLCA.
    03  SQLCAID         PIC X(8)          VALUE "SQLCA   ".
    03  SQLCABC         USAGE BINARY-LONG VALUE 136.
    03  SQLCODE         USAGE BINARY-LONG VALUE 0.
    03  SQLERRM.
        05  SQLERRML    USAGE BINARY-SHORT.
        05  SQLERRMC    PIC X(70).
    03  SQLERRP         PIC X(8).
    03  SQLERRD         USAGE BINARY-LONG OCCURS 6.
    03  SQLWARN.
        05  SQLWARN0    PIC X.
        05  SQLWARN1    PIC X.
        05  SQLWARN2    PIC X.
        05  SQLWARN3    PIC X.
        05  SQLWARN4    PIC X.
        05  SQLWARN5    PIC X.
        05  SQLWARN6    PIC X.
        05  SQLWARN7    PIC X.
        05  SQLWARN8    PIC X.
        05  SQLWARN9    PIC X.
        05  SQLWARN10   PIC X.
        05  SQLWARNA    REDEFINES SQLWARN10 PIC X.
    03  SQLSTATE        PIC X(5).
    03  FILLER          PIC X(21).
```

Remote network access is accessible via the `USING` phrase of the `CONNECT` embedded SQL command.

```
*    CONNECT
     MOVE  "ocesql@host:port"  TO   DBNAME.
     MOVE  "postgres"          TO   USERNAME.
     MOVE  SPACE               TO   PASSWD.
     EXEC SQL
         CONNECT :USERNAME IDENTIFIED BY :PASSWD USING :DBNAME
     END-EXEC.
     IF  SQLSTATE NOT = ZERO PERFORM ERROR-RTN STOP RUN.
```

PostgreSQL samples

Along with DB2 access, László Erdős added some very informative GnuCOBOL to PostgreSQL linkage samples using OCESQL `EXEC SQL` to the GnuCOBOL contributions tree on SourceForge.

https://sourceforge.net/p/gnucobol/contrib/HEAD/tree/trunk/samples/DBsample/PostgreSQL/

Another well documented, step by step contribution from László. The displayed readme.txt from the above link will help get you started.

5.4.2 esqlOC

By Sergey Kashyrin, for access to MariaDB and other ODBC compliant SQL engines. C++ code, with no-thinking required C bindings.

Another beauty.

Code is hosted in Contributions at

https://sourceforge.net/p/gnucobol/contrib/HEAD/tree/trunk/esql/

See *Getting Started with esqlOC* (page 1374) for a complete write up.

Also see, https://gitlab.cobolworx.com/gnucobol/sql using embedded SQL with DB2, SQL Server, PostreSQL, and MariaDB.

5.4.3 Firebird gpre

The good folk at IBPheonix have modified the Firebird `gpre` COBOL preprocessor slightly and it now integrates well with GnuCOBOL. The Firebird database has been in use in production (originally as InterBase) since 1981. Firebird started with a fork of the open source InterBase 6.0. Instructions on getting the COBOL `gpre` command to link with embedded Firebird is documented at http://www.ibphoenix.com/resources/documents/how_to/doc_382

5.4.4 Oracle

Oracle's **procob** preprocessor generates code that can be compiled with GnuCOBOL. **procob** is an Oracle® licensed product.

- as reported on opencobol.org the **procob 10.2 Oracle** preprocessor produces code that compiles and executes just fine with GnuCOBOL 1.1 See note about data sizes and the *binary-size:* configuration below.

5.4.5 DB2

Dick Rietveld has posted up the steps to link GnuCOBOL programs to DB2.

See http://db2twilight.blogspot.nl/2014/01/linuxdb2-running-cobol-with-inline-sql.html

László Erdős also added some very informative DB2 linkage samples to the GnuCOBOL contributions tree on SourceForge.

https://sourceforge.net/p/gnucobol/contrib/HEAD/tree/trunk/samples/DBsample/DB2/

László's entry covers you how to pre-compile and compile a GnuCOBOL program with embedded IBM DB2 SQL. The focus lies on the DB2MODx.sqb modules, and not on the DB2TESTx.cob test program.

Samples build on each other and demonstrate

- Connect
- Select
- Insert
- Update
- Delete
- Paging
- Listing

He uses a BOOK database and walks people through the steps in a very thorough and easy to follow manner. Build tests use Cygwin on Windows 7, GnuCOBOL 2, and IBM DB2 Express-C 10.5 (64 bit).

The main DB2MOD.sqb file is

```
Gnu   *>*****************************************************************
COBOL *>  This file is part of DB2sample.
      *>
      *>  DB2MOD1.cob is free software: you can redistribute it and/or
```

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```
      *>  modify it under the terms of the GNU Lesser General Public License as
      *>  published by the Free Software Foundation, either version 3 of the
      *>  License, or (at your option) any later version.
      *>
      *>  DB2MOD1.cob is distributed in the hope that it will be useful,
      *>  but WITHOUT ANY WARRANTY; without even the implied warranty of
      *>  MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
      *>  See the GNU Lesser General Public License for more details.
      *>
      *>  You should have received a copy of the GNU Lesser General Public
      *>  License along with DB2MOD1.cob.
      *>  If not, see <http://www.gnu.org/licenses/>.
      *>*****************************************************************

      *>*****************************************************************
      *> Program:      DB2MOD1.sqb
      *>
      *> Purpose:      DB2 sample module
      *>
      *> Author:       Laszlo Erdos - https://www.facebook.com/wortfee
      *>
      *> Date-Written: 2015.12.24
      *>
      *> Tectonics:    DB2 precompile:
      *>               db2cmd -i -w -c db2 -tvf db2_precompile1.sql
      *>
      *>               Compile under cygwin:
      *>               cobc -m -std=mf DB2MOD1.cbl \
      *>               -I/cygdrive/c/IBM/SQLLIB/include/cobol_mf \
      *>               -L/cygdrive/c/IBM/SQLLIB/lib -ldb2api
      *>
      *> Usage:        To use this module, simply CALL it as follows:
      *>               CALL "DB2MOD1" USING LN-MOD
      *>
      *>               Implemented features:
      *>               - connect to DB2
      *>               - connect reset
      *>
      *>*****************************************************************
      *> Date       Name / Change description
      *> ========== ============================================================
      *> 2015.12.24 Laszlo Erdos:
      *>            - first version.
      *>*****************************************************************

       IDENTIFICATION DIVISION.
       PROGRAM-ID. DB2MOD1.

       ENVIRONMENT DIVISION.

       DATA DIVISION.
       WORKING-STORAGE SECTION.
      *> linkage for DB2SQLMSG.cob
       COPY "LNSQLMSG.cpy".

      *> SQL communication area
       COPY "sqlca.cbl".
```

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```
      *> SQL status
       01 WS-SQL-STATUS                 PIC S9(9) COMP-5.
          88 SQL-STATUS-OK              VALUE    0.
          88 SQL-STATUS-NOT-FOUND       VALUE  100.
          88 SQL-STATUS-DUP             VALUE -803.

      *> SQL declare variables
       EXEC SQL BEGIN DECLARE SECTION END-EXEC.
      *> connect fields with variable length
       01 HV-DBALIAS.
          49 HV-DBALIAS-LEN             PIC S9(4) COMP-5.
          49 HV-DBALIAS-BUF             PIC X(9).
       01 HV-USERID.
          49 HV-USERID-LEN              PIC S9(4) COMP-5.
          49 HV-USERID-BUF              PIC X(20).
       01 HV-PSWD.
          49 HV-PSWD-LEN                PIC S9(4) COMP-5.
          49 HV-PSWD-BUF                PIC X(20).
       EXEC SQL END   DECLARE SECTION END-EXEC.

       LINKAGE SECTION.
       COPY "LNMOD1.cpy".

       PROCEDURE DIVISION USING LN-MOD.

      *>-----------------------------------------------------------------------
       MAIN-DB2MOD1 SECTION.
      *>-----------------------------------------------------------------------

          INITIALIZE LN-MSG

          EVALUATE TRUE
             WHEN V-LN-FNC-CONNECT
                PERFORM CONNECT

             WHEN V-LN-FNC-CONNECT-RESET
                PERFORM CONNECT-RESET

             WHEN OTHER
                MOVE "Wrong linkage function"
                  TO LN-MSG-1 OF LN-MOD
          END-EVALUATE

          GOBACK

          .
       MAIN-DB2MOD1-EX.
          EXIT.

      *>-----------------------------------------------------------------------
       CONNECT SECTION.
      *>-----------------------------------------------------------------------

          MOVE LN-DBALIAS OF LN-MOD TO HV-DBALIAS-BUF
          MOVE FUNCTION STORED-CHAR-LENGTH(HV-DBALIAS-BUF)
            TO HV-DBALIAS-LEN
```

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```
           MOVE LN-USERID  OF LN-MOD TO HV-USERID-BUF
           MOVE FUNCTION STORED-CHAR-LENGTH(HV-USERID-BUF)
             TO HV-USERID-LEN

           MOVE LN-PSWD    OF LN-MOD TO HV-PSWD-BUF
           MOVE FUNCTION STORED-CHAR-LENGTH(HV-PSWD-BUF)
             TO HV-PSWD-LEN

           PERFORM SQL-CONNECT

           PERFORM COPY-SQL-MSG-IN-LINKAGE

           .
       CONNECT-EX.
           EXIT.

      *>-------------------------------------------------------------------------
       CONNECT-RESET SECTION.
      *>-------------------------------------------------------------------------

           PERFORM SQL-CONNECT-RESET

           PERFORM COPY-SQL-MSG-IN-LINKAGE

           .
       CONNECT-RESET-EX.
           EXIT.

      *>-------------------------------------------------------------------------
       COPY-SQL-MSG-IN-LINKAGE SECTION.
      *>-------------------------------------------------------------------------

      *>  get SQL message with DB2 functions: sqlgintp, sqlggstt
           CALL "DB2SQLMSG" USING SQLCA
                                  LN-SQLMSG
           END-CALL

           MOVE SQLCODE
             TO LN-SQLCODE              OF LN-MOD
           MOVE SQLSTATE
             TO LN-SQLSTATE             OF LN-MOD
           MOVE LN-MSG-1                OF LN-SQLMSG
             TO LN-MSG-1                OF LN-MOD
           MOVE LN-MSG-2                OF LN-SQLMSG
             TO LN-MSG-2                OF LN-MOD
           MOVE LN-MSG-3                OF LN-SQLMSG
             TO LN-MSG-3                OF LN-MOD
           MOVE LN-MSG-4                OF LN-SQLMSG
             TO LN-MSG-4                OF LN-MOD

           .
       COPY-SQL-MSG-IN-LINKAGE-EX.
           EXIT.

      *>-------------------------------------------------------------------------
       SQL-CONNECT SECTION.
```

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```
      *>-----------------------------------------------------------------------

          EXEC SQL
               CONNECT TO    :HV-DBALIAS
                       USER  :HV-USERID
                       USING :HV-PSWD
          END-EXEC

          MOVE SQLCODE TO WS-SQL-STATUS

          .
       SQL-CONNECT-EX.
          EXIT.

      *>-----------------------------------------------------------------------
       SQL-CONNECT-RESET SECTION.
      *>-----------------------------------------------------------------------

          EXEC SQL
               CONNECT RESET
          END-EXEC

          MOVE SQLCODE TO WS-SQL-STATUS

          .
       SQL-CONNECT-RESET-EX.
          EXIT.

       END PROGRAM DB2MOD1.
```

And the initial CONNECT sample from example1/

```
DB2   *>*****************************************************************
Sample*>  This file is part of DB2sample.
      *>
      *>  DB2TEST1.cob is free software: you can redistribute it and/or
      *>  modify it under the terms of the GNU Lesser General Public License as
      *>  published by the Free Software Foundation, either version 3 of the
      *>  License, or (at your option) any later version.
      *>
      *>  DB2TEST1.cob is distributed in the hope that it will be useful,
      *>  but WITHOUT ANY WARRANTY; without even the implied warranty of
      *>  MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
      *>  See the GNU Lesser General Public License for more details.
      *>
      *>  You should have received a copy of the GNU Lesser General Public
      *>  License along with DB2TEST1.cob.
      *>  If not, see <http://www.gnu.org/licenses/>.
      *>*****************************************************************

      *>*****************************************************************
      *> Program:      DB2TEST1.cob
      *>
      *> Purpose:      Test program for the DB2 sample module
      *>
      *> Author:       Laszlo Erdos - https://www.facebook.com/wortfee
      *>
```

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```
      *> Date-Written: 2015.12.24
      *>
      *> Tectonics:    cobc -x DB2TEST1.cob
      *>
      *> Usage:        This is a test program for the DB2 sample module. You
      *>               can call and test through a few simple screens the
      *>               code in the DB2 module.
      *>
      *>               Implemented features:
      *>               - connect to DB2
      *>               - connect reset
      *>
      *>*****************************************************************
      *> Date       Name / Change description
      *> ========== ============================================================
      *> 2015.12.24 Laszlo Erdos:
      *>            - first version.
      *>*****************************************************************

       IDENTIFICATION DIVISION.
       PROGRAM-ID. DB2TEST1.

       ENVIRONMENT DIVISION.
       CONFIGURATION SECTION.
       SPECIAL-NAMES.
          CRT STATUS IS WS-FNC-KEY.

       DATA DIVISION.
       WORKING-STORAGE SECTION.
       01 WS-FNC-KEY                   PIC 9(4).
          88 V-FNC-F1                  VALUE 1001.
          88 V-FNC-F2                  VALUE 1002.
          88 V-FNC-F9                  VALUE 1009.
          88 V-FNC-F10                 VALUE 1010.
       01 WS-ACCEPT-FNC-KEY            PIC X.

       01 WS-MSG.
         02 WS-SQLCODE                 PIC S9(10).
         02 WS-SQLSTATE                PIC X(5).
         02 WS-MSG-1                   PIC X(80).
         02 WS-MSG-2                   PIC X(80).
         02 WS-MSG-3                   PIC X(80).
         02 WS-MSG-4                   PIC X(80).

       01 WS-CONNECT.
         02 WS-DBALIAS                 PIC X(9).
         02 WS-USERID                  PIC X(20).
         02 WS-PSWD                    PIC X(20).

      *> linkage
       COPY "LNMOD1.cpy".

      *> colors
       COPY SCREENIO.

       SCREEN SECTION.
       01 HEADER-SCREEN.
```

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```
           05 FILLER LINE 2 COLUMN 13
              VALUE "DB2 sample program, please select a function"
      *>      this deletes the screen
              BLANK SCREEN
              FOREGROUND-COLOR COB-COLOR-GREEN.

       01 MAIN-FUNCTION-SCREEN.
           05 FILLER LINE 4 COLUMN 5
              VALUE "F1 - Connect to DB2"
              FOREGROUND-COLOR COB-COLOR-GREEN.
           05 FILLER LINE 5 COLUMN 5
              VALUE "F2 - Connect reset"
              FOREGROUND-COLOR COB-COLOR-GREEN.

           05 FILLER LINE 18 COLUMN 5
              VALUE "F9 - Exit"
              FOREGROUND-COLOR COB-COLOR-GREEN.
           05 FILLER PIC X TO WS-ACCEPT-FNC-KEY SECURE
              LINE 18 COLUMN 79
              FOREGROUND-COLOR COB-COLOR-GREEN.

       01 MESSAGE-SCREEN.
      *> line 20
           05 FILLER LINE 20 COLUMN 1
              VALUE "SQLCODE: "
              FOREGROUND-COLOR COB-COLOR-GREEN.
           05 FILLER PIC -Z(9)9 FROM WS-SQLCODE OF WS-MSG
              LINE 20 COLUMN 10
              FOREGROUND-COLOR COB-COLOR-GREEN.
           05 FILLER LINE 20 COLUMN 30
              VALUE "SQLSTATE: "
              FOREGROUND-COLOR COB-COLOR-GREEN.
           05 FILLER PIC X(5) FROM WS-SQLSTATE OF WS-MSG
              LINE 20 COLUMN 40
              FOREGROUND-COLOR COB-COLOR-GREEN.
      *> line 21
           05 FILLER PIC X(80) FROM WS-MSG-1 OF WS-MSG
              LINE 21 COLUMN 1
              FOREGROUND-COLOR COB-COLOR-GREEN.
      *> line 22
           05 FILLER PIC X(80) FROM WS-MSG-2 OF WS-MSG
              LINE 22 COLUMN 1
              FOREGROUND-COLOR COB-COLOR-GREEN.
      *> line 23
           05 FILLER PIC X(80) FROM WS-MSG-3 OF WS-MSG
              LINE 23 COLUMN 1
              FOREGROUND-COLOR COB-COLOR-GREEN.
      *> line 24
           05 FILLER PIC X(80) FROM WS-MSG-4 OF WS-MSG
              LINE 24 COLUMN 1
              FOREGROUND-COLOR COB-COLOR-GREEN.

       01 CONNECT-SCREEN.
           05 FILLER LINE 4 COLUMN 1
              VALUE "DBALIAS:"
              FOREGROUND-COLOR COB-COLOR-GREEN.
           05 FILLER PIC X(9) TO WS-DBALIAS
```

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```
           LINE 4 COLUMN 10
           FOREGROUND-COLOR COB-COLOR-GREEN.
       05 FILLER LINE 4 COLUMN 50
           VALUE "eg.: testdb"
           FOREGROUND-COLOR COB-COLOR-GREEN.
       05 FILLER LINE 5 COLUMN 1
           VALUE "USERID:"
           FOREGROUND-COLOR COB-COLOR-GREEN.
       05 FILLER PIC X(20) TO WS-USERID
           LINE 5 COLUMN 10
           FOREGROUND-COLOR COB-COLOR-GREEN.
       05 FILLER LINE 5 COLUMN 50
           VALUE "eg.: LASZLO.ERDOES"
           FOREGROUND-COLOR COB-COLOR-GREEN.
       05 FILLER LINE 6 COLUMN 1
           VALUE "PSWD:"
           FOREGROUND-COLOR COB-COLOR-GREEN.
       05 FILLER PIC X(20) TO WS-PSWD SECURE
           LINE 6 COLUMN 10
           FOREGROUND-COLOR COB-COLOR-GREEN.
       05 FILLER LINE 6 COLUMN 50
           VALUE "eg.: laszlopw"
           FOREGROUND-COLOR COB-COLOR-GREEN.
       05 FILLER LINE 18 COLUMN 1
           VALUE "F1 - Connect to DB2"
           FOREGROUND-COLOR COB-COLOR-GREEN.
       05 FILLER LINE 18 COLUMN 25
           VALUE "F10 - Back to main"
           FOREGROUND-COLOR COB-COLOR-GREEN.
       05 FILLER PIC X TO WS-ACCEPT-FNC-KEY SECURE
           LINE 18 COLUMN 79
           FOREGROUND-COLOR COB-COLOR-GREEN.


        PROCEDURE DIVISION.

      *>-----------------------------------------------------------------------
        MAIN-DB2TEST1 SECTION.
      *>-----------------------------------------------------------------------

           PERFORM FOREVER
              DISPLAY HEADER-SCREEN END-DISPLAY
              DISPLAY MAIN-FUNCTION-SCREEN END-DISPLAY
              DISPLAY MESSAGE-SCREEN END-DISPLAY
              ACCEPT MAIN-FUNCTION-SCREEN END-ACCEPT

      *>       init message
              INITIALIZE WS-MSG
              DISPLAY MESSAGE-SCREEN END-DISPLAY

              EVALUATE TRUE
                 WHEN V-FNC-F1
                    PERFORM FNC-CONNECT-SCREEN

                 WHEN V-FNC-F2
                    PERFORM FNC-CONNECT-RESET
```

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```
               WHEN V-FNC-F9
                  EXIT PERFORM

               WHEN OTHER
                  MOVE "Please select a valid function key"
                    TO WS-MSG-1 OF WS-MSG
            END-EVALUATE
         END-PERFORM

         STOP RUN

         .
       MAIN-DB2TEST1-EX.
         EXIT.

      *>-----------------------------------------------------------------------
       FNC-CONNECT-SCREEN SECTION.
      *>-----------------------------------------------------------------------

         PERFORM FOREVER
            DISPLAY HEADER-SCREEN END-DISPLAY
            DISPLAY CONNECT-SCREEN END-DISPLAY
            DISPLAY MESSAGE-SCREEN END-DISPLAY
            ACCEPT CONNECT-SCREEN END-ACCEPT

      *>       init message
            INITIALIZE WS-MSG
            DISPLAY MESSAGE-SCREEN END-DISPLAY

            EVALUATE TRUE
               WHEN V-FNC-F1
                  PERFORM FNC-CONNECT

               WHEN V-FNC-F10
                  EXIT PERFORM

               WHEN OTHER
                  MOVE "Please select a valid function key"
                    TO WS-MSG-1 OF WS-MSG
            END-EVALUATE
         END-PERFORM

         .
       FNC-CONNECT-SCREEN-EX.
         EXIT.

      *>-----------------------------------------------------------------------
       FNC-CONNECT SECTION.
      *>-----------------------------------------------------------------------

         INITIALIZE LN-MOD
         INITIALIZE WS-MSG
         SET V-LN-FNC-CONNECT OF LN-MOD TO TRUE
         MOVE WS-CONNECT TO LN-CONNECT OF LN-MOD

         CALL "DB2MOD1" USING LN-MOD END-CALL
```

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```
           PERFORM COPY-LN-MSG-IN-WS-MSG

           .
       FNC-CONNECT-EX.
           EXIT.

      *>-------------------------------------------------------------------------
       FNC-CONNECT-RESET SECTION.
      *>-------------------------------------------------------------------------

           INITIALIZE LN-MOD
           INITIALIZE WS-MSG
           SET V-LN-FNC-CONNECT-RESET OF LN-MOD TO TRUE

           CALL "DB2MOD1" USING LN-MOD END-CALL

           PERFORM COPY-LN-MSG-IN-WS-MSG

           .
       FNC-CONNECT-RESET-EX.
           EXIT.

      *>-------------------------------------------------------------------------
       COPY-LN-MSG-IN-WS-MSG SECTION.
      *>-------------------------------------------------------------------------

           MOVE LN-MSG                  OF LN-OUTPUT
             TO WS-MSG

           .
       COPY-LN-MSG-IN-WS-MSG-EX.
           EXIT.

       END PROGRAM DB2TEST1.
```

As with all László's contributions, there is a lot to learn from DB2sample, and if you are using GnuCOBOL with DB2, then this is a recommended read, and download.

5.4.6 Other SQL engines

Along with the GnuCOBOL specific `ocesql` pre processor, `procob` and `gpre`, there are are *at least* two usable CALL extensions. There are currently *(March 2018)* quite a few active developments for easing SQL engine access.

- There is a contribution with a set of User Defined Functions for access to SQLite3, by Robert Mills at https://sourceforge.net/p/gnucobol/contrib/HEAD/tree/trunk/tools/CobolSQLite3/
- There are workable prototypes for SQLite at ocshell.c
  - with a sample usage program at sqlscreen.cob
  - and supporting documentation at sqlscreen.html
- The SQLite extension comes in two flavours; a shell mode discussed above and a direct API interface housed at ocsqlite.c
- A libdbi (generic database access) extension is also available. See cobdbi for full details.
- Jim Currey's team has kindly posted an ease-of-use MySQL preprocessing layer.

  - https://sourceforge.net/p/gnucobol/contrib/HEAD/tree/trunk/tools/JC-SQL-Precompiler/
  - https://sourceforge.net/projects/dbpre
  - http://www.applewood.dtdns.net/files/acas/nightlybuilds/
- Rumours of a potential PostgreSQL layer have also been heard.
  - Not a rumour anymore. Work on a nicely complete PostgreSQL binding was posted by gchudyk in 2009, listed in the Notes section. See *libpgsql.cob* (page 1413)
- Robert Mills, author of the COBOLMAC macro preprocessor has been building up an SQLite UDF repository. Detailed at
  - https://sourceforge.net/p/gnucobol/discussion/help/thread/cc255167/#403a
- **AND** as a *thing to watch for*, one of the good people of the GnuCOBOL community has written a layer that converts READ and WRITE verbiage to SQL calls *at run time*. More on this as it progresses. *Update: there has been no activity in a while now, might not be a thing.*

5.4.7 Oracle procob and binary data sizes

Details of the configuration setting for proper Oracle procob processing.

From Angus on opencobol.org

```
Hi

I had some trouble with Oracle procob 10.2 and OpenCobol 1.1 with std=mf.
For PIC S9(2) COMP, procob seems to use 2 bytes, and OpenCobol only one.
It doesn't work well. It comes from the parameter binary-size in the
mf.conf, which seems to tell to opencobol the larger of comp type
I modify to binary-size: 2-4-8 and it works (same as the mvs.conf)
Our application works with Micro Focus / Oracle, and micro Focus use 2 bytes,
like Oracle. Perhaps because we have the mvs toggle

Except for this thing, opencobol and oracle work like a charm,
on a debian 32bit.

Regards,
Angus
```

5.4.8 Direct PostgreSQL Sample

Nowhere near as complete as the binding that Gerald later posted to opencobol.org, the example below was a starting point.

Note that the PostgreSQL runtime library is **libpq**, *ending in q not g*.

```
GCobol*> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20091129, 20140915
      *> Purpose:   PostgreSQL connection test, updated for clarity
      *> Tectonics: cobc -x -lpq pgcob.cob
      *> ************************************************************
       identification division.
       program-id. pgcob.
```

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```
       data division.
       working-storage section.
       01 pgconn usage pointer.
       01 pgres  usage pointer.
       01 resptr usage pointer.
       01 resstr pic x(80) based.
       01 result usage binary-long.
       01 answer pic x(80).

      *> ************************************************************
       procedure division.
       display "Before connect:     " pgconn end-display

      *> connect to PostgreSQL
       call "PQconnectdb" using
           by reference "dbname = postgres" & x"00"
           returning pgconn
           on exception
               display
                   "Error: PQconnectdb link problem, try -lpq"
                   upon syserr
               end-display
bail           stop run returning 1
       end-call
       display "After connect:      " pgconn end-display

       if pgconn equal null then
           display "Error: PQconnectdb failure" upon syserr end-display
bail       stop run returning 1
       end-if

      *> request a connection status
       call "PQstatus" using by value pgconn returning result end-call
       if result equal 0 then
           move "OK" to answer
       else
           move "BAD" to answer
       end-if
       display
           "Status:             " result
           " CONNECTION_" function trim(answer)
       end-display

      *> sample call to get the connection name credentials
       call "PQuser" using by value pgconn returning resptr end-call

       if resptr not equal null then
           set address of resstr to resptr
           string resstr delimited by x"00" into answer end-string
       else
           move "PQuser returned null" to answer
       end-if
       display "User:               " function trim(answer) end-display

      *> Evaluate a query
       display " -- call PQexec --" end-display
       call "PQexec" using
```

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```
           by value pgconn
           by reference "select version();" & x"00"
           returning pgres
       end-call
       display "PQexec return code: " pgres end-display

      *> Pull out a result. row 0, field 0
       if pgres not equal null then
           call "PQgetvalue" using
               by value pgres
               by value 0
               by value 0
               returning resptr
           end-call
           if resptr not equal null then
               set address of resstr to resptr
               string resstr delimited by x"00" into answer end-string
           else
               move "PQgetvalue returned null" to answer
           end-if
       else
           move "PQexec returned null" to answer
       end-if
       display "PostgreSQL version: " answer end-display

      *> close the PostgreSQL connection
       call "PQfinish" using by value pgconn returning omitted end-call
       set pgconn to NULL

       goback.
       end program pgcob.
```

with a run sample (September 2014):

```
$ cobc -x pgcob.cob
$ ./pgcob
Before connect:     0x0000000000000000
Error: PQconnectdb link problem, try -lpq

$ cobc -x -lpq pgcob.cob
$ ./pgcob
Before connect:     0x0000000000000000
After connect:      0x00000000020975d0
Status:             +0000000001 CONNECTION_BAD
User:               btiffin
 -- call PQexec --
PQexec return code: 0x0000000000000000
PostgreSQL version: PQexec returned null
After PQfinish:     0x00000000020975d0

$ sudo service postgresql start

$ ./pgcob
Before connect:     0x0000000000000000
After connect:      0x00000000007d25d0
Status:             +0000000000 CONNECTION_OK
User:               btiffin
```

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```
 -- call PQexec --
PQexec return code: 0x00000000007d31e0
PostgreSQL version: PostgreSQL 9.2.8 on x86_64-redhat-linux-gnu,
                    compiled by gcc (GCC) 4.8.2 2013121
After PQfinish:     0x00000000007d25d0
```

And the original, WHICH CONFUSED MORE THAN HELPED. It does not have enough COBOL style fencing to be a program that can withstand change. And fails in ways that aren't overly educational.

```
GCobol*> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20091129
      *> Purpose:   PostgreSQL connection test
      *> Tectonics: cobc -x -lpq pgcob.cob
      *> ************************************************************
       identification division.
       program-id. pgcob.

       data division.
       working-storage section.
       01 pgconn usage pointer.
       01 pgres  usage pointer.
       01 resptr usage pointer.
       01 resstr pic x(80) based.
       01 result usage binary-long.
       01 answer pic x(80).

      *> ************************************************************
       procedure division.
       display "Before connect:" pgconn end-display

       call "PQconnectdb" using
           by reference "dbname = postgres" & x"00"
           returning pgconn
       end-call
       display "After connect: " pgconn end-display

       call "PQstatus" using by value pgconn returning result end-call
       display "Status:        " result end-display

       call "PQuser" using by value pgconn returning resptr end-call

       set address of resstr to resptr
       string resstr delimited by x"00" into answer end-string
       display "User:          " function trim(answer) end-display

       display "call PQexec" end-display
       call "PQexec" using
           by value pgconn
           by reference "select version();" & x"00"
           returning pgres
       end-call
       display pgres end-display

      *> Pull out a result. row 0, field 0 <*
       call "PQgetvalue" using
```

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```
           by value pgres
           by value 0
           by value 0
           returning resptr
       end-call
       set address of resstr to resptr
       string resstr delimited by x"00" into answer end-string
       display "Version:       " answer end-display

       call "PQfinish" using by value pgconn returning omitted end-call
       display "After finish:  " pgconn end-display

       call "PQstatus" using by value pgconn returning result end-call
       display "Status:        " result end-display

      *> this will now return garbage, DON'T DO THIS <*
       call "PQuser" using by value pgconn returning resptr end-call
       set address of resstr to resptr
       string resstr delimited by x"00" into answer end-string
       display "User after:    " function trim(answer) end-display

       goback.
       end program pgcob.
```

Run from a user account that has default PostgreSQL credentials:

```
$ cobc -x -lpq pgcob.cob
$ ./pgcob
Before connect:0x00000000
After connect: 0x086713e8
Status:        +0000000000
User:          brian
call PQexec
0x08671a28
Version:       PostgreSQL 8.3.7 on i486-pc-linux-gnu,
               compiled by GCC gcc-4.3.real (Debian 4.3.
After finish:  0x086713e8
Status:        +0000000001
User after:    PostgreSQL 8.3.7 on i486-pc-linux-gnu,
               compiled by GCC gcc-4.3.real (Debian 4.3.
```

Note that *User after* is **not the valid answer, shown on purpose**. The connection had been closed and the status was correctly reported as non-zero, being an error, but this example continued through as a demonstration.

Please note: The second (original copy) is included here for historical **don't** purposes. Don't write code like that, it doesn't age well, and it can confuse.

5.4.9 Oracle 12.1

Thanks to Reinhard Prehofer for a little clarification on Oracle® integration.

WORKING SAMPLES FOR **GnuCobol 2.0** connecting to **Oracle 12.1** under **ubuntu**

I have seen a lot of questions and hints (some correct, other misleading) as of how to get Oracle procob-programs up and running with GnuCobol. Here is a summary of my steps where I am using the oracle sample provided in a previous post:

(0) the prerequisites.

best have a look at https://help.ubuntu.com/community/Oracle%20Instant%20Client which explains in detail (and correctly !) how to set up a runtime system for Oracle under ubuntu. I downloaded the latest releases, which were 12.1.0.2 . Download the correct version - 32 or 64Bit, depending on your operating system, of course.

Run the following commands after downloading:

```
sudo alien -iv oracle-instantclient12.1-basic-12.1.0.1.0-1.x86_64.rpm
sudo alien -iv oracle-instantclient12.1-devel-12.1.0.2.0-1.x86_64.rpm
sudo alien -iv oracle-instantclient12.1-odbc-12.1.0.2.0-1.x86_64.rpm
sudo alien -iv oracle-instantclient12.1-precomp-12.1.0.2.0-1.x86_64.rpm
sudo alien -iv oracle-instantclient12.1-sqlplus-12.1.0.2.0-1.x86_64.rpm
```

have a close look where your Oracle has been installed to and set the ORACLE_HOME to the appropriate directory - which is the "client64" subdir for the 64bit installation:

```
# Extensions when using Oracle with GnuCobol
export ORACLE_HOME=/usr/lib/oracle/12.1/client64
export LD_LIBRARY_PATH=$ORACLE_HOME/lib:$LD_LIBRARY_PATH
export PATH=$PATH:$ORACLE_HOME/bin

# Oracle-sid and tnsnames.ora
export ORACLE_SID=MYORADB
export TWO_TASK=$ORACLE_SID
```

(it is an old trick dating back to the last yearthousand to use TWO_TASK in addition to ORACLE_SID . . .)

Using procob and thus embedded sql, you have to define your db-connection in the "**tnsnames.ora**" file. After above installation, you will have to do the following:

```
mkdir -p $ORACLE_HOME/network/admin
cd $ORACLE_HOME/network/admin
```

and there create your tnsadmin.ora file - or just transfer it from another installation where the entries have been verified to work. The entry thus should look like the following lines:

```
cat tnsnames.ora
MYORADB =
  (DESCRIPTION =
    (ADDRESS_LIST =
      (ADDRESS = (PROTOCOL = TCP)(HOST = host-db.test.xxx.at)(PORT = 1521))
    )
    (CONNECT_DATA =
      (SERVER = DEDICATED)
      (SERVICE_NAME = MYORADB)
    )
  )
```

(1) Precompile

use Oracle procob for precompiling the *.pco into a cobol-file You are free to invoke that precompiler on any host/operating system So it need not be the same machine where you later on are using your GnuCobol installation.

```
procob OraSimple.pco oname=OraSimple.cbl

Pro*COBOL: Release 12.1.0.2.0 - Production on Do Nov 19 15:45:05 2015

Copyright (c) 1982, 2014, Oracle and/or its affiliates.  All rights reserved.
```

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```
System-Standardoptionswerte aus:
  /usr/oraClnt/product/client-12.1.0.2_64/precomp/admin/pcbcfg.cfg

ls -la OraS*
-rw-rw-rw-    1 rpreh    seucc         16300 Nov 19 15:45 OraSimple.cbl
-rw-rw-rw-    1 rpreh    seucc          9255 Nov 19 15:45 OraSimple.lis
-rw-rw-rw-    1 rpreh    seucc          1368 Nov 19 15:44 OraSimple.pco

===> take the OraSimple.cbl File and transfer it to you
GnuCobol environment.
```

There is NO NEED to change anything in the OraSimple.cbl file so in contrast to other messages or post I have seen and read herein, no upper/lower-case replacement of SQLADR => sqladr etc has to be done. just take the file (with UPPERCASE SQLADR, SQLBEX etc) and statically link it together with some Oracle-libraries. The Interface file for cobol ("**cobsqlintf.o**") takes care of the UPPERCASE-SQL-library calls and matches them to those in the libclntsh etc.

```
cobc -v -x -std=mf -P -ftraceall -debug -g OraSimple.cbl
  $ORACLE_HOME/lib/cobsqlintf.o -L/usr/local/lib -lcob -L$ORACLE_HOME/lib
  -lclntsh
```

you should get a compiler report like:

```
reinhard@reinhard-CELSIUS-W530:$

cobc -v -x -std=mf -P -ftraceall -debug -g OraSimple.cbl
  $ORACLE_HOME/lib/cobsqlintf.o -L/usr/local/lib -lcob -L$ORACLE_HOME/lib -lclntsh
Command Line:cobc -v -x -std=mf -P -ftraceall -debug -g -L/usr/local/lib -lcob
   -L/usr/lib/oracle/12.1/client64/lib -lclntsh OraSimple.cbl
   /usr/lib/oracle/12.1/client64/lib/cobsqlintf.o
Preprocessing:OraSimple.cbl -> OraSimple.i
Return status:0Parsing:OraSimple.i (OraSimple.cbl)
Return status:0Translating:OraSimple.i -> OraSimple.c (OraSimple.cbl)
Executing:gcc -std=gnu99 -c -I/usr/local/include -pipe -Wno-unused
        -fsigned-char -Wno-pointer-sign -g -o "/tmp/cob22892_0.o"
        "OraSimple.c"
Return status:0Executing:gcc -std=gnu99 -Wl,--export-dynamic -o "OraSimple"
        "/tmp/cob22892_0.o"
        "/usr/lib/oracle/12.1/client64/lib/cobsqlintf.o"
        -L/usr/local/lib -lcob -lm -lgmp -lncurses -ldb -ldl -l"cob"
        -l"clntsh" -L"/usr/local/lib"
        -L"/usr/lib/oracle/12.1/client64/lib"
Return status:0
```

we are about to execute the program.

Maybe its not the worst idea to enable tracing, so you could see the line where whatever problem might have occurred.

```
export COB_SET_TRACE=YES
export COB_TRACE_FILE=./my_cobol_trace.log
export LD_LIBRARY_PATH=/usr/local/lib:$LD_LIBRARY_PATH
```

and now => fire the command:

```
./OraSimple
```

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```
reinhard@reinhard-CELSIUS-W530:~/gnu-cobol-2.0/ta2$ ./OraSimple
sqlcode connect +0000000000
ename SMITH     empno 7369
ename ALLEN     empno 7499
ename WARD      empno 7521
ename JONES     empno 7566
ename MARTIN    empno 7654
ename BLAKE     empno 7698
ename CLARK     empno 7782
ename SCOTT     empno 7788
ename KING      empno 7839
ename TURNER    empno 7844
ename ADAMS     empno 7876
ename JAMES     empno 7900
ename FORD      empno 7902
ename MILLER    empno 7934
ename Hofer     empno 1530
```

be aware that userid and passwd are hardcoded

```
move 'scott' to hv-userid.
move 'tiger' to hv-passwd.
```

and that the connection to Oracle is combined in such a way:

```
scott/tiger@MYORADB
```

Ubuntu-version in use, btw:

```
reinhard@reinhard-CELSIUS-W530:~/gnu-cobol-2.0/ta2$ lsb_release -a
No LSB modules are available.
Distributor ID:Ubuntu
Description:Ubuntu 14.04.3 LTS
Release:14.04
Codename:trusty
```

And finally the coding “OraSimple.pco” => you have to use procob to get the rather lengthy OraSimple.cbl, which I included as an attachment.

```
Oracle*> OraSimple

       identification division.
       program-id. OraSimple.
       data division.
       working-storage section.

               exec sql begin declare section end-exec.

       01 hvs.
               05 hv-userid pic x(5).
               05 hv-passwd pic x(5).
               05 hv-ename pic x(8).
               05 hv-empno pic x(8).

               exec sql end declare section end-exec.
```

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```
               exec sql include sqlca end-exec.

       procedure division.
       a-main section.
               move 'scott' to hv-userid.
               move 'tiger' to hv-passwd.
               exec sql connect :hv-userid identified by :hv-passwd
               end-exec.
               display 'sqlcode connect ' sqlcode.
               exec sql declare c1 cursor for
                       select ename,empno from emp
               end-exec
               exec sql open c1
               end-exec
               exec sql fetch c1 into
                       :hv-ename,:hv-empno
               end-exec
               perform until sqlcode not = 0
                       display 'ename ' hv-ename ' empno ' hv-empno
                       exec sql fetch c1 into
                               :hv-ename,:hv-empno
                       end-exec
               end-perform.
               stop run.
```

5.4.10 ODBC

Steve Williams posted a Simple ODBC sample to

http://sourceforge.net/p/gnucobol/discussion/contrib/thread/3d4f1141/

`Simpleodbc.tar.gz`.

Here is the README:

```
Simpleodbc

A preprocessor and a compile-time library
implementing an odbc interface, together with a
test program and free and fixed format test scripts
demonstrating and documenting the interface.

This software was written and tested using cobc
(GNU Cobol) 2.0.0 built Jan 28 2015 22:41:38 and
unixODBC-2.3.2 running under Ubuntu 14.04,
VMWARE and Windows 8.1 on a Lenovo G70 laptop.

Primary testing used Postgres 9.3 and the psqlODBC
driver accessing an 8.5 million row AllCities
WorldCity table and a 220 row Country table.

This odbc interface is not like other COBOL odbc
interfaces and is not intended to support existing
COBOL odbc code or statements.

Features
```

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```
The preprocessor, library and test program
are written in free format COBOL.

The preprocessor accepts free and fixed format
and single and double quoted COBOL programs.

A supplied test script executes the free version of
the software.

A second supplied test script creates and executes
a fixed format version of the software.

The following limits can be changed by changing
pictures, occurs values and associated limit
values in the preprocessor and the libraries:

    100 host variables
    5 active connections
    10 active statements per connection
    100 bound parameters per statement
    100 bound columns per statement
    unbound row length 16384
    sql statement length 1024

connections have autocommit off by default

autocommit for a connection can be turned
on and off programmatically

The preprocessor, in addition to the usual
two parameters for input and output,
accepts an OPTIONAL diagnostic third parameter
consisting of any of the following letters
in any case and in any order

    d - dump the host variable definition table
    p - dump procedure definitions
    s - dump source input scan values
    r - display run-time diagnostics

the display of run-time diagnostics may also
be turned on and on procedurally at run-time

Connections, transactions and statements may be
prefixed by OPTIONAL 'in <connection>' and
'as <statement>' clauses which name the connection
and the statement or transaction.  This is to
identify multiple connections and multiple statements
per connection.

Subparagraphs may use 'in current' and 'as current'
to use the parent 'in' and 'as' values.

If you don't use the OPTIONAL 'in' and 'as features,
the connections, transactions and statements
are named 'default' and need not be specified.
```

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```
A (named) transaction may reference multiple connections
and (named) rollbacks and (named) commits will honor
this (named) transaction.

The test program demonstrates the following features:

    perform test-driver
    perform test-datasource
    perform test-disconnect

    perform test-connect
    perform test-connect-dsn
    perform test-table

    perform test-select0
        select count(*) from worldcities
        select count(*) as rowcount1 from worldcities
    perform test-select1
        as cursor3 in connection1
        select * from worldcities
        where countrycode = 'DE'
        and population > 1000000
    perform test-select2
        as cursor3 in connection1
        select
            countrycode
           ,cc2
           ,country
        from worldcities
        inner join country on
        ISO = countrycode
        where countrycode = :countrycode
        and population > :population
    perform test-load
        start transaction
        truncate or create country table
        load country table from a file
        commit
    perform test-select3
        as cursor3 in connection1
        select
            geonameid
           ,name
           ,asciiname
           ,alternatenames
           ,latitude
           ,longitude
           ,featureclass
           ,featurecode
           ,countrycode
           ,cc2
           ,admin1code
           ,admin2code
           ,admin3code
           ,admin4code
           ,population
```

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```
           ,elevation
           ,timezone
           ,modificationdate
        from worldcities
        where countrycode = :countrycode
        and population > :population
    perform test-select4
        two active statements, same connection

        as cursor3 in connection1
        select * from worldcities
        where countrycode = 'DE'
        and population > 1000000

        as cursor4 in connection1
        select * from worldcities
        where countrycode = 'FR'
        and population > 1000000
    perform test-select5
        two statements, different connections

        select * from worldcities
        where countrycode = 'DE'
        and population > 1000000
        (note the use of defaults here)

        as cursor1 in connection1
        select * from worldcities
        where countrycode = 'FR'
        and population > 1000000
    perform test-delete
        start a transaction

        delete the country table
        rollback

        delete countrycode = 'US'
        rollback
    perform test-update
        create and update a table and row
        with various data types
    perform test-dynamic
        create and execute sql statements
        and bound parameters directly

Bugs and Obscurities

    copy and include statements in an exec sql/end-sql
    block must be on a separate line

    64-bit odbc doesn't handle BINARY-DOUBLE/bigint
    postgresql doesn't have comps99/tinyint

    bound unsigned comp data returns in byte-reverse order

The preprocessor assumes the input source
is valid COBOL.  It will abort on
```

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```
    identical input and output files

    the source is neither fixed nor free

    the usual invalid source type in column 7

    a single source line generating more than 500 lines

    odbc copy/include file error

    an unexpected data division statement
    (something in EXECUTE SQL DECLARE . . .)

    an unexpected data division level number
    (something in EXECUTE SQL DECLARE . . .)

    . . . not implemented . . .
    (some USAGE(s) in EXECUTE SQL DECLARE . . .)

    number of host variables exceeds . . .

    number of sql lines exceeds . . .

The compile libary will abort on

    SODBCAllocEnv failure (I've never seen this)

The test program will abort on

    failure to perform check-return after executing
    a procedural statement

    use of bigint in test-update (I don't remember the
    error, so try it yourself)

The compile library will issue the following messages:

    SOCN01 (named) connection exceeds . . .

    SOFC01 (named) connection not found

    SOAA01 (named) statement exceeds . . .

    SOST01 invalid statement handle

these won't be aborts, but they're not a good sign.

Getting Started

1.  Download and install the current version of
GNU COBOL 2.0

2.  download unixodbc from unixodbc.com and extract
./configure make
sudo make install
```

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```
3. If you are on Ubuntu you already have some
version of Postgresql installed.

4. apt-get update
apt-get install postgresql postgresql-contrib
sudo -i -u postgres
createuser --interactive
\q

5. Create Drivers
sudo find / -name odbcinst.ini.template
sudo odbcinst -i -d -f /usr/share/psqlodbc/odbcinst.ini.template

for example:

[PostgreSQL ANSI]
Description     = PostgreSQL ODBC driver (ANSI version)
Driver          = /usr/lib/x86_64-linux-gnu/odbc/psqlodbca.so
Setup           = libodbcpsqlS.so
Debug           = 0
CommLog         = 1

[PostgreSQL Unicode]
Description     = PostgreSQL ODBC driver (Unicode version)
Driver          = /usr/lib/x86_64-linux-gnu/odbc/psqlodbcw.so
Setup           = libodbcpsqlS.so
Debug           = 0
CommLog         = 1

6.  Create a simple dsn

sudo odbcinst -i -s -f simpledsn

where simpledsn is a file containing:

[PostgresqlSimpleDSN]
Description         = PostgreSQL Simple
Driver              = PostgreSQL ANSI
Trace               = No
TraceFile           = /tmp/psqlodbc.log
Database            = simpledb
Servername          = localhost
UserName            = simpleuser
Password            = simplepassword
Port                = 5432
ReadOnly            = No
RowVersioning       = No
ShowSystemTables    = No
ShowOidColumn       = No
FakeOidIndex        = No
ConnSettings        =


************************************
**Note:
**  postgresql template0 is a database
**  odbc template is an ini text file
```

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```
************************************

7.  Create the Test Database
psql (from command line)
createdb -T template0 simpledb;
/q

8. Create the Test User
psql simpledb
createuser simpleuser with password simplepassword;
/q

9.  Get the test data

Download and unzip allCountries.txt from
http://download.geonames.org/export/dump/

Download and unzip countryInfo.txt from
http://download.geonames.org/export/dump/

Note: The SODBCTest.cbl program assumes the
countryInfo.txt file is in the the test directory.
If not, modify the country-file-name value in
SODBCTest.cbl.

10.  Load the test data

psql simpledb (command line)

drop table worldcities;

create table worldcities(
    geonameid int
   ,name varchar(200)
   ,asciiname varchar(200)
   ,alternatenames varchar(8000)
   ,latitude varchar(10)
   ,longitude varchar(10)
   ,featureclass char(1)
   ,featurecode char(10)
   ,countrycode char(2)
   ,cc2 varchar(60)
   ,admin1code varchar(60)
   ,admin2code varchar(80)
   ,admin3code varchar(20)
   ,admin4code varchar(20)
   ,population numeric
   ,elevation varchar(6)
   ,dem varchar(6)
   ,timezone varchar(40)
   ,modificationdate char(10)
);

The following will take a few minutes

\copy worldcities from '/home/<your account>/. . ./allCountries.txt';
```

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```
The following will take a few minutes

create index worldcities01 on worldcities(countrycode);

grant all privileges on worldcities to simpleuser;

\q

Note: This copy loads latitude, longitude and elevation
as VARCHAR so the following functions will be useful:

psql simpledb (command line)

    DROP FUNCTION todecimal(text);
    CREATE OR REPLACE FUNCTION todecimal(x text) RETURNS DECIMAL AS $$
    BEGIN
        RETURN CAST(x AS DECIMAL);
    EXCEPTION WHEN others THEN
        RETURN NULL;
    END;
    $$ LANGUAGE plpgsql IMMUTABLE;

and

    DROP FUNCTION toint(text);
    CREATE OR REPLACE FUNCTION toint(x text) RETURNS INT AS $$
    BEGIN
        RETURN CAST(x AS INT);
    EXCEPTION WHEN others THEN
        RETURN NULL;
    END;
    $$ LANGUAGE plpgsql IMMUTABLE;

and then

    the following will take a few minutes

    create index worldcities03 on
worldcities(todecimal(latitude),todecimal(longitude));

\q

11. Run the tests

    chmod +x SODBCTest.sh
    chmod +x SODBCTestFixed.sh

    ./SODBTest.sh > SODBCTest.txt
    less SODBCTest.txt

    (the tests produce lots of output)

    ./SODBCTestFixed.sh > SODBCTestFixed.txt
    less SODBCTestFixed.txt
```

If you haven't seen Steve's work, do yourself a favour and snag a copy of his tarball. The World Cities application suites he has contributed are a great way of learning COBOL, and in particular, a great way of learning well fenced,

good, sound COBOL. *Unlike many of the loose samples that are written here in the FAQ, Steve demonstrates more professional code, with very informative error messages and robust code checks, for the inevitable times when something goes wrong. Plus, they demonstrate larger file access than most of the small examples here. His samples highlight how GnuCOBOL can chew through multimillion record datasets, with ease.*

5.4.11 CobolSQLite3

Robert Mills, author of the COBOLMAC macro preprocessor, has contributed a User Defined Function library for direct access to SQLite3.

https://sourceforge.net/p/gnucobol/contrib/HEAD/tree/trunk/tools/CobolSQLite3/

Robert provides a test program with the contribution, listed below, but check the link above for any changes to get the latest and greatest.

```
*> ** >>SOURCE FORMAT IS FREE
*>
*> Test program for CobolSQLite3 [an SQLite3 Interface for GnuCOBOL 2.x].
*>
*> Written by Robert W.Mills, September 2017.
*>
*> Tectonics:
*>
*>   Install the SQLite3 library (sqlite.org), if required.
*>   prompt$ cobc -x -fdebugging-line CobolSQLite3-test.cob
*>   prompt$ export COB_PRE_LOAD=CobolSQLite3
*>   prompt$ ./CobolSQLite3-test

identification division.

  program-id.                           CobolSQLite3-test.

environment division.

  configuration section.

    repository.
      copy "CobolSQLite3-CSR.cpy".
      function all intrinsic.

data division.

  working-storage section.

    copy "CobolSQLite3-WS.cpy".

    01  foo-column-number.
      05  fcn-line-no                  pic s9(04) comp value 1.
      05  fcn-line-text                pic s9(04) comp value 2.

    01  sql-statements.
      05  create-table-foo             pic x(080) value
            "create table foo(line_no int, line_text text);".
      05  commit-sql                   pic x(080) value "commit;".
      05  insert-into-foo-1            pic x(088) value
            "insert into foo (line_no, line_text) values (1, 'this is line 1');".
      05  insert-into-foo-2            pic x(080) value
```

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```
             "insert into foo (line_no, line_text) values (2, 'this is line 2');".
      05  insert-into-foo-3            pic x(080) value
             "insert into foo (line_no, line_text) values (3, 'this is line 3');".
      05  select-from-foo              pic x(080) value
             "select * from foo;".

    01  foo-heading-1.
      05                               pic x(001) value spaces.
      05  fh-line-no                   pic x(007) value "Line No".
      05                               pic x(003) value spaces.
      05  fh-line-text                 pic x(060) value "Line Text".
      05                               pic x(001) value spaces.

    01  foo-heading-2.
      05                               pic x(001) value spaces.
      05                               pic x(007) value all "-".
      05                               pic x(003) value spaces.
      05                               pic x(060) value all "-".
      05                               pic x(001) value spaces.

    01  foo-detail.
      05                               pic x(004) value spaces.
      05  fd-line-no                   pic Z(3)9(1).
      05                               pic x(003) value spaces.
      05  fd-line-text                 pic x(060).
      05                               pic x(001) value spaces.

procedure division.

testsqlite3-mainline.

>>D display "- opening database" end-display

  move "test.sdb" to db-name
  move DBOPEN(db-name) to db-object

  if DBSTATUS <> ZERO then
    display "DBOPEN: ", DBERRMSG end-display
    goback
  end-if

>>D display "- creating table foo" end-display

  if DBSQL(db-object, create-table-foo) <> ZERO then
    display "DBSQL (create table): ", DBERRMSG end-display
    goback
  end-if

>>D display "- adding record(s) to table foo" end-display

  if DBSQL(db-object, insert-into-foo-1) <> ZERO then
    display "DBSQL (insert 1): ", DBERRMSG end-display
    goback
  end-if

  if DBSQL(db-object, insert-into-foo-2) <> ZERO then
    display "DBSQL (insert 2): ", DBERRMSG end-display
```

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```
    goback
  end-if

  if DBSQL(db-object, insert-into-foo-3) <> ZERO then
    display "DBSQL (insert 3): ", DBERRMSG end-display
    goback
  end-if

>>D display "- selecting all records from foo" end-display

  move DBCOMPILE(db-object, select-from-foo) to sql-object

  if DBSTATUS <> ZERO then
    display "DBCOMPILE (select foo): ", DBERRMSG end-display
    goback
  end-if

  move DBEXECUTE(sql-object) to db-status

  evaluate true

    when database-row-available

      perform print-column-headings

      perform get-print-data
        until sql-statement-finished

      display space end-display
      display "-- End of Report --" end-display

    when sql-statement-finished
      continue

    when database-lock-failed
      display "DBEXECUTE: ", DBERRMSG end-display
      goback

    when other
      display "DBEXECUTE: ", DBERRMSG end-display
      goback

  end-evaluate

  if DBRELEASE(sql-object) <> ZERO then
    display "DBRELEASE: ", DBERRMSG end-display
  end-if

>>D display "- closing database" end-display

  if DBCLOSE(db-object) <> ZERO then
    display "DBCLOSE: ", DBERRMSG end-display
  end-if

  move zero to return-code
  goback
  .
```

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```
print-column-headings.

  *> Print the column heading lines.

  display foo-heading-1 end-display
  display foo-heading-2 end-display
  .

get-print-data.

  *> Get the line-no and line-text values.

  move DBGETINT(sql-object, fcn-line-no) to fd-line-no
  move DBGETSTR(sql-object, fcn-line-text) to fd-line-text

  *> Print the detail line.

  display foo-detail end-display

  *> Get the next row.

  move DBEXECUTE(sql-object) to db-status
  .

end program CobolSQLite3-test.
```

Another handy way of using GnuCOBOL.

See *Does GnuCOBOL support source code macros?* (page 998) for some of Robert's other works.

5.5 Does GnuCOBOL support ISAM?

Yes. The official release used Berkeley DB, but there are also experimental configurations of the compiler that use VBISAM, CISAM, DISAM or other external handlers. See *What are the configure options available for building GnuCOBOL?* (page 72) for more details about these options. The rest of this entry assumes the default Berkeley database.

ISAM (page 1321) is an acronym for Indexed Sequential Access Method.

GnuCOBOL has fairly full support of all standard specified ISAM compile and runtime semantics.

Update: GnuCOBOL 3.0 supports split keys, reportwriter branch has functional code, as of April 2015. The second listing will work with pre-release reportwriter and 3.0 mainline.

For example

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *><* ================
      *><* indexing example
      *><* ================
      *><* :Author:    Brian Tiffin
      *><* :Date:      17-Feb-2009, 28-Jan-2014
      *><* :Purpose:   Demonstrate Indexed IO routines and START
      *><* :Tectonics: cobc -x indexing.cob
```

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```
      *> ****************************************************************
       identification division.
       program-id. indexing.

       environment division.
       configuration section.

       input-output section.
       file-control.
          select optional indexed-file
          assign to "indexed-file.dat"
          status is indexing-status
          organization is indexed
          access mode is dynamic
          record key is keyfield of indexing-record
          alternate record key is altkey of indexing-record
              with duplicates
          .

      *> ** GnuCOBOL only supports split keys **
      *> **    in the reportwriter branch     **
      *> **        see second listing         **

      *>
      *>  alternate record key is splitkey
      *>      source is first-part of indexing-record
      *>                last-part of indexing-record
      *>      with duplicates

       data division.
       file section.
       fd indexed-file.
       01 indexing-record.
          03 keyfield          pic x(8).
          03 filler            pic x.
          03 altkey.
             05 first-part     pic 99.
             05 middle-part    pic x.
             05 last-part      pic 99.
          03 filler            pic x.
          03 data-part         pic x(52).

       working-storage section.
       01 indexing-status.
          03 high-status-code  pic xx.
          03 high-status redefines high-status-code pic 99.
             88 indexing-ok              values 0 thru 10.
          03 low-status-code   pic xx.
          03 low-status redefines low-status-code pic 99.


       01 display-record.
          03 filler            pic x(4)  value spaces.
          03 keyfield          pic x(8).
          03 filler            pic xx    value spaces.
          03 altkey.
             05 first-part     pic 99.
```

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```
           05 filler          pic x     value space.
           05 middle-part     pic x.
           05 filler          pic x     value space.
           05 last-part       pic 99.
        03 filler             pic xx    value ", ".
        03 data-part          pic x(52).

      *> control break
       01 oldkey              pic 99x99.

      *> read control fields
       01 duplicate-flag      pic x.
          88 no-more-duplicates          value high-value
             when set to false is              low-value.
       01 record-flag         pic x.
          88 no-more-records             value high-value
             when set to false is              low-value.

      *> ****************************************************************
       procedure division.

      *> Populate a sample database, create or overwrite keys
       perform populate-sample

      *> clear the record space for this example
       move spaces to indexing-record

      *> open the data file again
       open i-o indexed-file
       perform indexing-check

      *> bail if things are going wrong
       if not indexing-ok then
           display "error opening for read pass, stopping" upon syserr
           stop run returning 1
       end-if

      *> read all the duplicate 00b02 keys
       move 00 to first-part of indexing-record
       move "b" to middle-part of indexing-record
       move 02 to last-part of indexing-record

      *> using read key and then next key / last key compare
       set no-more-duplicates to false

       display "Read all 00b02 keys sequentially" end-display
       perform read-indexing-record
       perform read-next-record
           until no-more-duplicates
       display space end-display

      *> read by key of reference ... the cool stuff
       move 00 to first-part of indexing-record
       move "a" to middle-part of indexing-record
       move 02 to last-part of indexing-record
       set no-more-records to false
```

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```
      *> using start and read next
       display "Read all alternate keys greater than 00a02" end-display
       perform start-at-key
       perform read-next-by-key
           until no-more-records
       display space end-display

      *> read by primary key of reference
       move "87654321" to keyfield of indexing-record
       set no-more-records to false

      *> using start and previous by key
       display
           "Read all primary keys less than "
           keyfield of indexing-record
       end-display
       perform start-prime-key
       perform read-previous-by-key
           until no-more-records
       display space end-display

      *> and with that we are done with indexing sample
       close indexed-file

       goback.
      *> ****************************************************************

      *> ****************************************************************
      *><* read by alternate key paragraph
       read-indexing-record.
           display "Reading: " altkey of indexing-record end-display
           read indexed-file key is altkey of indexing-record
               invalid key
                   display
                       "bad read key: " altkey of indexing-record
                       upon syserr
                   end-display
               set no-more-duplicates to true
           end-read
           perform indexing-check
       .

      *><* read next sequential paragraph
       read-next-record.
           move corresponding indexing-record to display-record
           display display-record end-display
           move altkey of indexing-record to oldkey

           read indexed-file next record
               at end set no-more-duplicates to true
               not at end
                   if oldkey not equal altkey of indexing-record
                       set no-more-duplicates to true
                   end-if
           end-read
           perform indexing-check
       .
```

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```
      *><* start primary key of reference paragraph
       start-prime-key.
           display "Prime < " keyfield of indexing-record end-display
           start indexed-file
              key is less than
                  keyfield of indexing-record
              invalid key
                  display
                      "bad start: " keyfield of indexing-record
                      upon syserr
                  end-display
                  set no-more-records to true
              not invalid key
                  read indexed-file previous record
                      at end set no-more-records to true
                  end-read
           end-start
           perform indexing-check
       .

      *><* read previous by key of reference paragraph
       read-previous-by-key.
           move corresponding indexing-record to display-record
           display display-record end-display

           read indexed-file previous record
               at end set no-more-records to true
           end-read
           perform indexing-check
       .
      *><* start alternate key of reference paragraph
       start-at-key.
           display "Seeking >= " altkey of indexing-record end-display
           start indexed-file
              key is greater than or equal to
                  altkey of indexing-record
              invalid key
                  display
                      "bad start: " altkey of indexing-record
                      upon syserr
                  end-display
                  set no-more-records to true
              not invalid key
                  read indexed-file next record
                      at end set no-more-records to true
                  end-read
           end-start
           perform indexing-check
       .

      *><* read next by key of reference paragraph
       read-next-by-key.
           move corresponding indexing-record to display-record
           display display-record end-display

           read indexed-file next record
```

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```
            at end set no-more-records to true
        end-read
        perform indexing-check
     .

    *><* populate a sample database
     populate-sample.

    *> Open optional index file for read write
        open i-o indexed-file
        perform indexing-check

        move "12345678 00a01 some 12345678 data" to indexing-record
        perform write-indexing-record
        move "87654321 00a01 some 87654321 data" to indexing-record
        perform write-indexing-record
        move "12348765 00a01 some 12348765 data" to indexing-record
        perform write-indexing-record
        move "87651234 00a01 some 87651234 data" to indexing-record
        perform write-indexing-record

        move "12345679 00b02 some 12345679 data" to indexing-record
        perform write-indexing-record
        move "97654321 00b02 some 97654321 data" to indexing-record
        perform write-indexing-record
        move "12349765 00b02 some 12349765 data" to indexing-record
        perform write-indexing-record
        move "97651234 00b02 some 97651234 data" to indexing-record
        perform write-indexing-record

        move "12345689 00c13 some 12345689 data" to indexing-record
        perform write-indexing-record
        move "98654321 00c13 some 98654321 data" to indexing-record
        perform write-indexing-record
        move "12349865 00c13 some 12349865 data" to indexing-record
        perform write-indexing-record
        move "98651234 00c13 some 98651234 data" to indexing-record
        perform write-indexing-record

    *> close it ... not necessary, but for the example we will
        close indexed-file
        perform indexing-check
     .

    *><* Write paragraph
     write-indexing-record.
        write indexing-record
            invalid key
                display
                    "rewriting key: " keyfield of indexing-record
                    upon syserr
                end-display
                rewrite indexing-record
                    invalid key
                        display
                            "really bad key: "
                            keyfield of indexing-record
```

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```
                                upon syserr
                            end-display
                    end-rewrite
            end-write
        .

       *><* file status quick check.  For this sample, keep running
        indexing-check.
            if not indexing-ok then
                display
                    "isam file io problem: " indexing-status
                    upon syserr
                end-display
            end-if
        .

        end program indexing.
       *><*
       *><* Last Update: 20140128
```

which outputs:

```
Read all 00b02 keys sequentially
Reading: 00b02
    12345679  00 b 02, some 12345679 data
    97654321  00 b 02, some 97654321 data
    12349765  00 b 02, some 12349765 data
    97651234  00 b 02, some 97651234 data

Read all alternate keys greater than 00a02
Seeking >= 00a02
    12345679  00 b 02, some 12345679 data
    97654321  00 b 02, some 97654321 data
    12349765  00 b 02, some 12349765 data
    97651234  00 b 02, some 97651234 data
    12345689  00 c 13, some 12345689 data
    98654321  00 c 13, some 98654321 data
    12349865  00 c 13, some 12349865 data
    98651234  00 c 13, some 98651234 data

Read all primary keys less than 87654321
Prime < 87654321
    87651234  00 a 01, some 87651234 data
    12349865  00 c 13, some 12349865 data
    12349765  00 b 02, some 12349765 data
    12348765  00 a 01, some 12348765 data
    12345689  00 c 13, some 12345689 data
    12345679  00 b 02, some 12345679 data
    12345678  00 a 01, some 12345678 data
```

on any first runs, when **indexed-file.dat** does not exist.

Subsequent runs have the same output with:

```
rewriting key: 12345678
rewriting key: 87654321
rewriting key: 12348765
```

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```
rewriting key: 87651234
rewriting key: 12345679
rewriting key: 97654321
rewriting key: 12349765
rewriting key: 97651234
rewriting key: 12345689
rewriting key: 98654321
rewriting key: 12349865
rewriting key: 98651234
```

prepended, as the WRITE INVALID KEY clause triggers a REWRITE to allow overwriting key and data when setting up the sample.

Update: GnuCOBOL 3.0 supports split keys, from work in the reportwriter branch from 2015; the sample needs to be rewritten, but was quickly changed to:

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *><* ======================================
      *><* indexing example with split key support
      *><* ======================================
      *><* :Author:    Brian Tiffin
      *><* :Date:      17-Feb-2009, 28-Jan-2014
      *><* :Modified:  2015-05-28 22:38 EDT, Thursday
      *><* :Purpose:   Demonstrate Indexed IO routines and START
      *><* :Tectonics: cobc -x indexing.cob
      *> ***************************************************************
       identification division.
       program-id. indexing.

       environment division.
       configuration section.

       input-output section.
       file-control.
          select optional indexed-file
          assign to "indexed-file.dat"
          status is indexing-status
          organization is indexed
          access mode is dynamic
          record key is keyfield of indexing-record
          alternate record key is split-key
              source is first-part of indexing-record
                        last-part of indexing-record
              with duplicates
          .

       data division.
       file section.
       fd indexed-file.
       01 indexing-record.
          03 keyfield          pic x(8).
          03 filler            pic x.
          03 altkey.
             05 first-part     pic 99.
             05 middle-part    pic x.
             05 last-part      pic 99.
```

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```
          03 filler            pic x.
          03 data-part         pic x(52).

       working-storage section.
       01 indexing-status.
          03 high-status       pic 99.
             88 indexing-ok              values 0 thru 10.
          03 low-status        pic 99.

       01 display-record.
          03 filler            pic x(4)  value spaces.
          03 keyfield          pic x(8).
          03 filler            pic xx    value spaces.
          03 altkey.
             05 first-part     pic 99.
             05 filler         pic x     value space.
             05 middle-part    pic x.
             05 filler         pic x     value space.
             05 last-part      pic 99.
          03 filler            pic xx    value ", ".
          03 data-part         pic x(52).

      *> alternate key control break, split-key is two pic 99 fields.
       01 oldkey               pic 9999.

      *> read control fields
       01 duplicate-flag       pic x.
          88 no-more-duplicates          value high-value
             when set to false is              low-value.
       01 record-flag          pic x.
          88 no-more-records             value high-value
             when set to false is              low-value.

      *> ***************************************************************
       procedure division.

      *> Populate a sample database, create or overwrite keys
       perform populate-sample

      *> clear the record space for this example
       move spaces to indexing-record

      *> open the data file again
       open i-o indexed-file
       perform indexing-check

      *> read all the duplicate 0002 keys
       move 00 to first-part of indexing-record
       move "b" to middle-part of indexing-record
       move 02 to last-part of indexing-record

      *> load key space
       move function concatenate(first-part of indexing-record,
           last-part of indexing-record)
          to split-key

      *> using read key and then next key / last key compare
```

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```
       set no-more-duplicates to false

       display "Read all 00b02 keys sequentially" end-display
       perform read-indexing-record
       perform read-next-record
           until no-more-duplicates
       display space end-display

      *> read by key of reference ... the cool stuff
       move 00 to first-part of indexing-record
       move "a" to middle-part of indexing-record
       move 02 to last-part of indexing-record
       set no-more-records to false

      *> using start and read next
       display "Read all alternate keys greater than 0002" end-display
       perform start-at-key
       perform read-next-by-key
           until no-more-records
       display space end-display

      *> read by primary key of reference
       move "87654321" to keyfield of indexing-record
       set no-more-records to false

      *> using start and previous by key
       display
           "Read all primary keys less than "
           keyfield of indexing-record
       end-display
       perform start-prime-key
       perform read-previous-by-key
           until no-more-records
       display space end-display

      *> and with that we are done with indexing sample
       close indexed-file

       goback.
      *> ****************************************************************

      *> ****************************************************************
      *><* read by alternate key paragraph
       read-indexing-record.
           display
               "Reading: " split-key " from " altkey of indexing-record
           end-display
           read indexed-file key is split-key
               invalid key
                   display
                       "bad read key: " split-key
                       upon syserr
                   end-display
               set no-more-duplicates to true
           end-read
           perform indexing-check
       .
```

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```
      *><* read next sequential paragraph
       read-next-record.
           move corresponding indexing-record to display-record
           display display-record end-display
           *> move altkey of indexing-record to oldkey
           move split-key to oldkey

           read indexed-file next record
               at end set no-more-duplicates to true
               not at end
                   move function concatenate(
                       first-part of indexing-record,
                       last-part of indexing-record)
                     to split-key
                   if oldkey not equal split-key
                       set no-more-duplicates to true
                   end-if
           end-read
           perform indexing-check
       .

      *><* start primary key of reference paragraph
       start-prime-key.
           display "Prime < " keyfield of indexing-record end-display
           start indexed-file
              key is less than
                  keyfield of indexing-record
              invalid key
                  display
                      "bad start: " keyfield of indexing-record
                      upon syserr
                  end-display
                  set no-more-records to true
              not invalid key
                  read indexed-file previous record
                      at end set no-more-records to true
                  end-read
           end-start
           perform indexing-check
       .

      *><* read previous by key of reference paragraph
       read-previous-by-key.
           move corresponding indexing-record to display-record
           display display-record end-display

           read indexed-file previous record
               at end set no-more-records to true
           end-read
           perform indexing-check
       .
      *><* start alternate key of reference paragraph
       start-at-key.
           display "Seeking >= " split-key end-display
           start indexed-file
              key is greater than or equal to
```

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```
                split-key
            invalid key
                display
                    "bad start: " split-key
                    upon syserr
                end-display
                set no-more-records to true
            not invalid key
                read indexed-file next record
                    at end set no-more-records to true
                end-read
        end-start
        perform indexing-check
    .

    *><* read next by key of reference paragraph
     read-next-by-key.
        move corresponding indexing-record to display-record
        display display-record end-display

        read indexed-file next record
            at end set no-more-records to true
        end-read
        perform indexing-check
    .

    *><* populate a sample database
     populate-sample.

    *> Open optional index file for read write
        open i-o indexed-file
        perform indexing-check

        move "12345678 00a01 some 12345678 data" to indexing-record
        perform write-indexing-record
        move "87654321 00a01 some 87654321 data" to indexing-record
        perform write-indexing-record
        move "12348765 00a01 some 12348765 data" to indexing-record
        perform write-indexing-record
        move "87651234 00a01 some 87651234 data" to indexing-record
        perform write-indexing-record

        move "12345679 00b02 some 12345679 data" to indexing-record
        perform write-indexing-record
        move "97654321 00b02 some 97654321 data" to indexing-record
        perform write-indexing-record
        move "12349765 00b02 some 12349765 data" to indexing-record
        perform write-indexing-record
        move "97651234 00b02 some 97651234 data" to indexing-record
        perform write-indexing-record

        move "12345689 00c13 some 12345689 data" to indexing-record
        perform write-indexing-record
        move "98654321 00c13 some 98654321 data" to indexing-record
        perform write-indexing-record
        move "12349865 00c13 some 12349865 data" to indexing-record
        perform write-indexing-record
```

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```
           move "98651234 00c13 some 98651234 data" to indexing-record
           perform write-indexing-record

      *> close it ... not necessary, but for the example we will
           close indexed-file
           perform indexing-check
       .

      *><* Write paragraph
       write-indexing-record.
           write indexing-record
               invalid key
                   display
                       "rewriting key: " keyfield of indexing-record
                       upon syserr
                   end-display
                   rewrite indexing-record
                       invalid key
                           display
                               "really bad key: "
                               keyfield of indexing-record
                               upon syserr
                           end-display
                   end-rewrite
           end-write
       .

      *><* file status quick check.  For this sample, keep running
       indexing-check.
           if not indexing-ok then
               display
                   "isam file io problem: " indexing-status
                   upon syserr
               end-display
           end-if
       .

       end program indexing.
      *><*
      *><* Last Update: 20150528
```

5.5.1 FILE STATUS

Historically, the condition of a COBOL I/O operation is set in an identifier specified in a *FILE STATUS IS* clause.

John Ellis did us the favour of codifying the GnuCOBOL FILE STATUS codes. See *GnuCOBOL FILE STATUS codes* (page 262) for the details.

Of note, `FILE STATUS` codes are alphanumeric by spec. Most (all that I've ever bumped into) look like numbers, but the standard calls for file status identifiers to be defined as `PIC xx`.

5.5.2 VBISAM

Along with GnuCOBOL, Roger While also put in efforts to "libtoolize" a database engine called VBISAM, by Trevor van Bremen (the VB in VBISAM).

More details follow, but the latest, most debugged version of VBISAM is shipped as part of opensource-cobol from the OSS Consortium based in Japan, and can be downloaded from:

https://github.com/opensourcecobol/opensource-cobol/tree/master/vbisam

For the curious, opensource-cobol is a version of OpenCOBOL 1.1 with enhancements enabling SJIS and UTF-8 character encoding that makes OpenCOBOL more useful for use in Japan. Based on OpenCOBOL 1.1, opensource-cobol is now at version 1.4.0J. This is the same team that developed the `ocesql` engine that allows embedded SQL EXEC handling in GnuCOBOL using PostgreSQL.

The VBISAM engine is one of 4 main configurable database engines that ship with the GnuCOBOL source kit.

- `./configure` defaults to using Berkeley DB, now owned by Oracle Corporation.
- `./configure --with-vbisam` sets up GnuCOBOL to build with Trevor's database engine.
- `./configure --with-cisam` sets up GnuCOBOL to build with CISAM.
- `./configure --with-disam` sets up GnuCOBOL to build with DISAM.

CISAM is a proprietary engine from IBM, and will require a license purchase, but GnuCOBOL knows how to make the calls into this library.

DISAM, by Byte Designs Ltd., is also supported, requiring a license for use.

The main free software alternative to `libdb` is `libvbisam`.

VBISAM is not quite as mature as `libdb`, and has nowhere near the number of active installs, but it is a respectable alternative ISAM engine to `libdb`.

The VBISAM project is hosted on SourceForge at http://sourceforge.net/projects/vbisam/, but that code repository is now approaching 12 years of age.

Sources for version 2.0, with Roger's changes to allow it to fit into a GnuCOBOL build can be found at http://sourceforge.net/projects/vbisam/files/vbisam2/ and includes the following README:

```
                            VBISAM - ISAM File handler
               http://sourceforge.net/projects/vbisam

VBISAM is a replacement for IBM's C-ISAM.
(Version 2 by Roger While)

All programs are distributed under either the GNU General Public
License or the GNU Lesser General Public License.
See COPYING and COPYING.LIB for details.

Authors:
* Trevor van Bremen <trev_vb@users.sourceforge.net> wrote
  VBISAM.
* Roger While <simrw@users.sourceforge.net> autoconf'd/libtoolized
  it. Also major code restructure.

Requirements
============

VBISAM only requires a working C development system.

Installation
============

See INSTALL for general installation instruction.  Typically,
this is done by the following commands:
```

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```
    ./configure
    make
    make install

The default target for installed files is "/usr/local".

Other than the usual configure options (./configure --help)
there are the following specific VBISAM configure options:

  --with-cisamcompat    use VBISAM C-ISAM comatibility mode
  --with-lfs64          use large file system for file I/O (default)
  --with-debug          Enable debugging mode

To squeeze extra performance out of the code, you may want to
do for the install eg :
make install-strip


Development
===========

You need to install the following extra packages with specified
minumum version before hacking VBISAM configure/makefile files:

  o Autoconf 2.59
  o Automake 1.9.6
  o Libtool 1.5.24
  o m4 1.4

Run "autoreconf -ifv -I m4" to regenerate configure/makefile scripts.
You need to run autoreconf whenever you modify configure.ac
or Makefile.am.
```

5.6 Does GnuCOBOL support modules?

Yes. Quite nicely in fact. Dynamically! COBOL modules, and object files of many other languages are linkable. As GnuCOBOL uses intermediate C, linkage to other languages is well supported across many platforms. The GnuCOBOL *CALL* (page 219) instruction maps COBOL *USAGE* (page 427) to many common C stack frame data representations.

Multipart, complex system development is well integrated in the GnuCOBOL model.

```
$ cobc -b hello.cob goodbye.cob
```

Combines both source files into a single dynamically loadable module. Example produces **hello.so**.

Using the **-l** link library option, GnuCOBOL has access to most shared libraries supported on its platforms.

```
$ cobc -x -lcurl showcurl.cob
```

Will link the /usr/lib/libcurl.so (*from the cURL project*) to showcurl. The GnuCOBOL *CALL* (page 219) verb will use this linked library to resolve calls at runtime.

Large scale systems are at the heart of COBOL development and GnuCOBOL is no exception.

For more information, see *What is COB_PRE_LOAD?* (page 671).

5.7 What is COB_PRE_LOAD?

COB_PRE_LOAD is an environment variable that controls what dynamic link modules are included in a run.

For example:

```
$ cobc occurl.c
$ cobc occgi.c
$ cobc -x myprog.cob
$ export COB_PRE_LOAD=occurl:occgi
$ ./myprog
```

That will allow the GnuCOBOL runtime link resolver to find the entry point for CALL "CBL_OC_CURL_INIT" in the occurl.so module. *Note:* the modules listed in the COB_PRE_LOAD environment variable DO NOT have extensions. GnuCOBOL will do the right thing on the various platforms.

If the *DSO* (page 1319) files are not in the current working directory along with the executable, the COB_LIBRARY_PATH can be set to find them.

See *What is COB_LIBRARY_PATH?* (page 867) for information on setting the module search path.

5.8 What is the GnuCOBOL LINKAGE SECTION for?

Argument passing in COBOL is normally accomplished through the **LINKAGE SECTION**. This section does not allocate or initialize memory as would definitions in the WORKING-STORAGE SECTION.

Care must be taken to inform COBOL of the actual source address of these variables before use. Influences CHAINING and USING phrases. See *CALL* (page 219) for more details.

5.9 What does the -fstatic-linkage GnuCOBOL compiler option do?

Under normal conditions, the *LINKAGE SECTION* is unallocated and uninitialized. When a LINKAGE SECTION variable, that is not part of the *USING* phrase (not a named calling argument), any memory that has been addressed becomes unaddressable across calls. *-fstatic-linkage* creates static addressing to the LINKAGE SECTION.

From [Roger]:

```
This relates to LINKAGE items that are NOT referred
to in the USING phrase of the PROCEDURE DIVISION.
It also only has relevance when the program is CALL'ed
from another prog.
This means that the addressability of these items must
be programmed (usually with SET ADDRESS) before reference.

Per default, the item loses its addressability on exit
from the program. This option causes the module to retain
the item's address between CALL invocations of the program.
```

With some rumours that this may become the default in future releases of GnuCOBOL, and the *-fstatic-linkage* option may be deprecated.

5.10 Does GnuCOBOL support Message Queues?

Yes, but not out of the box. A linkable *POSIX* (page 1361) message queue layer is available.

```
/* GnuCOBOL access to POSIX Message Queues                    */
/* Author: Brian Tiffin                                       */
/* Date:   August, 2008                                       */
/* Build:  gcc -c ocmq.c                                      */
/* Usage:  cobc -x -lrt program.cob ocmq.o                    */

#include <fcntl.h>           /* For O_* constants */
#include <sys/stat.h>        /* For mode constants */
#include <errno.h>           /* Access to error values */
#include <mqueue.h>          /* The message queues */
#include <signal.h>          /* for notification */
#include <time.h>            /* for the timed versions */
#include <stdio.h>
#include <string.h>          /* For strerror */

#include <libcob.h>          /* for cob_resolve */

/* Forward declarations */
static void ocmq_handler(int, siginfo_t *, void *);
static void (*MQHANDLER)(int *mqid);

/* Return C runtime global errno */
int ERRORNUMBER() {
    return errno;
}

/* Load a COBOL field with an error string */
int ERRORSTRING(char *errbuff, int buflen) {
    void *temperr;

    temperr = strerror(errno);
    memcpy((void *)errbuff, temperr, buflen);
    return strlen(temperr);
}

/*

/* Open Message Queue */
int MQOPEN(char *mqname, int oflags) {
    mqd_t mqres;

    errno = 0;
    mqres = mq_open(mqname, oflags);
    return (int)mqres;
}

/* Creating a queue requires two extra arguments, permissions and attributes */
int MQCREATE(char *mqname, int oflags, int perms, char *mqattr) {
    mqd_t mqres;

    errno = 0;
    mqres = mq_open(mqname, oflags, (mode_t)perms, (struct mq_attr *)mqattr);
    return (int)mqres;
```

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```
}

/* Get current queue attributes */
int MQGETATTR(int mqid, char *mqattr) {
    mqd_t mqres;

    errno = 0;
    mqres = mq_getattr((mqd_t)mqid, (struct mq_attr *)mqattr);
    return (int)mqres;
}

/* Set current queue attributes */
/*   only accepts mqflags of 0 or MQO-NONBLOCK once created */
int MQSETATTR(int mqid, char *mqattr, char *oldattr) {
    mqd_t mqres;

    errno = 0;
    mqres = mq_setattr((mqd_t)mqid, (struct mq_attr *)mqattr, (struct mq_attr␣
↪*)oldattr);
    return (int)mqres;
}

/* Send a message to the queue */
int MQSEND(int mqid, char *message, int length, unsigned int mqprio) {
    mqd_t mqres;

    errno = 0;
    mqres = mq_send((mqd_t)mqid, message, (size_t)length, mqprio);
    return (int)mqres;
}

/* Read the highest priority message */
int MQRECEIVE(int mqid, char *msgbuf, int buflen, int *retprio) {
    ssize_t retlen;

    errno = 0;
    retlen = mq_receive((mqd_t)mqid, msgbuf, buflen, retprio);
    return (int)retlen;
}

/* Timeout send */
int MQTIMEDSEND(int mqid, char *message, int length,
                unsigned int mqprio, int secs, long nanos) {

    mqd_t mqres;
    struct timespec mqtimer;
    struct timeval curtime;

    /* Expect seconds and nanos to wait, not absolute.  Add the GnuCOBOL values */
    gettimeofday(&curtime, NULL);
    mqtimer.tv_sec = curtime.tv_sec + (time_t)secs;
    mqtimer.tv_nsec = nanos;

    errno = 0;
    mqres = mq_timedsend((mqd_t)mqid, message, (size_t)length, mqprio, &mqtimer);
    return (int)mqres;
}
```

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```
/* Read the highest priority message */
int MQTIMEDRECEIVE(int mqid, char *msgbuf, int buflen,
                   int *retprio, int secs, long nanos) {
    ssize_t retlen;
    struct timespec mqtimer;

    struct timeval curtime;

    /* Expect seconds and nanos to wait, not absolute.  Add the GnuCOBOL values */
    gettimeofday(&curtime, NULL);
    mqtimer.tv_sec = curtime.tv_sec + (time_t)secs;
    mqtimer.tv_nsec = nanos;

    errno = 0;
    retlen = mq_timedreceive((mqd_t)mqid, msgbuf, buflen, retprio, &mqtimer);
    return (int)retlen;
}


/* Notify of new message written to queue */
int MQNOTIFY(int mqid, char *procedure) {
    struct sigevent ocsigevent;
    struct sigaction ocsigaction;

    /* Install signal handler for the notify signal - fill in a
     * sigaction structure and pass it to sigaction(). Because the
     * handler needs the siginfo structure as an argument, the
     * SA_SIGINFO flag is set in sa_flags.
     */
    ocsigaction.sa_sigaction = ocmq_handler;
    ocsigaction.sa_flags = SA_SIGINFO;
    sigemptyset(&ocsigaction.sa_mask);

    if (sigaction(SIGUSR1, &ocsigaction, NULL) == -1) {
        fprintf(stderr, "%s\n", "Error posting sigaction");
        return -1;
    }

    /* Set up notification: fill in a sigevent structure and pass it
     * to mq_notify(). The queue ID is passed as an argument to the
     * signal handler.
     */
    ocsigevent.sigev_signo      = SIGUSR1;
    ocsigevent.sigev_notify     = SIGEV_SIGNAL;
    ocsigevent.sigev_value.sival_int = (int)mqid;

    if (mq_notify((mqd_t)mqid, &ocsigevent) == -1) {
        fprintf(stderr, "%s\n", "Error posting notify");
        return -1;
    }
    return 0;
}

/* Close a queue */
int MQCLOSE(int mqid) {
    mqd_t mqres;
```

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```
    errno = 0;
    mqres = mq_close((mqd_t)mqid);
    return (int)mqres;
}

/* Unlink a queue */
int MQUNLINK(char *mqname) {
    mqd_t mqres;

    errno = 0;
    mqres = mq_unlink(mqname);
    return (int)mqres;
}

/* The signal handling section */
/* signal number */
/* signal information */
/* context unused (required by posix) */
static void ocmq_handler(int sig, siginfo_t *pInfo, void *pSigContext) {
    struct sigevent ocnotify;
    mqd_t mqid;

    /* Get the ID of the message queue out of the siginfo structure.     */
    mqid = (mqd_t) pInfo->si_value.sival_int;

    /* The MQPROCESSOR is a hardcoded GnuCOBOL resolvable module name */
    /*   It must accept an mqd_t pointer  */
    cob_init(0, NULL);
    MQHANDLER = cob_resolve("MQPROCESSOR");
    if (MQHANDLER == NULL) {
        /* What to do here? */
        fprintf(stderr, "%s\n", "Error resolving MQPROCESSOR");
        return;
    }

    /* Request notification again; it resets each time a notification
     * signal goes out.
     */
    ocnotify.sigev_signo = pInfo->si_signo;
    ocnotify.sigev_value = pInfo->si_value;
    ocnotify.sigev_notify = SIGEV_SIGNAL;

    if (mq_notify(mqid, &ocnotify) == -1) {
        /* What to do here? */
        fprintf(stderr, "%s\n", "Error posting notify");
        return;
    }

    /* Call the cobol module with the message queue id */
    MQHANDLER(&mqid);
    return;
}
/**/
```

With a sample of usage. Note the linkage of the rt.so realtime library.

```
GCobol >>SOURCE FORMAT IS FIXED
      ******************************************************************
      * Author:    Brian Tiffin
      * Date:      August 2008
      * Purpose:   Demonstration of GnuCOBOL message queues
      * Tectonics: gcc -c ocmq.c
      *            cobc -Wall -x -lrt mqsample.cob ocmq.o
      ******************************************************************
       identification division.
       program-id. mqsample.

       data division.
       working-storage section.
      * Constants for the Open Flags
       01 MQO-RDONLY           constant as 0.
       01 MQO-WRONLY           constant as 1.
       01 MQO-RDWR             constant as 2.
       01 MQO-CREAT            constant as 64.
       01 MQO-EXCL             constant as 128.
       01 MQO-NONBLOCK         constant as 2048.
      * Constants for the protection/permission bits
       01 MQS-IREAD            constant as 256.
       01 MQS-IWRITE           constant as 128.

      * Need a better way of displaying newlines
       01 newline              pic x value x'0a'.

      * Message Queues return an ID, maps to int
       01 mqid                 usage binary-long.
       01 mqres                usage binary-long.
      * Queue names end up in an mqueue virtual filesystem on GNU/Linux
       01 mqname.
          02 name-display      pic x(5) value "/ocmq".
          02 filler            pic x value x'00'.
       01 mqopenflags          usage binary-long.
       01 mqpermissions        usage binary-long.

       01 default-message      pic x(20) value 'GnuCOBOL is awesome'.
       01 user-message         pic x(80).
       01 send-length          usage binary-long.

       01 urgent-message       pic x(20) value 'Urgent GnuCOBOL msg'.

      * Data members for access to C global errno and error strings
       01 errnumber            usage binary-long.
       01 errstr               pic x(256).
      * legend to use with the error reporting
       01 operation            pic x(7).

       01 loopy                pic 9.

      * Debian GNU/Linux defaults to Message Queue entry limit of 8K
       01 msgbuf               pic x(8192).
       01 msglen               usage binary-long value 8192.
      * Priorities range from 0 to 31 on many systems, can be more
       01 msgprio              usage binary-long.
      * MQ attributes.  See /usr/include/bits/mqueue.h
```

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```
       01 mqattr.
          03 mqflags           usage binary-long.
          03 mqmaxmsg          usage binary-long.
          03 mqmsgsize         usage binary-long.
          03 mqcurmsqs         usage binary-long.
          03 filler            usage binary-long occurs 4 times.
       01 oldattr.
          03 mqflags           usage binary-long.
          03 mqmaxmsg          usage binary-long.
          03 mqmsgsize         usage binary-long.
          03 mqcurmsqs         usage binary-long.
          03 filler            usage binary-long occurs 4 times.

       procedure division.
      * The ocmq API support MQCREATE and MQOPEN.
      * This example uses non blocking, non exclusive create
      *   read/write by owner and default attributes
       compute
           mqopenflags = MQO-RDWR + MQO-CREAT + MQO-NONBLOCK
       end-compute.
       compute
           mqpermissions = MQS-IREAD + MQS-IWRITE
       end-compute.

      * Sample shows the two types of open, but only evaluates create
       if zero = zero
       call "MQCREATE" using mqname
                             by value mqopenflags
                             by value mqpermissions
                             by value 0
                       returning mqid
       end-call
       else
       call "MQOPEN" using mqname
                           by value mqopenflags
                       returning mqid
       end-call
       end-if.
       move "create" to operation.
       perform show-error.

      * Show the attributes after initial create
       perform show-attributes.

      * Register notification
       call "MQNOTIFY" using by value mqid
                             mqname
                             returning mqres
       end-call.
       move "notify" to operation.
       perform show-error.

      * Create a temporary queue, will be removed on close
      * call "MQUNLINK" using mqname
      *                 returning mqres
      * end-call.
      * move "unlink" to operation.
```

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```
      * perform show-error.

      * Use the command line arguments or a default message
       accept user-message from command-line end-accept.
       if user-message equal spaces
           move default-message to user-message
       end-if.
       move function length
           (function trim(user-message trailing))
           to send-length.

      * Queue up an urgent message (priority 31)
       call "MQSEND" using by value mqid
                           by reference urgent-message
                           by value 20
                           by value 31
       end-call.
       move "send-31" to operation.
       perform show-error.

      * Queue up a low priority message (1)
       call "MQSEND" using by value mqid
                           by reference user-message
                           by value send-length
                           by value 1
                     returning mqres
       end-call.
       move "send-1" to operation.
       perform show-error.

      * Queue up a middle priority message (16)
       inspect urgent-message
           replacing leading "Urgent" by "Middle".
       call "MQSEND" using by value mqid
                           by reference urgent-message
                           by value 20
                           by value 16
                     returning mqres
       end-call.
       move "send-16" to operation.
       perform show-error.

      * Redisplay the queue attributes
       perform show-attributes.

      * Pull highest priority message off queue
       call "MQRECEIVE" using by value mqid
                              by reference msgbuf
                              by value msglen
                              by reference msgprio
                        returning mqres
       end-call.
       display
           newline "receive len: " mqres " prio: " msgprio
       end-display.
       if mqres > 0
           display
```

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```
                "priority 31 message: " msgbuf(1:mqres)
            end-display
        end-if.
        move "receive" to operation.
        perform show-error.

      * Pull the middling priority message off queue
        call "MQRECEIVE" using by value mqid
                               by reference msgbuf
                               by value msglen
                               by reference msgprio
                         returning mqres
        end-call.
        display
            newline "receive len: " mqres " prio: " msgprio
        end-display.
        if mqres > 0
            display
                "priority 16 message: " msgbuf(1:mqres)
            end-display
        end-if.
        move "receive" to operation.
        perform show-error.

      * ** INTENTIONAL ERROR msglen param too small **
      * Pull message off queue
        call "MQRECEIVE" using by value mqid
                               by reference msgbuf
                               by value 1024
                               by reference msgprio
                         returning mqres
        end-call.
        display
            newline "receive len: " mqres " prio: " msgprio
        end-display.
        if mqres > 0
            display
                "no message: " msgbuf(1:mqres)
            end-display
        end-if.
        move "receive" to operation.
        perform show-error.

      * Pull the low priority message off queue, in blocking mode
        move MQO-NONBLOCK to mqflags of mqattr.
        call "MQSETATTR" using by value mqid
                               by reference mqattr
                               by reference oldattr
                         returning mqres
        end-call
        move "setattr" to operation.
        perform show-error.
        perform show-attributes.

        call "MQRECEIVE" using by value mqid
                               by reference msgbuf
                               by value msglen
```

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```
                        by reference msgprio
                    returning mqres
      end-call.
      display
          newline "receive len: " mqres " prio: " msgprio
      end-display.
      if mqres > 0
          display
              "priority 1 message: " msgbuf(1:mqres)
          end-display
      end-if.
      move "receive" to operation.
      perform show-error.

      perform varying loopy from 1 by 1
          until loopy > 5
              display "Sleeper call " loopy end-display
              call "CBL_OC_NANOSLEEP" using 50000000000
                                      returning mqres
              end-call
      end-perform.

     * Close the queue.  As it is set unlinked, it will be removed
      call "MQCLOSE" using by value mqid
                     returning mqres
      end-call.
      move "close" to operation.
      perform show-error.

     * Create a temporary queue, will be removed on close
      call "MQUNLINK" using mqname
                      returning mqres
      end-call.
      move "unlink" to operation.
      perform show-error.

      goback.

     ******************************************************************
     * Information display of the Message Queue attributes.
      show-attributes.
      call "MQGETATTR" using by value mqid
                             by reference mqattr
                      returning mqres
      end-call
      move "getattr" to operation.
      perform show-error.

     * Display the message queue attributes
      display
          name-display " attributes:"       newline
          "flags:    " mqflags   of mqattr  newline
          "max msg:  " mqmaxmsg  of mqattr  newline
          "mqs size: " mqmsgsize of mqattr  newline
          "cur msgs: " mqcurmsqs of mqattr
      end-display
      .
```

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```
      * The C global errno error display paragraph
       show-error.
           call "ERRORNUMBER" returning mqres end-call
           if mqres > 0
               display
                   operation " errno: " mqres
               end-display
               call "ERRORSTRING" using errstr
                                        by value length errstr
                                  returning mqres end-call
               if mqres > 0
                   display
                       "     strerror: " errstr(1:mqres)
                   end-display
               end-if
           end-if
       .
       end program mqsample.

      ******************************************************************
      * Author:    Brian Tiffin
      * Date:      August 2008
      * Purpose:   Demonstration of GnuCOBOL message queue notification
      * Tectonics: gcc -c ocmq.c
      *            cobc -Wall -x -lrt mqsample.cob ocmq.o
      ******************************************************************
       identification division.
       program-id. MQSIGNAL.

       data division.
       working-storage section.
       01 msgbuf pic x(8192).
       01 msglen usage binary-long value 8192.
       01 msgprio usage binary-long.
       01 mqres  usage binary-long.

       linkage section.
       01 mqid usage binary-long.

       procedure division using mqid.

       display "in MQSIGNAL".
       display "In the COBOL procedure with " mqid end-display.
       perform
           with test after
           until mqres <= 0

           call "MQRECEIVE" using by value mqid
                                  by reference msgbuf
                                  by value msglen
                                  by reference msgprio
                            returning mqres
           end-call
           display
               "receive len: " mqres " prio: " msgprio
           end-display
```

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```
           if mqres > 0
               display
                   "priority 31 message: " msgbuf(1:mqres)
               end-display
           end-if
       end-perform.

       goback.
       end program MQSIGNAL.
```

5.11 Can GnuCOBOL interface with Lua?

Yes. As a builtin or via the Lua C interface.

5.11.1 Intrinsic Lua

There is an optional builtin Intrinsic Function that embeds Lua.

```
GCOB  *>-<*
      *> Author: Brian Tiffin
      *> Dedicated to the public domain
      *>
      *> Date started: June 2017
      *> Modified: 2017-06-25/04:30-0400 btiffin
      *>+<*
      *>
      *> lua.cob, intrinsic Lua demo
      *> Tectonics: cobc -xj lua.cob
      *>
       >>SOURCE FORMAT IS FREE
       identification division.
       program-id. sample.

       REPLACE ==newline== BY ==& x'0a' &==.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       COPY luaapi.

       01 extraneous pic x.
       01 comparator pic 9(2).

       procedure division.
       sample-main.
      *> mandatory intro
       move lua("print 'Hello, world'") to extraneous

      *> ref mod
```

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```
       display ":" lua("return 'abc'")(2:1) ":"

      *> persistent
       display ":" lua("return 'abc'") ":"
       display ":" lua("a = 'abcdef'; return a") ":"
       display ":" lua("return a") ":"

      *> non persistent across close
       display ":" lua(LUA-COMMAND-CLOSE) ": close"
       display ":" lua("return a") ": want empty"

      *> syntax error
       display ":" lua("text")(1:1) ": want error"
       display exception-status
       display script-return-code

       display ":" lua("n = 5") ": want empty"
       display ":" lua("5 , ") ": want error"
       display exception-status
       display script-return-code

      *> SUBJECT TO CHANGE *<
      *> multiple returns, top is resulting value
       display ":" lua("return 11,22,33,44") ":"

      *> request stack dump
       move lua(LUA-COMMAND-STACKDUMP) to extraneous

      *> get entry n from stack relative from top
      *>   (negative value "commands")
      *> needs to be a string, a raw value will be passed in the field
      *>   as sign trailing...
       display ":" lua("-2") ":"
       display ":" lua("-2") ":"

      *> request stack dump
       move lua(LUA-COMMAND-STACKDUMP) to extraneous

      *> script from file, this will eat a stack value assumed from file
       move lua("dofile('local.lua')") to extraneous
       display ":" extraneous ": file has no returns, still want to eat"

      *> request stack dump
       move lua(LUA-COMMAND-STACKDUMP) to extraneous

       display ":" lua("n = norm(3.4, 2.0); return twice(n)") ":"

      *> request stack dump
       move lua(LUA-COMMAND-STACKDUMP) to extraneous

      *> tables
       move lua(
           'function f(n) return n + 100 end' newline
           'g = 42' newline
           'a = { [f(4)] = g; "x", "y"; z = 1, f(1), [30] = 23; 45 }'
           newline
           'return a, "a table and string", 0')
```

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```
           to extraneous
      *> don't expect error
       display exception-status
       display script-return-code

      *> will be an internal format
       move lua(LUA-COMMAND-STACKDUMP) to extraneous

      *> pop the string
       display ":" lua("-1") ":"

      *> will still be an internal format
       display ":" lua("-1") ":"

      *> Lua table constructors take some getting used to
       display ":" lua("return a[1]") ': expect the first "x", implicit'
       display ":" lua("return a[3]") ": from  f(1)"
       display ":" lua("return a[30]") ":"
       display ":" lua("return a[104]") ": from [f(4)]"
       display ":" lua("return a['z']") ": from z = 1"

      *> user input
       move lua(
           "-- defines a factorial function"                    newline
           "function fact (n)"                                  newline
           "  if n == 0 then"                                   newline
           "    return 1"                                       newline
           "  else"                                             newline
           "    return n * fact(n-1)"                           newline
           "  end"                                              newline
           "end"                                                newline
           " "                                                  newline
           'print("enter a number:")'                           newline
           'a = io.read("*number")        -- read a number'     newline
           'print("Factorial " .. a .. " is " .. fact(a))'      newline
           "return a")
         to comparator

      *> should be no cruft on the stack
       move lua(LUA-COMMAND-STACKDUMP) to extraneous

       goback.
       end program sample.
```

lua-sample.cob

```
prompt$ cobc -xj lua-sample.cob
Hello, world
:b:
:abc:
:abcdef:
:abcdef:
:: close
:: want empty
:: want error
EC-IMP-SCRIPT
+00000000000000000002
```

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```
:: want empty
:: want error
EC-IMP-SCRIPT
+00000000000000000002
:44:
Lua Stack Dump, 3 items
001: number : 11
002: number : 22
003: number : 33
:22:
:11:
Lua Stack Dump, 1 item
001: number : 33
:3: file has no returns, still want to eat
Lua Stack Dump, 0 items
:7.8892331693264:
Lua Stack Dump, 0 items

+00000000000000000000
Lua Stack Dump, 2 items
001: other  : table
002: string : 'a table and string'
:a table and string:
:table: 0x1bc7af0:
:x: expect the first "x", implicit
:101: from  f(1)
:23:
:42: from [f(4)]
:1: from z = 1
enter a number:
17
Factorial 17 is 355687428096000
Lua Stack Dump, 0 items
```

FUNCTION LUA(script) makes embedding Lua a very easy thing.

5.11.2 oclua

Lua can also be embedded in GnuCOBOL applications using the full Lua C API.

Code, circa 2008. Use FUNCTION LUA if you want easy to use Lua scripting.

```
GCobol >>SOURCE FORMAT IS FIXED
      *><* ======================
      *><* GnuCOBOL Lua Interface
      *><* ======================
      *><*
      *><* .. sidebar:: Contents
      *><*
      *><*     .. contents::
      *><*         :local:
      *><*         :depth: 2
      *><*         :backlinks: entry
      *><*
      *><* :Author:    Brian Tiffin
      *><* :Date:      28-Oct-2008
```

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```
      *><* :Purpose:   interface to Lua scripting
      *><* :Rights:    | Copyright 2008 Brian Tiffin
      *><*             | Licensed under the GNU General Public License
      *><*             | No warranty expressed or implied
      *><* :Tectonics: | cobc -c -I/usr/include/lua5.1/ oclua.c
      *><*             | cobc -x -llua5.1 luacaller.cob oclua.o
      *><*             | ./ocdoc luacaller.cob oclua.rst oclua.html ocfaq.css
      *><* :Requires:  lua5.1, liblua5.1, liblua5.1-dev
      *><* :Link:      http://www.lua.org
      *><* :Thanks to: The Lua team, Pontifical Catholic University
      *><*             of Rio de Janeiro in Brazil.
      *><*             http://www.lua.org/authors.html
      *><* :Sources:   | http://opencobol.add1tocobol.com/luacaller.cob
      *><*             | http://opencobol.add1tocobol.com/oclua.c
      *><*             | http://opencobol.add1tocobol.com/oclua.lua
      *><*             | http://opencobol.add1tocobol.com/oclua.rst
      *><*             | http://opencobol.add1tocobol.com/ocfaq.rss
      *><*
      *> ****************************************************************
       identification division.
       program-id. luacaller.

       data division.
       working-storage section.
       01 luastate             usage pointer.
       01 luascript            pic x(10) value 'oclua.lua' & x"00".
       01 luacommand           pic x(64).
       01 luaresult            pic x(32).
       01 lualength            usage binary-long.

       01 items                pic 9 usage computational-5.
       01 luastack.
          03 luaitem           pic x(32) occurs 5 times.
       01 depth                usage binary-long.

      *> ****************************************************************
       procedure division.

       call "OCLUA_OPEN" returning luastate end-call

       move 'return "GnuCOBOL " .. 1.0 + 0.1' & x"00" to luacommand
       call "OCLUA_DOSTRING"
           using
               by value luastate
               by reference luacommand
               by reference luaresult
               by value function length(luaresult)
           returning depth
       end-call
       display
           "GnuCOBOL displays: " depth " |" luaresult "|"
       end-display

       call "OCLUA_DOFILE"
           using
               by value luastate
               by reference luascript
```

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```
            by reference luaresult
            by value 32
        returning depth
    end-call
    display
        "GnuCOBOL displays: " depth " |" luaresult "|"
    end-display

    call "OCLUA_DOFILE"
        using
            by value luastate
            by reference luascript
            by reference luaresult
            by value 32
        returning depth
    end-call
    display
        "GnuCOBOL displays: " depth " |" luaresult "|"
    end-display

    call "OCLUA_DEPTH"
        using
            by value luastate
        returning depth
    end-call
    display "Lua depth: " depth end-display

    perform varying items from 1 by 1
        until items > depth
            call "OCLUA_GET"
                using
                    by value luastate
                    by value items
                    by reference luaresult
                    by value 32
                returning lualength
            end-call
            move luaresult to luaitem(items)
    end-perform

    perform varying items from 1 by 1
        until items > depth
            display
                "Item " items ": " luaitem(items)
            end-display
    end-perform

    call "OCLUA_POP"
        using
            by value luastate
            by value depth
        returning depth
    end-call

    call "OCLUA_DEPTH"
        using
            by value luastate
```

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```
           returning depth
       end-call

       display "Lua depth: " depth end-display

       call "OCLUA_CLOSE" using by value luastate end-call

       goback.
       end program luacaller.
      *> ****************************************************************
      *><* ++++++++
      *><* Overview
      *><* ++++++++
      *><* The GnuCOBOL Lua interface is defined at a very high level.
      *><*
      *><* The objective is to provide easy access to Lua through
      *><* script files or strings to be evaluated.
      *><*
      *><* Command strings and script file names passed to Lua MUST be
      *><* terminated with a null byte, as per C Language conventions.
      *><*
      *><* A Lua engine is started with a call to OCLUA_OPEN, which
      *><* returns a GnuCOBOL POINTER that is used to reference
      *><* the Lua state for all further calls.
      *><*
      *><* A Lua engine is run down with a call to OCLUA_CLOSE.
      *><*
      *><* .. Attention::
      *><*   Calls to Lua without a valid state will cause
      *><*   undefined behaviour and crash the application.
      *><*
      *><* Lua uses a stack and results of the Lua RETURN reserved
      *><* word are placed on this stack.  Multiple values can be
      *><* returned from Lua.
      *><*
      *><* The developer is responsible for stack overflow conditions
      *><* and the size of the stack (default 20 elements) is
      *><* controlled with OCLUA_STACK using an integer that
      *><* determines the numbers of slots to reserve.
      *><*
      *><* Requires package installs of:
      *><*
      *><* * lua5.1
      *><* * liblua5.1
      *><* * liblua5.1-dev
      *><*
      *><* ++++++++++++++++
      *><* GnuCOBOL Lua API
      *><* ++++++++++++++++
      *><* ----------
      *><* OCLUA_OPEN
      *><* ----------
      *><* Initialize the Lua engine.
      *><*
      *><* ::
      *><*
      *><*   01 luastate USAGE POINTER.
```

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```
      *><*
      *><*   CALL "OCLUA_OPEN" RETURNING luastate END-CALL
      *><*
      *><* -----------
      *><* OCLUA_STACK
      *><* -----------
      *><* Check and possibly resize the Lua data stack.  Returns 0 if
      *><* Lua cannot expand the stack to the requested size.
      *><*
      *><* ::
      *><*
      *><*   01 elements USAGE BINARY-LONG VALUE 32.
      *><*   01 result   USAGE BINARY-LONG.
      *><*
      *><*   CALL "OCLUA_STACK"
      *><*       USING
      *><*           BY VALUE luastate
      *><*           BY VALUE elements
      *><*       RETURNING result
      *><*   END-CALL
      *><*
      *><* --------------
      *><* OCLUA_DOSTRING
      *><* --------------
      *><* Evaluate a null terminated alphanumeric field as a Lua program
      *><* producing any top of stack entry and returning the depth of
      *><* stack after evaluation.
      *><*
      *><* Takes a luastate, a null terminated command string,
      *><* a result field and length and returns an integer depth.
      *><*
      *><* .. Attention::
      *><*   The Lua stack is NOT popped while returning the top of stack entry.
      *><*
      *><* ::
      *><*
      *><*   01 luacommand pic x(64).
      *><*   01 luaresult  pic x(32).
      *><*   01 depth      usage binary-long.
      *><*
      *><*   move 'return "GnuCOBOL " .. 1.0 + 0.1' & x"00" to luacommand
      *><*   call "OCLUA_DOSTRING"
      *><*       using
      *><*           by value luastate
      *><*           by reference luacommand
      *><*           by reference luaresult
      *><*           by value function length(luaresult)
      *><*       returning depth
      *><*   end-call
      *><*   display
      *><*       "GnuCOBOL displays: " depth " |" luaresult "|"
      *><*   end-display
      *><*
      *><* Outputs::
      *><*
      *><*   GnuCOBOL displays: +0000000001 |GnuCOBOL 1.1                   ||
      *><*
```

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```
      *><* ------------
      *><* OCLUA_DOFILE
      *><* ------------
      *><* Evaluate a script using a null terminated alphanumeric field
      *><* naming a Lua program source file, retrieving any top of
      *><* stack entry and returning the depth of stack after evaluation.
      *><*
      *><* Takes a luastate, a null terminated filename,
      *><* a result field and length and returns an integer depth.
      *><*
      *><* .. Attention::
      *><*   The Lua stack is NOT popped while returning the top of
      *><*   stack entry.
      *><*
      *><* ::
      *><*
      *><*   01 luascript  pic x(10) value 'oclua.lua' & x"00".
      *><*   01 luaresult  pic x(32).
      *><*
      *><*   call "OCLUA_DOFILE"
      *><*       using
      *><*           by value luastate
      *><*           by reference luascript
      *><*           by reference luaresult
      *><*           by value function length(luaresult)
      *><*       returning depth
      *><*   end-call
      *><*   display
      *><*       "GnuCOBOL displays: " depth " |" luaresult "|"
      *><*   end-display
      *><*
      *><* Given oclua.lua::
      *><*
      *><*   -- Start
      *><*   -- Script: oclua.lua
      *><*   print("Lua prints hello")
      *><*
      *><*   hello = "Hello GnuCOBOL from Lua"
      *><*   return math.pi, hello
      *><*   -- End
      *><*
      *><* Outputs::
      *><*
      *><*   Lua prints hello
      *><*   GnuCOBOL displays: +0000000002 |Hello GnuCOBOL from Lua        ||
      *><*
      *><* and on return from Lua, there is *math.pi* and the
      *><* Hello string remaining on the Lua state stack.
      *><*
      *><* -----------
      *><* OCLUA_DEPTH
      *><* -----------
      *><* Returns the current number of elements on the Lua stack.
      *><*
      *><* ::
      *><*
      *><*   call "OCLUA_DEPTH"
```

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```
      *><*       using
      *><*           by value luastate
      *><*       returning depth
      *><*   end-call
      *><*   display "Lua depth: " depth end-display
      *><*
      *><* ---------
      *><* OCLUA_GET
      *><* ---------
      *><* Retrieves values from the Lua stack, returning the length
      *><* of the retrieved item.
      *><*
      *><* An example that populates and displays a GnuCOBOL table::
      *><*
      *><*   01 items                pic 9 usage computational-5.
      *><*   01 luastack.
      *><*      03 luaitem           pic x(32) occurs 5 times.
      *><*
      *><*   perform varying items from 1 by 1
      *><*       until items > depth
      *><*           call "OCLUA_GET"
      *><*               using
      *><*                   by value luastate
      *><*                   by value items
      *><*                   by reference luaresult
      *><*                   by value function length(luaresult)
      *><*               returning lualength
      *><*           end-call
      *><*           move luaresult to luaitem(items)
      *><*   end-perform
      *><*
      *><*   perform varying items from 1 by 1
      *><*       until items > depth
      *><*           display
      *><*              "Item " items ": " luaitem(items)
      *><*           end-display
      *><*   end-perform
      *><*
      *><* Lua numbers the indexes of stacked items from 1, first
      *><* item to n, last item (current top of stack). Negative
      *><* indexes may also be used as documented by Lua, -1 being
      *><* top of stack.
      *><*
      *><* Sample output::
      *><*
      *><*   Item 1: GnuCOBOL 1.1
      *><*   Item 2: 3.1415926535898
      *><*   Item 3: Hello GnuCOBOL from Lua
      *><*   Item 4: 3.1415926535898
      *><*   Item 5: Hello GnuCOBOL from Lua
      *><*
      *><* ---------
      *><* OCLUA_POP
      *><* ---------
      *><* Pops the given number of elements off of the Lua stack
      *><* returning the depth of the stack after the pop.
      *><*
```

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```
      *><* Example that empties the Lua stack::
      *><*
      *><*   call "OCLUA_POP"
      *><*       using
      *><*           by value luastate
      *><*           by value depth
      *><*       returning depth
      *><*   end-call
      *><*
      *><* -----------
      *><* OCLUA_CLOSE
      *><* -----------
      *><* Close and free the Lua engine.
      *><*
      *><* .. Danger::
      *><*    Further calls to Lua are unpredictable and may well
      *><*    lead to a SIGSEGV crash.
      *><*
      *><* ::
      *><*
      *><*   call "OCLUA_CLOSE" using by value luastate end-call
      *><*
```

With usage document at oclua.html

The above code uses a wrapper layer of C code

```
/* GnuCOBOL Lua interface */
/* tectonics: cobc -c -I/usr/include/lua5.1 oclua.c */

#include <stdlib.h>
#include <stdio.h>
#include <string.h>

/* Include the Lua API header files. */
#include <lua.h>
#include <lauxlib.h>
#include <lualib.h>

/* Open the Lua engine and load all the default libraries */
lua_State *OCLUA_OPEN() {
    lua_State *oclua_state;
    oclua_state = lua_open();
    luaL_openlibs(oclua_state);
    return oclua_state;
}

int OCLUA_DO(lua_State *L, int which, const char *string,
             unsigned char *cobol, int coblen) {
    int result;
    int stacked;
    const char *retstr;
    int retlen;

    memset(cobol, ' ', coblen);
    result = ((which == 0) ? luaL_dostring(L, string) : luaL_dofile(L, string));
    if (result == 1) {
```

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```
        /* error condition */
        return -1;
    } else {
        stacked = lua_gettop(L);
        if (stacked > 0) {
            /* populate cobol field with top of stack */
            retstr = lua_tolstring(L, stacked, &retlen);
            memcpy(cobol, retstr, (coblen > retlen) ? retlen : coblen);
        }
        /* return number of items on the stack */
        return stacked;
    }
}

/* by filename */
int OCLUA_DOFILE(lua_State *L, const char *filename,
                 unsigned char *cobol, int coblen) {
    return OCLUA_DO(L, 1, filename, cobol, coblen);
}

/* by string */
int OCLUA_DOSTRING(lua_State *L, const char *string,
                   unsigned char *cobol, int coblen) {
    return OCLUA_DO(L, 0, string, cobol, coblen);
}

/* retrieve stack item as string */
int OCLUA_GET(lua_State *L, int element, unsigned char *cobol, int coblen) {
    const char *retstr;
    int retlen;

    /* populate cobol field with top of stack */
    memset(cobol, ' ', coblen);
    retstr = lua_tolstring(L, element, &retlen);
    if (retstr == NULL) {
        return -1;
    } else {
        memcpy(cobol, retstr, (coblen > retlen) ? retlen : coblen);
        return retlen;
    }
}

/* check the stack, resize if needed, returns false if stack can't grow */
int OCLUA_STACK(lua_State *L, int extra) {
    return lua_checkstack(L, extra);
}

/* depth of Lua stack */
int OCLUA_DEPTH(lua_State *L) {
    return lua_gettop(L);
}

/* pop elements off stack */
int OCLUA_POP(lua_State *L, int elements) {
    lua_pop(L, elements);
    return lua_gettop(L);
}
```

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```
/* close the engine */
void OCLUA_CLOSE(lua_State *L) {
    lua_close(L);
}

/**/
```

and this sample Lua script **oclua.lua**

```
-- Start
-- Script: oclua.lua
print("Lua prints hello")

hello = "Hello GnuCOBOL from Lua"
return math.pi, hello
-- End
```

5.12 Can GnuCOBOL use ECMAScript?

Yes. Using the SpiderMonkey engine. Also with `libseed` a GNOME project exposing JavaScriptCore from WebKitGTK. And with the easily embedded DukTape ES 5 interpreter (with good support for ECMAScript 2015 (ES 6) and ECMAScript 2016 (E7)).

See *Can GnuCOBOL use JavaScript?* (page 694)

5.13 Can GnuCOBOL use JavaScript?

Yes. A wrapper for the SpiderMonkey engine allows GnuCOBOL access to core JavaScript. *You'll need a copy of the Mozilla spidermonkey library installed, along with the development headers for smjs for this to work.*

```
/* GnuCOBOL with embedded spidermonkey javascript */
/*   cobc -c -I/usr/include/smjs ocjs.c
 *   cobc -x -lsmjs jscaller.cob
 *   some people found mozjs before smjs
 */
#include <stdio.h>
#include <string.h>

/* javascript api requires an environment type */
#define XP_UNIX

#if (defined(XP_WIN) || defined(XP_UNIX) || defined(XP_BEOS) || defined(XP_OS2))
#include "jsapi.h"
#else
#error "Must define one of XP_BEOS, XP_OS2, XP_WIN or XP_UNIX"
#endif

/* Error codes */
#define OCJS_ERROR_RUNTIME  -1
#define OCJS_ERROR_CONTEXT  -2
#define OCJS_ERROR_GLOBAL   -3
```

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```
#define OCJS_ERROR_STANDARD -4
#define OCJS_ERROR_EVALUATE -5

/* GnuCOBOL main CALL interface */
/* javascript layer requires
 *   a runtime per process,
 *   a context per thread,
 *   a global object per context
 * and will initialize
 *   standard classes.
 */
static JSRuntime *rt;
static JSContext *cx;
static JSObject *global;
static JSClass global_class = {
    "global",0,
    JS_PropertyStub,JS_PropertyStub,JS_PropertyStub,JS_PropertyStub,
    JS_EnumerateStub,JS_ResolveStub,JS_ConvertStub,JS_FinalizeStub
};

/* Initialize the engine resources */
int ocjsInitialize(int rtsize, int cxsize) {
    JSBool ok;

    /* on zero sizes, pick reasonable values */
    if (rtsize == 0) { rtsize = 0x100000; }
    if (cxsize == 0) { cxsize = 0x1000; }

    /* Initialize a runtime space */
    rt = JS_NewRuntime(rtsize);
    if (rt == NULL) { return OCJS_ERROR_RUNTIME; }
    /* Attach a context */
    cx = JS_NewContext(rt, cxsize);
    if (cx == NULL) { return OCJS_ERROR_CONTEXT; }
    /* And a default global */
    global = JS_NewObject(cx, &global_class, NULL, NULL);
    if (global == NULL) { return OCJS_ERROR_GLOBAL; }
    /* Load standard classes */
    ok = JS_InitStandardClasses(cx, global);

    /* Return success or standard class load error */
    return (ok == JS_TRUE) ? 0 : OCJS_ERROR_STANDARD;
}

/* Evaluate script */
int ocjsEvaluate(char *script, char *result, int length) {
    jsval rval;
    JSString *str;
    int reslen = OCJS_ERROR_EVALUATE;

    JSBool ok;

    /* filename and line number, not reported */
    char *filename = NULL;
    int lineno = 0;

    /* clear the result field */
```

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```
    memset(result, ' ', length);

    /* Evaluate javascript */
    ok = JS_EvaluateScript(cx, global, script, strlen(script),
                           filename, lineno, &rval);

    /* Convert js result to JSString form */
    if (ok == JS_TRUE) {
        str = JS_ValueToString(cx, rval);
        reslen = strlen(JS_GetStringBytes(str));
        if (length < reslen) { reslen = length; }
        /* convert down to char and move to OpenCOBOl result field */
        memcpy(result, JS_GetStringBytes(str), reslen);
    }
    return reslen;
}

/* Evaluate script from file */
int ocjsFromFile(char *filename, char *result, int length) {
    FILE *fin;
    int bufsize = 10240;
    char inbuf[bufsize];
    int reslen;

    fin = fopen(filename, "r");
    if (fin == NULL) { return OCJS_ERROR_EVALUATE; }
    //while (fread(inbuf, sizeof(char), bufsize, fin) > 0) {
    if (fread(inbuf, 1, bufsize, fin) > 0) {
        reslen = ocjsEvaluate(inbuf, result, length);
    }
    return reslen;
}

/* release js engine */
int ocjsRunDown() {
    if (cx != NULL) { JS_DestroyContext(cx); }
    if (rt != NULL) { JS_DestroyRuntime(rt); }
    JS_ShutDown();
    return 0;
}

/* Quick call; start engine, evaluate, release engine */
int ocjsString(char *script, char *result, int length) {
    int reslen;

    reslen = ocjsInitialize(0, 0);
    if (reslen < 0) { return reslen; }
    reslen = ocjsEvaluate(script, result, length);
    ocjsRunDown();
    return reslen;
}
/**/
```

A sample GnuCOBOL application:

```
GCobol >>SOURCE FORMAT IS FIXED
      *>*****************************************************************
```

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```
      *>Author:    Brian Tiffin
      *>Date:      11-Sep-2008
      *>Purpose:   Embed some javascript
      *>Tectonics: cobc -c -I/usr/include/smjs ocjs.c
      *>           cobc -x -l/smjs jscaller.cob ocjs.o
      *>*****************************************************************
       identification division.
       program-id. jscaller.

       data division.

       working-storage section.
       78 ocjs-error-runtime  value -1.
       78 ocjs-error-context  value -2.
       78 ocjs-error-global   value -3.
       78 ocjs-error-standard value -4.
       78 ocjs-error-evaluate value -5.

       78 newline              value x"0a".
       01 source-data          pic x(40)
            value "----+----1----+-$56.78 90----3----+----4".
       01 result               pic s9(9).
       01 result-field         pic x(81).

       01 javascript           pic x(1024).
       01 safety-null          pic x value x"00".

      *>*****************************************************************
      *><* Evaluate spidermonkey code, return the length of js result
       procedure division.

       display "js> " with no advancing end-display
       accept javascript end-accept
       call "ocjsString"
           using javascript
               result-field
               by value function length(result-field)
           returning result
       end-call
       display "GnuCOBOL result-field: " result-field end-display
       display "GnuCOBOL received    : " result newline end-display

      *><* Initialize the javascript engine
       call "ocjsInitialize"
           using by value 65536
               by value 1024
           returning result
       end-call
       if result less 0
           stop run returning result
       end-if

      *><* find (zero offest) dollar amount, space, number
       move spaces to javascript
       string
           "pat = /\$\d+\.\d+\s\d+/; "
           'a = "' delimited by size
```

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```
           source-data delimited by size
           '"; ' delimited by size
           "a.search(pat); " delimited by size
           x"00" delimited by size
           into javascript
       end-string

       display
           "Script: " function trim(javascript, trailing)
       end-display

       call "ocjsEvaluate"
           using javascript
               result-field
               by value function length(result-field)
           returning result
       end-call
       display "GnuCOBOL result-field: " result-field end-display
       display "GnuCOBOL received    : " result newline end-display

      *><* values held in js engine across calls
       move spaces to javascript
       string
           'a;' delimited by size
           x"00" delimited by size
           into javascript
       end-string

       display
           "Script: " function trim(javascript, trailing)
       end-display

       call "ocjsEvaluate"
           using javascript
               result-field
               by value function length(result-field)
           returning result
       end-call
       display "GnuCOBOL result-field: " result-field end-display
       display "GnuCOBOL received    : " result newline end-display

      *><* erroneous script
       move spaces to javascript
       string
           'an error of some kind;' delimited by size
           x"00" delimited by size
           into javascript
       end-string

       display
           "Script: " function trim(javascript, trailing)
       end-display

       call "ocjsEvaluate"
           using javascript
               result-field
               by value function length(result-field)
```

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```
           returning result
       end-call
       if result equal ocjs-error-evaluate
           display " *** script problem ***" end-display
       end-if
       display "GnuCOBOL result-field: " result-field end-display
       display "GnuCOBOL received    : " result newline end-display

      *><* script from file
       move spaces to javascript
       string
           'ocjsscript.js' delimited by size
           x"00" delimited by size
           into javascript
       end-string

       display
           "Script: " function trim(javascript, trailing)
       end-display

       call "ocjsFromFile"
           using javascript
               result-field
               by value function length(result-field)
           returning result
       end-call
       if result equal ocjs-error-evaluate
           display " *** script problem ***" end-display
       end-if
       display "GnuCOBOL result-field: " result-field end-display
       display "GnuCOBOL received    : " result newline end-display

      *><* Rundown the js engine
       call "ocjsRunDown" returning result

      *><* take first name last name, return last "," first
       move spaces to javascript
       string
           "re = /(\w+)\s(\w+)/; " delimited by size
           'str = "John Smith"; ' delimited by size
           'newstr = str.replace(re, "$2, $1"); ' delimited by size
           "newstr;" delimited by size
           x"00" delimited by size
           into javascript
       end-string

       display
           "Script: " function trim(javascript, trailing)
       end-display

       call "ocjsString"
           using javascript
               result-field
               by value function length(result-field)
           returning result
       end-call
       display "GnuCOBOL result-field: " result-field end-display
```

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```
       display "GnuCOBOL received    : " result newline end-display

      *><* split a string using numbers return array (as js string form)
       move spaces to javascript
       string
           'myString = "Hello 1 word. Sentence number 2."; '
               delimited by size
           'splits = myString.split(/(\d)/); ' delimited by size
           'splits;'  delimited by size
           x"00" delimited by size
           into javascript
       end-string

       display
           "Script: " function trim(javascript, trailing)
       end-display

       call "ocjsString"
           using javascript
               result-field
               by value function length(result-field)
           returning result
       end-call
       display "GnuCOBOL result-field: " result-field end-display
       display "GnuCOBOL received    : " result newline end-display

      *><* Get javascript date
       move "new Date()" & x"00" to javascript

       display
           "Script: " function trim(javascript, trailing)
       end-display

       call "ocjsString"
           using javascript
               result-field
               by value function length(result-field)
           returning result
       end-call
       display "GnuCOBOL result-field: " result-field end-display
       display "GnuCOBOL received    : " result end-display

       goback.
       end program jscaller.
```

And with a sample script:

ocjsscript.js

```
var x = 2
var y = 39
var z = "42"
// boths line evaluate to 42
eval("x + y + 1")
eval(z)
```

Sample output:

```
js> 123 * 456 + 789
GnuCOBOL result-field: 56877
GnuCOBOL received    : +000000005

Script: pat = /\$\d+\.\d+\s\d+/; a = "----+----1----+-$56.78 90----3----+----4"; a.
↪search(pat);
GnuCOBOL result-field: 16
GnuCOBOL received    : +000000002

Script: a;
GnuCOBOL result-field: ----+----1----+-$56.78 90----3----+----4
GnuCOBOL received    : +000000040

Script: an error of some kind;
 *** script problem ***
GnuCOBOL result-field:
GnuCOBOL received    : -000000005

Script: re = /(\w+)\s(\w+)/; str = "John Smith";
        newstr = str.replace(re, "$2, $1"); newstr;
GnuCOBOL result-field: Smith, John
GnuCOBOL received    : +000000011

Script: myString = "Hello 1 word. Sentence number 2.";
        splits = myString.split(/(\d)/); splits;
GnuCOBOL result-field: Hello ,1, word. Sentence number ,2,.
GnuCOBOL received    : +000000036

Script: new Date()
GnuCOBOL result-field: Mon Sep 15 2008 04:16:06 GMT-0400 (EDT)
GnuCOBOL received    : +000000039
```

5.13.1 Seed

A far more powerful linkage to Javascript is available through the `Seed` project and `libseed-gtk`.

```
GCobol >>SOURCE FORMAT IS FREE

REPLACE ==:SAMPLE:== BY ==callseed==.
>>IF docpass NOT DEFINED

      *> ************************************************************
      *>****p* project/:SAMPLE:
      *> Author:
      *>   Brian Tiffin
      *> Date:
      *>   20141204
      *> License:
      *>   GNU General Public License, GPL, 3.0 (or greater)
      *> Purpose:
      *>   Test out libseed JavaScriptCore hooks
      *> Tectonics:
      *>   cobc -x callseed.cob -g -debug -lseed-gtk3
      *> ************************************************************
       identification division.
       program-id. :SAMPLE:.
```

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```
       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 seed-engine          usage pointer.
       01 seed-engine-record based.
          05 seed-context      usage pointer.
          05 seed-global       usage pointer.
          05 seed-searchpath   usage pointer.
          05 seed-group        usage pointer.
       01 seed-script          usage pointer.
       01 seed-exception       usage pointer.
       01 seed-value           usage pointer.
       01 seed-object          usage pointer.

       01 cobol-pic9           pic s9(8).
       01 cobol-long           usage binary-long value 42.
       01 cobol-picx           pic x(17).

      *> ****************************************************************
       procedure division.

      *> Initialize libseed, bail if no engine can be created
       call "seed_init" using by reference 0 0
           returning seed-engine
           on exception
               display "no libseed" upon syserr
               stop run
       end-call
       if seed-engine equal null then
           display "no libseed engine" upon syserr
           stop run
       else
           set address of seed-engine-record to seed-engine
       end-if
       display
           ":init  : " seed-engine space seed-context space
           seed-global space seed-group upon syserr

      *> convert some values
       call "seed_value_from_int" using
           by value seed-context
           by value cobol-long
           by reference seed-exception
           returning seed-value
       end-call
       display
           ":long  : " seed-engine space seed-context space
           seed-exception space seed-value upon syserr

      *> load in a javascript file
       call "seed_script_new_from_file" using
           by value seed-context
```

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```
           by content z"webkit.js"
           returning seed-script
       end-call
       display ":script: " seed-script upon syserr

      *> evaluate the script
       call "seed_evaluate" using
           by value seed-context
           by value seed-script
           by value seed-object
           returning seed-value
       end-call
       display ":webkit: " seed-script space seed-value upon syserr

      *> evaluate some strings of javascript

      *> javascript print
       call "seed_simple_evaluate" using
           by value seed-context
           by content concatenate('print("Hello, seed");', x"00")
           by reference seed-exception
           returning seed-value
       end-call
       display
           ":print : " seed-engine space seed-context
           space seed-exception space seed-value upon syserr

      *> empty GTK+ window with title
       call "seed_simple_evaluate" using
           by value seed-context
           by content concatenate(
               "Gtk = imports.gi.Gtk; ",
               "Gtk.init(null, null); ",
               "window = new Gtk.Window({ type: Gtk.WindowType.TOPLEVEL }); ",
               "window.signal.hide.connect(Gtk.main_quit); ",
               "window.set_default_size(250, 200); ",
               "window.set_title('Center'); ",
               "window.set_position(Gtk.WindowPosition.CENTER); ",
               "window.show(); ",
               "Gtk.main();", x"00")
           by reference seed-exception
           returning seed-value
       end-call
       display
           ":center: " seed-engine space seed-context
           space seed-exception space seed-value upon syserr

      *> GTK+ window with a button, and hover over tooltip
       call "seed_simple_evaluate" using
           by value seed-context
           by content concatenate(
               "Example = new GType({ ",
               "    parent: Gtk.Window.type, ",
               "    name: 'Example', ",
               "    init: function() ",
               "    { ",
               "        init_ui(this); ",
```

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```
                "        function init_ui(w) { ",
                "            w.signal.hide.connect(Gtk.main_quit); ",
                "            w.set_default_size(250, 200); ",
                "            w.set_title('Tooltips'); ",
                "            w.set_position(Gtk.WindowPosition.CENTER);     ",
                "            var fix = new Gtk.Fixed(); ",
                "            var button = new Gtk.Button({ label: 'Button' }); ",
                "            button.set_size_request(80, 35);      ",
                "            button.set_tooltip_text('Button widget'); ",
                "            fix.put(button, 50, 50); ",
                "            w.add(fix); ",
                "            w.set_tooltip_text('Window widget');             ",
                "            w.show_all(); ",
                "        } ",
                "    }     ",
                "}); ",
                "var window = new Example(); ",
                "Gtk.main();", x"00")
            by reference seed-exception
            returning seed-value
        end-call
        display
            ":hover : " seed-engine space seed-context
            space seed-exception space seed-value upon syserr

       *> call libSOUP to read a web page
        call "seed_simple_evaluate" using
            by value seed-context
            by content concatenate(
                "Soup = imports.gi.Soup; ",
                "var session = new Soup.SessionSync(); ",
                "// Soup.URI is a struct. ",
                "var uri = new Soup.URI.c_new('http://www.google.com'); ",
                "var request = new Soup.Message({method:'GET', uri:uri}); ",
                "var status = session.send_message(request); ",
                'print("status");', x"00")
            by reference seed-exception
            returning seed-value
        end-call
        display
            ":soup  : " seed-engine space seed-context
            space seed-exception space seed-value upon syserr

        goback.
        end program :SAMPLE:.
       *> ************************************************************
>>ELSE
```

```
==============
:SAMPLE: usage
==============

An example of using libseed to run JavaScriptCore (which is part of
WebKitGTK)

Introduction
```

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```
------------

Call some libseed from GnuCOBOL

Building
--------

::

    cobc -x callseed.cob -g -debug -lseed-gtk3
    ./callseed

So far, this simple example

* converts some values between COBOL and Javascript
* creates a web browser from a script file, webkit.js
* evaluates a string to centre an empty window
* evaluates a string to show a hover over tooltip on a button
* evaluates a string to use libSOUP to read a web page


Source
------

.. code-include::  :SAMPLE:.cob
      :language: cobol
>>END-IF
```

With a sample run of:

```
$ cobc -x callseed.cob -lseed-gtk3
$ ./callseed
:init  : 0x00000000012da3a0 0x00007fe9303afb78 0x00007fe9303af970 0x00007fe970c25000
:long  : 0x00000000012da3a0 0x00007fe9303afb78 0x0000000000000000 0xffff00000000002a
:script: 0x00000000012dd380
:webkit: 0x00000000012dd380 0x000000000000000a
Hello, seed
:print : 0x00000000012da3a0 0x00007fe9303afb78 0x0000000000000000 0x000000000000000a
:center: 0x00000000012da3a0 0x00007fe9303afb78 0x0000000000000000 0x000000000000000a
:hover : 0x00000000012da3a0 0x00007fe9303afb78 0x0000000000000000 0x000000000000000a
:soup  : 0x00000000012da3a0 0x00007fe9303afb78 0x0000000000000000 0x00007fe9301f3170
```

The example also displays a browser window, an empty window and a window with a button and hover over tooltip. The Seed project provides fairly easy access to the entire GNOME software stack.

5.13.2 Duktape

ECMAScript can also be added to GnuCOBOL via Duktape (by Sami Vaalrala and contributors).

```
GCobol >>SOURCE FORMAT IS FREE
      *> ************************************************************
      *>****J* gnucobol/cobduk
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
```

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```
      *>   20161122  Modified: 2016-11-22/01:44-0500
      *> LICENSE
      *>   Copyright 2016 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or superior)
      *> PURPOSE
      *>   Integrate Duktape
      *> TECTONICS
      *>   cobc -x -g -debug cobduk.cob duktape.c
      *> ****************************************************************
       identification division.
       program-id. cobduk.
       author. Brian Tiffin.
       date-written. 2016-11-22/00:18-0500.
       date-modified. 2016-11-22/01:44-0500.
       installation. Needs Duktape 1.5.1
       remarks. Just add duktape.c
       security. Probably worth keeping an eye on the ECMAScripting.

       environment division.
       configuration section.
       source-computer. gnulinux.
       object-computer. gnulinux
           classification is canadian.

       special-names.
           locale canadian is "en_CA.UTF-8".

       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 duk-ctx usage pointer.
       01 duk-str usage pointer.
       01 based-str pic x(80) based.
       01 fixed-str pic x(80).

      *> ****************************************************************
       procedure division.
      *> Init Duktape
       call "duk_create_heap" using null null null null null
           returning duk-ctx
           on exception
               display "error: no duktape" upon syserr
               perform soft-exception
               goback
       end-call
       if duk-ctx equal null then
           display "duktape init failed" upon syserr
           goback
       end-if

      *> Evaluate a test hello
       call "duk_eval_raw" using
           by value duk-ctx
           by content z"print('Hello, world');"
           by value 0 b"11100001001"
```

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```
           returning omitted
       end-call

      *> Evaluate a custom Duktape JSON encode, no replace, 4 spaces
       call "duk_eval_raw" using
           by value duk-ctx
           by content z"print(Duktape.enc('jx', {foo: 123}, null, 4));"
           by value 0 b"11100001001"
           returning omitted
       end-call

      *> Evaluate a more JSON Duktape JSON encode, no replace, 4 spaces
       call "duk_eval_raw" using
           by value duk-ctx
           by content z"print(Duktape.enc('jc', {foo: 123}, null, 4));"
           by value 0 b"11100001001"
           returning omitted
       end-call

      *> decode some JSON, and print out a field
       call "duk_eval_raw" using
           by value duk-ctx
           by content "print(Duktape.dec('jx', " & z'"{foo:123}").foo);'
           by value 0 b"11100001001"
           returning omitted
       end-call

      *> stringy some JSON, leave data on the Duktape stack
       call "duk_eval_raw" using
           by value duk-ctx
           by content
               z"var res = JSON.stringify({foo: 123}, null, 4); res;"
           by value 0 b"11100001001"
           returning omitted
       end-call

      *> get the character data into COBOL, -1 is top of stack
       call "duk_get_string" using
           by value duk-ctx
           by value -1
           returning duk-str
       end-call
       if duk-str not equal null then
           set address of based-str to duk-str
           string based-str delimited by low-value into fixed-str
           display "COBOL view of JSON: " fixed-str
       else
           display "JSON conversion failed" upon syserr
       end-if

       goback.
      *> ****************************************************************

       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
      *> informational warnings and abends
       soft-exception.
```

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```
          display space upon syserr
          display "--Exception Report-- " upon syserr
          display "Time of exception:   " current-date upon syserr
          display "Module:              " module-id upon syserr
          display "Module-path:         " module-path upon syserr
          display "Module-source:       " module-source upon syserr
          display "Exception-file:      " exception-file upon syserr
          display "Exception-status:    " exception-status upon syserr
          display "Exception-location:  " exception-location upon syserr
          display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:

       end program cobduk.
      *> ****************************************************************
```

cobduk.cob

Sample run:

```
prompt$ cobc -x -g -j cobduk.cob duktape.c
Hello, world
{
    foo: 123
}
{
    "foo": 123
}
123
COBOL view of JSON: {
    "foo": 123
}
```

Duktape ships as an amalgam source release, so all you need to do is include a single .c file during a compile.

Duktape license:

```
===============
Duktape license
===============

(http://opensource.org/licenses/MIT)

Copyright (c) 2013-2017 by Duktape authors (see AUTHORS.rst)

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```

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```
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THE SOFTWARE.
```

http://duktape.org/

Duktape is now on version 2.2 and some features have been moved out of the main sources and into extensions. The example above is from 1.5.1 and may require some tweaking to update to version 2.

5.14 Can GnuCOBOL interface with Scheme?

Yes, directly embedded with Guile and libguile.

`callguile.cob`

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20090215
      *> Purpose:   Demonstrate libguile Scheme interactions
      *> Tectonics: cobc -x -lguile callguile.cob
      *> ************************************************************
       identification division.
       program-id. callguile.

       data division.
       working-storage section.
       01 tax-scm              usage pointer.
       01 shipping-scm         usage pointer.
       01 scm-string           usage pointer.
       01 radix-scm            usage pointer.

       01 subtotal             pic 999v99 value 80.00.
       01 subtotal-display     pic z(8)9.99.
       01 weight               pic 99v99  value 10.00.
       01 weight-display       pic Z9.99.
       01 breadth              pic 99v99  value 20.00.
       01 breadth-display      pic Z9.99.

       01 answer               pic x(80).
       01 len                  usage binary-long.

       01 tax                  pic 9(9)v9(2).
       01 tax-display          pic z(8)9.9(2).
       01 shipping             pic 9(9)v9(2).
       01 shipping-display     pic z(8)9.9(2).
```

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```
       01 invoice-total        pic 9(9)v9(2).
       01 invoice-display      pic $(8)9.9(2).

      *> ****************************************************************
       procedure division.

       display "OC: initialize libguile" end-display
       call "scm_init_guile" end-call

       display "OC: load scheme code" end-display
       call "scm_c_primitive_load" using "script.scm" & x"00" end-call
       display "OC:" end-display

       display "OC: evaluate one of the defined functions" end-display
       call "scm_c_eval_string" using "(do-hello)" & x"00" end-call
       display "OC:" end-display

       display "OC: perform tax calculation" end-display
       move subtotal to subtotal-display
       move weight to weight-display
       move breadth to breadth-display
       call "scm_c_eval_string"
           using
               function concatenate(
                   "(compute-tax "; subtotal-display; ")"; x"00"
               )
           returning tax-scm
       end-call

       display "OC: perform shipping calculation" end-display
       display "OC: " function concatenate(
                           "(compute-shipping "; weight-display; " ";
                           breadth-display; ")"; x"00"
                       )
       end-display
       call "scm_c_eval_string"
           using
               function concatenate(
                   "(compute-shipping "; weight-display; " ";
                   breadth-display; ")"; x"00"
               )
           returning shipping-scm
       end-call

       display "OC: have guile build a scheme integer 10" end-display
       call "scm_from_int32"
           using by value size is 4 10 returning radix-scm
       end-call

       display "OC: have guile convert number, base 10" end-display
       call "scm_number_to_string"
           using
               by value tax-scm by value radix-scm
           returning scm-string
       end-call

       display "OC: get numeric string to COBOL" end-display
```

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```
       call "scm_to_locale_stringbuf"
           using
               by value scm-string
               by reference answer
               by value 80
           returning len
       end-call
       display "OC: tax as string: " answer end-display
       move answer to tax

       call "scm_number_to_string"
           using
               by value shipping-scm by value radix-scm
           returning scm-string
       end-call

       call "scm_to_locale_stringbuf"
           using
               by value scm-string
               by reference answer
               by value 80
           returning len
       end-call
       display "OC: shipping as string: " answer end-display
       move answer to shipping

       compute invoice-total = subtotal + tax + shipping end-compute

       move subtotal to subtotal-display
       move tax to tax-display
       move shipping to shipping-display
       move invoice-total to invoice-display
       display "OC:" end-display
       display "OC: subtotal   " subtotal-display end-display
       display "OC: tax        " tax-display end-display
       display "OC: shipping   " shipping-display end-display
       display "OC: total:     " invoice-display end-display
       goback.
       end program callguile.
```

script.scm

```
(define (do-hello)
  (begin
    (display "Welcome to Guile")
    (newline)))

(define (compute-tax subtotal)
  (* subtotal 0.0875))


(define (compute-shipping weight length)

  ;; For small, light packages, charge the minimum
  (if (and (< weight 20) (< length 5))
      0.95
```

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```
      ;; Otherwise for long packages, charge a lot
      (if (> length 100)
          (+ 0.95 (* weight 0.1))

          ;; Otherwise, charge the usual
          (+ 0.95 (* weight 0.05)))))

(display "Loaded script.scm")(newline)
```

Outputs:

```
OC: initialize libguile
OC: load scheme code
Loaded script.scm
OC:
OC: evaluate one of the defined functions
Welcome to Guile
OC:
OC: perform tax calculation
OC: perform shipping calculation
OC: (compute-shipping 10.00 20.00)
OC: have guile build a scheme integer 10
OC: have guile convert number, base 10
OC: get numeric string to COBOL
OC: tax as string: 7.0
OC: shipping as string: 1.45
OC:
OC: subtotal          80.00
OC: tax                7.00
OC: shipping           1.45
OC: total:           $88.45
```

Of course using Scheme for financial calculations in a GnuCOBOL application would not be a smart usage. This is just a working sample.

5.15 Can GnuCOBOL interface with Tcl/Tk?

Yes. There are multiple ways to embed Tcl/Tk.

First up are the optional intrinsic functions. Configure a GnuCOBOL build `-with-tcl`. That will provide FUNCTION TCL(script) and FUNCTION TCL-UNRESTRICTED(script). The result of the last Tcl command will be returned to GnuCOBOL as character data. Normal Tcl is a safe mode Tcl interpreter. FUNCTION TCL-UNRESTRICTED is full featured Tcl/Tk.

```
GCOBOL*>-<*
      *> Author: Brian Tiffin
      *> Dedicated to the public domain
      *>
      *> Date started: July 2017
      *> Modified: 2017-07-08/01:29-0400 btiffin
      *>+<*
      *>
      *> safetcl.cob, test Safe Tcl mode
      *> Tectonics: cobc -xj safetcl.cob
```

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```
      *>
       >>SOURCE FORMAT IS FREE
       identification division.
       program-id. sample.

       REPLACE ==newline== BY ==& x'0a' &==.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       COPY tclapi.

      *> make extraneous large enough to hold a Tcl error message
       01 extraneous pic x(80).

       procedure division.
       sample-main.

      *> predefined in compiler for conditional compilation
       >>IF INTRINSIC-TCL IS SET

       display tcl-unrestricted("puts {Hello, world};" newline
                                "return Hello;")

      *> safe interp will have no stdio channels
       display tcl("puts {Test}")

      *> but will be able to compute expressions
       display tcl("expr {1 + 2}")

      *> Ensure master still has stdio
       display tcl-unrestricted("puts {Hello, world};" newline
                                "return Hello;")

      *> try some of the disabled commands
       display tcl-unrestricted("pwd")
       display tcl("pwd")
       display tcl("exit")

      *> manipulate the safe interpreter
       display tcl-unrestricted("interp slaves")

      *> allow pwd
       move tcl-unrestricted("interp expose SaferTcl pwd")
         to extraneous
       display tcl("pwd")

      *> disable pwd again
       move tcl-unrestricted(concatenate("interp hide "
                             TCL-SAFE-NAME " pwd")) to extraneous
       display tcl("pwd")

      *> run some Tk gui
```

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```
       display tcl-unrestricted("source adclock.tcl")

      *> idiom to avoid inadvertently terminating a program on Tcl exit
       display tcl-unrestricted(
           "interp alias {} exit {} return"                      newline
           "puts {Tcl 'exit' normally causes full process exit}" newline
           "exit 1")
       display "GnuCOBOL still running"

       >>END-IF

       goback.
       end program sample.
```

safetcl.cob, an early test head for Intrinsic Tcl. Testing FUNCTION TCL and FUNCTION TCL-UNRESTRICTED.

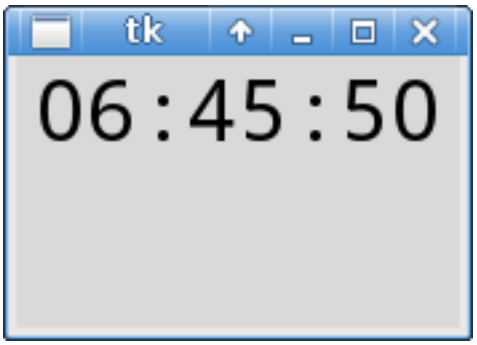
```
prompt$ cobc -xj safetcl.cob
Hello, world
Hello
can not find channel named "stdout"
3
Hello, world
Hello
/home/btiffin/forge/gnucobol/extensions/demos
invalid command name "pwd"
invalid command name "exit"
SaferTcl
/home/btiffin/forge/gnucobol/extensions/demos
invalid command name "pwd"
Time is 06:46:05
Calling 'exit' normally causes process exit

GnuCOBOL still running
```

Sample run to demonstrate expose and hide of commands available to the safe mode Tcl interpreter. Both modes are available TCL-UNRESTRICTED and TCL at any given time. Use safe mode for untrusted user land scripting.

The adclock.tcl file is a small Tk Analog Digital clock toggle demo from https://wiki.tcl.tk/2563 by Richard Suchenwirth, Kevin Kenny and user HJG adding the clock tick marks. Customized a bit return the time to GnuCOBOL for this example.

Toggled from analog to digital display by clicking on the clock



On key press, the current time is returned to GnuCOBOL.

Time is 06:46:05 in the example.

adclock.tcl

```
# Intrinsic Tcl example with Tk
package require Tk

proc every {ms body} {eval $body; after $ms [info level 0]}
proc drawhands w {
    $w delete hands
    set secSinceMidnight [expr { [clock seconds] - [clock scan 00:00:00] }]
    foreach divisor {60 3600 43200} length {45 40 30} width {1 3 7} {
        set angle [expr {$secSinceMidnight * 6.283185 / $divisor}]
        set x [expr {50 + $length * sin($angle)}]
        set y [expr {50 - $length * cos($angle)}]
        $w create line 50 50 $x $y -width $width -tags hands
    }
}
proc drawmarks w {
  set length1 46
  set length2 50
  foreach h {0 1 2 3 4 5 6 7 8 9 10 11} {
    set angle [expr {6.283185 / 12 * $h} ]
    set x1 [expr {50 + $length1 * sin($angle)}]
    set x2 [expr {50 + $length2 * sin($angle)}]
    set y1 [expr {50 - $length1 * cos($angle)}]
    set y2 [expr {50 - $length2 * cos($angle)}]
    $w create line $x1 $y1 $x2 $y2 -width 1
  }
}
proc toggle {w1 w2} {
    if [winfo ismapped $w2] {
        foreach {w2 w1} [list $w1 $w2] break ;# swap
    }
    pack forget $w1
    pack $w2
}
canvas .analog -width 100 -height 100 -bg white

drawmarks .analog
every 1000 {drawhands .analog}

label .digital -textvar ::time -font {Courier 24}
every 1000 {set ::time [clock format [clock sec] -format %H:%M:%S]}
```

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```
pack .analog

bind . <1> {toggle .analog .digital}
bind . <Key> {
    destroy .
}
tkwait window .
return "Time is $::time"
```

The original was expected to be run under the Tk *wish* shell, but `tkwait window .` was added to allow for the Tcl event loop to properly run and return when embedded as an intrinsic function in GnuCOBOL.

5.15.1 tclgui

GnuCOBOL also supports the Tcl/Tk embedding engine developed by Rildo Pragana as part of the TinyCOBOL project. We have been given permission by Rildo to embed his engine in GnuCOBOL.

This code is almost 20 years old now, and as a testament to Tcl and COBOL, still runs just fine.

See http://ww1.pragana.net/cobol.html for sources.

A working sample

```
GCobol IDENTIFICATION DIVISION.
       PROGRAM-ID.    tclgui.
       AUTHOR. Rildo Pragana.
      *> REMARKS.
      *>    Example tcl/tk GUI program for Cobol.
      *>
       ENVIRONMENT DIVISION.
       DATA DIVISION.
      *>
       WORKING-STORAGE SECTION.
       01 DATA-BLOCK.
          05 NAME           PIC X(40).
          05 W-ADDRESS      PIC X(50).
          05 PHONE          PIC X(15).
          05 END-PGM                PIC X.
                05 QUICK-RET      PIC X.
       01 SITE-INFO.
          05  TITLE       PIC X(20).
          05  URL         PIC X(50).
       77 GUI-01          PIC X(64) VALUE "formA.tcl".
       77 GUI-02          PIC X(64) VALUE "formB.tcl".
       77 END-OF-STRING   pic X value LOW-VALUES.
       77 T-SCRIPT                PIC X(128).
       77 T-RESULT                PIC X(80).
       01 dummy                 pic X value X"00".

       PROCEDURE DIVISION.

       CALL "initTcl"

      *> test for stcleval function
       string "expr 12 * 34" END-OF-STRING into T-SCRIPT
       call "stcleval" using T-SCRIPT T-RESULT
```

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```
       display "eval by tcl: |" T-SCRIPT "| returned " T-RESULT

       MOVE "Your name here" to NAME
       MOVE "Your address" TO W-ADDRESS
       MOVE "Phone number" to PHONE
      *> this variable tells Cobol that the user required an exit
       MOVE "0" to END-PGM
       MOVE "1" to QUICK-RET
       MOVE "Afonso Pena" to NAME
      *> now we may have the script name as a variable, terminated by a space
       CALL "tcleval" USING DATA-BLOCK "./formA.tcl "
       MOVE "Deodoro da Fonseca" to NAME
       CALL "tcleval" USING DATA-BLOCK GUI-01
       MOVE "Rui Barbosa" to NAME
       CALL "tcleval" USING DATA-BLOCK GUI-01
       MOVE "Frei Caneca" to NAME
       CALL "tcleval" USING DATA-BLOCK GUI-01

       MOVE "0" to QUICK-RET
       MOVE "Your name here" to NAME.
       100-restart.
      *> call C wrapper, passing data block and size of data
       CALL "tcleval" USING DATA-BLOCK GUI-01

       DISPLAY "Returned data:"
       DISPLAY "NAME    [" NAME "]"
       DISPLAY "ADDRESS [" W-ADDRESS "]"
       DISPLAY "PHONE   [" PHONE "]"
      *> if not end of program required, loop
       if END-PGM = 0
           go to 100-restart.
      *> to start a new GUI (graphical interface), call this first
       call "newGui"
       MOVE "Title of the site" to TITLE
       MOVE "URL (http://..., ftp://..., etc)" to URL
      *> now we may draw other main window...
       CALL "tcleval" USING SITE-INFO GUI-02
       DISPLAY "Returned data:"
       DISPLAY "TITLE   [" TITLE "]"
       DISPLAY "URL     [" URL "]"

       STOP RUN.
```

Which uses two Tcl/Tk scripts

```
#!/bin/sh
# the next line restarts using wish\
exec wish "$0" "$@"
```

```
if {![info exists vTcl(sourcing)]} {

    package require Tk
    switch $tcl_platform(platform) {
        windows {
            option add *Button.padY 0
        }
```

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```
        default {
            option add *Scrollbar.width 10
            option add *Scrollbar.highlightThickness 0
            option add *Scrollbar.elementBorderWidth 2
            option add *Scrollbar.borderWidth 2
        }
    }

}

###############################################################################
# Visual Tcl v1.60 Project
#


#################################
# VTCL LIBRARY PROCEDURES
#

if {![info exists vTcl(sourcing)]} {
###############################################################################
## Library Procedure:  Window

proc ::Window {args} {
    ## This procedure may be used free of restrictions.
    ##    Exception added by Christian Gavin on 08/08/02.
    ## Other packages and widget toolkits have different licensing requirements.
    ##    Please read their license agreements for details.

    global vTcl
    foreach {cmd name newname} [lrange $args 0 2] {}
    set rest    [lrange $args 3 end]
    if {$name == "" || $cmd == ""} { return }
    if {$newname == ""} { set newname $name }
    if {$name == "."} { wm withdraw $name; return }
    set exists [winfo exists $newname]
    switch $cmd {
        show {
            if {$exists} {
                wm deiconify $newname
            } elseif {[info procs vTclWindow$name] != ""} {
                eval "vTclWindow$name $newname $rest"
            }
            if {[winfo exists $newname] && [wm state $newname] == "normal"} {
                vTcl:FireEvent $newname <<Show>>
            }
        }
        hide    {
            if {$exists} {
                wm withdraw $newname
                vTcl:FireEvent $newname <<Hide>>
                return}
        }
        iconify { if $exists {wm iconify $newname; return} }
        destroy { if $exists {destroy $newname; return} }
    }
}
```

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```
###############################################################################
## Library Procedure:  vTcl:DefineAlias

proc ::vTcl:DefineAlias {target alias widgetProc top_or_alias cmdalias} {
    ## This procedure may be used free of restrictions.
    ##    Exception added by Christian Gavin on 08/08/02.
    ## Other packages and widget toolkits have different licensing requirements.
    ##    Please read their license agreements for details.

    global widget
    set widget($alias) $target
    set widget(rev,$target) $alias
    if {$cmdalias} {
        interp alias {} $alias {} $widgetProc $target
    }
    if {$top_or_alias != ""} {
        set widget($top_or_alias,$alias) $target
        if {$cmdalias} {
            interp alias {} $top_or_alias.$alias {} $widgetProc $target
        }
    }
}
###############################################################################
## Library Procedure:  vTcl:DoCmdOption

proc ::vTcl:DoCmdOption {target cmd} {
    ## This procedure may be used free of restrictions.
    ##    Exception added by Christian Gavin on 08/08/02.
    ## Other packages and widget toolkits have different licensing requirements.
    ##    Please read their license agreements for details.

    ## menus are considered toplevel windows
    set parent $target
    while {[winfo class $parent] == "Menu"} {
        set parent [winfo parent $parent]
    }

    regsub -all {\%widget} $cmd $target cmd
    regsub -all {\%top} $cmd [winfo toplevel $parent] cmd

    uplevel #0 [list eval $cmd]
}
###############################################################################
## Library Procedure:  vTcl:FireEvent

proc ::vTcl:FireEvent {target event {params {}}} {
    ## This procedure may be used free of restrictions.
    ##    Exception added by Christian Gavin on 08/08/02.
    ## Other packages and widget toolkits have different licensing requirements.
    ##    Please read their license agreements for details.

    ## The window may have disappeared
    if {![winfo exists $target]} return
    ## Process each binding tag, looking for the event
    foreach bindtag [bindtags $target] {
        set tag_events [bind $bindtag]
        set stop_processing 0
```

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```
        foreach tag_event $tag_events {
            if {$tag_event == $event} {
                set bind_code [bind $bindtag $tag_event]
                foreach rep "\{%W $target\} $params" {
                    regsub -all [lindex $rep 0] $bind_code [lindex $rep 1] bind_code
                }
                set result [catch {uplevel #0 $bind_code} errortext]
                if {$result == 3} {
                    ## break exception, stop processing
                    set stop_processing 1
                } elseif {$result != 0} {
                    bgerror $errortext
                }
                break
            }
        }
        if {$stop_processing} {break}
    }
}
#############################################################################
## Library Procedure:  vTcl:Toplevel:WidgetProc

proc ::vTcl:Toplevel:WidgetProc {w args} {
    ## This procedure may be used free of restrictions.
    ##    Exception added by Christian Gavin on 08/08/02.
    ## Other packages and widget toolkits have different licensing requirements.
    ##    Please read their license agreements for details.

    if {[llength $args] == 0} {
        ## If no arguments, returns the path the alias points to
        return $w
    }
    set command [lindex $args 0]
    set args [lrange $args 1 end]
    switch -- [string tolower $command] {
        "setvar" {
            foreach {varname value} $args {}
            if {$value == ""} {
                return [set ::${w}::${varname}]
            } else {
                return [set ::${w}::${varname} $value]
            }
        }
        "hide" - "show" {
            Window [string tolower $command] $w
        }
        "showmodal" {
            ## modal dialog ends when window is destroyed
            Window show $w; raise $w
            grab $w; tkwait window $w; grab release $w
        }
        "startmodal" {
            ## ends when endmodal called
            Window show $w; raise $w
            set ::${w}::_modal 1
            grab $w; tkwait variable ::${w}::_modal; grab release $w
        }
```

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```
        "endmodal" {
            ## ends modal dialog started with startmodal, argument is var name
            set ::${w}::_modal 0
            Window hide $w
        }
        default {
            uplevel $w $command $args
        }
    }
}
#############################################################################
## Library Procedure:  vTcl:WidgetProc

proc ::vTcl:WidgetProc {w args} {
    ## This procedure may be used free of restrictions.
    ##    Exception added by Christian Gavin on 08/08/02.
    ## Other packages and widget toolkits have different licensing requirements.
    ##    Please read their license agreements for details.

    if {[llength $args] == 0} {
        ## If no arguments, returns the path the alias points to
        return $w
    }

    set command [lindex $args 0]
    set args [lrange $args 1 end]
    uplevel $w $command $args
}
#############################################################################
## Library Procedure:  vTcl:toplevel

proc ::vTcl:toplevel {args} {
    ## This procedure may be used free of restrictions.
    ##    Exception added by Christian Gavin on 08/08/02.
    ## Other packages and widget toolkits have different licensing requirements.
    ##    Please read their license agreements for details.

    uplevel #0 eval toplevel $args
    set target [lindex $args 0]
    namespace eval ::$target {set _modal 0}
}
}


if {[info exists vTcl(sourcing)]} {

proc vTcl:project:info {} {
    set base .top43
    namespace eval ::widgets::$base {
        set set,origin 1
        set set,size 1
        set runvisible 1
    }
    namespace eval ::widgets::$base.lab44 {
        array set save {-disabledforeground 1 -font 1 -text 1}
    }
    namespace eval ::widgets::$base.cpd45 {
```

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```
        array set save {-disabledforeground 1 -font 1 -text 1}
    }
    namespace eval ::widgets::$base.cpd46 {
        array set save {-disabledforeground 1 -font 1 -text 1}
    }
    namespace eval ::widgets::$base.che47 {
        array set save {-disabledforeground 1 -font 1 -text 1 -variable 1}
    }
    namespace eval ::widgets::$base.but48 {
        array set save {-command 1 -disabledforeground 1 -font 1 -text 1}
    }
    namespace eval ::widgets::$base.ent49 {
        array set save {-background 1 -insertbackground 1 -textvariable 1}
    }
    namespace eval ::widgets::$base.cpd50 {
        array set save {-background 1 -insertbackground 1 -textvariable 1}
    }
    namespace eval ::widgets::$base.cpd51 {
        array set save {-background 1 -insertbackground 1 -textvariable 1}
    }
    namespace eval ::widgets::$base.lis43 {
        array set save {-background 1 -listvariable 1}
    }
    namespace eval ::widgets::$base.lab45 {
        array set save {-disabledforeground 1 -font 1 -text 1}
    }
    namespace eval ::widgets::$base.but47 {
        array set save {-command 1 -disabledforeground 1 -text 1}
    }
    namespace eval ::widgets::$base.but51 {
        array set save {-command 1 -disabledforeground 1 -text 1}
    }
    set base .top47
    namespace eval ::widgets::$base {
        set set,origin 1
        set set,size 1
        set runvisible 1
    }
    namespace eval ::widgets::$base.ent48 {
        array set save {
            -background 1 -disabledforeground 1 -insertbackground 1 -textvariable 1
        }
    }
    namespace eval ::widgets::$base.but49 {
        array set save {-command 1 -disabledforeground 1 -text 1}
    }
    namespace eval ::widgets::$base.but50 {
        array set save {-command 1 -disabledforeground 1 -text 1}
    }
    namespace eval ::widgets_bindings {
        set tagslist _TopLevel
    }
    namespace eval ::vTcl::modules::main {
        set procs {
            init
            main
            cobol_update
```

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```
        }
        set compounds {
        }
        set projectType single
    }
}
}

#################################
# USER DEFINED PROCEDURES
#
#########################################################################
## Procedure:  main

proc ::main {argc argv} {
global cobol_fields widget

set cobol_fields {
    name        40
    address     50
    phone       15
    endpgm      1
    quickret      1
}

global nomes_anteriores
if {![info exists nomes_anteriores]} {
        set nomes_anteriores {}
}

#bind all <Return> do_exit
}

proc ::cobol_preprocess {args} {
        global quickret
        if {$quickret} {
                do_exit
        }
}
#########################################################################
## Procedure:  cobol_update

proc ::cobol_update {} {
global widget
global nomes_anteriores name

#puts "tcl-TC LOG: lappend nomes_anteriores $name"
lappend nomes_anteriores $name
focus $widget(nome_entry)

}

#########################################################################
## Initialization Procedure:  init

proc ::init {argc argv} {
```

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```
}

init $argc $argv

#################################
# VTCL GENERATED GUI PROCEDURES
#

proc vTclWindow. {base} {
    if {$base == ""} {
        set base .
    }
    ###################
    # CREATING WIDGETS
    ###################
    wm focusmodel $top passive
    wm geometry $top 1x1+0+0; update
    wm maxsize $top 1265 994
    wm minsize $top 1 1
    wm overrideredirect $top 0
    wm resizable $top 1 1
    wm withdraw $top
    wm title $top "vtcl.tcl"
    bindtags $top "$top Vtcl.tcl all"
    vTcl:FireEvent $top <<Create>>
    wm protocol $top WM_DELETE_WINDOW "vTcl:FireEvent $top <<DeleteWindow>>"

    ###################
    # SETTING GEOMETRY
    ###################

    vTcl:FireEvent $base <<Ready>>
}

proc vTclWindow.top43 {base} {
    if {$base == ""} {
        set base .top43
    }
    if {[winfo exists $base]} {
        wm deiconify $base; return
    }
    set top $base
    ###################
    # CREATING WIDGETS
    ###################
    vTcl:toplevel $top -class Toplevel \
        -highlightcolor black
    wm focusmodel $top passive
    wm geometry $top 570x523+318+169; update
    wm maxsize $top 1265 994
    wm minsize $top 1 1
    wm overrideredirect $top 0
    wm resizable $top 1 1
    wm deiconify $top
    wm title $top "New Toplevel 1"
    vTcl:DefineAlias "$top" "Toplevel1" vTcl:Toplevel:WidgetProc "" 1
    bindtags $top "$top Toplevel all _TopLevel"
```

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```
    vTcl:FireEvent $top <<Create>>
    wm protocol $top WM_DELETE_WINDOW "vTcl:FireEvent $top <<DeleteWindow>>"

    label $top.lab44 \
        -disabledforeground #a1a4a1 -font {helvetica 18 bold} -text Nome:
    vTcl:DefineAlias "$top.lab44" "Label1" vTcl:WidgetProc "Toplevel1" 1
    label $top.cpd45 \
        -disabledforeground #a1a4a1 -font {helvetica 18 bold} -text Endereco:
    vTcl:DefineAlias "$top.cpd45" "Label2" vTcl:WidgetProc "Toplevel1" 1
    label $top.cpd46 \
        -disabledforeground #a1a4a1 -font {helvetica 18 bold} -text Telefone:
    vTcl:DefineAlias "$top.cpd46" "Label3" vTcl:WidgetProc "Toplevel1" 1
    checkbutton $top.che47 \
        -disabledforeground #a1a4a1 -font {helvetica 10} -text concluido \
        -variable endpgm
    vTcl:DefineAlias "$top.che47" "Checkbutton1" vTcl:WidgetProc "Toplevel1" 1
    button $top.but48 \
        -command do_exit -disabledforeground #a1a4a1 \
        -font {helvetica 10 bold} -text entra
    vTcl:DefineAlias "$top.but48" "Button1" vTcl:WidgetProc "Toplevel1" 1
    entry $top.ent49 \
        -background white -insertbackground black -textvariable name
    vTcl:DefineAlias "$top.ent49" "nome_entry" vTcl:WidgetProc "Toplevel1" 1
    entry $top.cpd50 \
        -background white -insertbackground black -textvariable address
    vTcl:DefineAlias "$top.cpd50" "Entry2" vTcl:WidgetProc "Toplevel1" 1
    entry $top.cpd51 \
        -background white -insertbackground black -textvariable phone
    vTcl:DefineAlias "$top.cpd51" "Entry3" vTcl:WidgetProc "Toplevel1" 1
    listbox $top.lis43 \
        -background white -listvariable nomes_anteriores
    vTcl:DefineAlias "$top.lis43" "Listbox1" vTcl:WidgetProc "Toplevel1" 1
    label $top.lab45 \
        -disabledforeground #a1a4a1 -font {verdana -11} \
        -text {nomes
anteriores}
    vTcl:DefineAlias "$top.lab45" "Label4" vTcl:WidgetProc "Toplevel1" 1
    button $top.but47 \
        -command {source /usr/bin/tkcon} -disabledforeground #a1a4a1 \
        -text tkcon
    vTcl:DefineAlias "$top.but47" "Button2" vTcl:WidgetProc "Toplevel1" 1
    button $top.but51 \
        -command {MinhaJanela show} -disabledforeground #a1a4a1 \
        -text {nome (aux)}
    vTcl:DefineAlias "$top.but51" "Button3" vTcl:WidgetProc "Toplevel1" 1
    ###################
    # SETTING GEOMETRY
    ###################
    place $top.lab44 \
        -x 25 -y 35 -anchor nw -bordermode ignore
    place $top.cpd45 \
        -x 25 -y 100 -anchor nw
    place $top.cpd46 \
        -x 25 -y 170 -anchor nw
    place $top.che47 \
        -x 30 -y 440 -anchor nw -bordermode ignore
    place $top.but48 \
```

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```
        -x 205 -y 430 -anchor nw -bordermode ignore
    place $top.ent49 \
        -x 140 -y 40 -width 403 -height 27 -anchor nw -bordermode ignore
    place $top.cpd50 \
        -x 175 -y 100 -width 368 -height 27 -anchor nw
    place $top.cpd51 \
        -x 175 -y 175 -width 273 -height 27 -anchor nw
    place $top.lis43 \
        -x 155 -y 245 -width 383 -height 156 -anchor nw -bordermode ignore
    place $top.lab45 \
        -x 35 -y 250 -anchor nw -bordermode ignore
    place $top.but47 \
        -x 470 -y 430 -anchor nw -bordermode ignore
    place $top.but51 \
        -x 320 -y 430 -anchor nw -bordermode ignore

    vTcl:FireEvent $base <<Ready>>
}

proc vTclWindow.top47 {base} {
    if {$base == ""} {
        set base .top47
    }
    if {[winfo exists $base]} {
        wm deiconify $base; return
    }
    set top $base
    ###################
    # CREATING WIDGETS
    ###################
    vTcl:toplevel $top -class Toplevel \
        -highlightcolor black
    wm withdraw $top
    wm focusmodel $top passive
    wm geometry $top 433x150+169+728; update
    wm maxsize $top 1265 994
    wm minsize $top 1 1
    wm overrideredirect $top 0
    wm resizable $top 1 1
    wm title $top "New Toplevel 2"
    vTcl:DefineAlias "$top" "MinhaJanela" vTcl:Toplevel:WidgetProc "" 1
    bindtags $top "$top Toplevel all _TopLevel"
    vTcl:FireEvent $top <<Create>>
    wm protocol $top WM_DELETE_WINDOW "vTcl:FireEvent $top <<DeleteWindow>>"

    entry $top.ent48 \
        -background white -disabledforeground #a1a4a1 -insertbackground black \
        -textvariable name1
    vTcl:DefineAlias "$top.ent48" "Entry1" vTcl:WidgetProc "MinhaJanela" 1
    button $top.but49 \
        -command {global name name1
set name $name1
MinhaJanela hide} \
        -disabledforeground #a1a4a1 -text ok
    vTcl:DefineAlias "$top.but49" "Button1" vTcl:WidgetProc "MinhaJanela" 1
    button $top.but50 \
        -command {MinhaJanela hide} -disabledforeground #a1a4a1 -text fechar
```

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```
    vTcl:DefineAlias "$top.but50" "Button2" vTcl:WidgetProc "MinhaJanela" 1
    ###################
    # SETTING GEOMETRY
    ###################
    place $top.ent48 \
        -x 50 -y 30 -width 353 -height 27 -anchor nw -bordermode ignore
    place $top.but49 \
        -x 145 -y 90 -anchor nw -bordermode ignore
    place $top.but50 \
        -x 240 -y 90 -anchor nw -bordermode ignore

    vTcl:FireEvent $base <<Ready>>
}

###############################################################################
## Binding tag:  _TopLevel

bind "_TopLevel" <<Create>> {
    if {![info exists _topcount]} {set _topcount 0}; incr _topcount
}
bind "_TopLevel" <<DeleteWindow>> {
    if {[set ::%W::_modal]} {
                vTcl:Toplevel:WidgetProc %W endmodal
            } else {
                destroy %W; if {$_topcount == 0} {exit}
            }
}
bind "_TopLevel" <Destroy> {
    if {[winfo toplevel %W] == "%W"} {incr _topcount -1}
}

Window show .
Window show .top43
Window show .top47

main $argc $argv
## ** ##
```

and

```
#!/bin/sh
# the next line restarts using wish\
exec wish "$0" "$@"
# this script receives "data_block" with the (group) value
# of the cobol variable and returns "result"

## visual tcl leaves the main window iconified, so let's show it
wm deiconify .

###### put in this list varname, size pairs

set cobol_fields {
        title                   20
        url                           50
}

grid [label .msg -text \
```

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```
        "Use <Tab> to navigate, <Return> (or click button) \n\
to return to main program."] -columnspan 2

grid \
        [label .lab1 -text "Title:"] \
        [entry .e1 -width 20 -textvariable title] -padx 5 -pady 5 -sticky nsw
grid \
        [label .lab2 -text "URL:"] \
        [entry .e2 -width 50 -textvariable url] -padx 5 -pady 5 -sticky nsw

grid [button .ready -text Enter -command do_exit] \
        -columnspan 2 -pady 20 -sticky ns

bind all <Return> do_exit
focus .e1

#trace add variable ::ready write show_variables


proc show_variables {args} {
        uplevel #0 {
                set exclude {^::(env|auto_index|tcl_.*|widget|tk_.*|auto_.*)$}
                puts "variables: ----------------------------------------"
                foreach v [info vars ::*] {
                        if {[regexp $exclude $v]} {
                                continue
                        }
                        if {[array exists $v]} {
                                puts "$v: [array get $v]"
                        } else {
                                puts "$v: [set $v]"
                        }
                }
        }
}
```

5.16 Can GnuCOBOL interface with Falcon PL?

Yes, yes it can.

This is from the linked post . . . but the Falcon programming language embeds in GnuCOBOL just fine.

`falconscript.fal`

```
> "Falcon list comprehension called from GnuCOBOL"
sums = [].mfcomp( {x,y=> x+y}, .[1 2 3], .[4 5 6] )
return sums.describe()
```

And a quick sample:

```
$ ./callfalcon
argv[1]: falconscript.fal
Falcon list comprehension called from GnuCOBOL
VM Output: [ 5, 6, 7, 6, 7, 8, 7, 8, 9]
```

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```
Intermediate: [ 5, 6, 7, 6, 7, 8, 7, 8, 9]
Falcon says: [ 5, 6, 7, 6, 7, 8, 7, 8, 9]
```

A Falcon list comprehension with **mfcomp** applies the reduction x+y on 1 and 4, 1 and 5, 1 and 6, then 2 and 4, 2 and 5 etc.

From opencobol.org back in 2010:

`callfalcon.cob`

```
OCOBOL*>>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin
      *> Date:
      *> Purpose:
      *> Tectonics: cobc -x callfalcon.cob ocfalcon.o
      *>            $(falcon-conf --libs-only-l) -lstdc++
      *> ****************************************************************
       identification division.
       program-id. callfalcon.

       data division.
       working-storage section.
       01 argc usage binary-long value 2.
       01 argv.
          03 pointers usage pointer occurs 2 times.
       01 mock.
          03 strings pic x(80) occurs 2 times.

       01 stat usage binary-long.
       01 result pic x(80).
       01 resmax usage binary-long value 80.
       01 display-string pic x(80).

      *> ****************************************************************
       procedure division.

      *> Setup an argc, argv thingy
       move "callfalcon" & x"00" to strings(1)
       move "falconscript.fal" &x"00" to strings(2)
       set pointers(1) to address of strings(1)
       set pointers(2) to address of strings(2)

       call "CBL_OC_FALCON" using
            by value argc
            by reference argv
            by reference result
            by value resmax
            returning stat
       end-call
       string
           result delimited by low-value into display-string
       end-string
       display "Falcon says: " display-string end-display

       goback.
       end program callfalcon.
```

and, with EXTERN "C" to get C++ to play nice with the nameing

```
/*
   MODIFIED BY btiffin to interface with OpenCOBOL

   FALCON - The Falcon Programming Language.
   FILE: falcon_embed_3.cpp

   Embedding samples
   Adding VM interaction - input parameters and output result

   VM can give the embedder program access to exported symbols.
   The items inside the VM can be inspected and changed.
   The core module exports three symbols that every kind embedder
   should fill: the scriptName, scriptPath and args global variables.

   When a script returns from a routine, or from the main code, the
   return value is left in the A register of the VM. This script
   will transform that item in a string and will report it
   as output.

   Compile with
      g++ $(falcon-conf --cflags-only-I) $(falcon-conf -L) \
         falcon_embed_3.cpp -o falcon_embed_3

   ---------------------------------------------------------------------
   Author: Giancarlo Niccolai
   Begin: 2007-08-11 19:49:00

   ---------------------------------------------------------------------
   (C) Copyright 2004: the FALCON developers (see list in AUTHORS file)

   See LICENSE file for licensing details.
*/

// Inclusion of the Falcon Engine
#include <falcon/engine.h>
#include <iostream>
#include <string.h>

class AppFalcon
{
public:
   AppFalcon();
   ~AppFalcon();
   const char* embed( const char *script_name, int argc, char **argv );
};

AppFalcon::AppFalcon()
{
   Falcon::Engine::Init();
}

AppFalcon::~AppFalcon()
{
   Falcon::Engine::Shutdown();
}
```

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```
// This is the routine that embeds falcon
const char* AppFalcon::embed( const char *script_name, int argc, char **argv )
{
   // first of all, we need a module loader to load the script.
   // The parameter is the search path for where to search our module
   Falcon::ModuleLoader theLoader(".");

   // As we want to use standard Falcon installation,
   // tell the loader that is safe to search module in system path
   theLoader.addFalconPath();

   // Allow the script to load iteratively other resources it may need.
   Falcon::Runtime rt( &theLoader );
   rt.loadFile( script_name );

   // We are ready to go. Let's create our VM and link in minimal stuff
   Falcon::VMachineWrapper vm;

   vm->link( Falcon::core_module_init() );  // add the core module

   // try to link our module and its dependencies.
   // -- It may fail if there are some undefined symbols
   vm->link( &rt );

   // Now that we have linked everything, we can set the script name,
   // the script path and the arguments.

   Falcon::Item *scriptName = vm->findGlobalItem( "scriptName" );
   Falcon::Item *scriptPath = vm->findGlobalItem( "scriptPath" );
   Falcon::Item *args = vm->findGlobalItem( "args" );

   // get the topmost (and so, the main) module, just to set the correct name.
   const Falcon::Module *mainMod = vm->mainModule()->module();

   //items can directly be set to Core and Garbage object pointers.
   *scriptName = new Falcon::CoreString( mainMod->name() );
   *scriptPath = new Falcon::CoreString( script_name );

   // create the arguments.
   // It is correct to pass an empty array if we haven't any argument to pass.
   Falcon::CoreArray *argsArray = new Falcon::CoreArray;
   for( int i = 0; i < argc; i ++ )
   {
      argsArray->append( new Falcon::CoreString( argv[i] ) );
   }
   *args = argsArray;

   // end of parameters

   // we're ready to go. Still, we may fail if the script has not a main routine.
   vm->launch();

   // We should have now an output value. It is advisable to turn it
   // in a string before to show it.
   Falcon::String str_regA;
   vm->regA().toString( str_regA );
```

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```
   // Falcon provides a nice helper to convert falcon strings into char * or wchar_t
   Falcon::AutoCString c_regA( str_regA );
   std::cout << "VM Output: " << c_regA.c_str() << std::endl;

   return c_regA.c_str();
}

extern "C" {
    int CBL_OC_FALCON(int argc, char* argv[], char* result, int resmax) {
       //=====================================================
       // Falcon engine initialization.
       AppFalcon myApp;

       char *script_name;
       const char *intermediate;

       if ( argc < 2 ) {
          std::cout << "Please, provide a script name" << std::endl;
          return 0;
       }

       script_name = argv[1];
       std::cout << "argv[1]: " << script_name << std::endl;

       // now we also pass the arguments.
       try {
          intermediate = myApp.embed( script_name, argc - 2, argv + 2 );
          std::cout << "Intermediate: " << intermediate << std::endl;
          memcpy(result, intermediate, resmax);
          return 0;
       }
       catch( Falcon::Error* err )
       {
          // This time let's use a Falcon stream,
          // that knows how to handle Falcon strings.
          Falcon::Stream* stdErr = new Falcon::StdErrStream();
          stdErr->writeString( err->toString() );
          err->decref();
          delete stdErr;
          return 0;
       }
    }
}
```

and `falconscript.fal`

```
> "Falcon called from OpenCOBOL"
return "42"
```

Built with:

```
prompt$ g++ $(falcon-conf --cflags-only-I) $(falcon-conf -L) ocfalcon.cpp -c
prompt$ cobc -x callfalcon.cob ocfalcon.o $(falcon-conf --libs-only-l) -lstdc++
prompt$ ./callfalcon
argv[1]: falconscript.fal
Falcon called from OpenCOBOL
VM Output: 42
```

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```
Intermediate: 42
Falcon says: 42
```

with `falconscript.fal`

```
> "Falcon list comprehension called from OpenCOBOL"
sums = [].mfcomp( {x,y=> x+y}, .[1 2 3], .[4 5 6] )
return sums.describe()
```

Repeating the initial example from above:

```
prompt$ ./callfalcon
argv[1]: falconscript.fal
Falcon list comprehension called from OpenCOBOL
VM Output: [ 5, 6, 7, 6, 7, 8, 7, 8, 9]
Intermediate: [ 5, 6, 7, 6, 7, 8, 7, 8, 9]
Falcon says: [ 5, 6, 7, 6, 7, 8, 7, 8, 9]
```

FalconPL has some nice features.

```
saying = List("Have", "a", "nice", "day")

for elem in saying
   >> elem
   formiddle: >> " "
   forlast: > "!"
end
```

giving:

```
Have a nice day!
```

5.17 Can GnuCOBOL interface with Ada?

Yes. The freely available **gnat** system can be used and will create object files that can be included in a GnuCOBOL project.

This example compiles an gnat package that includes *hello* and *ingress* PROCEDURE and a *echo* FUNCTION. These will be called from a GnuCOBOL **adacaller.cob** program.

The gnat specification file

```
with Interfaces.C;
use Interfaces.C;
package HelloAda is

   procedure hello;
   procedure ingress(value : in INTEGER);
   function echo(message : in char_array) return integer;
   pragma export(C, hello);
   pragma export(C, ingress);
   pragma export(C, echo);

end HelloAda;
```

The gnat implementation body

```
with Ada.Text_IO, Ada.Integer_Text_IO, Interfaces.C;
use  Ada.Text_IO, Ada.Integer_Text_IO, Interfaces.C;
package body HelloAda is

procedure hello is
begin
   Put_Line("Hello from Ada and GnuCOBOL");
   New_Line;
end hello;

procedure ingress(value : in integer) is
begin
   Put_Line("Passing integer to Ada from GnuCOBOL");
   Put("GnuCOBOL passed: ");
   Put(value);
   New_Line;
   New_Line;
end ingress;

function echo(message : in char_array) return integer is
begin
    Put(To_Ada(message, true));
    return To_Ada(message, true)'length;
end echo;

end HelloAda;
```

The adacaller.cob source file

```
GCobol****************** adacaller.cob ********************************
       >>SOURCE FORMAT IS FIXED
      ************************************************************
      * Author:    Brian Tiffin
      * Date:      08-Sep-2008
      * Purpose:   Demonstrate using Ada subprograms
      * Tectonics: gnatgcc -c helloada.adb
      *            gnatbind -n helloada
      *            gnatgcc -c b~helloada.abd
      *            cobc -x -lgnat caller.cob helloada.o b~helloada.o
      ************************************************************
       identification division.
       program-id. caller.

       data division.
       working-storage section.
       01 ada-message      pic x(10) value "Ada echo" & x'0a' & x'00'.
       01 result           pic s9(9) value high-value.
      ************************************************************
       procedure division.
       begin.
       call "adainit" end-call

       call "hello" end-call

       call "ingress" using by value 42 end-call
```

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```
       call "echo" using
           by reference ada-message
           returning result
       end-call
       display "Ada return: " result end-display

       call "adafinal" end-call

       goback
       .
       end program caller.
```

And the tectonics; Debian GNU/Linux *build.sh*

```
gnatgcc -c helloada.adb
gnatbind -n helloada
gnatgcc -c b~helloada.adb
cobc -x -lgnat adacaller.cob helloada.o b~helloada.o
```

An important step is the creation of the object file from the *gnatbind* output *with -n* that is used in the final GnuCOBOL executable.

Sample run using ./adacaller:

```
Hello from Ada and GnuCOBOL

Passing integer to Ada from GnuCOBOL
GnuCOBOL passed:          42

Ada echo
Ada return: +000000009
```

See *Can the GNAT Programming Studio be used with GnuCOBOL?* (page 747) for more.

5.18 Can GnuCOBOL interface with Vala?

Yes. Very easily. The Vala design philosophy of producing C application binary interface code means that Vala is directly usable with GnuCOBOL's *CALL* (page 219) statement.

See https://wiki.gnome.org/Projects/Vala for some details on this emerging programming environment.

This interface will be seeing more and more use as it really does open the door to some very powerful extensions.

- WebKit embedding
- PDF Viewers
- GTK
- Media streaming
- much more

5.18.1 Call GnuCOBOL programs from Vala

Using a few simple tricks, Vala can easily call GnuCOBOL programs. Vala uses a predictable link module naming convention. Inside a class, from.vala, the linker will try and find from_vala_name, in this case from_vala_ochello.

```
/* Call GnuCOBOL from Vala */

public class from.vala
{

    public static int main(string[] args)
    {
        stdout.printf("Result: %d\n", ochello());
        return 0;

    }
    [import()]
    public extern static int ochello();
}
/**/
```

So the PROGRAM-ID here is from_vala_ochello.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20101017
      *> Purpose:   Call ochello from Vala in a from.vala Class
      *> Tectonics:
      *>   cobc -fimplicit-init -C ochello.cob
      *>   valac callcobol.vala ochello.c -X -lcob
      *> ***************************************************************
       identification division.
       program-id. from_vala_ochello.

      *> ***************************************************************
       procedure division.
       display "Hello GnuCOBOL's World!" end-display
       move 42 to return-code
       goback.
       end program from_vala_ochello.
```

The tectonics might seem a little bit mysterious. *cobc* is used to produce C source code, including calls for initialization of the GnuCOBOL runtime.

valac is then used to compile and link the Vala source, the generated ochello.c and then the *gcc* compiler is passed the -lcob to link in libcob.so.

5.18.2 Call GnuCOBOL from a Vala GTK gui application

And another experiment, with a gui button and repeated timer calls.

callhellogui.vala

```
// Call GnuCOBOL program from Vala and show the return code on a button
using Gtk;

public class from.vala {
    public static int cobolcode;
    public static char[] valarray = new char[80];

```

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```
    public static int main (string[] args) {

        Gtk.init (ref args);
        var time = new TimeoutSource(50);

        var window = new Window (WindowType.TOPLEVEL);
        window.title = "Invoke GnuCOBOL program";
        window.set_default_size (300, 50);
        window.position = WindowPosition.CENTER;
        window.destroy.connect (Gtk.main_quit);

        cobolcode = ochello();

        var button = new Button.with_label (cobolcode.to_string());
        button.clicked.connect (() => {
            button.label = "Thanks for all the fish!";
            stdout.printf("%d\n", fishy());
        });

        time.set_callback(() => {
            var t = Time.local(time_t());
            string fromvala = "From vala string type + time to_string:  "
                              + t.to_string();
            string fromcobol = "xxxx/xx/xxbxx/xx/xxxxxxx/xx";

            stdout.printf("Vala fromcobol string was   : %s\n", fromcobol);

            datey(fromvala, fromcobol);

            stdout.printf("Vala fromcobol string set to: %s\n", fromcobol);
            return true;
        });

        time.attach(null);

        window.add (button);
        window.show_all ();

        Gtk.main ();
        return 0;
    }

    [import()]
    public extern static int ochello();
    public extern static int fishy();
    public extern static int datey(string arg1, string arg2);
}
```

ochellogui.cob

And here we define *from_vala_ochello*, *from_vala_fishy*, *from_vala_datey*.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20101017
      *> Purpose:   Call ochello from Vala in a from.vala Class
```

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```
      *> Tectonics:
      *>   cobc -fimplicit-init -C ochellogui.cob
      *>   valac --pkg gtk+-2.0 callcobolgui.vala ochellogui.c -X -lcob
      *> ****************************************************************
       identification division.
       program-id. from_vala_ochello.
       procedure division.
       display "Hello GnuCOBOL's Wonderful World!" end-display
       move 42 to return-code
       goback.
       end program from_vala_ochello.

      *> ****************************************************************
      *> ****************************************************************

       program-id. from_vala_fishy.
       procedure division.
       display "We really do mean, thanks for all the fish!" end-display
       goback.
       end program from_vala_fishy.

      *> ****************************************************************
      *> ****************************************************************

       program-id. from_vala_datey.
       data division.
       working-storage section.
       01 editted-date pic xxxx/xx/xxbxx/xx/xxxxxxx/xx.

       linkage section.
       01 datafromvala pic x(60).
       01 datafromcobol pic x(27).

       procedure division using datafromvala datafromcobol.
       move function current-date to editted-date
       inspect editted-date replacing all "/" by ":" after initial space
       display editted-date end-display

       display datafromvala end-display

       move editted-date to datafromcobol
       goback.
       end program from_vala_datey.
```

Tectonics similar to the first sample. With this one, a timer fires every 50 milliseconds passing data back and forth between Vala and GnuCOBOL **unsafely, mind you**. If you push button “42”, a message is printed to standard out.

Along with the GUI button, produces:

```
$ ./callcobolgui
...
Vala fromcobol string was    : xxxx/xx/xxbxx/xx/xxxxxxx/xx
2010/10/17 18:19:5598-04:00
From vala string type + time to_string:  2010-10-17 18:19:55
Vala fromcobol string set to: 2010/10/17 18:19:5598-04:00
Vala fromcobol string was    : xxxx/xx/xxbxx/xx/xxxxxxx/xx
2010/10/17 18:19:5603-04:00
From vala string type + time to_string:  2010-10-17 18:19:56
Vala fromcobol string set to: 2010/10/17 18:19:5603-04:00
...
```

5.18.3 Call Genie program from GnuCOBOL

Here is a sample that calls a small Genie program.

piping.gs, a small program that spawns out some shell commands. One fails on purpose, *ech* is not a valid executable. The next *echo* call has the output captured in *ret_stdout*. 42 is then passed as the return code to GnuCOBOL.

```
// Tectonics: valac -c piping.gs
[indent=4]
class wrapper : Object
    def static hellogenie() : int
        ret_stdout : string
        ret_stderr : string
        ret_status : int

        try
            Process.spawn_command_line_sync("ech 'ech?'", out ret_stdout,
                out ret_stderr, out ret_status)
        except ex : Error
            print("in catch")
            print(ex.message)

        print("stdout: %s", ret_stdout)
        print("stderr: %s", ret_stderr)
        print("status: %d", ret_status)

        try
            Process.spawn_command_line_sync("echo -n 'hey it works!'",
                out ret_stdout, out ret_stderr, out ret_status)
        except ex : Error
            print("in catch")
            print(ex.message)

        print("stdout: %s", ret_stdout)
        print("stderr: %s", ret_stderr)
        print("status: %d", ret_status)

        return 42
```

callgenie.cob

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *><* =========
```

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```
      *><* callgenie
      *><* =========
      *><* :Author:    Brian Tiffin
      *><* :Date:      29-Sep-2010
      *><* :Purpose:   Demonstrate getting at Genie code
      *><* :Tectonics:
      *><*    valac -c piping.gs
      *><*    cobc -x callgenie.cob piping.vala.o
      *><*         -lglib-2.0 -lgobject-2.0
      *> ************************************************************
       identification division.
       program-id. callgenie.

       data division.
       working-storage section.
       01 result usage binary-long.

      *> ************************************************************
       procedure division.
       call "wrapper_hellogenie" returning result end-call
       display "Result from Genie: " result end-display
       .
       goback.
       end program callgenie.
      *><*
      *><* Last Update: 29-Sep-2010
```

The Vala/Genie link naming is predictable. Inside a *class*, **wrapper**, the Genie generated link name is *wrapper_hellogenie*.

With a sample run producing:

```
[btiffin@home vala]$ ./callgenie
in catch
Failed to execute child process "ech" (No such file or directory)
stdout: (null)
stderr: (null)
status: 0
stdout: hey it works!
stderr:
status: 0
Result from Genie: +0000000042
```

5.18.4 Pass data to and from Genie

The Genie

```
// Tectonics: valac -c genieregex.gs
[indent=4]
class cbl.oc.genie : Object
    def static regexing(pattern : string, subject : string, out value : string,
                        out leng : int) : int
        print " "
        print "Pattern: %s", pattern
        print "Subject: %s", subject
```

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```
        try
            var r = new Regex(pattern)
            var s = subject
            s = r.replace(s, s.length, 0, "COBOL")
            value = s
            leng = (int)s.length
        except ex : Error
            print ex.message
            value = subject
            leng = (int)subject.length
            return 1
        return 0
```

The COBOL

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *><* ================
      *><* Call Genie Regex
      *><* ================
      *><* :Author:    Brian Tiffin
      *><* :Date:      20101101
      *><* :Purpose:   Getting at Genie Regex code
      *><* :Tectonics: vala -c genieregex.gs
      *><*              cobc -x callgenieregex.cob genieregex.vala.o
      *><*                   -lglib-2.0 -lgobject-2.0
      *> ***************************************************************
       identification division.
       program-id. callgenieregex.

       data division.
       working-storage section.
       01 pattern pic x(80) value "Fortran|APL|Python" & x"00".
       01 subject pic x(80) value
           "GnuCOBOL, Fortran, Vala, Genie, Python, C, APL" & x"00".
       01 out-pointer usage pointer.
       01 out-length usage binary-long.
       01 middleman pic x(80) based.
       01 replacement pic x(80).
       01 result usage binary-long.

      *> ***************************************************************
       procedure division.
       call "cbl_oc_genie_regexing"
           using
               by reference pattern
               by reference subject
               by reference out-pointer
               by reference out-length
           returning result
       end-call
       display "Result from Genie: " result end-display

       set address of middleman to out-pointer
       move middleman(1:out-length) to replacement
       display "replacement now: " replacement end-display
```

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```
       move "(red)" & x'00' to pattern
       move "The red car was going too fast" & x'00' to subject
       move 0 to out-length
       set out-pointer to null
       free middleman

       call "cbl_oc_genie_regexing"
           using
               by reference pattern
               by reference subject
               by reference out-pointer
               by reference out-length
           returning result
       end-call
       display "Result from Genie: " result end-display

       set address of middleman to out-pointer
       move middleman(1:out-length) to replacement
       display "replacement now: " replacement end-display

       move "[:digit:]" & x'00' to pattern
       move "The Regex fails" & x'00' to subject
       move 0 to out-length
       set out-pointer to null
       free middleman

       call "cbl_oc_genie_regexing"
           using
               by reference pattern
               by reference subject
               by reference out-pointer
               by reference out-length
           returning result
       end-call
       display "Result from Genie: " result end-display

       set address of middleman to out-pointer
       move middleman(1:out-length) to replacement
       display "replacement now: " replacement end-display
       goback.
       end program callgenieregex.
```

The Output

```
$ valac -g -v -c genieregex.gs
cc -g -c '/home/btiffin/lang/cobol/genieregex.vala.c' \
         -pthread -I/usr/include/glib-2.0 -I/usr/lib64/glib-2.0/include

$ cobc -g -debug -v -x callgenieregex.cob genieregex.vala.o -lgobject-2.0 -lglib-2.0
Preprocessing:  callgenieregex.cob to callgenieregex.i
Return status:  0
Parsing:        callgenieregex.i
Return status:  0
Translating:    callgenieregex.i to callgenieregex.c
Executing:      gcc -c -I/usr/local/include -pipe -g -Wno-unused -fsigned-char
                -Wno-pointer-sign -o "/tmp/cob3411_0.o" "callgenieregex.c"
Return status:  0
```

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```
Executing:      gcc -Wl,--export-dynamic -o "callgenieregex"
                "/tmp/cob3411_0.o" "genieregex.vala.o" -L/usr/local/lib -lcob
                -lm -lgmp -lncurses -ldb -ldl -l"gobject-2.0" -l"glib-2.0"
Return status:  0

$ ./callgenieregex

Pattern: Fortran|APL|Python
Subject: GnuCOBOL, Fortran, Vala, Genie, Python, C, APL
Result from Genie: +0000000000
replacement now: GnuCOBOL, COBOL, Vala, Genie, COBOL, C, COBOL

Pattern: (red)
Subject: The red car was going too fast
Result from Genie: +0000000000
replacement now: The COBOL car was going too fast

Pattern: [:digit:]
Subject: The Regex fails
Error while compiling regular expression [:digit:] at char 0:
      POSIX named classes are supported only within a class
Result from Genie: +0000000001
replacement now: The Regex fails
```

5.19 Can GnuCOBOL interface with S-Lang?

Yes. The S-Lang engine can be used with GnuCOBOL for two purposes. Supporting a very nice terminal and keyboard programmer interface S-Lang can be used to scan the keyboard for non-waiting ACCEPT key routines. As a bonus, S-Lang has a very nice scripting engine that allows easy and direct linkage of script variables with GnuCOBOL defined storage members.

5.19.1 Setup

You will need the S-Lang library for this interface. Under *Debian* (page 65) that is simply

```
$ apt-get install libslang2
```

See http://www.jedsoft.org/slang for details of this very capable library.

5.19.2 Keyboard control

This sample only show S-Lang terminal input. A very sophisticated terminal output control interface is also available.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20090503
      *> Purpose:   Experimental S-Lang interface
      *> Tectonics: cobc -x slangkey.cob -lslang
      *> ************************************************************
       identification division.
```

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```
       program-id. slangkey.

       data division.
       working-storage section.
       01 thekey               usage binary-long unsigned.
       01 thekm                usage binary-long.
       01 result               usage binary-long.

      *> exit handler address and priority (prio is IGNORED with OC1.1)
       01 install-flag       pic 9 comp-x value 0.
       01  install-params.
           02 exit-addr       usage is procedure-pointer.
           02 handler-prio    pic 999 comp-x.

      *> ****************************************************************
       procedure division.

      *> Initialize low and high level S-Lang terminal routines
       call "SLtt_get_terminfo" end-call
       call "SLkp_init" returning result end-call
       if result equal -1
           display "problem intializing S-Lang tty" end-display
           stop run giving 1
       end-if

       call "SLang_init_tty" using
           by value -1      *> abort char
           by value -1      *> flow ctrl
           by value 0       *> output processing
         returning result
       end-call
       if result equal -1
           display "problem intializing S-Lang tty" end-display
           stop run giving 1
       else
           display "Keyboard in special mode" x"0d" end-display
       end-if

      *> install an exit handler to put terminal back
       set exit-addr to entry "tty-reset"
       call "CBL_EXIT_PROC" using
           install-flag
           install-params
           returning result
       end-call
       if result not equal zero
           display "error installing exit procedure" end-display
       end-if

      *> Not sure?  Have SLang handle ^C or let GnuCOBOL take over?
       call "SLang_set_abort_signal" using by value 0 end-call

      *> The demo.  Fetch a key, then fetch a keycode.  4 times.
      *>   SLang terminals display newline as newline.  Need explicit
      *>   CR to get a carriage return.  Hence the x"0d".
      *>   Plus, output is buffered until line terminators.
       display
```

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```
           "Tap a normal key, then tap a 'special' key, ie F1, 4 times"
           x"0d"
       end-display
       perform 4 times
           call "SLang_getkey" returning thekey end-call
           display thekey space with no advancing end-display
           call "SLkp_getkey" returning thekm end-call
           display thekm x"0d" end-display
       end-perform

      *> Exit handler will take care of resetting terminal
       goback.
       end program slangkey.


      *> ****************************************************************
      *> Exit procedure to ensure terminal properly reset
      *> ****************************************************************
       identification division.
       program-id. tty-reset.

       call "SLang_reset_tty" end-call
       display "exit proc, reset the tty" end-display

       goback.
       end program tty-reset
```

Outputs:

```
Keyboard in special mode
Tap a normal key, then tap a 'special' key, ie F1, 4 times
0000000097 +0000000513
0000000001 +0000000002
0000000099 +0000065535
0000000003 +0000000003
exit proc, reset the tty
```

having tapped, A, F1, Ctrl-A, Ctrl-B, C, EscEsc and Ctrl-C. The S-Lang abort handler pretty much takes over the Ctrl-C handling in this sample so it looks at though Ctrl-C was tapped twice, but it wasn't.

5.19.3 Scripting

S-Lang also provides a very comprehensive scripting language, which is very easy to embed.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20090505
      *> Purpose:   Experimental S-Lang interface
      *> Tectonics: cobc -x callslang.cob -lslang
      *> ****************************************************************
       identification division.
       program-id. callslang.

       data division.
```

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```
       working-storage section.
       01 result               usage binary-long.
       01 cobol-integer        usage binary-long value 42.
       01 cobol-float          usage float-long value 0.0.
       01 sl-int-type          constant as 20.
       01 sl-double-type       constant as 27.
       01 read-write           constant as 0.

      *> ****************************************************************
       procedure division.

      *> Initialize S-Lang
       call "SLang_init_all" returning result
       if result equal -1
           display "Sorry, problem initializing SLang" end-display
       end-if

      *> Register "slint" variable
       call "SLadd_intrinsic_variable" using
           by reference "slint" & x"00"
           by reference cobol-integer
           by value sl-int-type
           by value read-write
           returning result
       end-call
       if result equal -1
           display "Could not register cobol-integer" end-display
       end-if

      *> Register "sldbl" variable
       call "SLadd_intrinsic_variable" using
           by reference "sldbl" & x"00"
           by reference cobol-float
           by value sl-double-type
           by value read-write
           returning result
       end-call
       if result equal -1
           display "Could not register cobol-float" end-display
       end-if

       call "SLang_load_string" using
           "sldbl = sum([0, 1, 2, 3, 4, 5, 6, 7, 8, 9]);" & x"00"
           returning result
       end-call
       if result equal -1
           display "Could not interpret sum intrinsic" end-display
       end-if
       display "S-Lang set cobol-float to " cobol-float end-display

       display "Next lines of output are S-Lang printf" end-display
       call "SLang_load_string" using
           '() = printf("slint (cobol-integer) = %d\n", slint);' & x"00"
           returning result
       end-call
       if result equal -1
           display "Could not interpret printf" end-display
```

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```
       end-if

       add 1 to cobol-integer

       call "SLang_load_string" using
           '() = printf("slint after COBOL add = %d\n", slint);' & x"00"
           returning result
       end-call
       if result equal -1
           display "error with printf after cobol add" end-display
       end-if

      *> Let's get out of here and do the Dilbert Nerd Dance...Woohoo!
       goback.
       end program callslang.
```

Which produces:

```
S-Lang set cobol-float to 45.000000000000000000
Next lines of output are S-Lang printf
slint (cobol-integer) = 42
slint after COBOL add = 43
```

5.20 Can the GNAT Programming Studio be used with GnuCOBOL?

Yes. Extensions to smooth the integration of GnuCOBOL development in gnat-gps is posted at http://svn.wp0.org/ocdocs/brian/opencobol.xml

```
<?xml version="1.0"?>
<Custom>
  <Language>
    <Name>GnuCOBOL</Name>
    <Spec_Suffix>.cob</Spec_Suffix>
    <Extension>.cbl</Extension>
    <Extension>.cpy</Extension>

    <Keywords>^(identification|id|environment|data|procedure|division|</Keywords>
    <Keywords>program-id|author|</Keywords>
    <Keywords>configuration|source-computer|object-computer|</Keywords>
    <Keywords>special-names|repository|</Keywords>
    <Keywords>input-output|file-control|io-control|</Keywords>
    <Keywords>file|working-storage|local-storage|linkage|</Keywords>
    <Keywords>communication|report|screen|</Keywords>
    <Keywords>section|declaratives|</Keywords>
    <Keywords>end|</Keywords>
    <Keywords>perform|end-perform|until|times|varying|</Keywords>
    <Keywords>add|subtract|multiply|divide|compute|</Keywords>
    <Keywords>end-add|end-subtract|end-multiply|end-divide|end-compute|</Keywords>
    <Keywords>accept|display|read|write|rewrite|sort|</Keywords>
    <Keywords>end-accept|end-display|end-read|end-write|end-rewrite|</Keywords>
    <Keywords>move|evaluate|end-evaluate|if|end-if|when|</Keywords>
    <Keywords>(un)?string|end-(un)?string|call|end-call|</Keywords>
    <Keywords>goback|stop[\s]+run|</Keywords>
    <Keywords>filler|low-value[s]?|high-value[s]?|space[s]?|zero[es]?[s]?)\b</
↪Keywords>
```

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```
  <Context>
    <New_Line_Comment_Start>\*&gt;|[ ]{6}\*</New_Line_Comment_Start>
    <String_Delimiter>&quot;</String_Delimiter>
    <Constant_Character>&apos;</Constant_Character>
    <Can_Indent>True</Can_Indent>
    <Syntax_Highlighting>True</Syntax_Highlighting>
    <Case_Sensitive>False</Case_Sensitive>
  </Context>

  <Categories>
    <Category>
      <Name>procedure</Name>
      <Pattern>^[0-9a-z]+\.</Pattern>
      <Index>1</Index>
      <Icon>subprogram_xpm</Icon>
    </Category>
  </Categories>
</Language>

<alias name="program">
  <param name="pid">prog</param>
  <text>*&gt;OC&lt;*
    *&gt;&gt;SOURCE FORMAT IS FIXED
    *&gt; ****************************************************************
    *&gt; Author:    Brian Tiffin
    *&gt; Date:      %D
    *&gt; Purpose:   %_
    *&gt; Tectonics: make
    *&gt; ****************************************************************
     identification division.
     program-id %(pid).

     environment division.
     configuration section.
     special-names.
     repository.
     input-output section.

     data division.
     file section.
     working-storage section.
     local-storage section.
     linkage section.
     screen section.

     procedure division.
     declaratives.
     end declaratives.

     00-main.

     .
     00-finish.
     goback.
    *&gt; ****************************************************************
```

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```
      end program %(pid).
    </text>
  </alias>

  <Language>
    <Name>Vala</Name>
    <Spec_Suffix>.vala</Spec_Suffix>

    <Keywords>^(bool|char|constpointer|double|float|size_t|ssize_t|string|</Keywords>
    <Keywords>unichar|void|int|int8|int16|int32|int64|long|short|</Keywords>
    <Keywords>uint|uint8|uint16|uint32|uint64|ulong|ushort|</Keywords>
    <Keywords>class|delegate|enum|errordomain|interface|namespace|struct|</Keywords>
    <Keywords>break|continue|do|for|foreach|return|while|</Keywords>
    <Keywords>else|if|switch|</Keywords>
    <Keywords>case|default|</Keywords>
    <Keywords>abstract|const|dynamic|ensures|extern|inline|internal|override|</
↪Keywords>
    <Keywords>private|protected|public|requires|signal|static|virtual|</Keywords>
    <Keywords>volatile|weak|false|null|true|</Keywords>
    <Keywords>try|catch|finally|throw|</Keywords>
    <Keywords>as|base|construct|delete|get|in|is|lock|new|out|params|ref|</Keywords>
    <Keywords>sizeof|set|this|throws|typeof|using|value|var|yield|yields)\b</Keywords>

    <Context>
      <New_Line_Comment_Start>//</New_Line_Comment_Start>
      <Comment_Start>/*</Comment_Start>
      <Comment_End>*/</Comment_End>
      <String_Delimiter>&amp;quot;</String_Delimiter>
      <Constant_Character>&amp;apos;</Constant_Character>
      <Can_Indent>True</Can_Indent>
      <Syntax_Highlighting>True</Syntax_Highlighting>
      <Case_Sensitive>True</Case_Sensitive>
    </Context>

    <Categories>
      <Category>
        <Name>procedure</Name>
        <Pattern>^[0-9a-z]+\.</Pattern>
        <Index>1</Index>
        <Icon>subprogram_xpm</Icon>
      </Category>
    </Categories>
  </Language>

  <tool name="cobc" package="OpenCOBOL" index="opencobol">
    <language>OpenCOBOL</language>
    <initial-cmd-line>-m</initial-cmd-line>
      <switches lines="3" columns="2">
         <title line="1" column="1" >Code generation</title>
         <title line="1" column="2" >Run-time options</title>
         <title line="2" column="1" line-span="2" >Source forms and Warnings</title>
         <title line="3" column="1" line-span="0" />
         <title line="2" column="2" >Debugging</title>
         <title line="3" column="2" >Syntax</title>

         <radio>
            <radio-entry label="Build dynamic module (default)" switch="-m" />
```

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```
            <radio-entry label="Build executable" switch="-x" />
            <radio-entry label="Build object file" switch="-c" />
            <radio-entry label="Preprocess only" switch="-E" />
            <radio-entry label="Translation only, COBOL to C" switch="-C" />
            <radio-entry label="Compile only, output assembly file" switch="-S" />
         </radio>
         <check label="Syntax checking only" switch="-fsyntax-only"
                tip="Syntax error checking only; no output emitted" />

         <combo label="Optimization" switch="-O" nodigit="1" noswitch="0"
                tip="Controls the optimization level">
            <combo-entry label="No optimization" value="0" />
            <combo-entry label="Simple optimization" value="1" />
            <combo-entry label="Some more optimization" value="s" />
            <combo-entry label="Full optimization" value="2" />
         </combo>

         <field label="Generate listing to " switch="-t" separator=" " as-file="true"
                tip="Generate a listing file to given filename" />
         <field label="Save generated files to " switch="-save-temps"
                separator="=" as-directory="true"
                tip="Save temporary files to given directory" />

         <radio line="2" column="1">
            <radio-entry label="Format FIXED" switch="-fixed"
                tip="Standards mandate default is fixed format source code" />
            <radio-entry label="Format FREE (FIXED is default)" switch="-free"
                tip="Assume free format source code" />
         </radio>
         <check label="MF comment (may lead to ambiguous source)"
                switch="-fmfcomment" line="2" column="1"
                tip="Allow * or / in column 1 as FIXED format line comment" />
         <check label="FUNCTION implied" switch="-ffunctions-all" line="2" column="1"
                tip="Allow use of intrinsic functions without FUNCTION keyword" />
         <check label="Fold Copy LOWER" switch="-ffold-copy-lower" line="2" column="1"
                tip="Fold COPY subject to lower case" />
         <check label="Fold Copy UPPER" switch="-ffold-copy-upper" line="2" column="1"
                tip="Fold COPY subject to upper case" />
         <check label="Full Warnings" switch="-W" line="2" column="1"
                tip="ALL possible warnings" />
         <popup label="Warnings" line="2" column="1">
            <check label="All (exceptions listed below)" switch="-Wall" />
            <check label="Obsolete" switch="-Wobsolete"
                   tip="Warn if obsolete features used" />
            <check label="Archaic" switch="-Warchaic"
                   tip="Warn if archaic features used" />
            <check label="Redefinition" switch="-Wredefinition"
                   tip="Warn of incompatible redefinition of data items" />
            <check label="Constant" switch="-Wconstant"
                   tip="Warn of inconsistent constant" />
            <check label="Parentheses" switch="-Wparentheses"
                   tip="Warn of lack of parentheses around AND within OR" />
            <check label="Strict typing" switch="-Wstrict-typing"
                   tip="Warn of type mismatch, strictly" />
            <check label="Implicit define" switch="-Wimplicit-define"
                   tip="Warn of implicitly defined data items" />
            <check label="Call params (Not set for All)" switch="-Wcall-params"
```

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```
                tip="Warn of non 01/77 items for CALL" />
          <check label="Column overflow (Not set for All)" switch="-Wcolumn-overflow
↪"
                tip="Warn for FIXED format text past column 72" />
          <check label="Terminator (Not set for All)" switch="-Wterminator"
                tip="Warn when missing scope terminator (END-xxx)" />
          <check label="Truncate (Not set for All)" switch="-Wtruncate"
                tip="Warn of possible field truncation" />
          <check label="Linkage (Not set for All)" switch="-Wlinkage"
                tip="Warn of dangling LINKAGE items" />
          <check label="Unreachable (Not set for All)" switch="-Wunreachable"
                tip="Warn of unreachable statements" />
        </popup>

        <check label="Internal run-time error checks" switch="-debug" column="2"
               tip="generate extra internal tests" />
        <check label="Implicit initialize" switch="-fimplicit-init" column="2"
               tip="Do automatic initialization of the Cobol runtime system" />
        <check label="No truncation" switch="-fnotrunc" column="2"
               tip="Do not truncate binary fields according to PICTURE" />
        <check label="Sign ASCII" switch="-fsign-ascii" column="2"
               tip="Numeric display sign ASCII (Default on ASCII machines)" />
        <check label="Sign EBCDIC" switch="-fsign-ebcdic" column="2"
               tip="Numeric display sign EBCDIC (Default on EBCDIC machines)" />
        <check label="Stack checking for PERFORM" switch="-fstack-check" column="2"
               tip="Generate code to verify the boundary of the stack" />
        <check label="Pass extra NULL" switch="-fnull-param" column="2"
               tip="Pass extra NULL terminating pointers on CALL statements" />

        <check label="Enable Debugging lines"
               switch="-fdebugging-line" line="2" column="2"
               tip="Enable column 7 debug lines and &gt;&gt;D compiler directive" />
        <check label="Object Debug Information" switch="-g" line="2" column="2"
               tip="Link level debug information" />
        <check label="Trace (SECTION/PARAGRAPH)" switch="-ftrace" line="2" column="2"
               tip="Enable output of trace statements for SECTION and PARAGRAPH" />
        <check label="Trace all (SECTION/PARAGRAPH/STATEMENT)"
               switch="-ftraceall" line="2" column="2"
               tip="Enable trace for SECTION, PARAGRAPH and STATEMENTS" />
        <check label="Source locations" switch="-fsource-location" line="2" column="2
↪"
               tip="Generate source location code (Turned on by -debug or -g)" />

        <check label="COBOL2002" switch="-std=cobol2002" line="3" column="2"
               tip="Override the compiler's default, and configure for COBOL 2002" />
        <check label="COBOL 85" switch="-std=cobol85" line="3" column="2"
               tip="Override the compiler's default, and configure for COBOL 85" />
        <check label="Micro Focus" switch="-std=mf" line="3" column="2"
               tip="Override the compiler's default, and Micro Focus compatibility" /
↪>
      </switches>
  </tool>

  <action name="make">
    <external>make</external>
  </action>
```

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```
  <action name="cobc">
    <external>cobc -x %f</external>
  </action>

  <action name="cobcrun">
    <external>cobcrun %p</external>
  </action>

  <action name="valac">
    <external>valac --pkg gtk+-2.0 %f</external>
  </action>

  <action name="gdb">
    <external>konsole --vt_sz 132x24 -e gdb ./%p</external>
  </action>

  <action name="cgdb">
    <external>konsole --vt_sz 132x24 -e cgdb ./%p</external>
  </action>

  <action name="cgdb...">
    <shell>MDI.input_dialog "Enter command arguments" "Args"</shell>
    <external>konsole --vt_sz 132x24 -e cgdb --args ./%p %1</external>
  </action>

  <action name="gdbtui">
    <external>konsole --vt_sz 132x24 -e gdbtui --args ./%p %1</external>
  </action>

  <action name="gdbtui...">
    <shell>MDI.input_dialog "Enter command arguments" "Args"</shell>
    <external>konsole --vt_sz 132x24 -e gdbtui --args ./%p %1</external>
  </action>

  <action name="DDD">
    <external>ddd ./%p</external>
  </action>

  <submenu after="Build">
    <title>OpenCOBOL</title>
    <menu action="make">
      <title>make</title>
    </menu>
    <menu action="cobc">
      <title>cobc</title>
    </menu>
    <menu action="cobcrun">
      <title>cobcrun</title>
    </menu>
    <menu action="valac">
      <title>valac</title>
    </menu>
    <menu><title /></menu>
    <menu action="gdb">
      <title>gdb</title>
    </menu>
    <menu action="cgdb">
```

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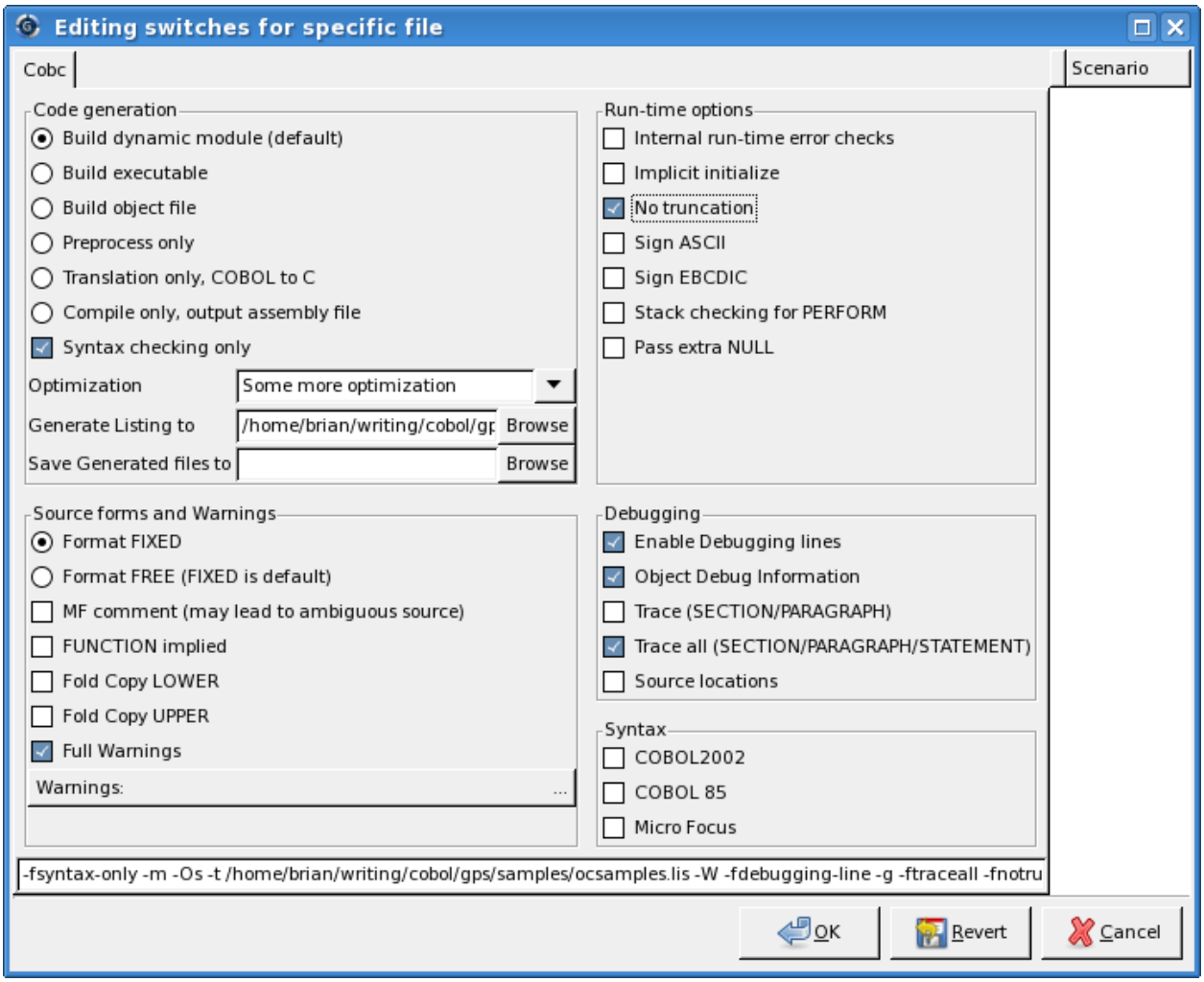
```
      <title>cgdb</title>
    </menu>
    <menu action="cgdb...">
      <title>cgdb...</title>
    </menu>
    <menu action="gdbtui">
      <title>gdbtui</title>
    </menu>
    <menu action="gdbtui...">
      <title>gdbtui...</title>
    </menu>
    <menu action="DDD">
      <title>ddd</title>
    </menu>
  </submenu>
</Custom>
```

which allows for development screens like



or *to be honest* would do, if the final touches were added to the XML to integrate more with the GPS suite. There is more work required to make a proud developer's interface. *Anyone?*

5.21 Does GnuCOBOL support SCREEN SECTION?

Yes. The GnuCOBOL 1.1 pre-release now includes support for SCREEN SECTION. Experimental release for this support occurred in early July, 2008.

The compiler recognizes most (if not all) of the *Screen description entry* of the COBOL 2014 Draft standard.

External variables that influence screen handling include

COB_SCREEN_EXCEPTIONS=Y To enable exceptions during ACCEPT.

COB_SCREEN_ESC=Y To enable handling of the escape key.

Note: When turning on COB_SCREEN_ESC, curses needs to be put in a mode that allows differentiation of Escape prefixed terminal control and the actual Esc key. There is a default timer set to 1 full second before bare Esc key processing is started. This delay is based on old terminal speeds and can be shorted to under 1/10th of a second on most modern systems. Changing this value is depedant on operating system and curses implementation, but a common setting is

```
export ESCDELAY=100
./tui-program
```

ESCDELAY values are in milliseconds, and most humans do not notice keyboard delays of under 100 milliseconds. Values as small as 25 milliseconds will not cause issues with modern hardware, the time taken to prefix terminal controls being much faster than was possible with dialup modems and 300 baud terminals of decades past. *PDCurses does not test for the ESCDELAY setting*.

See *Does GnuCOBOL support CRT STATUS?* (page 758) for more information on key codes and exception handling.

According to the standard a SCREEN SECTION ACCEPT does not need to be proceeded by a DISPLAY. The extra DISPLAY won't hurt, but is not necessary.

5.21.1 Environment variables in source code

Thanks to Gary Cutler and opencobol.org.

> In order to detect the PgUp, PgDn or PrtSc (screen print) keys, you must first set the environment variable COB_SCREEN_EXCEPTIONS to a non-blank value.
>
> If you want to detect the Esc key, you must set COB_SCREEN_EXCEPTIONS as described above AND you must also set COB_SCREEN_ESC to a non-blank value. Fortunately, both of these can be done within your GnuCOBOL program, as long as they're done before the ACCEPT.

```
SET ENVIRONMENT 'COB_SCREEN_EXCEPTIONS' TO 'Y'
SET ENVIRONMENT 'COB_SCREEN_ESC'        TO 'Y'
```

5.22 What are the GnuCOBOL SCREEN SECTION colour values?

The FOREGROUND-COLOR and BACKGROUND-COLOR clauses will accept

```
78  black                     value 0.
78  blue                      value 1.
78  green                     value 2.
78  cyan                      value 3.
78  red                       value 4.
```

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```
78  magenta                     value 5.
78  brown                       value 6.
78  white                       value 7.
```

The compiler actually ships with a COPY book,

`/usr/local/share/gnu-cobol/copy/screenio.cpy`

and

```
COPY screenio.
```

gives access to (along with many extended keycode values)

```
*>   Colors
 78  COB-COLOR-BLACK     VALUE 0.
 78  COB-COLOR-BLUE      VALUE 1.
 78  COB-COLOR-GREEN     VALUE 2.
 78  COB-COLOR-CYAN      VALUE 3.
 78  COB-COLOR-RED       VALUE 4.
 78  COB-COLOR-MAGENTA   VALUE 5.
 78  COB-COLOR-YELLOW    VALUE 6.
 78  COB-COLOR-WHITE     VALUE 7.
```

The display of these colours are also influenced by HIGHLIGHT, LOWLIGHT and REVERSE-VIDEO options. For instance, brown will display as yellow when HIGHLIGHT is used.

```
GNU    >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
Color *> Author:    Brian Tiffin
      *> Date:      20131026
      *> License:   Public Domain
      *> Purpose:   Show the GnuCOBOL default colour palette
      *> Tectonics: cobc -x gnucobol-colours.cob
      *> ***************************************************************
       identification division.
       program-id. gnucobol-colours.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 black   constant as 0.
       01 blue    constant as 1.
       01 green   constant as 2.
       01 cyan    constant as 3.
       01 red     constant as 4.
       01 magenta constant as 5.
       01 brown   constant as 6.
       01 white   constant as 7.

       01 anykey           pic x.

       01 backing          pic 9.
```

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```
       01 foreing           pic 9.
       01 l                 pic 99.
       01 c                 pic 99.

       screen section.
       01 gnu-cobol-colours.
          05 line  1 column 1 value "GnuCOBOL Colours".
          05 line  2 column 1 value "----------------".
          05 line  3 column 1
               value "default          highlight        "
                   & "lowlight         reverse-video    "
                   & "blink".
          05 line  4 column 1 value "Black   0" foreground-color black.
          05 line  5 column 1 value "Blue    1" foreground-color blue.
          05 line  6 column 1 value "Green   2" foreground-color green.
          05 line  7 column 1 value "Cyan    3" foreground-color cyan.
          05 line  8 column 1 value "Red     4" foreground-color red.
          05 line  9 column 1 value "Magenta 5"
                                    foreground-color magenta.
          05 line 10 column 1 value "Brown   6" foreground-color brown.
          05 line 11 column 1 value "White   7"
                                    foreground-color white
                                    background-color black.

          05 line  4 column plus 9   value "Black   0"
                               highlight foreground-color black
                                         background-color white.
          05 line  5 column minus 10 value "Blue    1"
                               highlight foreground-color blue.
          05 line  6 column minus 10 value "Green   2"
                               highlight foreground-color green.
          05 line  7 column minus 10 value "Cyan    3"
                               highlight foreground-color cyan.
          05 line  8 column minus 10 value "Red     4"
                               highlight foreground-color red.
          05 line  9 column minus 10 value "Magenta 5"
                               highlight foreground-color magenta.
          05 line 10 column minus 10 value "Brown   6"
                               highlight foreground-color brown.
          05 line 11 column minus 10 value "White   7"
                               highlight foreground-color white
                                         background-color black.

          05 line  4 column plus 9   value "Black   0"
                               lowlight  foreground-color black
                                         background-color white.
          05 line  5 column minus 10 value "Blue    1"
                               lowlight  foreground-color blue.
          05 line  6 column minus 10 value "Green   2"
                               lowlight  foreground-color green.
          05 line  7 column minus 10 value "Cyan    3"
                               lowlight  foreground-color cyan.
          05 line  8 column minus 10 value "Red     4"
                               lowlight  foreground-color red.
          05 line  9 column minus 10 value "Magenta 5"
                               lowlight  foreground-color magenta.
          05 line 10 column minus 10 value "Brown   6"
```

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```
                                lowlight  foreground-color brown.
           05 line 11 column minus 10 value "White   7"
                                lowlight  foreground-color white
                                          background-color black.

           05 line  4 column plus 9   value "Black   0"
                           reverse-video  foreground-color black
                                          background-color white.
           05 line  5 column minus 10 value "Blue    1"
                           reverse-video  foreground-color blue.
           05 line  6 column minus 10 value "Green   2"
                           reverse-video  foreground-color green.
           05 line  7 column minus 10 value "Cyan    3"
                           reverse-video  foreground-color cyan.
           05 line  8 column minus 10 value "Red     4"
                           reverse-video  foreground-color red.
           05 line  9 column minus 10 value "Magenta 5"
                           reverse-video  foreground-color magenta.
           05 line 10 column minus 10 value "Brown   6"
                           reverse-video  foreground-color brown.
           05 line 11 column minus 10 value "White   7"
                           reverse-video  foreground-color white
                                          background-color black.

           05 line  4 column plus 9   value "Black   0"
                                  blink  foreground-color black
                                          background-color white.
           05 line  5 column minus 10 value "Blue    1"
                                  blink  foreground-color blue.
           05 line  6 column minus 10 value "Green   2"
                                  blink  foreground-color green.
           05 line  7 column minus 10 value "Cyan    3"
                                  blink  foreground-color cyan.
           05 line  8 column minus 10 value "Red     4"
                                  blink  foreground-color red.
           05 line  9 column minus 10 value "Magenta 5"
                                  blink  foreground-color magenta.
           05 line 10 column minus 10 value "Brown   6"
                                  blink  foreground-color brown.
           05 line 11 column minus 10 value "White   7"
                                  blink  foreground-color white
                                          background-color black.

           05 line plus 2 column 30 value "Enter to exit".
           05 column plus 2 using anykey.

       *> ****************************************************************
        procedure division.

       *> display a table of colour combinations
        perform varying backing from 0 by 1 until backing > 7
            perform varying foreing from 0 by 1 until foreing > 7
                compute l = backing + 15
                compute c = foreing * 10 + 2
                display
                    " colour " at line l column c
                    with background-color backing
```

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```
                        foreground-color foreing
                end-display
            end-perform
        end-perform

       *> put up the form oriented screen section
        accept gnu-cobol-colours end-accept

        goback.
        end program gnucobol-colours.
```

Which, showed up looking like

but many issues come into play getting colour on a screen and results will vary, considerably, between monitors.

5.23 Does GnuCOBOL support CRT STATUS?

Yes.

```
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SPECIAL-NAMES.
    CRT STATUS IS screen-status.

DATA DIVISION.
WORKING-STORAGE SECTION.
COPY screenio.
01 screen-status pic 9(4).

PROCEDURE DIVISION.
ACCEPT screen-sample.
```

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```
IF screen-status = COB-SCR-F1
    ...
```

There is also a special GnuCOBOL variable, **COB-CRT-STATUS** which can be used instead of the CRT STATUS special name.

There is also a COPY text that ships with GnuCOBOL, `copy/screenio.cpy` that can be included in the DATA DIVISION. `COPY screenio.` provides 78 level constants for supported key status codes. Some values include:

- COB-SCR-F1 thru
- COB-SCR-F64
- COB-SCR-ESC

examine the `screenio.cpy` file to see the other definitions.

5.24 What is CobCurses?

CobCurses is an optional package designed to work with OpenCOBOL 1.0, before GnuCOBOL 1.1 SCREEN SECTION support was initiated. It has many features beyond simple SCREEN SECTION handling.

See http://sourceforge.net/projects/cobcurses for full details. This is a major piece of work by Warren Gay, ve3wwg.

Update for June 2018; Warren has started up on CobCurses again, project now at https://github.com/ve3wwg/cobcurses

From an opencobol.org posting by Warren announcing release 0.95:

```
CobCurses is a package designed to allow Open-Cobol
programmers to create screens on open system platforms,
or those (like Windows) that can use PDCurses. Since
handcrafting screens is tedious work, this package
includes a "Screen Designer" utility.

All User Guides and Programmer Guide documentation can
be found on the source forge (see link at bottom).

==== RELEASE NOTES ====

A large number of internal changes were implemented in
this release, but first let's cover the user visible
improvements:

1. MENUS! Popup menus are now supported, and are available
 in sdesign with every Action field. In fact, any sdesign
 field that is marked with a diamond graphic, has the
 ability to popup a menu with F1 (or ^O).

2. To support menus, FUNCTION keys are now available in
 Action mode (though CONTROL-O is an alternate way
 of opening a menu). This included a new event
 callback NC-FKEY-EVENT.

3. GRAPHIC characters in the screen background. It is now
 possible using sdesign to draw alternate-charset
 graphics in your screen background. See the notes in
 the opening help screen for the "Paint" function.
```

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```
4. TRACE facilities. CobCurses now includes an
 environment variable that can enable capturing of
 trace information to a file for debugging. A routine
 named NC_TRACE_MSG can also be used to add custom
 messages to the trace file.

INTERNAL CHANGES:

The main two major internal changes were:

1. The terminal support has been virtualized, so that
 the CobCurses routines deal with a "terminal"
 object (not curses routines). This will eventually
 lead to other possible windowing interfaces like
 perhaps graphic X Window or native Windows support.

 The other motivation for this was to allow CobCurses
 to have one consistent set of constants for colours,
 attributes and character sets. Previously, these
 values were different depending upon the platform
 and implementation of curses used.

2. Menu support has been provided independently of curses.
 This is important for portability since PDCurses and
 some platforms do not provide a curses menu library.
 This also guarantees that CobCurses menus will behave
 consistently on all platforms (and overcome menu paging
 bugs in ncurses).

PLANNED FOR THE NEXT RELEASE:

Please avoid writing much code that works with colour pairs.
In the next release, it is planned to hide the colour pair
value altogether by using a TDC (Terminal Drawing Context).
This TDC will tie together attributes and colours, and
perhaps other "drawing contexts" so that you won't have to
manage colour pairs (this will be transparent). This will
also pave the way for graphical interfaces where a selected
font and line styles etc. may also be supported.

NOTES:

HPUX users will need to link with ncurses,
instead of the native HPUX curses libraries. I didn't
have time to fully investigate this, but the native
include files define things like MENU and ITEM types
that conflict with the CobCurses defined ones.

====

The release is available for download here:

http://sourceforge.net/projects/cobcurses
```

5.25 What is CobXRef?

CobXRef is a COBOL cross-referencing utility written by Vincent Coen and ported to GnuCOBOL 1.1.

Current source code is available at http://svn.wp0.org/add1/tools/cobxref or http://sourceforge.net/projects/cobxref/ and is currently *(March 2018)* in active development.

Update: July, 2014, code posted to the SVN tree at

http://sourceforge.net/p/gnucobol/contrib/HEAD/tree/

Full support for `cobc -Xref` during compiles should be easier for everyone to get installed soon, when contrib is packaged with the distribution.

The CobXRef system ships with full documentation and information for building from source is included in the *readme* file.

Fetching the utility

```
prompt$ svn checkout svn://svn.code.sf.net/p/gnucobol/contrib/ gnucobol-contrib
prompt$ cd gnucobol-contrib/trunk/tools/cobxref
prompt$ ./comp-cobxref.sh
```

Visit the project space at http://sourceforge.net/projects/cobxref/ for the latest information. Or the GnuCOBOL forums.

Example using the cobxref.cbl GnuCOBOL program for sourcecode:

```
prompt$ cobc -Xref cobxref.cbl
prompt$ cat cobxref.lst
```

Please note that formfeeds have been removed from the listing.

```
ACS Cobol Xref v1.01.15          Dictionary File for COBXREF    15/11/15  15:08:00:81  Page    1
Symbols of Module: COBXREF (COBXREF)
-------------------------------------

Data Section (FILE)               Defn    Locations
---------------------------------+-------------------------------------------------------------


FS-REPLY                        000095F  000239 003373
P-CONDITIONS                    000127F  002311
P-VARIABLES                     000128F  002310
PL-PROG-NAME                    000124F  002667 002670
PRINT-FILENAME                  000090F  000241 003317 003421
PRINTLINE                       000111F  001581 001582 001583 001584 002169 002176 002179 002263
                                         002271 002274 002359 002361 002404 002428 002437 002486
                                         002490 002492 002528 002531 002563 002573 002618 002628
                                         002641 002648 002651 002661 002674 002696 002707 002715
                                         002718 003113 003115 003141 003142 003143 003144 003156
                                         003157 003161 003162 003166 003167 003168 003169 003173
                                         003174 003176 003177 003178 003179 003183 003184 003185
                                         003186 003190 003191 003192 003196 003197 003198 003202
                                         003203 003204 003208 003209 003210 003211 003215 003216
                                         003217 003218 003420
PRINTLINE2                      000126F  002309 002312 002333
SDSORTKEY                       000145F  002109
SKADATANAME                     000135F  001256 001258 002154 002160 002162 002180 002237 002244
                                         002254 002275 002367 002376 002378 002385 002392 002397
                                         002399 002405 002461 002478 002480 002493 002538 002550
                                         002559 002564 002602 002610 002623 002629 002749 002751
SKAREFNO                        000138F  001260 002181 002189 002276 002284 002406 002419 002494
                                         002501 002539 002565 002630 002750 002752
```

```
SKAWSORPD                       000136F  001253 002182 002247 002249 002255 002277 002377 002379
                                         002394 002400 002411 002469 002495 002554 002566 002624
                                         002632 002739 002753 003105
SKAWSORPD2                      000137F  001254 002256 002380 002401 002410 002631 002740 003106
SL-GEN-REFNO1                   000108F  002732
SORT1TMP                        000097F  000249 003405
SORTFILE                        000097F  000143 002108
SORTRECORD                      000134F  001251 001262 002754 003420
SOURCE-LIST                     000107F  002730 002734
SOURCE-LISTING                  000090F  000106 001233 001281 001481 001570 001633 001657
SOURCEFILENAME                  000093F  000240 003271 003278 003300 003303 003307 003313 003315
                                         003421
SOURCEINPUT                     000093F  000130 001282 001482 001566 001633 001657 002775 003372
SOURCEOUTPUT                    000109F  002731
SOURCERECIN                     000131F  002731 002774 002778
SUPP-FILE-1                     000087F  000247 001577 003399
SUPP-FILE-2                     000084F  000248 001576 003402
SUPPLEMENTAL-PART1-OUT          000087F  000101 000133 001245 001281 001481 001564 001566 001634
                                         001657 002110
SUPPLEMENTAL-PART2-IN           000084F  000102 000140 002111 002137 002138 002147 002149 002217
                                         002218 002230 002233 002345 002346 002355 002357 002448
                                         002449 002456 002458 002514 002515 002524 002526 002587
                                         002588 002596 002599
XRCOND                          000115F  002701 002703
XRDATANAME                      000112F  002165 002180 002259 002275 002360 002405 002424 002482
                                         002493 002529 002564 002629 002649 002666 002669 002697
                                         002716
XRDEFN                          000113F  002181 002276 002406 002494 002565 002630 002663 002698
XRREFERENCE                     000118F  002189 002284 002419 002501

ACS Cobol Xref v1.01.15          Dictionary File for COBXREF    15/11/15  15:08:00:81  Page    2
Symbols of Module: COBXREF (COBXREF)
-------------------------------------

Data Section (FILE)              Defn    Locations
---------------------------------+-----------------------------------------------------------------


XRTYPE                          000114F  002182 002277 002411 002413 002495 002566 002632 002634
                                         002672 002699

ACS Cobol Xref v1.01.15          Dictionary File for COBXREF    15/11/15  15:08:00:81  Page    3
Symbols of Module: COBXREF (COBXREF)
-------------------------------------

Data Section (WORKING-STORAGE)   Defn    Locations
---------------------------------+-----------------------------------------------------------------


A                               000163W  001221 001222 001225 001226 001252 001253 001254 001256
                                         001258 001260 001261 001340 001350 001376 001394 001414
                                         001415 001419 001420 001447 001468 001498 001500 001523
                                         001535 001686 001687 001708 001733 001808 001809 001872
                                         001876 001919 001921 001921 001939 001983 001984 001985
                                         001986 001995 002017 002032 002033 002034 002036 002042
                                         002044 002046 002048 002054 002060 002061 002303 002307
                                         002308 002310 002311 002331 002662 002663 002664 002666
                                         002667 002669 002670 002693 002694 002695 002697 002698
                                         002699 002700 003039 003050 003051 003053 003058 003060
                                         003061 003067 003081 003084 003085 003300 003300 003302
A1                              000164W  003458 003459 003460 003461
A2                              000165W  003239 003240 003241 003244
ADDITIONAL-RESERVED-WORDS       000559W  001141
ADDITIONAL-RESERVED-WORDS-R     001141W  001204
ALL-FUN-IDX                     000550W  003104 003107
ALL-FUNCTIONS                   000550W  001214 003103
ALL-REPORTS                     000185W  002128
ARG-NUMBER                      000218W  003262 003263 003265
```

```
ARG-VALS                        000411W  001240 003322
ARG-VALUE                       000412W  003271 003326 003327 003330 003331 003337 003338 003343
                                         003344 003350 003351 003357 003358 003366 003367 003381
B                               000166W  001986 001994 002000 002035 002036 002059 002060 002083
                                         002094 002095 002098 002664 002672 002693 002705 002714
                                         003039 003043 003044 003046 003046 003054 003064 003066
                                         003067 003302 003303 003303 003305 003306 003307 003308
BUILD-NUMBER                    000220W  001641 001644 001650 001651 001656 001739 001742 001752
                                         001777 001784 001801 003225 003227 003230 003449
C                               000167W  001939 001998 001999 003039 003053 003055 003068
COBOL-WORD-SIZE                 000200W
CON-TAB-BLOCKS                  001148W  002298 002326
CON-TAB-COUNT                   001155W  001397 001399 001402 001403 001405 001406 001408 001743
                                         001753 001754 001756 001757 001759 001760 002295 002297
                                         002307 002325 003427
CON-TAB-SIZE                    001148W  001154 001397 001398 001743 001744 001745 001746 001753
                                         003425
CONDITION-TABLE                 001147W  003424
CONDITIONS                      001150W  001403 001406 001757 001760 002310 002326
CT-IN-USE-FLAG                  001152W  001408
CURRENCY-SIGN                   000224W  001436 001438 002935
CWS                             000201W  001235 001237 001306 001378 001403 001406 001656 001740
                                         001757 001760 002071 002071 002741 002743
D                               000168W  001939 002004 002005 002808 002845 002846 002848 002856
                                         002857 003034 003034 003036 003044 003051
DUMP-RESERVED-WORDS             000189W  001220
E                               000169W  002926 002928 002944 002945 003060 003062
END-PROG                        000207W  001279 001563 001568 001573 001579 001860 002768 002877
ERROR-MESSAGES                  000389W
F-POINTER                       000160W  001275 003102 003107 003428
FOUNDFUNCTION                   000253W  003087 003089
FS-REPLY                        000239W  003373
FULL-SECTION-NAME               000424W  001415 003164

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Symbols of Module: COBXREF (COBXREF)
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Data Section (WORKING-STORAGE)   Defn    Locations
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FUNCTION-TABLE                  000448W  000549
FUNCTION-TABLE-R                000549W  001202
FUNCTION-TABLE-SIZE             000553W  001203 001225
GEN-REFNO1                      000219W  001624 001632 001656 001770 002726 002732 002750 002752
GIT-BUILD-NO                    001165W  002700 003449
GIT-ELEMENTS                    001158W  001856 002113
GIT-HOLDWSORPD                  001163W  001253 001261 002664 002699 003451
GIT-HOLDWSORPD2                 001164W  001254 003452
GIT-IN-USE-FLAG                 001166W  002695 003447 003461
GIT-PROG-NAME                   001161W  002667 002670 003450
GIT-REFNO                       001162W  001260 002663 002698 003448
GIT-TABLE-COUNT                 001169W  001250 001252 001855 002112 002204 002662 002688 002694
                                         003438 003439 003446 003447 003448 003449 003450 003451
                                         003452 003459
GIT-TABLE-SIZE                  001158W  001168 003439 003440 003441 003442 003443
GIT-WORD                        001160W  001256 001258 001856 002113 002666 002669 002697 003446
                                         003460
GLOBAL-ACTIVE                   000213W  001779 001783 001800 001830
GLOBAL-CURRENT-LEVEL            000252W  001611 001614 001645 001648 001769 003436
GLOBAL-CURRENT-REFNO            000251W  001624 001770 003448
GLOBAL-CURRENT-WORD             000250W  001623 001771 001831 003420 003446
GLOBAL-ITEM-TABLE               001157W  001198
GOTASECTION                     000230W  001553 001600 001603 001604 003235 003242 003253
GOTENDPROGRAM                   000221W  003426
GOTPICTURE                      000222W  002931 002953 003017 003018 003022
H1-PAGE                         000301W  003139
```

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H1PROG-NAME                     000285W  001270
H1PROGRAMID                     000299W  003117 003131
HAD-END-PROG                    000210W  002765
HAVE-NESTED                     000216W  001308 001313
HD-D                            000364W  003122
HD-DATE-TIME                    000366W  003131
HD-HH                           000357W  003125
HD-M                            000363W  003121
HD-MM                           000358W  003126
HD-SS                           000359W  003127
HD-UU                           000360W  003128
HD-Y                            000362W  003120
HD2-D                           000367W  003122
HD2-HH                          000373W  003125
HD2-M                           000369W  003121
HD2-MM                          000375W  003126
HD2-SS                          000377W  003127
HD2-UU                          000379W  003128
HD2-Y                           000371W  003120
HDDATE                          000361W  003118 003119
HDR1                            000283W  003141 003142
HDR10                           000341W  003196
HDR11                           000344W  003208
HDR11A-SORTED                   000346W  002299 002328
HDR11B-SORTED                   000350W  002300 002327
HDR12-HYPHENS                   000353W  003209

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Data Section (WORKING-STORAGE)   Defn    Locations
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HDR2                            000303W  003215
HDR3                            000307W  003167 003177 003184 003216
HDR5-PROG-NAME                  000314W  003147 003152 003153
HDR5-SYMBOLS                    000312W  003156
HDR6-HYPHENS                    000321W  003153 003154
HDR6-SYMBOLS                    000316W  003157
HDR7-VARIABLE                   000325W  003163 003165 003175
HDR7-WS                         000323W  003166 003176
HDR8-HD                         000330W  002350 002432 002473
HDR8-WS                         000329W  003183
HDR9                            000335W  003190
HDR9B                           000338W  003202
HDTIME                          000356W  003123 003124
HOLDFOUNDWORD                   000232W  001918 001921
HOLDFOUNDWORD2                  000233W  002847 002848 002857 002858
HOLDFOUNDWORD2-SIZE             000161W  002836 002844 002849 002856 002859
HOLDFOUNDWORD2-TYPE             000162W  002837 002854
HOLDID                          000255W  001235 001237 001239 001310 001312 001632 001656 003129
                                         003148 003450
HOLDID-MODULE                   000256W  001239 001315 001317 003150
HOLDWSORPD                      000225W  001473 001508 001538 001555 001559 001601 001646 001683
                                         001805 002739 002744 002755 002799 002818 003063 003236
                                         003241 003427 003451
HOLDWSORPD2                     000226W  001474 001509 001539 001621 001911 001914 001920 001922
                                         002740 003245 003427 003452
LINE-COUNT                      000153W  001585 002170 002171 002199 002264 002265 002313 002314
                                         002362 002429 002430 002447 002472 002474 002487 002530
                                         002572 002574 002617 002619 002640 002642 002650 002673
                                         002675 002706 002708 002717 002733 002735 003145 003158
                                         003170 003180 003187 003193 003199 003205 003212 003219
LINE-END                        000157W  002804 002857 003044
LIST-SOURCE                     000187W  001271 002729
LSECT                           000406W  002182 002277 002411 002495 002566 002632 002672 002699
```

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MSG1                              000390W  002139 002219 002347 002450 002516 002589
MSG10                             000398W  003444
MSG16                             000400W  001480
MSG17                             000401W  001208
MSG2                              000391W  001280
MSG4                              000392W  001632
MSG5                              000393W  001656
MSG6                              000394W  001747
MSG7                              000395W  002024
MSG8                              000396W  002771
MSG9                              000397W  003374
OS-DELIMITER                      000229W  003393 003396 003398 003401 003404
P-FUNCTION                        000550W  000552 001214 001226 003104
P-OC-IMPLEMENTED                  000551W
PAGE-NO                           000154W  003114 003138 003139 003140
PRINT-FILENAME                    000241W  003317 003421
PROG-BASENAME                     000242W  001235 001237 003307 003313 003314 003316
PROG-NAME                         000148W  001270 003280
Q                                 000177W  001275 001939 001994 002000 002081 002088 002091 002143

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Data Section (WORKING-STORAGE)   Defn    Locations
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                                         002166 002167 002168 002175 002186 002188 002189 002223
                                         002260 002261 002262 002269 002281 002283 002284 002352
                                         002416 002418 002419 002425 002426 002427 002435 002452
                                         002483 002484 002485 002488 002498 002500 002501 002520
                                         002551 002567 002570 002593 002611 002614 002635 002638
Q2                                000178W  002270 002344 002358 002436 002446 002489
REPORTS-IN-LOWER                  000193W  001234 001255 001309 001314 001401 001755 002665 002742
RESERVED-NAMES                    001142W  001213 003082
RESVD-IDX                         001142W  003083 003084
RESVD-IMPLEMENTED                 001143W
RESVD-TABLE-SIZE                  001145W  001205 001221
RESVD-WORD                        001142W  001144 001213 001222 003083
S                                 000170W  001939 001940 001945 001946 001968 001970 001972 001973
                                           001981 001983 001984 001990 001991 001995 001998 002004
                                           002008 002010 002012 002081 002083 002897 002922 002932
                                           002935 002941 002959 002978 002990
S-POINTER                         000151W  001275 002513 002527 002571 002586 002616 002639 002647
                                           003428
S-POINTER2                        000152W  001556 001663 001664 002822 002828 002879 002880 002883
                                           002889 002890 002897 002902 002904 002907 002921 002922
                                           002924 002926 002941 002942 002944 002959 002965 002978
                                           002981 002990 002998 003428
S2                                000171W  001939 001972 001974
SAVED-VARIABLE                    000235W  001378 001402 001405 001642 001726 001734 001740 001756
                                           001759 001778 001802
SAVESKADATANAME                   000234W  002136 002160 002162 002216 002244 002254 002343 002376
                                           002378 002385 002392 002397 002399 002445 002478 002480
                                           002512 002550 002559 002585 002610 002623 003421
SAVESKAWSORPD                     000236W  002255 002344 002379 002386 002393 002400 002446 002513
                                           002586 002615 002624 002638
SAVESKAWSORPD2                    000237W  002256 002344 002380 002401 002446 002513
SECTION-NAME                      000426W  003240
SECTION-NAMES-TABLE               000414W  000423
SECTION-SHORT-NAMES-TABLE         000429W  000438
SECTION-USED-TABLE                000408W  002200 003426
SECTTABLE                         000403W  000405
SHORT-SECTION-NAME                000439W
SHT-SECTION-NAME                  000440W  002846 002848
SORT1TMP                          000249W  003405
SOURCE-EOF                        000204W  001278 001479 001862 002770 002876 003000
```

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SOURCE-LINE-END                 000158W  001663 002804 002835 002846 002849 002879 002889
SOURCE-WORDS                    000159W  001913 002829 003005
SOURCEFILENAME                  000240W  003271 003278 003300 003303 003307 003313 003315 003421
SOURCEINWS                      000258W  001286 001324 001327 001330 001333 001352 001355 001358
                                         001415 001449 001452 001455 001921 002774 002778 002782
                                         002785 002794 002795 002800 002802 002813 002819 002820
                                         002846 002855 002857 002858 002880 002883 002901 002907
                                         002921 002923 002928 002932 002935 002942 002945 002981
                                         003034 003042 003043 003046 003053 003058 003061 003062
                                         003067
STRING-POINTER                  000149W  003264 003270 003271 003279 003299 003328 003332 003380
                                         003381

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Symbols of Module: COBXREF (COBXREF)
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Data Section (WORKING-STORAGE)   Defn    Locations
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STRING-POINTER2                 000150W  003299 003318
SUPP-FILE-1                     000247W  001577 003399
SUPP-FILE-2                     000248W  001576 003402
SV1WHAT                         000259W  003240 003243
SW-1                            000183W  003368
SW-2                            000186W  003339
SW-4                            000188W  003345
SW-5                            000190W  003353
SW-6                            000192W  003359
SW-END-PROG                     000206W  001586 002821
SW-GIT                          000212W  001622 001647 001674 001797 003254
SW-HAD-END-PROG                 000209W  002766 002821
SW-NESTED                       000215W  002821
SW-SOURCE-EOF                   000203W  002776 003426
T                               000172W  001994 002000 002043 002049 002068 002080 002081 002083
                                         002084 002085
TEMP-PATHNAME                   000246W  003385 003386 003387 003388 003389 003390 003391 003392
                                         003394 003395 003397 003400 003403 003407
USECT                           000409W  001261 002212 002443 002753
VARIABLES                       001151W  001402 001405 001756 001759 002298 002311
WASPICTURE                      000223W  001670 001671 002948
WE-ARE-TESTING                  000191W  001325 001328 001331 001334 001353 001356 001359 001437
                                         001450 001453 001456 001572 002011 002056 003006 003045
                                         003243 003406
WORD-DELIMIT                    000227W  001364 001382 001409 001462 001470 001493 001498 001511
                                         001520 001541 001662 001665 001667 001776 001781 001864
                                         001912 002881 002902 002908 002924 002927 002929 002942
                                         002946 002981 002985 003007
WORD-DELIMIT2                   000228W  002960 002977 002981 002985 002991
WORD-LENGTH                     000156W  001502 001598 001631 001632 001889 001918 001919 001923
                                         001924 001925 001926 001941 001959 002068 002069 002084
                                         002086 002882 002909 002973 002992 003008 003009 003226
                                         003229
WS-ANAL1                        000238W  002201 002212 002213 002231 002247 002249 003164
WS-RETURN-CODE                  000155W  001200 001201 001207
WS-WC-DD                        000384W
WS-WC-HH                        000385W
WS-WC-MIN                       000386W
WS-WC-MM                        000383W
WS-WC-YY                        000382W  003283
WS-WHEN-COMPILED                000381W  003281
WSF1-1                          000265W  001303 001373 001391 001493 001495 001517 001696 001698
                                         001704 001865 001880 001883 001885 001888 001891 002906
                                         002912 002919 002920 002957 002963 002967 002970 002977
WSF1-1-NUMBER                   000266W  001373 001391 001495 001517 001702 001878 002918
WSF1-2                          000264W  001903 002916
WSF1-3                          000263W  001898 001905 002914
```

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WSF3-1                          000272W  003227 003230
WSF3-1-NUMERIC                  000273W
WSF3-2                          000274W  003230
WSFOUNDNEWWORD                  000277W  001304 001306 002006 002008 002010 002015 002079 002081
                                         002088 002089 002091 003423

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Data Section (WORKING-STORAGE)   Defn    Locations
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WSFOUNDNEWWORD2                 000278W  002079 002083 002095 002096 002098 003423
WSFOUNDNEWWORD3                 000279W  001938 002036 002060 002071 003422
WSFOUNDNEWWORD4                 000280W  002741 002743 002749 002751 003104 003422 003460
WSFOUNDNEWWORD5                 000281W  001688 001689 001810 001811 003040 003043 003067
WSFOUNDWORD                     000262W  000271
WSFOUNDWORD2                    000271W  001295 001304 001306 001310 001312 001315 001317 001366
                                         001369 001378 001384 001387 001388 001403 001406 001430
                                         001431 001436 001488 001529 001610 001613 001619 001623
                                         001631 001632 001656 001673 001677 001680 001684 001686
                                         001688 001689 001700 001725 001740 001757 001760 001771
                                         001791 001792 001796 001806 001808 001810 001811 001824
                                         001831 001839 001869 001881 001886 001918 001923 001924
                                         001945 001955 001956 001968 001973 001974 001981 001983
                                         001984 001986 001990 001991 001998 002004 002008 002010
                                         002012 002015 002025 002034 002036 002046 002057 002060
                                         002071 002081 002083 002090 002091 002097 002098 002741
                                         002743 002884 002896 002901 002910 002923 002942 002954
                                         002958 002960 002964 002971 002980 002981 002986 002991
                                         003008 003016 003020 003021 003083 003086
Y                               000173W  001939 001990 001991 001993
Z                               000174W  001700 001941 001955 001956 001957 001970 002033 002044
                                         002054 002971 002971 002973 002986 002986 002988 002990
                                         002991 002992
Z2                              000175W  001939 001941 001943 001947 001953 001958 001968 001971
                                         001981 001983 001984 001986 001990 001991 001998 002004
                                         002007 002008 002081 002083 002084 002086
Z3                              000176W  001939 001971 001974

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Variable Tested [S]            Symbol (88-Conditions)
-------------------------------------------------------------


SN-TEST-1                       SNT1-ON
SN-TEST-1                       SNT1-OFF
SW-1                            ALL-REPORTS
SW-2                            LIST-SOURCE
SW-4                            DUMP-RESERVED-WORDS
SW-5                            WE-ARE-TESTING
SW-6                            REPORTS-IN-LOWER
SW-END-PROG                     END-PROG
SW-GIT                          GLOBAL-ACTIVE
SW-HAD-END-PROG                 HAD-END-PROG
SW-NESTED                       HAVE-NESTED
SW-SOURCE-EOF                   SOURCE-EOF
WSF1-1                          WSF1-1-NUMBER
WSF3-1                          WSF3-1-NUMERIC

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Variable Tested                Symbol (88-Conditions) [S]
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SW-1                            ALL-REPORTS
```

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SW-4                            DUMP-RESERVED-WORDS
SW-END-PROG                     END-PROG
SW-GIT                          GLOBAL-ACTIVE
SW-HAD-END-PROG                 HAD-END-PROG
SW-NESTED                       HAVE-NESTED
SW-2                            LIST-SOURCE
SW-6                            REPORTS-IN-LOWER
SN-TEST-1                       SNT1-OFF
SN-TEST-1                       SNT1-ON
SW-SOURCE-EOF                   SOURCE-EOF
SW-5                            WE-ARE-TESTING
WSF1-1                          WSF1-1-NUMBER
WSF3-1                          WSF3-1-NUMERIC

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Functions                        Defn    Locations
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CURRENT-DATE                    003281I
E                               002926I  002928 002944 002945 003060 003062
LOWER-CASE                      001235I  001256 001310 001315 001402 001403 001756 001757 002666
                                         002667 002743
UPPER-CASE                      001237I  001312 001317 002778 003104 003322

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Procedure                        Defn    Locations
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AA000-XREF-DATA                 001172S
AA020-BYPASS-OPEN               001244P  001587
AA030-READLOOP1                 001277P  001296
AA040-READLOOP2                 001322P  001342
AA041-GET-SN                    001344P  001326 001335 001354 001365 001383 001410
AA042-GETWORD                   001362P  001368 001370 001374 001377
AA044-GETWORD3                  001380P  001386 001389 001392 001395 001411
AA045-EXIT                      001422P  001336 001349 001446 001522
AA045-TEST-SECTION              001413P  001336 001349 001446 001522
AA046-GET-CURRENCY              001425P  001367 001385 001432
AA047-GETIO                     001441P  001329 001357 001463 001471 001494 001499 001503 001512
AA047-GETWORD                   001460P  001469
AA047-GETWORD2                  001477P  001489
AA047-GETWORD3                  001491P  001496 001501 001513
AA048-GET-NEXT                  001519P  001542
AA048-GETIOC                    001515P  001332 001360 001451 001518 001530
AA049-GETWORD                   001532P  001536 001543
AA050-READLOOP3                 001545P  001454 001554 001560
AA060-READLOOP3A                001551P  001290 001341 001351 001448 001457 001524
BA000-EXIT                      001846P  001602
BA000-PROCESS-WS                001592S  001557
BA020-GETAWORD                  001593P  001599 001606 001627 001782 001787 001817
BA040-CLEAR-TO-NEXT-PERIOD      001661P  001626 001672 001676 001679 001682 001692 001697 001699
                                         001701 001703 001705 001709 001715 001786 001816
BA049-EXIT                      001717P  001626 001666 001668 001786 001816
BA050-BYPASS-ADD-2-CON-TABLE    001765P  001748
BA050-GET-USER-WORD             001720P  001652
BA051-AFTER-DATANAME            001775P  001727
BA051-AFTER-NEW-WORD            001790P  001735
BA052-AFTER-INDEX               001819P  001678 001825
BA053-AFTER-DEPENDING           001834P  001681 001840
BB000-EXIT                      002101P  001861 001863
BB000-PROCESS-PROCEDURE         001849S  001562
BB010-NEW-RECORD                001850P
BB020-GETAWORD                  001858P  001866 001877 001879 001882 001884 001887 001890 001899
                                         001904 001906 001931 001944 001954 001969 001975 001987
                                         002018 002021 002026 002070 002100
BB030-CHK1                      001868P  001928
```

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BB040-CHK2                      001894P
BB050-CHECK-SUBSCRIPTS          001933P  001892 002072
BB051-CLEAR-LEFT-BRACE          001942P  001948
BB052-CLEAR-RIGHT-BRACE         001952P  001960
BB053-NUMERICS                  001967P
BB054-SPACES                    002002P
BB060-SCAN4-QUOTES              002028P  001996 002037
BB070-GOT-QUOTE                 002041P  002047
BB080-QUOTE-CLEAN               002053P  002062
BB090-RECOVER-WORD              002064P  002045 002055
BB100-SCAN4-COLON               002074P  002001
BC000-EXIT                      002721P  002140 002150 002220 002348 002451 002517 002590 002600
BC000-LAST-ACT                  002104S  001567
BC010-GROUP-REPORT              002135P
BC020-READ-SORTER               002146P  002155 002157
BC030-ISX                       002153P  002144
BC040-PRINTXREF                 002159P  002156

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Procedure                        Defn    Locations
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BC050-CHECK-Q                   002164P  002148 002187
BC060-CONNECTC                  002178P
BC070-CONNECTD                  002185P  002161
BC080-EXIT                      002191P  002156 002183
BC090-LAST-PASS2                002194P  002129
BC100-WORKING-STORAGE-REPORT    002208P  002202
BC110-READ-SORTER               002229P  002238 002240
BC120-ISX2                      002236P  002227
BC130-PRINTXREF2                002242P  002239
BC140-CHECK-Q                   002258P  002232 002282
BC150-CONNECTC2                 002273P
BC160-CONNECTD2                 002280P  002245
BC170-EXIT                      002285P  002239 002248 002250 002278
BC180-EXIT                      002288P  002202 002214 002234
BC190-DO-CONDITIONS             002291P  002206
BC192-PRINT-CONDITIONS          002306P  002304 002318 002332
BC194-NOW-REVERSE               002320P  002305
BC195-DONE                      002334P  002296
BC200-LAST-PASS3                002339P
BC210-READ-SORTER3              002354P  002368 002370
BC220-ISX3                      002366P  002353
BC230-PRINTXREF3                002372P  002369
BC250-CONNECTC3                 002403P
BC260-CONNECTD3                 002415P  002398
BC270-EXIT                      002420P  002369 002381 002387 002395 002414
BC280-CHECK-Q                   002423P  002356 002402 002417
BC300-LAST-PASS4                002439P  002335
BC310-READ-SORTER4              002455P  002462 002464
BC320-ISX4                      002460P  002453
BC330-PRINTXREF4                002465P  002463
BC335-CHECK-Q                   002481P  002457 002499
BC340-CONNECTC4                 002491P
BC350-CONNECTD4                 002497P  002479
BC360-EXIT                      002502P  002463 002470 002496
BC399-EXIT                      002505P  002335 002444 002459
BC400-LAST-PASS5                002508P  002364
BC410-READ-SORTER5              002523P  002540 002542
BC420-ISX5                      002534P  002521
BC430-PRINTXREF5                002543P  002541
BC440-CHECK-4OLD                002569P  002525 002557
BC450-EXIT                      002578P  002541 002552 002555 002568
BC500-LAST-PASS6                002581P  002533
BC510-READ-SORTER6              002595P  002603 002605
BC520-ISX6                      002601P  002594
BC530-PRINTXREF6                002606P  002604
```

```
BC540-CHECK-4OLD                002637P  002597
BC540-CHECK-4OLD6               002646P  002598
BC550-EXIT                      002652P  002604 002612 002636
BC600-EXIT                      002681P  002205
BC600-PRINT-GLOBALS             002655P  002205
BC620-DO-GLOBAL-CONDITIONS      002684P  001569
BC629-EXIT                      002719P  001569 002689
ZZ000-INC-COBOLREFNO            002725P  002786 002809 002814 002826
ZZ000-OUTPUTSOURCE              002728P  002787 002810 002815 002827
ZZ000-ROUTINES                  002724S

ACS Cobol Xref v1.01.15          Dictionary File for COBXREF    15/11/15  15:08:00:82  Page   14
Procedure                        Defn    Locations
---------------------------------+-------------------------------------------------------------


ZZ030-WRITE-SORT                002738P  001475 001510 001540 001625 001691 001714 001773 001794
                                         001813 001829 001844 001930 002020 002092 002099
ZZ100-EXIT                      002868P  001274 001323 001348 001445 001521 001549 001605 002769
                                         002772 002777 002823 002839 002999
ZZ100-GET-A-SOURCE-RECORD       002760P  001274 001323 001348 001445 001521 001549 001605 002783
                                         002788 002811 002816 002850 002999
ZZ100-NEW-PROGRAM-POINT         002825P  002767
ZZ110-EXIT                      003023P  001285 001297 001363 001372 001381 001390 001429 001461
                                         001478 001492 001516 001526 001533 001597 001620 001669
                                         001685 001724 001788 001793 001807 001823 001838 001859
                                         002878 002885 002911 003001
ZZ110-GET-A-WORD                002871P  001285 001297 001363 001372 001381 001390 001429 001461
                                         001478 001492 001516 001526 001533 001597 001620 001669
                                         001685 001724 001788 001793 001807 001823 001838 001859
                                         002966 002968 003002
ZZ110-GET-A-WORD-COPY-CHECK     003003P  002974 002996
ZZ110-GET-A-WORD-LITERAL        002976P
ZZ110-GET-A-WORD-LITERAL2       002979P  002961
ZZ110-GET-A-WORD-OVERFLOW       002997P  002891 002905 002917
ZZ110-GET-A-WORD-UNSTRING       002895P  002913 002915
ZZ120-EXIT                      003073P  002803 003037 003047
ZZ120-KILL-SPACE                003049P  003041 003056 003059 003069
ZZ120-KILL-SPACE-EXIT           003070P  003041 003052
ZZ120-REPLACE-MULTI-SPACES      003026P  002803
ZZ130-EXIT                      003090P  001375 001393 001467 001497 001534 001707 001728 001870
                                         002016 003082
ZZ130-EXTRA-RESERVED-WORD-CHECK 003076P  001375 001393 001467 001497 001534 001707 001728 001870
                                         002016
ZZ140-EXIT                      003108P  002745 003103
ZZ140-FUNCTION-CHECK            003093P  002745
ZZ150-EXIT                      003221P  002141 002142 002172 002173 002221 002222 002266 002267
                                         002302 002316 002330 002351 002433 002476 002519 002576
                                         002592 002621 002644 002659 002660 002676 002677 002692
                                         002710 003159 003171 003181 003188 003194 003200 003206
                                         003213 003220
ZZ150-WRITEHDB                  003111P  001272 002141 002172 002221 002266 002301 002315 002329
                                         002349 002431 002475 002518 002575 002591 002620 002643
                                         002659 002676 002691 002709 002736
ZZ150-WRITEHDB1                 003146P
ZZ150-WRITEHDB2                 003160P  002222 002267
ZZ150-WRITEHDB2B                003172P  002660 002677
ZZ150-WRITEHDB3                 003182P  002351 002433 002476
ZZ150-WRITEHDB4                 003189P  002519 002576
ZZ150-WRITEHDB5                 003195P  002592 002621 002644
ZZ150-WRITEHDB6                 003201P  002692 002710
ZZ150-WRITEHDB7                 003207P  002302 002316 002330
ZZ150-WRITEHDB8                 003214P  002142 002173
ZZ160-CLEAN-NUMBER              003224P  001640
ZZ160-EXIT                      003231P  001640 003228
ZZ170-CHECK-4-SECTION           003234P  001552 002838 002867
ZZ170-EXIT                      003255P  001552 002838 002867 003237
ZZ180-CHECK-FOR-PARAM-ERRORS    003277P  003266 003329 003333
```

```
ZZ180-EXIT                      003411P  001216 003346 003377
ZZ180-GET-PROGRAM-ARGS          003379P  003265
ZZ180-OPEN-SOURCE-FILE          003258P  001216

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Procedure                        Defn    Locations
--------------------------------+-----------------------------------------------------------------


ZZ182-EXIT                      003408P  003275
ZZ182-GET-ENV-SET-TEMPFILES     003383P  003275
ZZ190-EXIT                      003429P  001197 001580
ZZ190-INIT-PROGRAM              003414P  001197 001580
ZZ200-EXIT                      003453P  001675 001780 001785 001798 001803 001832 003437 003445
ZZ200-LOAD-GIT                  003432P  001675 001780 001785 001798 001803 001832
ZZ310-CHECK-FOR-GLOBALS         003456P  002756
ZZ319-EXIT                      003466P  002756

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Unreferenced Working Storage Symbols


COBOL-WORD-SIZE                 000200W
ERROR-MESSAGES                  000389W
P-OC-IMPLEMENTED                000551W
RESVD-IMPLEMENTED               001143W
SHORT-SECTION-NAME              000439W
WS-WC-DD                        000384W
WS-WC-HH                        000385W
WS-WC-MIN                       000386W
WS-WC-MM                        000383W
WSF3-1-NUMERIC                  000273W

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Unreferenced Procedures


AA000-XREF-DATA                 001172S
BB010-NEW-RECORD                001850P
BB040-CHK2                      001894P
BB053-NUMERICS                  001967P
BB054-SPACES                    002002P
BC010-GROUP-REPORT              002135P
BC060-CONNECTC                  002178P
BC150-CONNECTC2                 002273P
BC200-LAST-PASS3                002339P
BC250-CONNECTC3                 002403P
BC340-CONNECTC4                 002491P
ZZ000-ROUTINES                  002724S
ZZ110-GET-A-WORD-LITERAL        002976P
ZZ150-WRITEHDB1                 003146P
```

5.26 Does GnuCOBOL implement Report Writer?

Yes, yes it does, as of November 2013, released as a branch on SourceForge.

See *REPORT* (page 369).

GnuCOBOL also supports LINAGE. See *Does GnuCOBOL implement LINAGE?* (page 772)

5.27 Does GnuCOBOL implement LINAGE?

Yes. LINAGE sets up logical pages inside file descriptors enhancing the WRITE operations and enabling the END-OF-PAGE clause.

```
FILE SECTION.
FD  A-REPORT
    LINAGE IS 13 LINES
    TOP 2
    FOOTING 2
    BOTTOM 3.
```

LINAGE clauses can set:

```
TOP
LINES
FOOTING
BOTTOM
```

The *LINAGE-COUNTER* (page 317) noun is maintained during writes to LINAGE output files.

See *LINAGE* (page 314) for a sample program.

5.28 Can I use ctags with GnuCOBOL?

Yes. Use the Exuberant version of ctags. Exuberant ctags recognizes COBOL, producing a TAGS or tags file suitable for `emacs`, `vi`, `nedit` and other editors that support the ctags format. *ctags, by default, only supports the competition, C and Fortran.*

After running `ctags program.cob`

```
$ vi -t WORKING-STORAGE
```

will open program.cob and start at the line defining the working-storage section. Note: tags are case-sensitive and for larger projects, the above vi command would start an edit of the *first* file with an occurrence of WORKING-STORAGE found in the tags.

5.28.1 Vim and ctags

Handy keys to remember with `ctags` and `vim`:

```
:tag name
    Go to tag by name
:ts
    Show the tag select list
:tn
    Next tag
:tp
    nasty halloween trick
:tf
    First tag
:tl
    Last tag
```

5.29 What about debugging GnuCOBOL programs?

New news as of May 2020 There are now options with GDB and GnuCOBOL. Original classic (requiring manual translation of COBOL names to C generated name is mentioned below. There is a GDB interface for use in VSCodium using vsix technology. And there is now a GnuCOBOL Enhanced Debugger suite, cbl-gdb, `cobcd` (which also happens to ship with a .vsix VSCode layer). See *What is the GnuCOBOL Enhanced Debugger?* (page 174) for information regarding the `cobcd` processor and GDB extensions allowing `PRINT` and `WATCH` commands from the (gdb) prompt; using COBOL identifier names, and COBOL datatypes while single stepping COBOL source lines. `(gdb) print *` is a highly satisfying experience with GnuCOBOL in GDB after `cobcd` processing.

Back to the original entry...

GnuCOBOL internal runtime checks are enabled with `-debug`.

Support for tracing is enabled with `-ftrace` and `-ftraceall`.

Source line location is enabled with `-fsource-location`, and implied with the `-g` and `-debug` options..

Activation of FIXED format `D` indicator debug lines is enabled with `-fdebugging-line`. In FREE format, `>>D` can be used anywhere on a line. See *Does GnuCOBOL support D indicator debug lines?* (page 790).

`-fstack-check` will perform stack checking when `-debug` or `-g` is used.

`-fsyntax-only` will ask the compiler to only check for syntax errors, and not emit any output.

To view the intermediate files that are generated, using **-C** will produce the .c source files and any .c.l.h and c.h header files. `-save-temps[=dir]` will leave all intermediate files in the current directory or the optional directory specified, including .i files that are the COBOL sources after COPY processing.

Support for *gdb* (page 1320) is enabled with `-g`.

```
$ gdb hello
GNU gdb 6.7.1-debian
Copyright (C) 2007 Free Software Foundation, Inc.
License GPLv3+: GNU GPL version 3 or later <http://gnu.org/licenses/gpl.html>
This is free software: you are free to change and redistribute it.
There is NO WARRANTY, to the extent permitted by law.  Type "show copying"
and "show warranty" for details.
This GDB was configured as "i486-linux-gnu"...
Using host libthread_db library "/lib/i686/cmov/libthread_db.so.1".
(gdb) break 106
Breakpoint 1 at 0xOBFUSCA: file hello.c, line 106.
(gdb) break 109
Breakpoint 2 at 0xTETHESY: file hello.c, line 109.
(gdb) run
Starting program: /home/brian/writing/cobol/hello
[Thread debugging using libthread_db enabled]
[New Thread 0xSTEMADDR (LWP 5782)]
[Switching to Thread 0xESSES6b0 (LWP 5782)]

Breakpoint 1, hello_ (entry=0) at hello.c:106
106         cob_new_display (0, 1, 1, &c_1);
(gdb) cont
Continuing.
Hello, world

Breakpoint 2, hello_ (entry=0) at hello.c:109
109       cob_set_location ("hello", "hello.cob", 6,
            "MAIN SECTION", "MAIN PARAGRAPH", "STOP");
(gdb) cont
```

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```
Continuing.

Program exited normally.
(gdb)
```

Setting a break at line 106 and 109 was found by a quick look through the C code from `$ cobc -C hello.cob` and seeing where the DISPLAY call and STOP RUN was located. *Note: just because; the gdb displayed addresses were obfuscated from this listing.*

5.29.1 Some debugging tricks

From [human] on opencobol.org:

If you want to have different outputs in debug / normal mode use a fake if 1 = 1 like

```
GCobol
      D     IF 1 = 1
      D        DISPLAY "Debug Line"  END-DISPLAY
      D     ELSE
               DISPLAY "Normal Line" END-DISPLAY
      D     END-IF
```

For using the environment Just define

```
GCobol
       01  debugmode pic x.
           88  debugmode-on values 'O', 'Y', 'J', 'o', 'y', 'j', '1'.
```

put an

```
GCobol
           accept debugmode from Environment "DEBUGMODE"
           end-accept
```

at the beginning of each program (or define debugmode as external) and use it in your programs like

```
GCobol
           IF debugmode-on
              DISPLAY "Debug Line"  END-DISPLAY
           ELSE
              DISPLAY "Normal Line" END-DISPLAY
           END-IF
```

For having no debug code in runtime you can combine these two

```
GCobol
      D 01 debugmode pic x.
      D    88 debugmode-on values 'O', 'Y', 'J', 'o', 'y', 'j', '1'.

      ...

      D    accept debugmode from Environment "DEBUGMODE"
      D    end-accept

      ...
```

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```
D    IF debugmode-on
D       DISPLAY "Debug Line"  END-DISPLAY
D    ELSE
        DISPLAY "Normal Line" END-DISPLAY
D    END-IF
```

In this way you have fast code at runtime (if not compiled with -fdebugging-line) and can switch the output during development.

The advantages over a compiler switch to disable the displays are:

- You can always use display in your program, not only for debug information.
- You see in the code what you do.
- If compiled with lines that have 'D' indicator you can switch at runtime.
- If compiled without lines that have 'D' indicator you can have faster and smaller modules.

5.29.2 Animator

Federico Priolo posted this beauty of a present on opencobol.org

TP-COBOL-DEBUGGER

http://sourceforge.net/projects/tp-cobol-debugg/ and on his company site at http://www.tp-srl.it/

A system to preprocess GnuCOBOL inserting animator source code that at runtime provides a pretty slick stepper with WORKING-STORAGE display.

This open source bundle is GnuCOBOL. Compile the animator, run it over your own programs and it generates a new source file that when compiled and evaluated, runs in a nice SCREEN SECTION showing original source and a view pane into WORKING-STORAGE.

5.29.3 Unit testing

See *What is COBOLUnit?* (page 942) for links to a well defined full on Unit testing framework for COBOL, written in GnuCOBOL.

See *What is cobol-unit-test?* (page 1039) for details of ZUTZCPC, a preprocessor and small Domain Specific Language that allows for isolated unit testing of individual paragraphs in COBOL programs.

5.30 Is there a C interface to GnuCOBOL?

Most definitely. GnuCOBOL generates C (and C++ with Sergey's branch) and can be seen as a dual COBOL and C system, or a pure COBOL system depending on application developer choice. As of January 2017, there is also a full fledged C API for getting and setting COBOL data fields.

As a short example, showing off a little of cobc's ease of use when it comes to C source code.

`hello.c`

```
#include <stdio.h>
int main(int argc, char *argv[]) {
    printf("Hello C compiled with cobc\n");
}

int hello(int argc, char *argv[]) {
    printf("Hello C compiled with cobc, run from hello.so with cobcrun\n");
}
```

With a sample run of

```
$ cobc hello.c
$ cobcrun hello
Hello C compiled with cobc, run from hello.so with cobcrun

$ cobc -x hello.c
$ ./hello
Hello C compiled with cobc

[btiffin@home cobol]$ cobc -v -x hello.c
Executing:      gcc -c -I/usr/local/include -pipe -Wno-unused -fsigned-char
                -Wno-pointer-sign -o "/tmp/cob2785_0.o" "hello.c"
Return status:  0
Executing:      gcc -Wl,--export-dynamic -o "hello" "/tmp/cob2785_0.o"
                -L/usr/local/lib -lcob -lm -lgmp -lncurses -ldb -ldl
Return status:  0
```

That pretty much treated `cobc` as a very capable C compiler.

Much of this FAQ leans to treating GnuCOBOL as a COBOL/C system, but for those that prefer, GnuCOBOL is also a tried and true COBOL system. Anyone wishing to ignore the underlying C code may do so with confidence. Focus on pure COBOL as you like, but know that integrations to the very lowest levels of your operating system are ready and available.

5.30.1 C API

Ron Norman added a feature to the ReportWriter branch that was quickly rolled into GnuCOBOL 2. There is a full fledged API for getting and setting GnuCOBOL data fields from within C modules.

General call frame parameter query functions:

```
int       cob_get_num_params  ( void );
int       cob_get_param_constant  ( int num_param );
int       cob_get_param_digits( int num_param );
int       cob_get_param_scale( int num_param );
int       cob_get_param_sign  ( int num_param );
int       cob_get_param_size  ( int num_param );
int       cob_get_param_type  ( int num_param );
void *    cob_get_param_data  ( int num_param );
cob_s64_t cob_get_s64_param   ( int num_param );
cob_u64_t cob_get_u64_param   ( int num_param );
char *    cob_get_picx_param  ( int num_param, void *charfld, int charlen );
void *    cob_get_grp_param   ( int num_param, void *charfld, int charlen );
void      cob_put_s64_param   ( int num_param, cob_s64_t value );
void      cob_put_u64_param   ( int num_param, cob_u64_t value );
void      cob_put_picx_param  ( int num_param, void *charfld );
void      cob_put_grp_param   ( int num_param, void *charfld, int charlen );
```

Typed access functions:

```
char *      cob_get_picx(void *cbldata, int len, void *charfld, int charlen);
cob_s64_t   cob_get_s64_comp3(void *cbldata, int len);
cob_s64_t   cob_get_s64_comp5(void *cbldata, int len);
cob_s64_t   cob_get_s64_compx(void *cbldata, int len);
cob_s64_t   cob_get_s64_pic9 (void *cbldata, int len);
cob_u64_t   cob_get_u64_comp3(void *cbldata, int len);
cob_u64_t   cob_get_u64_comp5(void *cbldata, int len);
cob_u64_t   cob_get_u64_comp6(void *cbldata, int len);
cob_u64_t   cob_get_u64_compx(void *cbldata, int len);
cob_u64_t   cob_get_u64_pic9 (void *cbldata, int len);
float       cob_get_comp1(void *cbldata);
double      cob_get_comp2(void *cbldata);
void        cob_put_comp1(float val, void *cbldata);
void        cob_put_comp2(double val, void *cbldata);
void        cob_put_picx( void *cbldata, int len, void *string);
void        cob_put_s64_comp3(cob_s64_t val, void *cbldata, int len);
void        cob_put_s64_pic9 (cob_s64_t val, void *cbldata, int  len);
void        cob_put_s64_comp5(cob_s64_t val, void *cbldata, int len);
void        cob_put_u64_comp3(cob_u64_t val, void *cbldata, int len);
void        cob_put_u64_comp5(cob_u64_t val, void *cbldata, int len);
void        cob_put_u64_comp6(cob_u64_t val, void *cbldata, int len);
void        cob_put_u64_compx(cob_u64_t val, void *cbldata, int len);
void        cob_put_u64_pic9 (cob_u64_t val, void *cbldata, int len);
void        cob_put_pointer(void *val, void *cbldata);
```

Along with some subtype macros

```
#define cobget_x1_compx(d)      (cobuns8_t)  cob_get_u64_compx(d, 1)
#define cobget_x2_compx(d)      (cobuns16_t) cob_get_u64_compx(d, 2)
#define cobget_x4_compx(d)      (cobuns32_t) cob_get_u64_compx(d, 4)
#define cobget_x8_compx(d)      (cobuns64_t) cob_get_u64_compx(d, 8)
#define cobget_sx1_compx(d)     (cobs8_t)    cob_get_s64_compx(d, 1)
#define cobget_sx2_compx(d)     (cobs16_t)   cob_get_s64_compx(d, 2)
#define cobget_sx4_compx(d)     (cobs32_t)   cob_get_s64_compx(d, 4)
#define cobget_sx8_compx(d)     (cobs64_t)   cob_get_s64_compx(d, 8)
#define cobget_x1_comp5(d)      (cobuns8_t)  cob_get_u64_comp5(d, 1)
#define cobget_x2_comp5(d)      (cobuns16_t) cob_get_u64_comp5(d, 2)
#define cobget_x4_comp5(d)      (cobuns32_t) cob_get_u64_comp5(d, 4)
#define cobget_x8_comp5(d)      (cobuns64_t) cob_get_u64_comp5(d, 8)
#define cobget_sx1_comp5(d)     (cobs8_t)    cob_get_s64_comp5(d, 1)
#define cobget_sx2_comp5(d)     (cobs16_t)   cob_get_s64_comp5(d, 2)
#define cobget_sx4_comp5(d)     (cobs32_t)   cob_get_s64_comp5(d, 4)
#define cobget_sx8_comp5(d)     (cobs64_t)   cob_get_s64_comp5(d, 8)
#define cobget_xn_comp5(d,n)    (cobuns64_t) cob_get_u64_comp5(d, n)
#define cobget_xn_compx(d,n)    (cobuns64_t) cob_get_u64_compx(d, n)
#define cobget_sxn_comp5(d,n)   (cobs64_t)   cob_get_s64_comp5(d, n)
#define cobget_sxn_compx(d,n)   (cobs64_t)   cob_get_s64_compx(d, n)

#define cobput_x1_compx(d,v)    (void)       cob_put_u64_compx((cob_u64_t)v,d,1)
#define cobput_x2_compx(d,v)    (void)       cob_put_u64_compx((cob_u64_t)v,d,2)
#define cobput_x4_compx(d,v)    (void)       cob_put_u64_compx((cob_u64_t)v,d,4)
#define cobput_x8_compx(d,v)    (void)       cob_put_u64_compx((cob_u64_t)v,d,8)
#define cobput_x1_comp5(d,v)    (void)       cob_put_u64_comp5((cob_u64_t)v,d,1)
#define cobput_x2_comp5(d,v)    (void)       cob_put_u64_comp5((cob_u64_t)v,d,2)
#define cobput_x4_comp5(d,v)    (void)       cob_put_u64_comp5((cob_u64_t)v,d,4)
#define cobput_x8_comp5(d,v)    (void)       cob_put_u64_comp5((cob_u64_t)v,d,8)
```

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```
#define cobput_sx1_comp5(d,v)    (void)       cob_put_s64_comp5((cob_s64_t)v,d,1)
#define cobput_sx2_comp5(d,v)    (void)       cob_put_s64_comp5((cob_s64_t)v,d,2)
#define cobput_sx4_comp5(d,v)    (void)       cob_put_s64_comp5((cob_s64_t)v,d,4)
#define cobput_sx8_comp5(d,v)    (void)       cob_put_s64_comp5((cob_s64_t)v,d,8)
#define cobput_xn_comp5(d,n,v)   (void)       cob_put_u64_comp5(v, d, n)
#define cobput_xn_compx(d,n,v)   (void)       cob_put_u64_compx(v, d, n)
#define cobput_sxn_comp5(d,n,v)  (void)       cob_put_s64_comp5(v, d, n)
#define cobput_sxn_compx(d,n,v)  (void)       cob_put_s64_compx(v, d, n)
```

This is on top of all of the other low level access functions that have been in GnuCOBOL since the very beginning:

```
#define    cobtidy()    cob_tidy ()
#define    cobinit()    cob_extern_init ()
#define    cobexit(x)   cob_stop_run (x)
```

Where cobinit() ensures the libcob runtime engine is properly initialized, cobtidy() allows for engine run down *without halting a C program* and cobexit(n) allows for the equivalent of a `STOP RUN RETURNING n`.

And other handy functions (this is not an exhaustive list of the available public functions):

```
#define    cobgetenv(x)    cob_getenv (x)
#define    cobputenv(x)    cob_putenv (x)
#define    cobclear()      (void) cob_sys_clear_screen ()
#define    cobmove(y,x)    cob_set_cursor_pos (y, x)
#define    cobcols()       cob_get_scr_cols ()
#define    coblines()      cob_get_scr_lines ()
#define    cobaddstrc(x)   cob_display_text (x) /* no limit */
#define    cobprintf       cob_display_formatted_text  /* limit of 2047 */
#define    cobgetch()      cob_get_char ()
```

These all become accessible to any C module that includes the main GnuCOBOL header file:

```
#include <libcob.h>
```

See `libcob/common.h` for many more details.

5.30.2 TCC

GnuCOBOL can even embed a C compiler, for C code on the fly. The Tiny C Compiler, TCC works very well with GnuCOBOL. http://bellard.org/tcc/

Applications can link to `libtcc1.a` and use the API that allows for in memory compilation, or as is done here, build the entire compiler into an application from source.

Tested with TCC 0.9.26 from http://download.savannah.gnu.org/releases/tinycc/

This Makefile:

```
# call tcc and libtcc1 run-time compile from GnuCOBOL
# public domain example by Brian Tiffin, Feb 2016
.RECIPEPREFIX = >

calltcc: calltcc.cob add.cob
> export COB_CFLAGS='-DTCC_TARGET_X86_64'; \
 cobc -x -g -debug calltcc.cob add.cob \
 tcc.c libtcc.c tccpp.c tccgen.c tccelf.c tccasm.c tccrun.c x86_64-gen.c i386-asm.c
```

Along with some controlling COBOL and a subprogram for testing

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ************************************************************
      *>****J* gnucobol/calltcc
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20160124  Modified: 2016-03-27/04:48-0400
      *> LICENSE
      *>   Copyright 2016 Brian Tiffin
      *>   GNU General Public License, GPL, 3.0 (or greater)
      *> PURPOSE
      *>   use tcc to compile some code and call it at run-time
      *> TECTONICS
      *> export COB_CFLAGS='-DTCC_TARGET_X86_64'
      *> cobc -x -g -debug calltcc.cob add.cob \
      *>      tcc.c libtcc.c tccpp.c tccgen.c tccelf.c tccasm.c \
      *>      tccrun.c x86_64-gen.c i386-asm.c
      *> ************************************************************
       identification division.
       program-id. calltcc.
       author. Brian Tiffin.
       date-written. 2016-01-15/01:45-0500.
       date-modified. 2016-03-27/04:48-0400.
       date-compiled.
       installation. Requires source tree for tcc-0.9.26.
       remarks. Just for fun.
       security. Run-time compiled code.

       environment division.
       configuration section.
       source-computer. gnulinux.
       object-computer. gnulinux
           classification is canadian.

       special-names.
           locale canadian is "en_CA.UTF-8".

       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 c-code.
          05 value
"int fib(int n)" & x"0a" &
"{" & x"0a" &
"    if (n <= 2)" & x"0a" &
"        return 1;" & x"0a" &
"    else" & x"0a" &
"        return fib(n-1) + fib(n-2);" & x"0a" &
"}" & x"0a" & x"0a" &

"int foo(int n)" & x"0a" &
"{" & x"0a" &
'    printf("Hello, tcc\n");' & x"0a" &
```

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```
'    printf("fib(%d) = %d\n", n, fib(n));' & x"0a" &
'    printf("add(%d, %d) = %d\n", n, 2 * n, add(n, 2 * n));' & x"0a" &
"    return 0;" & x"0a" &
z"}".

       01 tcc-state  usage pointer.
       01 tcc-result usage binary-long.

       01 TCC-OUTPUT-MEMORY usage binary-long value 0.
       01 TCC-RELOCATE-AUTO usage binary-long value 1.

       01 cob-entry  usage program-pointer.
       01 c-function usage program-pointer.

      *> ****************************************************************
       procedure division.
       call "tcc_new" returning tcc-state
           on exception
               display "no tcc_new" upon syserr
               perform hard-exception
       end-call

       call "tcc_set_lib_path" using
           by value tcc-state
           by reference z"."
           on exception
               display "no tcc_set_lib_path" upon syserr
               perform hard-exception
       end-call

       call "tcc_set_output_type" using
           by value tcc-state
           by value TCC-OUTPUT-MEMORY
           on exception
               display "no tcc_set_output_type" upon syserr
               perform hard-exception
       end-call

       call "tcc_compile_string" using
           by value tcc-state
           by reference c-code
           returning tcc-result
           on exception
               display "no tcc_compile_string" upon syserr
               perform hard-exception
       end-call
       if tcc-result not equal zero then
           display "tcc_compile_string failed: " tcc-result upon syserr
           display "Source: " upon syserr
           display c-code(1:length(c-code) - 1) upon syserr
           perform hard-exception
       end-if

      *> add.cob is an extra file in the compilation
       set cob-entry to entry "add"
       if cob-entry equal null then
           display '"add" lookup failure' upon syserr
```

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```
           perform hard-exception
       end-if
       call "tcc_add_symbol" using
           by value tcc-state
           by reference z"add"
           by value cob-entry
           on exception
               display "no tcc_add_symbol" upon syserr
               perform hard-exception
       end-call

       call "tcc_relocate" using
           by value tcc-state
           by value TCC-RELOCATE-AUTO
           returning tcc-result
           on exception
               display "no tcc_relocate" upon syserr
               perform hard-exception
       end-call
       if tcc-result less than zero then
           display "code relocation failure: " tcc-result
           perform hard-exception
       end-if

      *> entry point in c-code is foo(n)
       call "tcc_get_symbol" using
           by value tcc-state
           by reference z"foo"
           returning c-function
           on exception
               display "no tcc_get_symbol" upon syserr
               perform hard-exception
       end-call
       if c-function equal null then
           display '"foo" symbol lookup failure' upon syserr
           perform hard-exception
       end-if

      *> call foo(32)
       call c-function using
           by value 32
       end-call
       display "foo return: " return-code

       call "tcc_delete" using by value tcc-state end-call

       goback.
      *> ****************************************************************

       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
```

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```
          display "Module-path:         " module-path upon syserr
          display "Module-source:       " module-source upon syserr
          display "Exception-file:      " exception-file upon syserr
          display "Exception-status:    " exception-status upon syserr
          display "Exception-location:  " exception-location upon syserr
          display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:

       end program calltcc.
      *> ****************************************************************
      *>****
>>ELSE
!doc-marker!
=======
calltcc
=======

.. contents::

Introduction
------------

Call the Tiny C Compiler, to compile some C code at run-time.

Tectonics
---------

::

    prompt$ make

Usage
-----

::

    prompt$ ./calltcc

Source
------

.. include::  calltcc.cob
   :code: cobolfree

.. include:: add.cob
   :code: cobolfree

.. include:: Makefile
   :code: make
```

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```
>>END-IF
```

calltcc.cob and a small add.cob routine

```
identification division.
program-id. add.
data division.
linkage section.
01 a-num usage binary-long.
01 b-num usage binary-long.
procedure division using
    by value a-num
    by value b-num.
compute return-code = a-num + b-num
goback.
```

And then:

```
prompt$ make
export COB_CFLAGS='-DTCC_TARGET_X86_64'; \
 cobc -x -g -debug calltcc.cob add.cob \
 tcc.c libtcc.c tccpp.c tccgen.c tccelf.c tccasm.c tccrun.c x86_64-gen.c
i386-asm.c

prompt$ ./calltcc
Hello, tcc
fib(32) = 2178309
add(32, 64) = 96
foo return: +000000000
```

On demand, on the fly, C compiles. And the C can call back into GnuCOBOL subprogams. By the way; `calltcc` can actually be used as a full blown C compiler as well. The entire TCC stack is included in the executable, which weighs in at just under half a meg of binary. All you'd need to do is pass command arguments to the built in tcc command line parser.

Although calltcc uses fixed C sources, they are still only character string variables, and the code could easily come from user input or other sources.

```
-rwxrwxr-x  1 btiffin btiffin  457216 Mar 27 05:03 calltcc
```

On a 64bit GNU/Linux system running Xubuntu 15.10. TCC supports a few chipsets, but is mainly an X86 compiler.

.. index:: C; idioms

5.31 What are some idioms for dealing with C char * data from GnuCOBOL?

Thanks to Frank Swarbrick for pointing these idioms out

To add or remove a null terminator, use the STRING verb. For example

```
GCobol
      * Add a null for calling C
       STRING current-url
```

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```
           DELIMITED BY SPACE
           X"00" DELIMITED BY SIZE
           INTO display-url
       MOVE display-url TO current-url

      * Remove a null for display
       STRING current-url
           DELIMITED BY LOW-VALUE
           INTO display-url.
```

Or to make changes in place

```
GCobol
      * Change nulls to spaces
       INSPECT current-url
           REPLACING ALL X"00" WITH SPACE.
```

There is also reference modification in GnuCOBOL

```
GCobol
      * Assume IND is the first trailing space (or picture limit).
      * Note: GnuCOBOL auto initializes working-storage to SPACES or ZEROES
      *       depending on numeric or non-numeric pictures.
      * Remove null
       MOVE SPACE TO current-url(IND:1).

      * Add a zero terminator
       MOVE X"00" TO current-url(IND:1).
```

And the GnuCOBOL CONCATENATE intrinsic

```
GCobol
       MOVE FUNCTION CONCATENATE(filename; X"00") TO c-field.
```

[Roger] While points out: *X"00" is almost always interchangeable with LOW-VALUE.*

In all of the above snippets, the source code X"00" can be replaced by the COBOL noun `LOW-VALUE` or *LOW-VALUES. Except when a program collating sequence is active and where the first character is not X"00".*

With the CALL verb, use ADDRESS OF and/or BY REFERENCE

```
CALL "CFUNCTION" USING BY REFERENCE ADDRESS OF current-url.
```

The above being equivalent to `char**` in C.

COBOL, by its default nature, passes all arguments by reference. That can be overridden with the `BY VALUE` clause and the `BY CONTENT` clause.

`BY VALUE` passes the contents of the identifier, not the identifier reference. `BY CONTENT` creates a copy of the data in the identifier and passes a reference address of this transient copy.

GnuCOBOL 3.0 supports a *FUNCTION CONTENT-OF* (page 448) intrinsic function extension. This creates a COBOL character data field from the contents of memory addressed by a `POINTER`. If an optional length is given, then the new field is the data pointed at for the given length. If no length is passed to the function (or length less than 1) then the C style of scanning from the address pointed to, up to the first NUL zero byte terminator. A (transient) copy of the memory region is returned by the intrinsic as a COBOL *ALPHANUMERIC* (page 198) data item.

5.32 Does GnuCOBOL support COPY includes?

Yes. COPY is fully supported, all variations from the standards up to and including the proposed 2014 standards.

Inline REPLACE text substitutions are also supported.

The `-I` compiler option influences the copybook search path and `-E` can be used to examine the *after* COPY preprocessor output.

There is also `-ffold-copy-upper` and `-ffold-copy-lower` compiler controls.

5.33 Does GnuCOBOL support WHEN-COMPILED?

Yes, both as a special register, and as an intrinsic function.

```
DISPLAY WHEN-COMPILED.
DISPLAY FUNCTION WHEN-COMPILED.

07/05/0805.15.20
2008070505152000-0400
```

Note: The WHEN-COMPILED special register is non-standard and was deemed obsolete as far back as 1984.

See *WHEN-COMPILED* (page 431) for more details, and use *FUNCTION WHEN-COMPILED* (page 499) explicitly in any new programs.

5.34 What is PI in GnuCOBOL?

With GnuCOBOL 1.1

```
DISPLAY FUNCTION PI.
3.14159265358979323846264338327950 29

DISPLAY FUNCTION E.
2.71828182845904523536028747135266 25
```

Thats 34 digits after the decimal. Developers that need to know the tolerances for use in calculations are directed to poke around the freely available source code, and to read up on *GMP* (page 1320).

5.35 Does GnuCOBOL support the Object features of the 2002 standard?

Not yet. *July 2008*

5.36 Does GnuCOBOL implement level 78?

Yes. Data division 78 level clauses can be used for constants, translated at compile time. This common non-standard extension is supported in GnuCOBOL.

5.37 Does GnuCOBOL implement CONSTANT?

Current OC 1.1 has preliminary support for a subset of the standard conforming "CONSTANT" phrase. For example:

```
 01 myconst CONSTANT AS 1.

*> Note that CONSTANT identifiers cannot be passed to
*>   functions, or in CALL BY REFERENCE, as that exposes the
*>   constant to modification, and is disallowed.
```

Note: there is a syntax difference between level 78 and CONSTANT. Level 78s are an extension, `CONSTANT` is in the COBOL 2014 specification and is only allowed for 01 level items.

5.38 What source formats are accepted by GnuCOBOL?

Both FIXED and FREE source formats are supported. FIXED format follows the traditional 1-6, 7, 8-72 special columns of the COBOL standards.

1-6 is a free space, ignore by the compiler. Historically this was used as the line indicator for when decks of punch cards were dropped on the floor and had to be manually resorted, and as a protection from fraying around the edges of thin cardboard punch cards so the code was indented a little.

7 is an indicator column. Can hold, `* - / and D` special symbols.

8-72 is read by the compiler as COBOL source.

73 and beyond, (usually 80 columns max back when card punch input was used) is reserved as a sequence number. IBM mainframe editors will commonly place a sequential number in this field, historically used as a validation measure by the read hardware to ensure cards (source lines) were properly read in the right order, and none of the cards happened to get stuck together. And it was also anothe margin of indentation that helped alleviate the problems of frayed cardboard edges.

See https://en.wikipedia.org/wiki/Punched_card_input/output

and https://en.wikipedia.org/wiki/Punched_cards for some of the details surrounding the early history of `FIXED` form COBOL.

Dating back to very early computers, ala 1940 and 1950, right up until the early 1980's when modern consoles and cathrode ray tubes became all the rage. Now we enjoy wide full colour flat screens, but COBOL was designed and developed many years before that future became our very pleasant computing present.

A "line" of source code, used to be read into the computer encoded on a thin cardboard punch card.

Image in the Public Domain, courtesy of Wikimedia Commons, dedicated by user Arnold Reinhold.

Hence 80 columns. The history of these card forms touch on some of the reasons for the still standard 8 1/2 inch width of most sheets of paper in North America, and just happened to match the size of printed paper money of the era, as the boxes that held the cards of that time could be shared between various government departments.

The compiler directives:

```
>>SOURCE FORMAT IS FREE
>>SOURCE FORMAT IS FIXED
```

can be used at anytime to change to lexical scanning rules. The directive must occur at column 8 or beyond if the *ACTIVE* scan format is `FIXED`. As per the 2002 standard the *SOURCE* (page 409) directive can be used to switch formats multiple times within a compilation unit.

Please note, that `cobc` defaults to `FIXED` format processing, unless given the `-free` command line switch. That means that for any initial change to `FREE` format, the directive needs to start in column 8 or greater or it will not be recognized.

```
Column
12345678901234567890

       >>SOURCE FORMAT IS FREE
identification division.
...
```

After the initial directive (or `-free` switch), you are free to code COBOL starting at column 1.

Continuation indicators in column 7 are not applicable to `FREE` format and are not supported in this mode of translation. String catenation can always be used (the `&` operator) to continue long strings across line boundaries.

The special **>* *(till end of line comment)* is supported in both `FREE` and `FIXED` forms, but by necessity will need to be placed at column 7 or greater in `FIXED` format sources.

The `-free` and `-fixed` options to `cobc` also influence the expected source formats, with the default being mandated by the standards as FIXED.

5.38.1 commas

Commas undergo special handling by COBOL. For the most part, they are ignored, and never actually passed to the compiler after the text manipulation phase of the toolchain. This is complicated by the

```
DECIMAL POINT IS COMMA
```

mode allowed in the SPECIAL-NAMES paragraph as part of the COBOL standard. Then, commas *are* passed to the compiler, but only when forming numeric literals.

Ignoring `DECIMAL POINT IS COMMA` for a moment.

```
MOVE FUNCTION MAX(1, 2, 3, 4, 5) TO maximal
```

That source is passed to the compiler proper (after the preprocessing text manipulation phase) as

```
MOVE FUNCTION MAX(1 2 3 4 5) TO maximal
```

So is this source line:

```
MOVE FUNCTION MAX(1,,,,,2,,,,,,,3,,,4,5) TO maximal
```

All commas are stripped out, and the compiler only sees the 5 numbers.

When `DECIMAL POINT IS COMMA` is active, the line above becomes a syntax error as GnuCOBOL tries to figure out if the first number is actually 1,2 (being 1.2) in that mode.

5.39 Does GnuCOBOL support continuation lines?

Yes. A dash - in column 7 can be used for continuation lines. But, by necessity continuation lines only apply in `FIXED` format source code. `FREE` format COBOL does not support continuation as there is no real meaning to the *indicator column 7* in `FREE` form source.

GnuCOBOL normally stops reading FIXED format source code at column 72, and starts at column 8. The Text Manipulation phase reads column 7, strips out anything in column 1-6 and truncates the source line at column 72. *Ignoring that GnuCOBOL supports a configuration option*

```
cobc --cb_conf=text-column:72
```

which can be used to extend the right margin, but that setting is outside normal `FIXED` format COBOL processing, and ignored by `FREE` format processing.

Under normal circumstances, `FIXED` format sources are segmented as 1-6, 7, with 8-72 being the actual code.

Note that in this example there is no terminating quote on the string continuations, but there is an extra starting quote following each column 7 hyphen. *Also note that the first line of numbers below, is not COBOL, but shown as a visible column counter.*

```
123456789012345678901234567890123456789012345678901234567890123456789012
       identification division.
       program-id. longcont.

       data division.
       working-storage section.
       01  longstr     pic X(80)
                       value "This will all be one string in FIXED forma
```

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```
      -"t source code".
       01  otherstr    pic X(148) value "this
      -"string will have spaces between the words THIS and STRING, as
      -"continuation lines always fill to column 72.".
       procedure division.
       display longstr.
       display length longstr.
       display function length(function trim(longstr trailing)).
       display otherstr(1:72).
       display otherstr(73:75).
       display length otherstr.
       display function length(function trim(otherstr trailing)).
       goback.
```

Compiled with:

```
$ cobc longcont.cob
$ cobcrun longcont
```

produces:

```
This will all be one string in FIXED format source code
80
00000055
this                          string will have spaces between the words
THIS and STRING, as   continuation lines always fill to column 72.
148
00000139
```

Note: The DISPLAY of **otherstr** *was split to avoid any wide browser scrolling, not for any COBOL reasons.*

Also note that the rules for continuation lines are quite difficult to describe simply and concerned GnuCOBOL programmers are urged to read through the standards documents for full details. It all makes sense, once it makes sense.

5.40 Does GnuCOBOL support string concatenation?

Absolutely. Sources that need long strings, or those wishing to enhance source code readability, can use the `&` operator

```
identification division.
program-id. longstr.

data division.
working-storage section.
01  longstr     pic X(80)
                value "This " & "will " & "all " & "be " &
                      "one " &
                      "string " & "in both FIXED and FREE" &
                      " format source code".
procedure division.
display longstr.
goback.
```

Run this with

```
$ cobc longstr.cob
$ cobcrun longstr
This will all be one string in both FIXED and FREE format source code
$ cobc -free longstr.cob
$ cobcrun longstr
This will all be one string in both FIXED and FREE format source code
```

And for an Intrinsic FUNCTION unique to GnuCOBOL, see *FUNCTION CONCATENATE* (page 447).

5.41 Does GnuCOBOL support D indicator debug lines?

Yes, in two forms. As for continuation lines, column 7 has no meaning for SOURCE FORMAT IS FREE source code so the standard `D` in column 7 can not be used. FORMAT FREE source code can use the `>>D` compiler directive instead. Use `D` lines as a conditional include of a source code line. These debug lines will only be compiled if the *-fdebugging-line* compiler switch is used.

From human on opencobol.org

```
If you put a D in column 7 OC handles this as a comment. These lines are
only compiled if you run cobc with -fdebugging-line.

By using this you can put some test messages etc. into your program that
are only used if necessary (and therefore build with -fdebugging-line).
```

GnuCOBOL also supports a `>>D` debug compile time directive and a handy trick for those that like to write code that be compiled in both FIXED and FREE forms, is to place the directive in column 5, 6 and 7.

```
Column
12345678901234567890
       DISPLAY "Normal Line" END-DISPLAY
    >>DDISPLAY "Debug Line" END-DISPLAY
```

This allows use of the directive form in FORMAT FREE and also, with the **D** in column 7, will compile properly in FORMAT FIXED. In FORMAT FIXED the **>>** in columns 5 and 6 will be ignored as part of the *sequence number* field.

For more information on debugging support see *What about debugging GnuCOBOL programs?* (page 773)

5.42 Does GnuCOBOL support mixed case source code?

Absolutely, kind of. Mixed case and mixed format, *ASCII* (page 207) and *EBCDIC* (page 251). Most COBOL compilers have not required uppercase only source code for quite a few years now. Still, most COBOL compilers including GnuCOBOL folds parts of the source to uppercase *with certain rules* before translating.

The compiler is case insensitive to user names, *but not all system link names depending on operating system rules*.

```
000100 identification division.
000200 program-id. mixcase.
000300 data division.
000400 working-storage section.
000500 01 SOMEUPPER pic x(9).
000600 01 SomeUpper pic x(9).
000700 01 someupper pic x(9).
```

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```
000800
000900 procedure division.
001000 move "SOMEUPPER" to SOMEUPPER.
001100 move "SomeUpper" to SomeUpper.
001200 move "someupper" to someupper.
001300 display "SOMEUPPER: " SOMEUPPER end-display.
001400 display "SomeUpper: " SomeUpper end-display.
001500 display "someupper: " someupper end-display.
001600 stop run.
```

Attempted compile with:

```
$ cobc -x mixcase.cob
```

produces:

```
mixcase.cob:10: Error: 'SOMEUPPER' ambiguous; need qualification
mixcase.cob:5: Error: 'SOMEUPPER' defined here
mixcase.cob:6: Error: 'SOMEUPPER' defined here
mixcase.cob:7: Error: 'SOMEUPPER' defined here
```

Note; that although the folded declarations conflict, the DISPLAY quoted strings will NOT be folded, and would display as expected.

Case sensitivity is also at the mercy of operating system conventions. Under GNU/Linux, GnuCOBOL's dynamic link loader is case sensitive.

```
CALL "C$JUSTIFY" USING center-string "C" END-CALL.
```

is not the same as

```
CALL "c$justify" USING center-string "C" END-CALL.
```

In support of case folding and COPY libraries, GnuCOBOL supports *-ffold-copy-lower* and *-ffold-copy-upper*. For mixing and matching legacy sources.

Trivia:

```
The expressions "uppercase" and "lowercase" date back to early movable
type.  Typographers would keep two cases of metal casted letters,
Capitalized and normal.  Usually set on stacked shelves over the
workbench. The small letters, being used more frequently, ended up on the
lower, more easily reachable shelf; the lower case letters.
```

5.43 What is the shortest GnuCOBOL program?

All that is needed is a program-id. Doesn't do much.

```
program-id. a.
```

Update: It turns out that an empty file is the shortest GnuCOBOL that will do nothing. From *Roger* (page **??**)

```
$ ls -l empty.cob
-rw-r--r-- 1 root root 0 Jun 21 12:35 empty.cob
```

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```
$ cobc -x -frelax-syntax empty.cob
empty.cob: 1: Warning: PROGRAM-ID header missing - assumed

$ ./empty
$
```

(Alternate to -frelax-syntax is -std=mf)

5.44 What is the shortest Hello World program in GnuCOBOL?

A short version of GnuCOBOL hello world, compiled -free

```
program-id.hello.procedure division.display "Hello, world".
```

Thanks to human and the opencobol.org forums.

Please note: This is **not good** COBOL form, and is only shown as an example of the possibilities.

Update: From *Roger* (page **??**) the shortest hello world program can be

```
$ cat hello.cob
display"Hello, world".

$ cobc -x -frelax-syntax -free hello.cob
hello.cob: 1: Warning: PROGRAM-ID header missing - assumed
hello.cob: 1: Warning: PROCEDURE DIVISION header missing - assumed

$ ./hello
Hello, world
$
```

So, that means, `display"Hello, world".` is all you need, if you compile with *relax-syntax*.

5.45 How do I get those nifty sequential sequence numbers in a source file?

FIXED format COBOL uses the first 6 positions of each line as a programmer defined **sequence** field. This field is stripped as part of the preprocessing and is not validated. Historically, the sequence numbers were used to verify that card punch cards were read into a card reader in the proper order. Many legacy COBOL programs have sequentially numbered sequence values. Here is a little `vi` trick to renumber the sequence field by 100s.

Given

```
000005* HELLO.COB GnuCOBOL FAQ example
000010 IDENTIFICATION DIVISION.
000020 PROGRAM-ID. hello.
000030 PROCEDURE DIVISION.
000040 DISPLAY "Hello, world".
000100 STOP RUN.
```

Running the following `ex` filter, in Vim, after a `:` `command mode` keystroke:

```
%!perl -ne 'printf("\%06d\%s\n", $. * 100, substr($_, 6, -1));'
```

produces a nicely resequenced source file.

```
000100* HELLO.COB GnuCOBOL FAQ example
000200 IDENTIFICATION DIVISION.
000300 PROGRAM-ID. hello.
000400 PROCEDURE DIVISION.
000500 DISPLAY "Hello, world".
000600 STOP RUN.
```

- Note: Only use this on already FIXED form source. If used on any FREE format COBOL, the first 6 columns will be damaged and require an undo.

This has no effect on the compilation process, it only effects the appearance of the sources.

Note: Be careful not to confuse SEQUENCE NUMBERS with source code LINE NUMBERS. They are not the same.

- Vim: For users of the Vim editor, the command

```
:set number
```

will display the number of each source line. Many editors support the display of line numbers. Even

```
$ less -N
```

can be used to display line numbers of its input.

5.46 Is there a way to count trailing spaces in data fields using GnuCOBOL?

Yes. Quite a few. But instead of resorting to a PERFORM VARYING sequence try

```
01  B-COUNT                         PIC 999 VALUE 0.
01  TEST-CASE                       PIC X(80)
    VALUE "This is my string.".

ONE-WAY.
    INSPECT FUNCTION REVERSE(TEST-CASE)
        TALLYING B-COUNT
        FOR LEADING ' '.
    DISPLAY B-COUNT.

TWO-WAY.
    INSPECT TEST-CASE
        TALLYING B-COUNT
        FOR TRAILING SPACE.
    DISPLAY B-COUNT.

THREE-WAY.
    IF TEST-CASE EQUAL SPACES
        COMPUTE B-COUNT = LENGTH OF TEST-CASE
```

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```
    ELSE
        COMPUTE
            B-COUNT = LENGTH TEST-CASE -
                FUNCTION LENGTH(FUNCTION TRIM(TEST-CASE TRAILING))
        END-COMPUTE
    END-IF
    DISPLAY B-COUNT.
```

produces:

```
062
124
062
```

The second value is 124 as TWO-WAY accumulates another 62 after ONE-WAY. The INSPECT verb does not initialize a TALLYING variable.

Information modified from opencobol.org forum post.

5.47 Is there a way to left justify an edited numeric field?

Yes, a couple of ways.

Assuming a working storage of

```
01 mynumber PIC 9(8)    VALUE 123.
01 myedit   PIC Z(7)9.
01 mychars  PIC X(8).

01 spcount  PIC 99      USAGE COMPUTATIONAL.

MOVE mynumber TO myedit
MOVE myedit TO mychars
DISPLAY mynumber END-DISPLAY
DISPLAY myedit END-DISPLAY

00000123
     123
```

With GnuCOBOL, the intrinsic

```
FUNCTION TRIM(myedit LEADING)
```

will trim leading whitespace. The LEADING is not really necessary as TRIM removes both leading and trailing whitespace.

GnuCOBOL also ships with a library function for justification of strings

```
CALL "C$JUSTIFY" USING mychars "L" END-CALL
```

to left justify an alphanumeric field. “R” for right, or “C” for centre.

But a generic idiom that should work across all capable COBOL systems

```
MOVE 0 TO spcount
INSPECT myedit TALLYING spcount FOR LEADING SPACE
MOVE myedit(spcount + 1:) TO mychars

DISPLAY myedit END-DISPLAY
DISPLAY mychars END-DISPLAY
```

```
     123
123
```

```
MOVE 0 TO spcount
INSPECT mynumber TALLYING spcount FOR LEADING ZERO
DISPLAY mynumber
DISPLAY mynumber(spcount + 1:)
```

Uses the INSPECT verb to count leading spaces, then reference modification to move the characters one past the spaces till the end of the edit field to an alpha field.

With intelligent use of picture clauses, and redefines, the alignment may be a simple move. Courtesy of Bill Woodger.

```
IDENTIFICATION DIVISION.
PROGRAM-ID. EXAMPLE.
DATA DIVISION.
WORKING-STORAGE SECTION.
01 Y PIC X(15).
01 T REDEFINES Y PIC -(5)9(7).99.
01 U REDEFINES Y PIC -9(7).99B(4).
01 X PIC S9(7)V9(2).
PROCEDURE DIVISION.
MOVE -1234567.89 TO X
MOVE X TO T
DISPLAY 'X: >' X '< Y: >' Y '<'
MOVE X TO U
DISPLAY 'X: >' X '< Y: >' Y '<'
GOBACK .
```

T gives right-alignment, U gives left-alignment. As both REDEFINES occupy the full 15 bytes, there is no need to take account of any value in Y prior to the MOVEs to T or U.

Output is:

```
prompt$ cobc -xj aligning.cob
X: >12345678< Y: > -1234567.89<
X: >12345678< Y: >-1234567.89 <
```

5.48 Is there a way to detemermine when GnuCOBOL is running ASCII or EBCDIC?

GnuCOBOL supports both ASCII and EBCDIC character encodings. A simple test such as

```
01  MYSPACE   PIC X VALUE X"20".
    88 MYISASCII   VALUE SPACE.

IF MYISASCII
```

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```
    DISPLAY "I'm ASCII" END-DISPLAY
END-IF
```

can be used to determine the character set at run-time.

5.49 Is there a way to determine when GnuCOBOL is running on 32 or 64 bits?

GnuCOBOL builds and supports both 32 and 64 bit architectures. A simple test such as

```
01  MYPOINTER    USAGE POINTER.

IF FUNCTION LENGTH(MYPOINTER) EQUALS 8
    DISPLAY "This is a 64 bit machine"
END-IF
```

can be used to determine the native bit size at run-time.

GnuCOBOL 2.0, with the addition of the COBOL 2014 Compiler Directives and an extension, comes preloaded with some compile time settings that can be tested. `P64` is one of them.

```
>>IF P64 IS SET
display "Pointers are 64 bit"
>>ELSE
display "Pointers are 32 bits wide"
>>END-IF
```

This can come in handy when dealing with `size_t` data from C and numerics.

```
>>IF P64 IS SET
01 size-mod CONSTANT AS 18.
>>ELSE
01 size-mod CONSTANT AS 8.
>>END-IF

01 c-size-t   PIC 9(size-mod) COMP-5.
```

When passed in CALL, BY VALUE, c-size-t will have a right size on the stack frame, 4 or 8 bytes, and will have the right allocations when passed BY REFERENCE.

5.50 Does GnuCOBOL support recursion?

See *Does GnuCOBOL support recursion?* (page 796) (Just kidding, *"to understand recursion, one must first understand recursion"*).

Yes. Not completely to standard currently *(March 2018)*, as there are no restrictions on calling programs in a recursive manner, but yes.

Edward Hart has been updating this feature, and it will at some point be more in line with the COBOL 2014 specification.

A made up example using a factorial called program

```
GCobol*> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      29-Dec-2008
      *> Purpose:   Horsing around with recursion
      *> Tectonics: cobc -x recurse.cob
      *> ************************************************************
       identification division.
       program-id. recurse.

       data division.
       working-storage section.
       78 n      value 4.
       01 fact usage binary-long.

      *> ************************************************************
       procedure division.

       call "factorial" using by value n returning fact end-call
       display n "! = " fact end-display

       goback.
       end program recurse.
      *> ************************************************************
      *> ************************************************************

      *> ************************************************************
       identification division.
       program-id. factorial is recursive.

       data division.
       local-storage section.
       01 result usage is binary-long.

       linkage section.
       01 num usage is binary-long.

      *> ************************************************************
       procedure division using by value num.

       display "num: " num end-display
       if num equal zero
           move 1 to return-code
           display "ret: " return-code end-display
           goback
       end-if

       subtract 1 from num end-subtract
       call "factorial" using by value num returning result end-call
       compute return-code = (num + 1) * result end-compute
       display "ret: " return-code end-display
       goback.

       end program factorial.
```

Produces:

```
num: +0000000004
```

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```
num: +0000000003
num: +0000000002
num: +0000000001
num: +0000000000
ret: +000000001
ret: +000000001
ret: +000000002
ret: +000000006
ret: +000000024
4! = +0000000024
```

Of course the *Intrinsic FUNCTION FACTORIAL* might be a more efficient and much easier way at getting factorials.

5.51 Does GnuCOBOL capture arithmetic overflow?

Yes. Here is one sample using *ADD* with *ON SIZE ERROR*.

And please note that *OVERFLOW* (page 337) is a conditional for STRING. In COBOL, what this author terms 'overflow' is less technically correct than 'size error' when using COBOL arithmetic terminology.

```
GCobol*> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      04-Feb-2009
      *> Purpose:   Factorial and overflow
      *> Tectonics: cobc -x overflowing.cob
      *> ************************************************************
       identification division.
       program-id. overflowing.

       data division.
       working-storage section.
       01 fact   usage binary-long.
       01 answer usage binary-double.

      *> ************************************************************
       procedure division.
       00-main.

       perform
           varying fact from 1 by 1
           until fact > 21
               add function factorial(fact) to zero giving answer
                   on size error
                       display
                           "overflow at: " fact " is " answer
                           " without test " function factorial(fact)
                       end-display
                   not on size error
                       display fact ": " answer end-display
               end-add
       end-perform
       .

       00-leave.
       goback.
```

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```
       end program overflowing.
      *> ****************************************************************
```

which outputs:

```
+0000000001: +0000000000000000001
+0000000002: +0000000000000000002
+0000000003: +0000000000000000006
+0000000004: +0000000000000000024
+0000000005: +0000000000000000120
+0000000006: +0000000000000000720
+0000000007: +0000000000000005040
+0000000008: +0000000000000040320
+0000000009: +0000000000000362880
+0000000010: +0000000000003628800
+0000000011: +0000000000039916800
+0000000012: +0000000000479001600
+0000000013: +0000000006227020800
+0000000014: +0000000087178291200
+0000000015: +0000001307674368000
+0000000016: +0000020922789888000
+0000000017: +0000355687428096000
+0000000018: +0006402373705728000
+0000000019: +0121645100408832000
overflow at: +0000000020 is +0121645100408832000 without test 432902008176640000
overflow at: +0000000021 is +0121645100408832000 without test 197454024290336768
```

GnuCOBOL 2.0 has a significantly larger numerically accurate range.

```
*> Author:    Brian Tiffin
*> Date:      04-Feb-2009   Modified: 2015-11-11/07:44-0500
*> Purpose:   Factorial and overflow with SIZE ERROR
*> Tectonics: cobc -xj overflowing.cob
*> ****************************************************************
 identification division.
 program-id. overflowing.

 data division.
 working-storage section.
 01 fact          pic 99.
 01 answer        usage binary-double.
 01 bigger-answer pic 9(38).
 01 float-answer  usage float-short.

*> ****************************************************************
 procedure division.
 00-main.

 perform
     varying fact from 1 by 1
     until fact > 22
         add function factorial(fact) to zero giving answer
             on size error
                 display "binary-double overflow at: "
                     fact " is " answer
                 display " intrinsic: " function factorial(fact)
```

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```
            not on size error
                move answer to float-answer
                display fact ": " answer ", " float-answer
        end-add
 end-perform
 display space
 perform
     varying fact from 19 by 1
     until fact > 35
         add function factorial(fact) to zero giving bigger-answer
             on size error
                 display "pic 9(38) overflow at: "
                     fact " is " bigger-answer
                 display " intrinsic: " function factorial(fact)
             not on size error
                 move bigger-answer to float-answer
                 display fact ": " bigger-answer ", " float-answer
         end-add
 end-perform
 .

 00-leave.
 goback.

 end program overflowing.
*> *****************************************************************
```

Showing:

```
prompt$ cobc -xj overflowing.cob
01: +0000000000000000001, 1
02: +0000000000000000002, 2
03: +0000000000000000006, 6
04: +0000000000000000024, 24
05: +0000000000000000120, 120
06: +0000000000000000720, 720
07: +0000000000000005040, 5040
08: +0000000000000040320, 40320
09: +0000000000000362880, 362880
10: +0000000000003628800, 3628800
11: +0000000000039916800, 39916800
12: +0000000000479001600, 4.790016E+08
13: +0000000006227020800, 6.2270208E+09
14: +0000000087178291200, 8.7178289E+10
15: +0000001307674368000, 1.3076744E+12
16: +0000020922789888000, 2.0922791E+13
17: +0000355687428096000, 3.5568741E+14
18: +0006402373705728000, 6.4023735E+15
19: +0121645100408832000, 1.216451E+17
20: +2432902008176640000, 2.432902E+18
binary-double overflow at: 21 is +2432902008176640000
 intrinsic: 5109094217170944000
binary-double overflow at: 22 is +2432902008176640000
 intrinsic: 112400072777760768000

19: 000000000000000000000121645100408832000, 1.216451E+17
20: 000000000000000000002432902008176640000, 2.432902E+18
```

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```
21: 00000000000000000051090942171709440000, 5.1090941E+19
22: 00000000000000001124000727777607680000, 1.1240007E+21
23: 00000000000000025852016738884976640000, 2.5852017E+22
24: 00000000000000620448401733239439360000, 6.2044838E+23
25: 00000000000015511210043330985984000000, 1.551121E+25
26: 00000000004032914611266056355840000000, 4.0329146E+26
27: 00000000108888694504183521607680000000, 1.0888869E+28
28: 00000003048883446117138605015040000000, 3.0488835E+29
29: 00000088417619937397019545436160000000, 8.8417619E+30
30: 00002652528598121910586363084800000000, 2.6525285E+32
31: 00082228386541779228177255628800000000, 8.2228384E+33
32: 00263130836933693530167218012160000000, 2.6313083E+35
33: 08683317618811886495518194401280000000, 8.6833179E+36
pic 9(38) overflow at: 34 is 086833176188118864955181944012800000000
 intrinsic: 29523279903960414084761860964352000000
pic 9(38) overflow at: 35 is 086833176188118864955181944012800000000
 intrinsic: 10333147966386144929666651337523200000000
```

5.52 Can GnuCOBOL be used for plotting?

Yes.

- indirectly with an external call to *gnuplot*
- indirectly with integrated engines like Octave
- directly, with libraries like MathGL

5.52.1 gnuplot

```
GCobol >>SOURCE FORMAT IS FIXED
      ******************************************************************
      * Author:    Brian Tiffin
      * Date:      29-July-2008
      * Purpose:   Plot trig and a random income/expense/worth report
      * Tectonics: requires access to gnuplot. http://www.gnuplot.info
      *            cobc -Wall -x plotworth.cob
      *  OVERWRITES ocgenplot.gp ocgpdata.txt sincos.png ploworth.png
      ******************************************************************
       identification division.
       program-id. plotworth.

       environment division.
       input-output section.
       file-control.
           select scriptfile
               assign to "ocgenplot.gp"
               organization is line sequential.
           select outfile
               assign to "ocgpdata.txt"
               organization is line sequential.
           select moneyfile
               assign to "ocgpdata.txt"
               organization is line sequential.
```

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```
       data division.
       file section.
       fd scriptfile.
          01 gnuplot-command pic x(82).
       fd outfile.
          01 outrec.
             03 x-value   pic -zzzzzz9.99.
             03 filler    pic x.
             03 sin-value pic -zzzz9.9999.
             03 filler    pic x.
             03 cos-value pic -zzzz9.9999.
       fd moneyfile.
          01 moneyrec.
             03 timefield pic 9(8).
             03 filler    pic x.
             03 income    pic -zzzzzz9.99.
             03 filler    pic x.
             03 expense   pic -zzzzzz9.99.
             03 filler    pic x.
             03 networth  pic -zzzzzz9.99.

       working-storage section.
       01 angle   pic s9(7)v99.

       01 dates   pic 9(8).
       01 days    pic s9(9).
       01 worth   pic s9(9).
       01 amount  pic s9(9).

       01 gplot   pic x(80) value is 'gnuplot -persist ocgenplot.gp'.
       01 result  pic s9(9).

       procedure division.

      * Create the script to plot sin and cos
       open output scriptfile.
       move "plot 'ocgpdata.txt' using 1:2 with lines title 'sin(x)'"
      - to gnuplot-command.
       write gnuplot-command.
       move "replot 'ocgpdata.txt' using 1:3 with lines title 'cos(x)'"
      - to gnuplot-command.
       write gnuplot-command.
       move "set terminal png; set output 'sincos.png'; replot"
      - to gnuplot-command.
       write gnuplot-command.
       close scriptfile.

      * Create the sinoidal data
       open output outfile.
       move spaces to outrec.
       perform varying angle from -10 by 0.01
           until angle > 10
               move angle to x-value
               move function sin(angle) to sin-value
               move function cos(angle) to cos-value
               write outrec
```

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```
       end-perform.
       close outfile.

      * Invoke gnuplot
       call "SYSTEM" using gplot
                     returning result.
       if result not = 0
           display "Problem: " result
           stop run returning result
       end-if.

      * Generate script to plot the random networth
       open output scriptfile.
       move "set xdata time" to gnuplot-command.
       write gnuplot-command.
       move 'set timefmt "%Y%m%d"' to gnuplot-command.
       write gnuplot-command.
       move 'set format x "%m"' to gnuplot-command.
       write gnuplot-command.
       move 'set title "Income and expenses"' to gnuplot-command.
       write gnuplot-command.
       move 'set xlabel "2008 / 2009"' to gnuplot-command.
       write gnuplot-command.
       move 'plot "ocgpdata.txt" using 1:2 with boxes title "Income"
      -' linecolor rgb "green"' to gnuplot-command.
       write gnuplot-command.
       move 'replot "ocgpdata.txt" using 1:3 with boxes title "Expense"
      -' linecolor rgb "red"' to gnuplot-command.
       write gnuplot-command.
       move 'replot "ocgpdata.txt" using 1:4 with lines title "Worth"'
      -    to gnuplot-command.
       write gnuplot-command.
       move 'set terminal png; set output "plotworth.png"; replot'
      -    to gnuplot-command.
       write gnuplot-command.
       close scriptfile.

      * Generate a bi-weekly dataset with date, income, expense, worth
       open output moneyfile.
       move spaces to moneyrec.
       move function integer-of-date(20080601) to dates.
       move function random(0) to amount.

       perform varying days from dates by 14
           until days > dates + 365
               move function date-of-integer(days) to timefield
               compute amount = function random() * 2000
               compute worth = worth + amount
               move amount to income
               compute amount  = function random() * 1800
               compute worth = worth - amount
               move amount to expense
               move worth to networth
               write moneyrec
       end-perform.
       close moneyfile.
```

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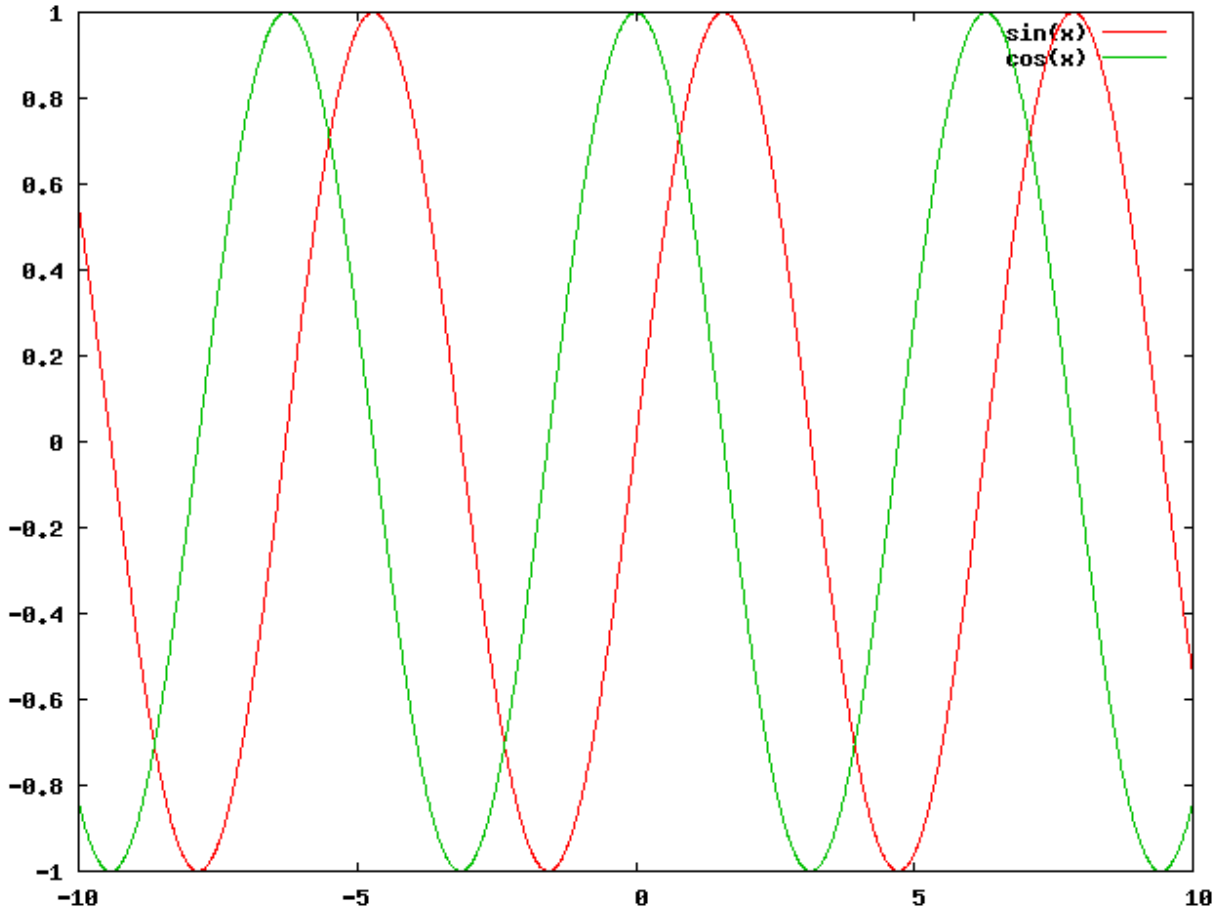
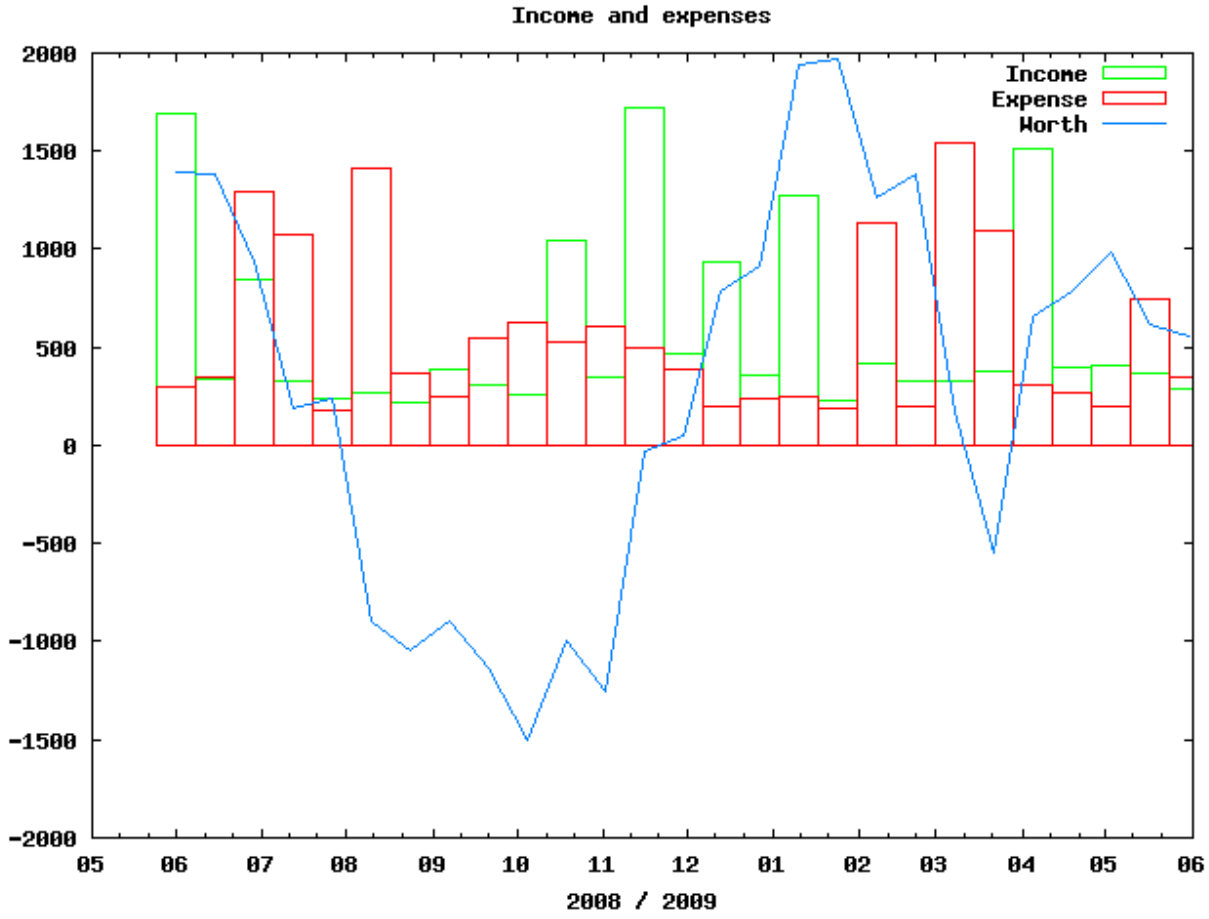
```
      * Invoke gnuplot again.  Will open new window.
       call "SYSTEM" using gplot
                    returning result.
       if result not = 0
           display "Problem: " result
           stop run returning result
       end-if.

       goback.
```

Which displays and saves:





5.52.2 MathGL

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20140424
      *> License:   Licensed under the GPL 2
      *> Purpose:   MathGL plotting, with MathGL Script
      *> Tectonics: cobc -x mgl-parser.cob -lmgl
      *> ***************************************************************
       identification division.
       program-id. mgl-parser.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 mgl-gr               usage pointer.
       01 mgl-dt               usage pointer.
       01 mgl-parser           usage pointer.
```

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```
      *> This example uses MathGL "double" C data, which is float-long
       01 dataset.
          05 dataitem          usage float-long occurs 100 times.
       01 item                 usage index.
       01 float-item           usage float-long.

      *> call by value needs helpers to align literal data types
       01 title-size           usage float-long value -2.0.

      *> MathGL script is newline sensitive, or use ":"
       01 newline              constant as x"0a".

      *> ****************************************************************
       procedure division.

      *> Prep a COBOL data set, in this case sinoidal
       perform varying item from 1 by 1 until item > 100
           compute float-item = item - 1 end-compute
           compute
               dataitem(item) = sin(4 * pi * float-item / 99)
           end-compute
       end-perform

      *> Initialize a MathGL graphic space
       call "mgl_create_graph" using
           by value 600
           by value 400
           returning mgl-gr
           on exception
               display "no MathGL, -lmgl" upon syserr end-display
               goback
       end-call

      *> Title the graph, as part of the plot
       call "mgl_title" using
           by value mgl-gr
           by content z"MGL parser sample"
           by content z""
           by value title-size
           returning omitted
       end-call

      *> create an MGL script handler
       call "mgl_create_parser" returning mgl-parser end-call

      *> register a variable, named "dat"
       call "mgl_parser_add_var" using
           by value mgl-parser
           by content z"dat"
           returning mgl-dt
       end-call

      *> Convert the COBOL dataset to an MGL array, (linked to "dat")
       call "mgl_data_set_double" using
           by value mgl-dt
           by reference dataset
```

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```
           by value 100
           by value 1
           by value 1
           returning omitted
       end-call

      *> Send MGL script commands to plot the "dat" array
      *>     within 0 and 1, then draw a box, then axis
       call "mgl_parse_text" using
           by value mgl-gr
           by value mgl-parser
           by content
               z"plot dat; xrange 0 1 : box : axis"
           returning omitted
       end-call

      *> continue the script with some labeling
       call "mgl_parse_text" using
           by value mgl-gr
           by value mgl-parser
           by content
               z"xlabel 'x' : ylabel 'y'"
           returning omitted
       end-call

      *> use some control flow to draw some lines
      *>   red 'r' when less than 0, 'g' green otherwise
       call "mgl_parse_text" using
           by value mgl-gr
           by value mgl-parser
           by content
               "for $0 -1 1 0.1" & newline &
               "    if $0<0" & newline &
               "        line 0 0 -1 $0 'r'" & newline &
               "    else" & newline &
               "        line 0 0 -1 $0 'g'" & newline &
               "    endif" & newline &
               z"next"
           returning omitted
       end-call

      *> and save the graph
       call "mgl_write_png" using
           by value mgl-gr
           by content z"mgl-parser.png"
           by content z""
           returning omitted
       end-call

       goback.
       end program mgl-parser.

      *> ***********************************************************
      *int sample(HMGL gr)
      *{
      *  mgl_title(gr, "MGL parser sample", "", -2);
      *  double a[100];   // let a_i = sin(4*pi*x), x=0...1
```

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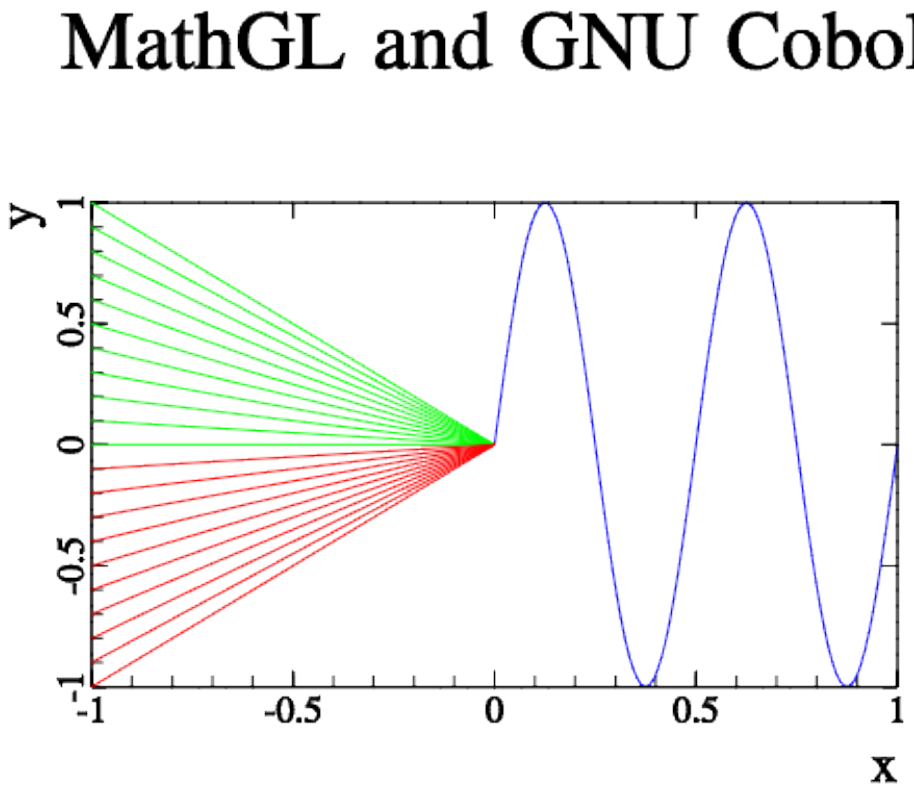
```
      *  int i;
      *  for(i=0;i<100;i++)  a[i]=sin(4*M_PI*i/99);
      *  HMPR parser = mgl_create_parser();
      *  HMDT d = mgl_parser_add_var(parser, "dat");
      *  mgl_data_set_double(d,a,100,1,1);    // set data to variable
      *  mgl_parse_text(gr, parser, "plot dat; xrange 0 1\nbox\naxis");
      *  // you may break script at any line do something
      *  // and continue after that
      *  mgl_parse_text(gr, parser, "xlabel 'x'\nylabel 'y'");
      *  // also you may use cycles or conditions in script
      *  mgl_parse_text(gr, parser, "for $0 -1 1 0.1\nif $0<0\n"
      *    "line 0 0 -1 $0 'r':else:line 0 0 -1 $0 'g'\n"
      *    "endif\nnext");
      *  mgl_write_png(gr, "test.png", "");  // don't forgot to save picture
      *  return 0;
      *}
```

giving



and, while `MathGL` is designed for scientific visualization, there are features that allow for sophisticated financial graphics.

At time of posting, this use of MathGL is not overly sophisticated, but don't let that stop anyone else.

The beginnings of a Financial Graphics Function repository perhaps?

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *> ************************************************************
```

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```
      *> Author:    Brian Tiffin
      *> Date:      20140503
      *> License:   Licensed under the GPL 2
      *> Purpose:   MathGL plotting, with MathGL Script
      *> Tectonics: cobc -x mathgl-finance.cob mathgl-repo.cob -lmgl
      *> ************************************************************
       identification division.
       program-id. mathgl-finance.

       environment division.
       configuration section.
       repository.
           function mathgl-script
           function all intrinsic.

data   data division.
       working-storage section.
      *> MathGL usually uses "double" C data, which is float-long
       01 dataset.
          05 dataitem          usage float-long occurs 100 times.
       01 item                 usage index.

       01 mathgl-return        usage binary-long.

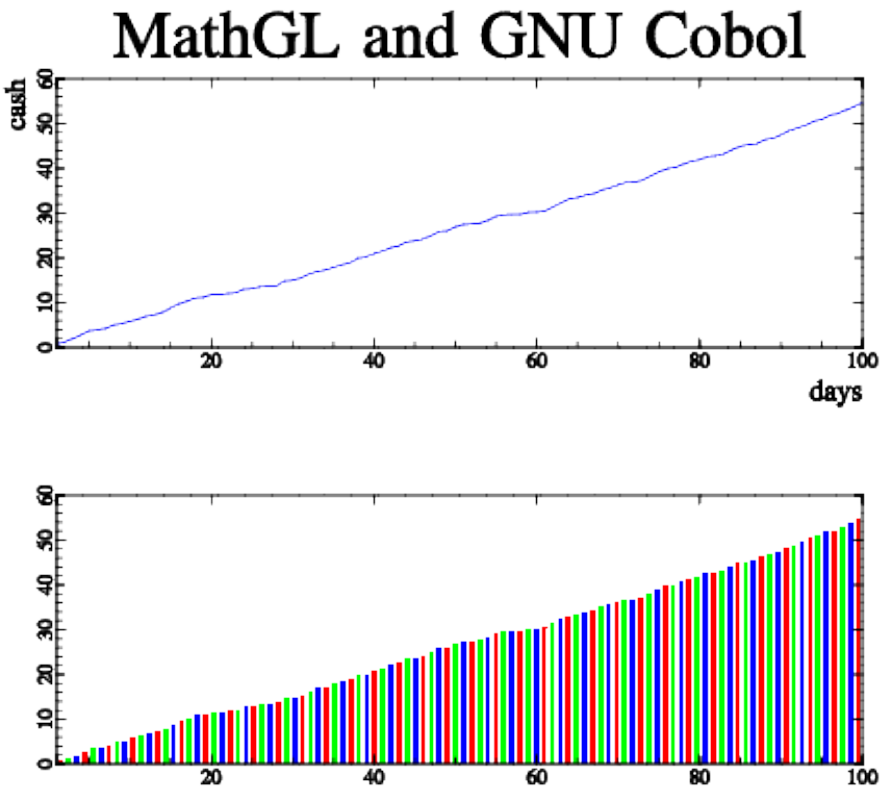
      *> ************************************************************
code   procedure division.

      *> Prep a COBOL data set, in this case, incrementally up, randomly
       move random(42) to dataitem(1)   *> seed the random function
       perform varying item from 1 by 1 until item > 99
           compute
               dataitem(item + 1) = dataitem(item) + random()
           end-compute
       end-perform

      *> Send MGL script commands to plot the "dat" array
      *>     within 1 and 100, then draw a box, then axis
      *>     continue the script with some labeling
      *> Upper range of 60, odds are the 100 random numbers
      *>     will sum up to 55.

       move mathgl-script(dataset,
           "subplot 1 2 0:" &
           "    ranges 1 100 0 60:" &
           "    plot dat : box : axis:" &
           "    xlabel 'days' : ylabel 'cash':" &
           "subplot 1 2 1:" &
           "    ranges 1 100 0 60:" &
           "    copy threed dat:" &
          z"    box : axis : bars threed 'o!rgb'")
         to mathgl-return

       display mathgl-return end-display
       goback.
       end program mathgl-finance.
```



from this *early, poorly factored* function repository.

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20140503
      *> License:   Licensed under the GPL 2
      *> Purpose:   MathGL plotting, with MathGL Script, as a function
      *> Tectonics: cobc -x mathgl-finance.cob mathgl-repo.cob -lmgl
      *> ***************************************************************
       identification division.
       function-id. mathgl-script.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.

       01 mgl-gr               usage pointer.
       01 mgl-dt               usage pointer.
       01 mgl-parser           usage pointer.

      *> call by value needs helpers to align literal data types
       01 float-title-size     usage float-long value -1.6.

      *> MathGL script is newline sensitive, or use ":"
```

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```
       01 newline              constant as x"0a".

       linkage section.
       01 mathgl-return        usage binary-long.
       01 mathgl-dataset.
          05 mathgl-y-value    usage float-long occurs 100 times.
       01 mathgl-text          pic x any length.

      *> ****************************************************************
       procedure division using mathgl-dataset mathgl-text
           returning mathgl-return.

       display length(mathgl-text) ":" trim(mathgl-text) end-display

      *> Initialize a MathGL graphic space
       call "mgl_create_graph" using
           by value 600
           by value 400
           returning mgl-gr
           on exception
               display "no MathGL, -lmgl" upon syserr end-display
               goback
       end-call

      *> Title the graph, as part of the plot
       call "mgl_title" using
           by value mgl-gr
           by content z"MathGL and GnuCOBOL"
           by content z""
           by value float-title-size
           returning omitted
       end-call

      *> create an MGL script handler
       call "mgl_create_parser" returning mgl-parser end-call

      *> register a variable, named "dat"
       call "mgl_parser_add_var" using
           by value mgl-parser
           by content z"dat"
           returning mgl-dt
       end-call

      *> Convert the COBOL dataset to an MGL array, (linked to "dat")
       call "mgl_data_set_double" using
           by value mgl-dt
           by reference mathgl-dataset
           by value 100
           by value 1
           by value 1
           returning omitted
       end-call

      *> plot the userland script
       call "mgl_parse_text" using
           by value mgl-gr
           by value mgl-parser
```

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```
           by reference mathgl-text
           returning omitted
       end-call

      *> and save the graph
       call "mgl_write_png" using
           by value mgl-gr
           by content z"mathgl-finance.png"
           by content z""
           returning omitted
       end-call

       goback.
       end function mathgl-script.
```

A real GnuCOBOL `mathgl-script` *UDF* (page 1384) will need to factor out

- graphic pane size
- title
- array dimensions for x, y, z
- etc…

Here is a later cut

```
GNU    >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20140503
      *> License:   Licensed under the GPL 2
      *> Purpose:   MathGL plotting, with MathGL Script
      *> Tectonics: cobc -x mathgl-finance.cob mathgl-repo.cob -lmgl
      *> ***************************************************************
       identification division.
       program-id. mathgl-finance.

       environment division.
       configuration section.
       repository.
           function mathgl-script
           function all intrinsic.

data   data division.
       working-storage section.
       01 graph-width          usage binary-long value 1200.
       01 graph-height         usage binary-long value 800.
       01 title-size           usage float-long value -1.4.
       01 graph-title          pic x(21) value z"MathGL and GnuCOBOL".
       01 output-filename      pic x(21) value z"mathgl-scripting.png".

      *> Using MathGL "double" C data, which is float-long
      *>  complicating factor is row-major order of the vectors.
      *>  3 by 12, not a 12 by 3.
       01 linkname             pic x(4) value z"dat".
       01 dataset.
          05 income            occurs 12 times usage float-long.
```

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```
          05 expense           occurs 12 times usage float-long.
          05 month-total       occurs 12 times usage float-long.
       01 item                 usage index.
       01 x-elements           usage binary-long value 12.
       01 y-elements           usage binary-long value 3.
       01 z-elements           usage binary-long value 1.

       01 mathgl-return        usage binary-long.

      *> ****************************************************************
code   procedure division.

      *> Prep a COBOL data set. Some sample monthlies
       compute expense(1) = random(42) end-compute
       perform varying item from 1 by 1 until item > 12
           compute income(item) = 1000.0 * random() end-compute
           compute expense(item) = 800.0 * random() end-compute
           if item > 1 then
               compute month-total(item) = month-total(item - 1) +
                         income(item - 1) - expense(item - 1)
               end-compute
           end-if
       end-perform

      *> Send MGL script commands to plot the "dat" array
      *>     then draw a box, then axis
      *>     continue the script with some labeling
      *>  and subplots

       >>source format is free
       move mathgl-script(
           graph-width, graph-height
           title-size, graph-title
           output-filename
           linkname, dataset
           x-elements, y-elements, z-elements
           "subplot 1 3 0:" &
           "    ranges 0 12 -1000 2000:" &
           "    tuneticks 0:" &
           "    origin 0 0:" &
           "    plot dat 'obrg': box : axis:" &
           "    line 0 0 12 0 'k':" &
           "    xlabel 'month' : ylabel 'income, expense, #g{balance}':" &
           "subplot 1 3 2:" &
           "    ranges 0 12 -1000 2000:" &
           "    copy threed dat:" &
           "    box : axis : bars threed '#brg':" &
           "    xlabel '2014' : ylabel '#b{Income}, #r{Expenses}, #g{Worth}':" &
           "    table 0.5 0 dat '#b{income}\\n#r{expense}\\n#g{worth}' '#':" &
           "subplot 1 3 1:" &
           "    ranges 0 12 -1000 2000:" &
           "    rotate 50 50:" &
           "    alpha on:" &
           "    box '@' : axis : area threed '#brg':" &
          z"    xlabel '2014' : ylabel '#b{In}, #r{Out}, #g{Worth}'")
         to mathgl-return
       >>source format is fixed
```

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```
      *> don't need the null on the z-string anymore
       inspect output-filename replacing all x"00" by " "
       display
           "Saved " output-filename " with status " mathgl-return
       end-display

      *> display image with feh command, white background
       call "SYSTEM" using concatenate("feh -B white " output-filename) end-call
      *> ask about removing image file after viewing
       call "SYSTEM" using concatenate("rm -vi " output-filename) end-call

       goback.
       end program mathgl-finance.
```

with an almost factored (but still requires more decoupling)

```
GNU    >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20140507
      *> License:   Licensed under the GPL 2
      *> Purpose:   MathGL plotting, with MathGL Script, as a function
      *> Tectonics: cobc -x mathgl-finance.cob mathgl-repo.cob -lmgl
      *> ***************************************************************
       identification division.
       function-id. mathgl-script.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.

      *> MathGL graphic, data pointer, script handler
       01 mgl-gr               usage pointer.
       01 mgl-dt               usage pointer.
       01 mgl-parser           usage pointer.

      *> fat linkage, problem area, it's coupled.
       linkage section.
       01 mathgl-return        usage binary-long.
       01 graph-pane-width     usage binary-long.
       01 graph-pane-height    usage binary-long.
       01 title-size           usage float-long.
       01 graph-title          pic x any length.
       01 output-filename      pic x any length.
       01 mathgl-linkname      pic x any length.
       01 mathgl-dataset.
          05 data-income       occurs 12 times usage float-long.
          05 data-expense      occurs 12 times usage float-long.
          05 data-total        occurs 12 times usage float-long.
       01 x-elements           usage binary-long.
       01 y-elements           usage binary-long.
       01 z-elements           usage binary-long.
```

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```
       01 mathgl-text          pic x any length.

      *> ****************************************************************
       procedure division using
           by value graph-pane-width graph-pane-height title-size
           by reference graph-title output-filename
           by reference mathgl-linkname mathgl-dataset
           by value x-elements y-elements z-elements
           by reference mathgl-text
           returning mathgl-return.

      *> Initialize a MathGL graphic space
       call "mgl_create_graph" using
           by value graph-pane-width
           by value graph-pane-height
           returning mgl-gr
           on exception
               display "no MathGL, -lmgl" upon syserr end-display
               goback
       end-call

      *> Title the graph, as part of the plot
       call "mgl_title" using
           by value mgl-gr
           by reference graph-title
           by content z""
           by value title-size
           returning omitted
       end-call

      *> create an MGL script handler
       call "mgl_create_parser" returning mgl-parser end-call

      *> register a variable, with a userland link name
       call "mgl_parser_add_var" using
           by value mgl-parser
           by reference mathgl-linkname
           returning mgl-dt
       end-call

      *> Convert the COBOL dataset to an MGL array,
      *>    (registered to the link name, above)
      *> for this example (and in the script)
      *> the name "dat" is used for userland access
       call "mgl_data_set_double" using
           by value mgl-dt
           by reference mathgl-dataset
           by value x-elements
           by value y-elements
           by value z-elements
           returning omitted
       end-call

      *> plot the userland script
       call "mgl_parse_text" using
           by value mgl-gr
           by value mgl-parser
```

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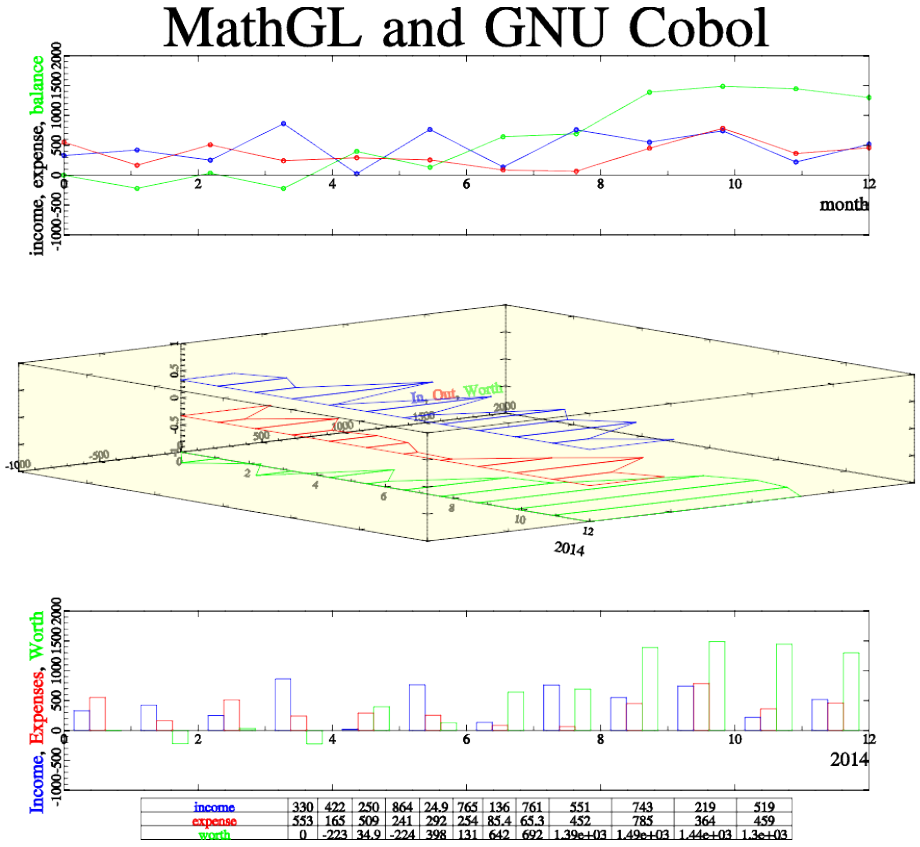
```
           by reference mathgl-text
           returning omitted
       end-call

      *> and save the graph
       call "mgl_write_png" using
           by value mgl-gr
           by reference output-filename
           by content z""
           returning omitted
       end-call

      *> and free the graphing space
       call "mgl_delete_graph" using
           by value mgl-gr
           returning omitted
       end-call
       goback.
       end function mathgl-script.
```

producing three subplots, and a table. The script could well be in a secure text file. `dat` used in the script text to reference the COBOL `dataset`.



5.53 Does GnuCOBOL support the GIMP ToolKit, GTK+?

Yes. A binding for GTK+ is in the works. Early samples have proven workable and screenshots of GnuCOBOL GUI screens are shown here.

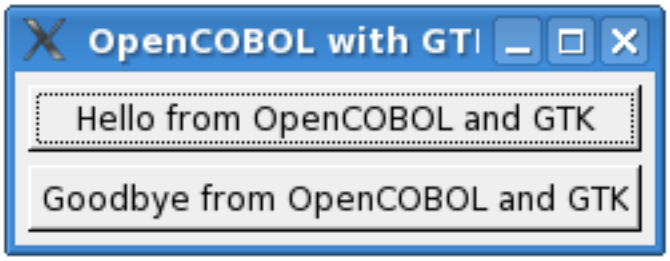
What does GIMP stand for?

GIMP is an acronym for the *GNU Image Manipulation Program*, a very complete and robust grapic design tool. See the GIMP site for more information.

GTK+ is the GIMP ToolKit. See the GTK site for more information.

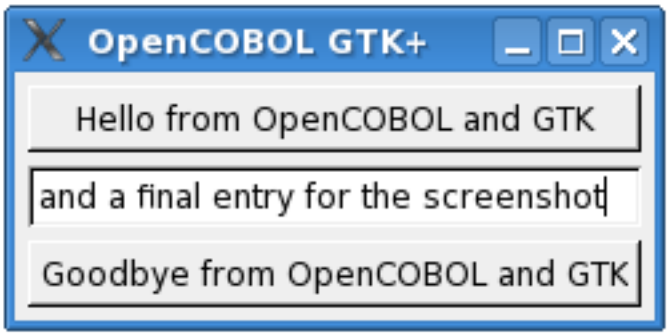
Simple buttons

```
Hello from GTK in OpenCOBOL at 2008120111495787-0500
Hello from GTK in OpenCOBOL at 2008120111500044-0500
```



Text entry widget

```
Hello from GTK in OpenCOBOL at 2008120312472750-0500
text: first entry                      , +0000000011
text: first entry - editted            , +0000000021
text: then a clear                     , +0000000012
text:                                  , +0000000000
text: and a final entry for the screen, +0000000032
```



Sample GnuCOBOL that generated the above

UPDATE for GnuCOBOL 2.2 (code for older versions of GnuCOBOL/OpenCOBOL follows)

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
```

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```
      *> Author:    Brian Tiffin
      *> Date:      03-Dec-2008
      *> Modified:   2017-07-07/07:52-0400
      *> Purpose:   Hello from GTK+
      *> Requires:  libgtk2.0, libgtk2.0-dev, gtk2.0, pkg-config
      *> Tectonics:
      *>     gcc -fPIC -c `pkg-config --cflags gtk+-2.0` ocgtk.c
      *>     cobc -x `pkg-config --libs gtk+-2.0` gtkhello.cob ocgtk.o
      *> ************************************************************
       identification division.
       program-id. gtkhello.

       data division.

       working-storage section.
       01 result               usage binary-long.
       01 gtk-window           usage pointer.
       01 gtk-box              usage pointer.
       01 gtk-hello            usage pointer.
       01 gtk-textentry        usage pointer.
       01 gtk-goodbye          usage pointer.

       01 callback             usage procedure-pointer.
       01 params               usage pointer.

      *> ************************************************************
       procedure division.

      *> Initialize GTK
       CALL "CBL_OC_GTK_INIT_CHECK" returning result END-CALL
     >>D   display "init: " result end-display

      *> Create a toplevel window
       CALL "CBL_OC_GTK_WINDOW_NEW" returning gtk-window END-CALL
     >>D   display "win: " gtk-window end-display

      *> Set the titlebar - using cob_field now **HERE**
       CALL "CBL_OC_GTK_WINDOW_SET_TITLE"
               using by value gtk-window
                   by reference "GnuCOBOL GTK+"
       END-CALL
     >>D   display "title: " gtk-window end-display

      *> Set the border width
       CALL "CBL_OC_GTK_CONTAINER_SET_BORDER_WIDTH"
               using by value gtk-window
                   by value 5
       END-CALL
     >>D   display "border: " gtk-window end-display

      *> connect a window destroy, quit main loop handler
       set callback to entry "CBL_OC_destroy"
       CALL "CBL_OC_G_SIGNAL_CONNECT"
               using by value gtk-window
                   by reference "delete_event" & x"00"
                   by value callback
                   by value params
```

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```
       END-CALL

      *> Create a vertically packed box
       CALL "CBL_OC_GTK_VBOX_NEW"
               using by value 0
                   by value 5
               returning gtk-box
       END-CALL
     >>D   display "box: " gtk-box end-display

      *> Add the box to the window
       CALL "CBL_OC_GTK_CONTAINER_ADD"
               using by value gtk-window
                   by value gtk-box
       END-CALL

      *> Create the hello button
       CALL "CBL_OC_GTK_BUTTON_NEW_WITH_LABEL"
           using by reference "Hello from GnuCOBOL and GTK" & x"00"
           returning gtk-hello
       END-CALL
     >>D   display "button: " gtk-hello end-display

      *> Connect the hello button to the hello code
       set callback to entry "CBL_OC_hello"
       CALL "CBL_OC_G_SIGNAL_CONNECT"
               using by value gtk-hello
                   by reference "clicked" & x"00"
                   by value callback
                   by value params
       END-CALL

      *> Pack the button into the box, top to bottom
       CALL "CBL_OC_GTK_BOX_PACK_START"
               using by value gtk-box
                   by value gtk-hello
                   by value 1
                   by value 1
                   by value 0
       END-CALL

      *> button is ready to show
       CALL "CBL_OC_GTK_WIDGET_SHOW"
               using by value gtk-hello
       END-CALL

      *> Add a text entry field
       CALL "CBL_OC_GTK_ENTRY_NEW"
               returning gtk-textentry
       END-CALL

      *> Connect code to the text entry, passing the entry widget
       set callback to entry "CBL_OC_activate"
       CALL "CBL_OC_G_SIGNAL_CONNECT"
               using by value gtk-textentry
                   by reference "activate" & x"00"
                   by value callback
```

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```
                by value gtk-textentry
     END-CALL

    *> Pack the text field into the box, top to bottom
     CALL "CBL_OC_GTK_BOX_PACK_START"
             using by value gtk-box
                 by value gtk-textentry
                 by value 1
                 by value 1
                 by value 0
     END-CALL

    *> text field is ready to show
     CALL "CBL_OC_GTK_WIDGET_SHOW"
             using by value gtk-textentry
     END-CALL

    *> Create the bye button
     CALL "CBL_OC_GTK_BUTTON_NEW_WITH_LABEL"
         using by reference "Goodbye from GnuCOBOL and GTK" & x"00"
             returning gtk-goodbye
     END-CALL
   >>D   display "button: " gtk-goodbye end-display

    *> Connect the bye button to the bye code
     set callback to entry "CBL_OC_destroy"
     CALL "CBL_OC_G_SIGNAL_CONNECT"
             using by value gtk-goodbye
                 by reference "clicked" & x"00"
                 by value callback
                 by value params
     END-CALL

    *> Pack the button into the box, under hello
     CALL "CBL_OC_GTK_BOX_PACK_START"
             using by value gtk-box
                 by value gtk-goodbye
                 by value 1
                 by value 1
                 by value 0
     END-CALL
   >>D   display "pack: " gtk-box end-display

    *> button is ready to show
     CALL "CBL_OC_GTK_WIDGET_SHOW"
             using by value gtk-goodbye
     END-CALL

    *> box is ready to show
     CALL "CBL_OC_GTK_WIDGET_SHOW"
             using by value gtk-box
     END-CALL

    *> window is ready to show
     CALL "CBL_OC_GTK_WIDGET_SHOW"
             using by value gtk-window
     END-CALL
```

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```
      *> Start up the event loop, control returned when GTK main exits
       CALL "CBL_OC_GTK_MAIN" END-CALL

      *> Something terminated the GTK main loop, sys-close or bye or
       display "ending..." end-display

       goback.
       end program gtkhello.
      *> ****************************************************************

      *> **** window shutdown callback ******************************
       identification division.
       program-id. CBL_OC_destroy.

       environment division.
       configuration section.
       special-names.
           call-convention 0 is extern.

       data division.
       linkage section.
       01 gtk-window           usage pointer.
       01 gtk-data             usage pointer.

       procedure division extern using
           by value gtk-window by value gtk-data returning omitted.

       CALL "CBL_OC_GTK_MAIN_QUIT" END-CALL

       goback.
       end program CBL_OC_destroy.
      *> ****************************************************************


      *> **** hello button click callback ***************************
       identification division.
       program-id. CBL_OC_hello.

       environment division.
       configuration section.
       special-names.
           call-convention 0 is extern.

       data division.
       linkage section.
       01 gtk-window           usage pointer.
       01 gtk-data             usage pointer.

       procedure division extern using
           by value gtk-window by value gtk-data returning omitted.

       display
               "Hello from GTK in GnuCOBOL at "
               function current-date
       end-display
```

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```
       goback.
       end program CBL_OC_hello.

      *> **** text entry activation callback ************************
      *> This procedure called from GTK on enter key pressed in entry
       identification division.
       program-id. CBL_OC_activate.

       environment division.
       configuration section.
       special-names.
           call-convention 0 is extern.

       data division.
       working-storage section.
       01 textfield            pic x(32).
       01 textlen              usage binary-long.

       linkage section.
       01 gtk-window           usage pointer.
       01 gtk-data             usage pointer.

       procedure division extern using
           by value gtk-window by value gtk-data returning omitted.

       CALL "CBL_OC_GTK_ENTRY_GET_TEXT"
               using by value gtk-data
                     by reference textfield
               returning textlen
       END-CALL
       display "text: " textfield ", " textlen end-display

       goback.
       end program CBL_OC_activate.
```

gtkhello.cob

Updated C support code, reflecting changes in GnuCOBOL 2 internals

```
/* GnuCOBOL GTK+ 2.0 wrapper */
/* Tectonics: cobc -c `pkg-config --cflags gtk+-2.0` ocgtk.c */

#include <memory.h>
#include <stdlib.h>
#include <libcob.h>

#include <gtk/gtk.h>
#include <glib.h>

#include "ocgtk.h"

/* Initialize the toolkit, abends if not possible */
int
CBL_OC_GTK_INIT(int argc, char *argv[])
{
    gtk_init(&argc, &argv);
    return 0;
```

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```
}

/* Initialize the toolkit, return false if not possible */
/* Need pointers to argc and argv here */
int
CBL_OC_GTK_INIT_CHECK()
{
    gboolean gres = gtk_init_check(0, NULL);
    return (gres == TRUE) ? 0 : -1;
}

/* Create new window */
GtkWidget*
CBL_OC_GTK_WINDOW_NEW()
{
    return gtk_window_new(GTK_WINDOW_TOPLEVEL);
}

/* set the title */
int
CBL_OC_GTK_WINDOW_SET_TITLE(void *window, char *title)
{
    //struct cob_module *module;
    cob_module *module;
    cob_field  *title_field;
    char       *cstr;

    /* Error conditions simply return, doing nothing */
    if (cob_get_global_ptr()->cob_call_params < 2) { return 1; }

    module = cob_get_global_ptr()->cob_current_module;
    if (module == NULL) {
        //cob_runtime_error("No module!");
        //cob_stop_run(1);
        return 1;
    }

    //title_field = module->cob_procedure_parameters[1];
    title_field = module->cob_procedure_params[1];
    if (!title_field) { return 1; }

    cstr = (char *)malloc(title_field->size + 1);
    if (!cstr) { return 1; }

    memcpy(cstr, title_field->data, title_field->size);
    cstr[title_field->size] = '\0';

    gtk_window_set_title(GTK_WINDOW(window), cstr);

    free(cstr);
    return 0;
}

/* Widget sizing */
int
CBL_OC_GTK_WIDGET_SET_SIZE_REQUEST(void *widget, int x, int y)
{
```

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```
    gtk_widget_set_size_request(GTK_WIDGET(widget), x, y);
    return 0;
}

/* Set border width */
int
CBL_OC_GTK_CONTAINER_SET_BORDER_WIDTH(void *window, int pixels)
{
    gtk_container_set_border_width(GTK_CONTAINER(window), pixels);
    return 0;
}

/* New vertical box */
GtkWidget*
CBL_OC_GTK_VBOX_NEW(int homogeneous, int spacing)
{
    return gtk_vbox_new((gboolean)homogeneous, (gint)spacing);
}

/* New horizontal box */
GtkWidget*
CBL_OC_GTK_HBOX_NEW(int homogeneous, int spacing)
{
    return gtk_hbox_new((gboolean)homogeneous, (gint)spacing);
}

/* packing boxes */
int
CBL_OC_GTK_BOX_PACK_START(void *gcont, void *gobj, int expand,
                          int fill, int padding)
{
    gtk_box_pack_start(GTK_BOX(gcont), gobj, (gboolean)expand,
                       (gboolean)fill, (guint)padding);
    return 0;
}

/* menus */
GtkWidget*
CBL_OC_GTK_MENU_BAR_NEW()
{
    return gtk_menu_bar_new();
}

GtkWidget*
CBL_OC_GTK_MENU_NEW()
{
    return gtk_menu_new();
}

GtkWidget*
CBL_OC_GTK_MENU_ITEM_NEW_WITH_LABEL(char *label)
{
    cob_module *module;
    cob_field  *title_field;
    char       *cstr;
    GtkWidget  *item;
```

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```
    /* Error conditions simply return, doing nothing */
    if (cob_get_global_ptr()->cob_call_params < 1) { return NULL; }

    module = cob_get_global_ptr()->cob_current_module;
    if (module == NULL) {
        //cob_runtime_error("No module!");
        cob_stop_run(1);
    }

    title_field = module->cob_procedure_params[0];
    if (!title_field) { return NULL; }

    cstr = (char *)malloc(title_field->size + 1);
    if (!cstr) { return NULL; }

    memcpy(cstr, title_field->data, title_field->size);
    cstr[title_field->size] = '\0';

    item = gtk_menu_item_new_with_label(cstr);
    gtk_widget_set_tooltip_text(item, (gchar *)cstr);

    free(cstr);

    return item;
}

int
CBL_OC_GTK_MENU_ITEM_SET_SUBMENU(void *item, void *menu)
{
    gtk_menu_item_set_submenu(GTK_MENU_ITEM(item), menu);
    return 0;
}

int
CBL_OC_GTK_MENU_SHELL_APPEND(void *menu, void *item)
{
    gtk_menu_shell_append(GTK_MENU_SHELL(menu), item);
    return 0;
}

/* New button */
GtkWidget*
CBL_OC_GTK_BUTTON_NEW_WITH_LABEL(char *label)
{
    GtkWidget *button;
    button = gtk_button_new_with_label(label);
    if (button) {
        gtk_widget_set_tooltip_text(button, (gchar *)label);
    }
    return button;
}

/* New text entry */
GtkWidget*
CBL_OC_GTK_ENTRY_NEW() {
    return gtk_entry_new();
}
```

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```
/* Set text in entry */
int
CBL_OC_GTK_ENTRY_SET_TEXT(void *entry, char *text)
{
    gtk_entry_set_text(GTK_ENTRY(entry), text);
    return 0;
}

/* Get the text in an entry */
int
CBL_OC_GTK_ENTRY_GET_TEXT(void *entry, char *text)
{
    cob_module *module;
    cob_field  *text_field;
    size_t     text_length;

    module = cob_get_global_ptr()->cob_current_module;
    text_field = module->cob_procedure_params[1];

    const gchar *entry_text;
    entry_text = gtk_entry_get_text(GTK_ENTRY(entry));
    text_length = entry_text ? strlen(entry_text) : 0;
    text_length = (text_length > text_field->size) ? text_field->size : text_length;

    memset(text_field->data, ' ', text_field->size);
    memcpy(text_field->data, entry_text, text_length);
    return (int)text_length;
}


/* connect event to callback */
int
CBL_OC_G_SIGNAL_CONNECT(int *gobj, char *sgn, void (cb)(void *, void *), void *parm)
{
    g_signal_connect(G_OBJECT(gobj), sgn, G_CALLBACK(cb), parm);
    return 0;
}

/* add object to container */
int
CBL_OC_GTK_CONTAINER_ADD(void *window, void *gobj)
{
    gtk_container_add(GTK_CONTAINER(window), gobj);
    return 0;
}

/* tell gtk that object is now ready */
int
CBL_OC_GTK_WIDGET_SHOW(void *gobj)
{
    gtk_widget_show(gobj);
    return 0;
}

/* tell gtk to ready all the wdigets */
int
```

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```
CBL_OC_GTK_WIDGET_SHOW_ALL(void *window)
{
    gtk_widget_show_all(window);
    return 0;
}

/* Some dialogs */
GtkWidget*
CBL_OC_GTK_FILE_SELECTION_NEW(char *title)
{
    return gtk_file_selection_new(title);
}

/* the event loop */
int
CBL_OC_GTK_MAIN()
{
    gtk_main();
    return 0;
}

/* stop the gui */
int
CBL_OC_GTK_MAIN_QUIT()
{
    gtk_main_quit();
    return 0;
}
```

Tectonics also changed with a new flag in pkg-config (-pthread), so cobc can't really be used for the ocgtk.c object compile anymore. Use this sample Makefile instead:

```
# ocgtk Make
.RECIPEPREFIX = >

gtkhello: gtkhello.cob ocgtk.c
> gcc -c -fPIC `pkg-config --cflags gtk+-2.0` ocgtk.c
> cobc -x -debug `pkg-config --libs gtk+-2.0` gtkhello.cob ocgtk.o
```

Here is some older code; just in case, but you'll need an operating system from 2008 for it to work and GnuCOBOL/OpenCOBOL from prior to 2011(ish).

Code below is old, use the shiny newer code above

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      03-Dec-2008
      *> Purpose:   Hello from GTK+
      *> Requires:  libgtk2.0, libgtk2.0-dev, gtk2.0, pkg-config
      *> Tectonics:
      *>     cobc -c `pkg-config --cflags gtk+-2.0` ocgtk.c
      *>     cobc -x `pkg-config --libs gtk+-2.0` gtkhello.cob ocgtk.o
      *> ************************************************************
       identification division.
       program-id. gtkhello.
```

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```
       data division.

       working-storage section.
       01 result               usage binary-long.
       01 gtk-window           usage pointer.
       01 gtk-box              usage pointer.
       01 gtk-hello            usage pointer.
       01 gtk-textentry        usage pointer.
       01 gtk-goodbye          usage pointer.

       01 callback             usage procedure-pointer.
       01 params               usage pointer.

      *> ************************************************************
       procedure division.

      *> Initialize GTK
       CALL "CBL_OC_GTK_INIT_CHECK" returning result END-CALL
     >>D   display "init: " result end-display

      *> Create a toplevel window
       CALL "CBL_OC_GTK_WINDOW_NEW" returning gtk-window END-CALL
     >>D   display "win: " gtk-window end-display

      *> Set the titlebar - using cob_field now **HERE**
       CALL "CBL_OC_GTK_WINDOW_SET_TITLE"
               using by value gtk-window
                   by reference "GnuCOBOL GTK+"
       END-CALL
     >>D   display "title: " gtk-window end-display

      *> Set the border width
       CALL "CBL_OC_GTK_CONTAINER_SET_BORDER_WIDTH"
               using by value gtk-window
                   by value 5
       END-CALL
     >>D   display "border: " gtk-window end-display

      *> connect a window destroy, quit main loop handler
       set callback to entry "CBL_OC_destroy"
       CALL "CBL_OC_G_SIGNAL_CONNECT"
               using by value gtk-window
                   by reference "delete_event" & x"00"
                   by value callback
                   by value params
       END-CALL

      *> Create a vertically packed box
       CALL "CBL_OC_GTK_VBOX_NEW"
               using by value 0
                   by value 5
               returning gtk-box
       END-CALL
     >>D   display "box: " gtk-box end-display

      *> Add the box to the window
       CALL "CBL_OC_GTK_CONTAINER_ADD"
```

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```
                using by value gtk-window
                    by value gtk-box
       END-CALL

      *> Create the hello button
       CALL "CBL_OC_GTK_BUTTON_NEW_WITH_LABEL"
           using by reference "Hello from GnuCOBOL and GTK" & x"00"
           returning gtk-hello
       END-CALL
     >>D   display "button: " gtk-hello end-display

      *> Connect the hello button to the hello code
       set callback to entry "CBL_OC_hello"
       CALL "CBL_OC_G_SIGNAL_CONNECT"
                using by value gtk-hello
                    by reference "clicked" & x"00"
                    by value callback
                    by value params
       END-CALL

      *> Pack the button into the box, top to bottom
       CALL "CBL_OC_GTK_BOX_PACK_START"
                using by value gtk-box
                    by value gtk-hello
                    by value 1
                    by value 1
                    by value 0
       END-CALL

      *> button is ready to show
       CALL "CBL_OC_GTK_WIDGET_SHOW"
                using by value gtk-hello
       END-CALL

      *> Add a text entry field
       CALL "CBL_OC_GTK_ENTRY_NEW"
                returning gtk-textentry
       END-CALL

      *> Connect code to the text entry, passing the entry widget
       set callback to entry "CBL_OC_activate"
       CALL "CBL_OC_G_SIGNAL_CONNECT"
                using by value gtk-textentry
                    by reference "activate" & x"00"
                    by value callback
                    by value gtk-textentry
       END-CALL

      *> Pack the text field into the box, top to bottom
       CALL "CBL_OC_GTK_BOX_PACK_START"
                using by value gtk-box
                    by value gtk-textentry
                    by value 1
                    by value 1
                    by value 0
       END-CALL
```

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```
      *> text field is ready to show
       CALL "CBL_OC_GTK_WIDGET_SHOW"
               using by value gtk-textentry
       END-CALL

      *> Create the bye button
       CALL "CBL_OC_GTK_BUTTON_NEW_WITH_LABEL"
           using by reference "Goodbye from GnuCOBOL and GTK" & x"00"
               returning gtk-goodbye
       END-CALL
     >>D   display "button: " gtk-goodbye end-display

      *> Connect the bye button to the bye code
       set callback to entry "CBL_OC_destroy"
       CALL "CBL_OC_G_SIGNAL_CONNECT"
               using by value gtk-goodbye
                   by reference "clicked" & x"00"
                   by value callback
                   by value params
       END-CALL

      *> Pack the button into the box, under hello
       CALL "CBL_OC_GTK_BOX_PACK_START"
               using by value gtk-box
                   by value gtk-goodbye
                   by value 1
                   by value 1
                   by value 0
       END-CALL
     >>D   display "pack: " gtk-box end-display

      *> button is ready to show
       CALL "CBL_OC_GTK_WIDGET_SHOW"
               using by value gtk-goodbye
       END-CALL

      *> box is ready to show
       CALL "CBL_OC_GTK_WIDGET_SHOW"
               using by value gtk-box
       END-CALL

      *> window is ready to show
       CALL "CBL_OC_GTK_WIDGET_SHOW"
               using by value gtk-window
       END-CALL

      *> Start up the event loop, control returned when GTK main exits
       CALL "CBL_OC_GTK_MAIN" END-CALL

      *> Something terminated the GTK main loop, sys-close or bye or
       display "ending..." end-display

       goback.
       end program gtkhello.
      *> ************************************************************

      *> **** window shutdown callback ******************************
```

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```
       identification division.
       program-id. CBL_OC_destroy.
       data division.
       linkage section.
       01 gtk-window           usage pointer.
       01 gtk-data             usage pointer.

       procedure division using by value gtk-window by value gtk-data.

       CALL "CBL_OC_GTK_MAIN_QUIT" END-CALL

       goback.
       end program CBL_OC_destroy.
      *> ***************************************************************


      *> **** hello button click callback ****************************
       identification division.
       program-id. CBL_OC_hello.
       data division.
       linkage section.
       01 gtk-window           usage pointer.
       01 gtk-data             usage pointer.

       procedure division using by value gtk-window by value gtk-data.
       display
               "Hello from GTK in GnuCOBOL at "
               function current-date
       end-display

       goback.
       end program CBL_OC_hello.

      *> **** text entry activation callback *************************
      *> This procedure called from GTK on enter key pressed in entry
       identification division.
       program-id. CBL_OC_activate.
       data division.
       working-storage section.
       01 textfield            pic x(32).
       01 textlen              usage binary-long.

       linkage section.
       01 gtk-window           usage pointer.
       01 gtk-data             usage pointer.

       procedure division using by value gtk-window by value gtk-data.

       CALL "CBL_OC_GTK_ENTRY_GET_TEXT"
               using by value gtk-data
                   textfield
               returning textlen
       END-CALL
       display "text: " textfield ", " textlen end-display

       goback.
       end program CBL_OC_activate.
```

Using this very early thin wrapper to GTK+

```
/* GnuCOBOL GTK+ 2.0 wrapper */
/* Tectonics: cobc -c `pkg-config --cflags gtk+-2.0` ocgtk.c */

#include <memory.h>
#include <stdlib.h>
#include <libcob.h>

#include <gtk/gtk.h>
#include <glib.h>

#include "ocgtk.h"

/* Initialize the toolkit, abends if not possible */
int
CBL_OC_GTK_INIT(int argc, char *argv[])
{
    gtk_init(&argc, &argv);
    return 0;
}

/* Initialize the toolkit, return false if not possible */
/* Need pointers to argc and argv here */
int
CBL_OC_GTK_INIT_CHECK()
{
    gboolean gres = gtk_init_check(0, NULL);
    return (gres == TRUE) ? 0 : -1;
}

/* Create new window */
GtkWidget*
CBL_OC_GTK_WINDOW_NEW()
{
    return gtk_window_new(GTK_WINDOW_TOPLEVEL);
}

/* set the title */
int
CBL_OC_GTK_WINDOW_SET_TITLE(void *window, char *title)
{
    struct cob_module *module;
    cob_field  *title_field;
    char       *cstr;

    /* Error conditions simply return, doing nothing */
    if (cob_get_global_ptr()->cob_call_params < 2) { return 1; }

    module = cob_get_global_ptr()->cob_current_module;
    if (module == NULL) {
        //cob_runtime_error("No module!");
        //cob_stop_run(1);
        return 1;
    }

    title_field = module->cob_procedure_parameters[1];
    if (!title_field) { return 1; }
```

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```
    cstr = (char *)malloc(title_field->size + 1);
    if (!cstr) { return 1; }

    memcpy(cstr, title_field->data, title_field->size);
    cstr[title_field->size] = '\0';

    gtk_window_set_title(GTK_WINDOW(window), cstr);

    free(cstr);
    return 0;
}

/* Widget sizing */
int
CBL_OC_GTK_WIDGET_SET_SIZE_REQUEST(void *widget, int x, int y)
{
    gtk_widget_set_size_request(GTK_WIDGET(widget), x, y);
    return 0;
}

/* Set border width */
int
CBL_OC_GTK_CONTAINER_SET_BORDER_WIDTH(void *window, int pixels)
{
    gtk_container_set_border_width(GTK_CONTAINER(window), pixels);
    return 0;
}

/* New vertical box */
GtkWidget*
CBL_OC_GTK_VBOX_NEW(int homogeneous, int spacing)
{
    return gtk_vbox_new((gboolean)homogeneous, (gint)spacing);
}

/* New horizontal box */
GtkWidget*
CBL_OC_GTK_HBOX_NEW(int homogeneous, int spacing)
{
    return gtk_hbox_new((gboolean)homogeneous, (gint)spacing);
}

/* packing boxes */
int
CBL_OC_GTK_BOX_PACK_START(void *gcont, void *gobj, int expand,
                          int fill, int padding)
{
    gtk_box_pack_start(GTK_BOX(gcont), gobj, (gboolean)expand,
                       (gboolean)fill, (guint)padding);
    return 0;
}

/* menus */
GtkWidget*
CBL_OC_GTK_MENU_BAR_NEW()
{
```

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```
    return gtk_menu_bar_new();
}

GtkWidget*
CBL_OC_GTK_MENU_NEW()
{
    return gtk_menu_new();
}

GtkWidget*
CBL_OC_GTK_MENU_ITEM_NEW_WITH_LABEL(char *label)
{
    struct cob_module *module;
    cob_field  *title_field;
    char       *cstr;
    GtkWidget  *item;

    /* Error conditions simply return, doing nothing */
    if (cob_get_global_ptr()->cob_call_params < 1) { return NULL; }

    module = cob_get_global_ptr()->cob_current_module;
    if (module == NULL) {
        //cob_runtime_error("No module!");
        cob_stop_run(1);
    }

    title_field = module->cob_procedure_parameters[0];
    if (!title_field) { return NULL; }

    cstr = (char *)malloc(title_field->size + 1);
    if (!cstr) { return NULL; }

    memcpy(cstr, title_field->data, title_field->size);
    cstr[title_field->size] = '\0';

    item = gtk_menu_item_new_with_label(cstr);
    gtk_widget_set_tooltip_text(item, (gchar *)cstr);

    free(cstr);

    return item;
}

int
CBL_OC_GTK_MENU_ITEM_SET_SUBMENU(void *item, void *menu)
{
    gtk_menu_item_set_submenu(GTK_MENU_ITEM(item), menu);
    return 0;
}

int
CBL_OC_GTK_MENU_SHELL_APPEND(void *menu, void *item)
{
    gtk_menu_shell_append(GTK_MENU_SHELL(menu), item);
    return 0;
}
```

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```
/* New button */
GtkWidget*
CBL_OC_GTK_BUTTON_NEW_WITH_LABEL(char *label)
{
    GtkWidget *button;
    button = gtk_button_new_with_label(label);
    if (button) {
        gtk_widget_set_tooltip_text(button, (gchar *)label);
    }
    return button;
}

/* New text entry */
GtkWidget*
CBL_OC_GTK_ENTRY_NEW() {
    return gtk_entry_new();
}

/* Set text in entry */
int
CBL_OC_GTK_ENTRY_SET_TEXT(void *entry, char *text)
{
    gtk_entry_set_text(GTK_ENTRY(entry), text);
    return 0;
}

/* Get the text in an entry */
int
CBL_OC_GTK_ENTRY_GET_TEXT(void *entry, char *text)
{
    struct cob_module *module;
    cob_field  *text_field;
    size_t     text_length;

    module = cob_get_global_ptr()->cob_current_module;
    text_field = module->cob_procedure_parameters[1];

    const gchar *entry_text;
    entry_text = gtk_entry_get_text(GTK_ENTRY(entry));
    text_length = entry_text ? strlen(entry_text) : 0;
    text_length = (text_length > text_field->size) ? text_field->size : text_length;

    memset(text_field->data, ' ', text_field->size);
    memcpy(text_field->data, entry_text, text_length);
    return (int)text_length;
}


/* connect event to callback */
int
CBL_OC_G_SIGNAL_CONNECT(int *gobj, char *sgn, void (cb)(void *, void *), void *parm)
{
    g_signal_connect(G_OBJECT(gobj), sgn, G_CALLBACK(cb), parm);
    return 0;
}

/* add object to container */
```

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```
int
CBL_OC_GTK_CONTAINER_ADD(void *window, void *gobj)
{
    gtk_container_add(GTK_CONTAINER(window), gobj);
    return 0;
}

/* tell gtk that object is now ready */
int
CBL_OC_GTK_WIDGET_SHOW(void *gobj)
{
    gtk_widget_show(gobj);
    return 0;
}

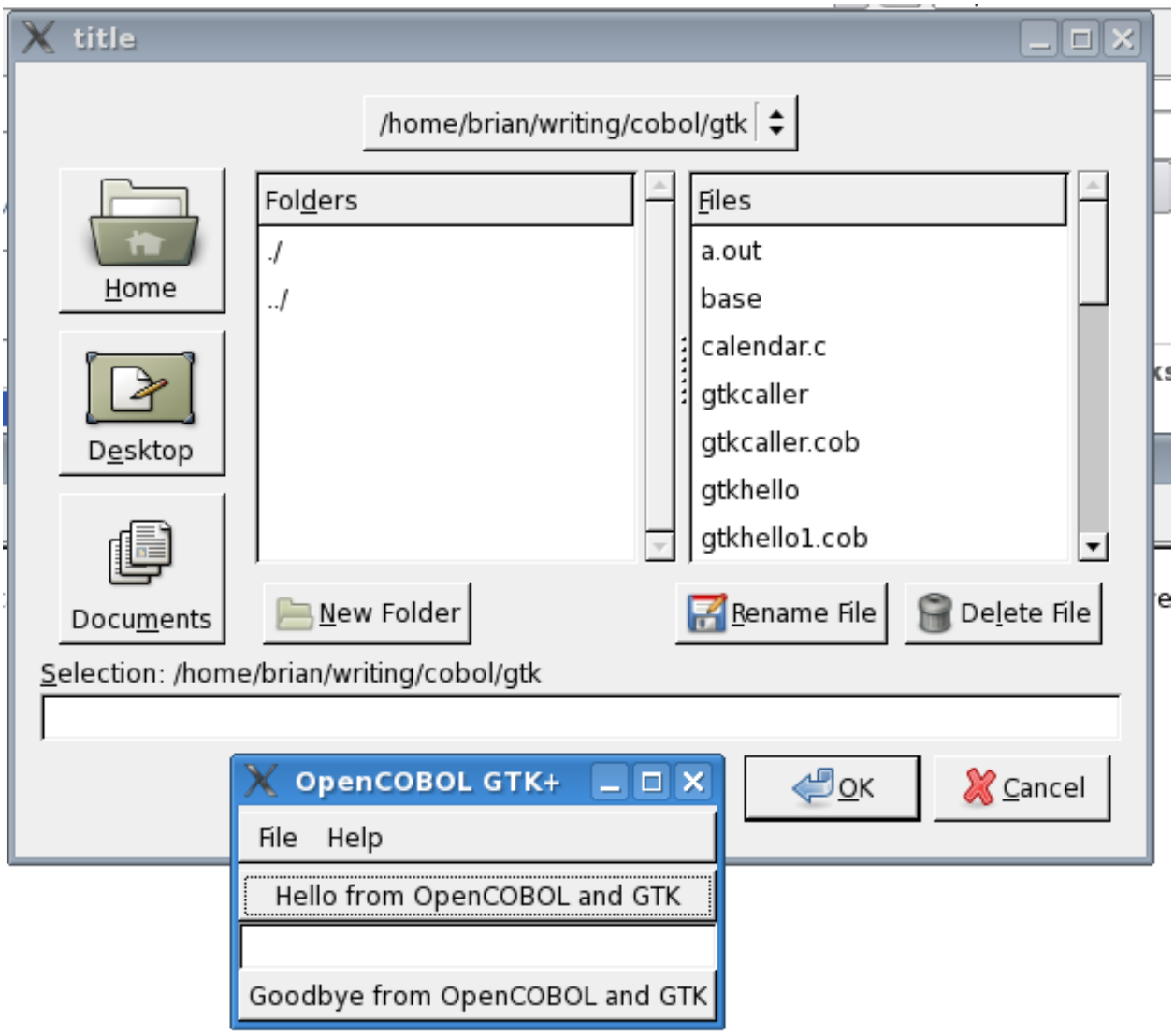
/* tell gtk to ready all the wdigets */
int
CBL_OC_GTK_WIDGET_SHOW_ALL(void *window)
{
    gtk_widget_show_all(window);
    return 0;
}

/* Some dialogs */
GtkWidget*
CBL_OC_GTK_FILE_SELECTION_NEW(char *title)
{
    return gtk_file_selection_new(title);
}

/* the event loop */
int
CBL_OC_GTK_MAIN()
{
    gtk_main();
    return 0;
}

/* stop the gui */
int
CBL_OC_GTK_MAIN_QUIT()
{
    gtk_main_quit();
    return 0;
}
```

A screenshot with added menu and file dialog after hitting File -> Open



5.53.1 The functional GTK+ project

With GnuCOBOL support of *FUNCTION-ID* (page 273) and improvements in the C interface model, the entire GTK binding is now slated for development using very few lines of C (less than 12 lines so far, required for wrapping event callback handlers that have `void` return signatures).

The following (along with the soon to be published supporting function library)

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *> ******************************************************
cob   *> Author:    Brian Tiffin
  web *> Date:      20130308, 20140814
      *> Purpose:   A cobweb GTK+ example
GTK+  *> License:   GPL 3.0 or greater
      *> Tectonics: cobc -x cobweb-gui.cob cobweb-gtk.so
      *> ******************************************************
       identification division.
       program-id. cobweb-gui.
```

(continues on next page)

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```
       environment division.
       configuration section.
       repository.
           function new-window
           function new-box
           function new-label
           function new-entry
           function new-button
           function gtk-go

           function all intrinsic.

       data division.
       working-storage section.
       01 GTK-ORIENTATION-HORIZONTAL constant as 0.
       01 GTK-ORIENTATION-VERTICAL   constant as 1.

       01 result               pic x(8).

       01 gtk-window           usage pointer.

       01 gtk-box              usage pointer.
       01 orientation          usage binary-long.

       01 gtk-label            usage pointer.
       01 gtk-entry            usage pointer.
       01 gtk-button           usage pointer.

      *> ****************************************************************
       procedure division.

       move new-window() to gtk-window
       move GTK-ORIENTATION-HORIZONTAL to orientation
       move new-box(gtk-window, orientation) to gtk-box
       move new-label(gtk-box, z"Goodbye") to gtk-label
       move new-entry(gtk-box, "cobweb-entry-activated") to gtk-entry
       move new-button(gtk-box, z"you're leaving me today",
                       "cobweb-button-clicked") to gtk-button
       move gtk-go(gtk-window) to result

       goback.
       end program cobweb-gui.
```

compiles to executable to display a prototype window of

Fig. 1: *Goodbye, process*, A GnuCOBOL, user FUNCTION, GTK+ example.

Floating a window that will send a SIGTERM to the given process id on text entry or button click. (Both, `cobweb-entry-activated` and `cobweb-button-clicked` are callback handlers written in COBOL).

The plan is to build an easy to use GUI toolbox for COBOL programmers.

Using the function model, a Hello button program could be a single expression

```
move gtk-go(new-button(new-box(new-window(), 0),
            z"Hello", "cobweb-button-clicked"))
  to return-code
```

requiring no working store definitions, *but that is stretching things a little bit too much*.

5.53.2 A web browsing widget embedded in GnuCOBOL?

Yep.

A short sample, made for GnuCOBOL 1.0's first birthday, Dec 27th, 2008.

```
int
CBL_OC_GTKHTML (char *html_string)
{
        GtkWidget *app;
        GtkWidget *html;
        GtkWidget *scrolled_window;

        char *fakeargv[2] = {"happybday", ""};

        /* prepare our environment, we need gnome and gconf */
        gnome_init ("Example_1", "1.0", 1, fakeargv);
        gconf_init (1, fakeargv);

        /* create GtkHTML widget */
        html = gtk_html_new ();
        gtk_signal_connect (GTK_OBJECT (html), "url_requested",
                            GTK_SIGNAL_FUNC (url_requested), NULL);
        gtk_signal_connect (GTK_OBJECT (html), "object_requested",
                            GTK_SIGNAL_FUNC (object_requested), NULL);

        gtk_html_load_from_string (GTK_HTML (html), html_string, -1);

        /* create GNOME app and put GtkHTML in scrolled window in it */
        app = gnome_app_new ("Example_1", "Happy Birthday OpenCOBOL");

        scrolled_window = gtk_scrolled_window_new (NULL, NULL);
        gtk_scrolled_window_set_policy (GTK_SCROLLED_WINDOW (scrolled_window),
                                        GTK_POLICY_AUTOMATIC, GTK_POLICY_AUTOMATIC);
        gtk_container_add (GTK_CONTAINER (scrolled_window), html);

        gnome_app_set_contents (GNOME_APP (app), scrolled_window);
        gtk_window_set_default_size (GTK_WINDOW (app), 320, 100);
        gtk_widget_show_all (app);

        /* run the main loop */
        gtk_main ();

        return 0;
}
/**/
```

That displays

when called with this COBOL:

```
*> ****************************************************************
*> Author:    Brian Tiffin
*> Date:      27-Dec-2008
*> Purpose:   Happy Birthday GnuCOBOL
*> Tectonics:
*> gcc -c `pkg-config --cflags --libs libgnome-2.0 libgnomeui-2.0
*>       gtk+-2.0 libgtkhtml-3.14` hellogtk.c
*> cobc -lgtkhtml-3.14 -lgnomeui-2 -lSM -lICE -lglade-2.0
*>      -lbonoboui-2 -lgnomevfs-2 -lgnomecanvas-2 -lgnome-2 -lpopt
*>      -lbonobo-2 -lbonobo-activation -lORBit-2 -lart_lgpl_2
*>      -lgconf-2 -lgthread-2.0 -lrt -lgtk-x11-2.0 -lxml2
*>      -lgdk-x11-2.0 -latk-1.0 -lgdk_pixbuf-2.0 -lm
*>      -lpangocairo-1.0 -lpango-1.0 -lcairo -lgobject-2.0
*>      -lgmodule-2.0 -ldl -lglib-2.0 -x ocgtkhtml.cob hellogtk.o
*> ****************************************************************
 identification division.
 program-id. ocgtkhtml.

 data division.
 working-storage section.
 01 result               usage binary-long.
 01 html-string          pic x(512) value
     "<B><FONT COLOR=Blue>Happy Birthday 1.0</FONT> " &
     "<FONT COLOR=LimeGreen>OpenCOBOL 1.0!!</FONT></B><br />" &
     "<div align='center'><a href='http://opencobol.org'>" &
     "opencobol</a> <img src='file:smiley.png' />" &
     "<br /><br /><OBJECT CLASSID=close_button>Closebutton" &
     "</OBJECT></div>" & x"00".

*> ****************************************************************
 procedure division.

 call "CBL_OC_GTKHTML" using
     by reference html-string
     returning result
 end-call

 goback.
 end program ocgtkhtml.
```

5.53.3 GTK-server

There is also GTK-server, by Peter van Eerten, who also develops *BaCon* (page 988).

GTK-server uses a text command/API model to produce the graphical user interface. Interpreted GUI scripting with GTK2+ or GTK3+. GTK 1 is also documented, but not overly recommended.

A short example for use from GnuCOBOL:

First a user defined function `gtk-function`. In this case the FIFO model is emulated by simply opening the command file for write, closing, and then opening it again to read results. About as simple as it gets when using COBOL to interface to the GTK API.

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****J* gnucobol/gtk-function
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20170115  Modified: 2017-01-16/10:18-0500
      *> LICENSE
      *>   Dedicated to the public domain
      *> PURPOSE
      *>   gtk-server user defined function
      *> TECTONICS
      *>   cobc -x -g -debug gtkprogram.cob gtk-function.cob
      *> ***************************************************************
       identification division.
       program-id. gtk-function.
       author. Brian Tiffin.
       date-written. 2017-01-15/19:41-0500.
       date-modified. 2017-01-16/10:18-0500.
       date-compiled.
       installation. Requires GTK3+ and GTK-server.
       remarks. All GTK commands passed as text.
       security. Someone might whack on the fifo pipe while running.

       environment division.
       configuration section.

       repository.
           function gtk
           function all intrinsic.

       data division.
       working-storage section.
       01 cli                  pic x(80).
          88 helping           values "help", "-h", "--help".
      *> ********

       procedure division.
       accept cli from command-line
       if helping then
           display "GTK-server module"
       end-if
       goback.
      *> ***************************************************************

       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
      *> informational warnings and abends
```

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```
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:

       end program gtk-function.
      *> ***************************************************************

      *> ***************************************************************
      *>****F* gtk-function/gtk
       identification division.
       function-id. gtk.

       environment division.
       configuration section.

       repository.
           function all intrinsic.

       input-output section.
       file-control.
           select optional gtk-fifo
           assign to gtk-fifo-name
           status is gtk-fifo-status
           organization is line sequential.

       data division.
       file section.
       fd gtk-fifo record varying depending on gtk-io-len.
       01 gtk-io               pic x(256).

       working-storage section.
       01 have-server          pic 9 value 0.

       01 gtk-server-options.
       >>IF DEBUG DEFINED
          05 filler            value "-debug".
       >>ELSE
          05 filler            value " ".
       >>END-IF
```

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```
       01 tmp-name-size        constant as 4096.
       01 tmp-buffer           pic x(tmp-name-size).
       01 gtk-fifo-name-len    pic 9(4) value tmp-name-size.
       01 gtk-fifo-name.
          05 filler            pic x occurs 0 to tmp-name-size times
                               depending on gtk-fifo-name-len.
       01 gtk-fifo-status      pic xx.
          88 fifo-ok           value "00".
       01 gtk-io-len           pic 999.

       01 empty-string pic x value " ".

       linkage section.
       01 api pic x any length.
       01 op2 pic x any length.
       01 op3 pic x any length.
       01 op4 pic x any length.
       01 op5 pic x any length.
       01 op6 pic x any length.
       01 op7 pic x any length.
       01 op8 pic x any length.
       01 op9 pic x any length.
       01 server-result pic x(16).

       procedure division
           using api op2 op3 op4 op5 op6 op7 op8 op9
           returning server-result.

      *> one time init of the server
       if have-server equal zero then
           *> get a temporary file name
           call static "cob_temp_name" using
               tmp-buffer ".tmp"
               returning omitted
           end-call
           string tmp-buffer delimited by low-value into gtk-fifo-name
           move length(trim(gtk-fifo-name)) to gtk-fifo-name-len

           *> start up gtk-server with a pipe interface
           call "SYSTEM" USING
               concatenate("gtk-server -fifo=" gtk-fifo-name
                           space gtk-server-options " -detach")
           move 1 to have-server
       end-if

      *> ease of use, just fill in empty parameters with a space
       if op9 omitted then
           set address of op9 to address of empty-string
       end-if
       if op8 omitted then
           set address of op8 to address of empty-string
       end-if
       if op7 omitted then
           set address of op7 to address of empty-string
       end-if
       if op6 omitted then
           set address of op6 to address of empty-string
```

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```
       end-if
       if op5 omitted then
           set address of op5 to address of empty-string
       end-if
       if op4 omitted then
           set address of op4 to address of empty-string
       end-if
       if op3 omitted then
           set address of op3 to address of empty-string
       end-if
       if op2 omitted then
           set address of op2 to address of empty-string
       end-if

       move concatenate(api space op2 space op3 space op4 space
                        op5 space op6 space op7 space op8 space
                        op9) to gtk-io
       perform gtk-routine
       move gtk-io to server-result

       >>IF DEBUG DEFINED
       display "api: " api " :" trim(server-result) ":"
       >>END-IF

      *> if this is a shutdown, reset the init flag
       if api equal "gtk_server_exit" and server-result = "ok" then
           move 0 to have-server
       end-if
       goback.
      *> ****************************************************************

      *> ********
       gtk-routine.
      *> write to pipe
       open output gtk-fifo
       if not fifo-ok then
           display "problem with " gtk-fifo-name upon syserr
           exit paragraph
       end-if

       move 256 to gtk-io-len
       write gtk-io
       if not fifo-ok then
           display "problem writing " trim(gtk-io) " to " gtk-fifo-name
              upon syserr
           exit  paragraph
       end-if

       close gtk-fifo
       if not fifo-ok then
           display "problem closing " gtk-fifo-name upon syserr
           exit
       end-if

      *> read from pipe
       open input gtk-fifo
       if not fifo-ok then
```

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```
           display "problem with " gtk-fifo-name upon syserr
           exit paragraph
       end-if

       read gtk-fifo
       if not fifo-ok then
           display "problem reading " gtk-fifo-name upon syserr
           exit paragraph
       end-if

       close gtk-fifo
       if not fifo-ok then
           display "problem closing " gtk-fifo-name upon syserr
           exit paragraph
       end-if

       >>IF DEBUG DEFINED
       display "gtk-io: " gtk-io-len " :" trim(gtk-io) ":"
       >>END-IF
       .

       :EXCEPTION-HANDLERS:

       end function gtk.
      *> ***************************************************************
      *>****
>>ELSE
!doc-marker!
============
gtk-function
============

.. contents::

Introduction
------------

GTK-server scripting.  Commands (API calls) are sent to a text file
and results from GTK-server are read from the same FIFO text file.
Events are passed back as strings, as are all the handles and status
messages.

http://www.gtk-server.org/

Tectonics
---------

::

    prompt$ cobc -x gtkprogram.cob gtk-function.cob
    or
    prompt$ TMPDIR=. cobc -x -DDEBUG gtkprogram.cob gtk-function.cob

Usage
-----

::
```

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```
    prompt$ ./gtk-function help

Source
------

.. include::  gtk-function.cob
   :code: cobolfree
>>END-IF
```

And a short demonstration:

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****J* gnucobol/gtkdemo-fifo
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20170115  Modified: 2017-01-16/09:15-0500
      *> LICENSE
      *>   Dedicated to the public domain
      *> PURPOSE
      *>   gtkdemo-fifo GTK-server demo
      *> TECTONICS
      *>   cobc -x -g -debug gtkdemo-fifo.cob gtk-function.cob
      *> ***************************************************************
       identification division.
       program-id. gtkdemo-fifo.
       author. Brian Tiffin.
       date-written. 2017-01-15/19:41-0500.
       date-modified. 2017-01-16/09:15-0500.
       date-compiled.
       installation. Requires GTK3+ and GTK-server.
       remarks. All GTK commands passed as text.
       security. Someone might whack on the fifo pipe while running.

       environment division.
       configuration section.

       repository.
           function gtk
           function all intrinsic.

       data division.
       working-storage section.
       01 gtk-result           pic x(16).
       01 gtk-window           pic x(16).
       01 gtk-table            pic x(16).
       01 gtk-label            pic x(16).
       01 gtk-info             pic x(16).
       01 gtk-quit             pic x(16).
       01 gtk-dialog           pic x(16).
       01 event                pic x(16).

      *> ***************************************************************
       procedure division.
```

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```
      *> send commands (API calls as text) to set up the GUI
       move gtk("gtk_init NULL NULL") to gtk-result
       move gtk("gtk_window_new 0") to gtk-window
       move gtk("gtk_window_set_title" gtk-window "'GTK-server Demo'")
         to gtk-result
       move gtk("gtk_window_set_default_size" gtk-window "400 200")
         to gtk-result
       move gtk("gtk_window_set_position" gtk-window "1") to gtk-result

      *> add a table with a label and some buttons
       move gtk("gtk_table_new 10 10 1") to gtk-table
       move gtk("gtk_container_add", gtk-window, gtk-table)
         to gtk-result

      *> A label
       move gtk("gtk_label_new 'Hello, from GTK-server'") to gtk-label
       move gtk("gtk_table_attach_defaults" gtk-table gtk-label
                "1 4 1 4") to gtk-result

      *> a button to invoke a dialog box (see main loop evaluate)
       move gtk("gtk_button_new_with_label" "'Info'") to gtk-info
       move gtk("gtk_table_attach_defaults" gtk-table gtk-info
                "1 4 6 9") to gtk-result

      *> a quit button
       move gtk("gtk_button_new_with_label 'Quit'") to gtk-quit
       move gtk("gtk_table_attach_defaults" gtk-table gtk-quit
                "6 9 6 9") to gtk-result

      *> a macro built into gtk-server.cfg
       move gtk('u_dialog Information "' & "'u_dialog macro'" &
                '" 200 130') to gtk-dialog

      *> show the gui
       move gtk("gtk_widget_show_all", gtk-window, "1") to gtk-result

      *> main loop
       move "0" to event
       perform until event = gtk-window or gtk-quit
           move gtk("gtk_server_callback WAIT") to event

       >>IF DEBUG DEFINED
           display "event :" trim(event) ":"
       >>END-IF

           evaluate event
               when gtk-dialog
                   move gtk("gtk_widget_hide", gtk-dialog) to gtk-result
               when "exit"
                   move gtk("gtk_widget_hide", gtk-dialog) to gtk-result
               when gtk-info
                   move gtk("gtk_widget_show_all", gtk-dialog)
                     to gtk-result
           end-evaluate
       end-perform

      *> shut down the server
```

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```
       move gtk("gtk_server_exit") to gtk-result

       goback.
      *> ****************************************************************

       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:

       end program gtkdemo-fifo.
      *> ****************************************************************
      *>****
>>ELSE
!doc-marker!
============
gtkdemo-fifo
============

.. contents::

Introduction
------------

Demonstrate GTK-server scripting.  Commands (API calls) are sent to a
text file and results from GTK-server are read from the same FIFO file.
Events are passed back as strings, as are all the handles.

http://www.gtk-server.org/

Tectonics
---------

::

    prompt$ cobc -x gtkdemo-fifo.cob gtk-function.cob

Usage
```

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```
-----

::

    prompt$ ./gtkdemo-fifo

Source
------

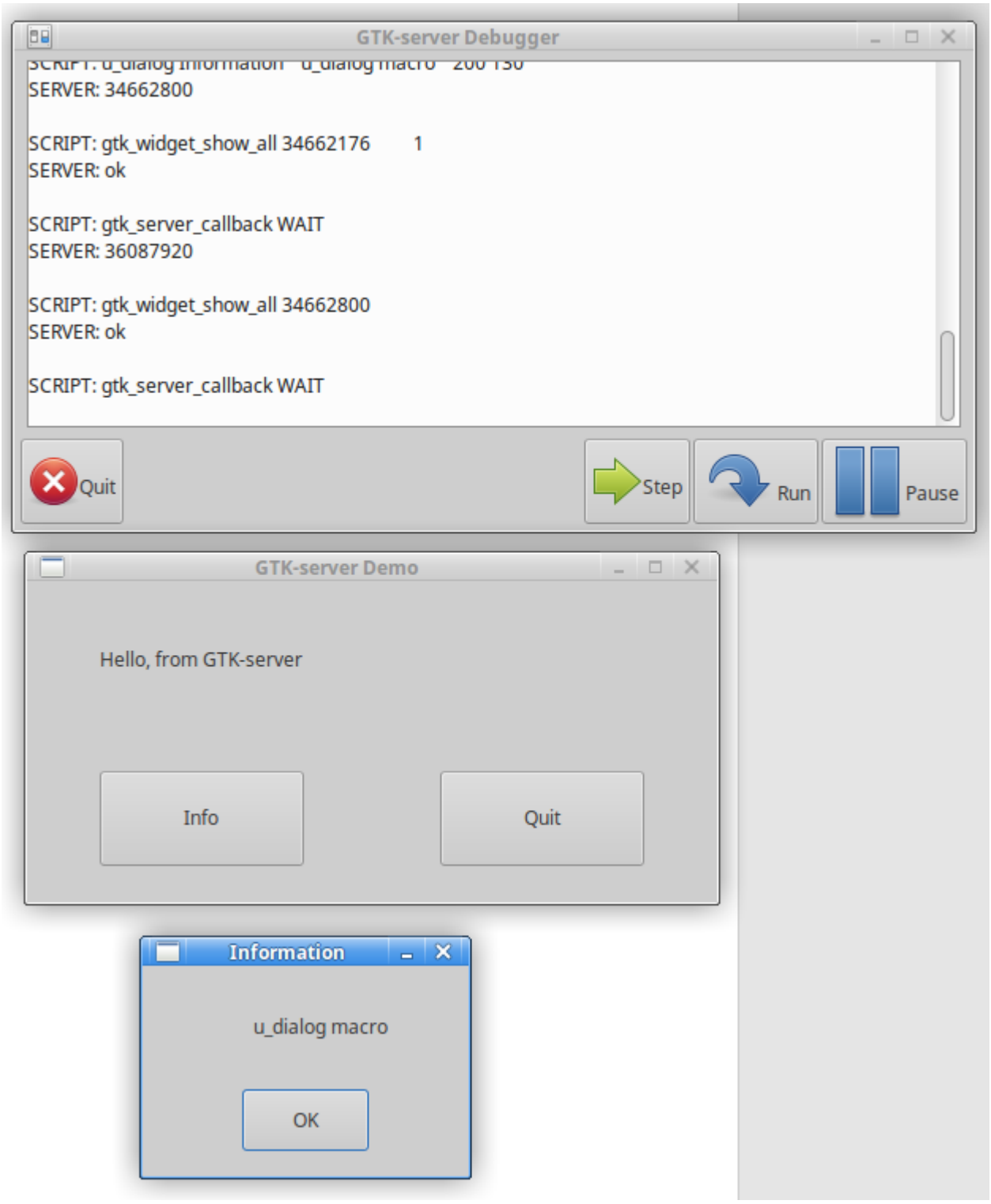
.. include::  gtkdemo-fifo.cob
   :code: cobolfree

.. include::  gtk-function.cob
   :code: cobolfree
>>END-IF
```

And a run sample:

```
prompt$ cobc -DDEBUG -xj gktdemo-fifo.cob gtk-function.cob
```

Producing the graphic display:



GTK-server can manage FIFO pipe streams, accepting command strings and returning results. STDIN, TCP and UDP communication models are also supported for both Unix-like and Windows. IPC is also supported on Unix-like systems.

http://www.gtk-server.org

There are plenty of examples along with screenshots available on the website.

GTK-server can be used from Forth, Shell, AWK, PHP, Python, M4 (yes M4), REXX, Tcl and just about any language that is capable of reading and writing to text files in pipe mode.

A `gtk-server.cfg` file exposes any of the GTK, GLib, GObject, Cairo, along with other C API library calls as a simple text entry.

5.54 What is GCSORT?

Update: Rebranded as GCSORT from the original OCSort

A powerful external sort utility, for use with sequential (fixed length record) files.

A preliminary version can be referenced from http://oldsite.add1tocobol.com/tiki-download_file.php?fileId=74

The sources are now included in the GnuCOBOL Contributions tree

http://sourceforge.net/p/gnucobol/contrib/HEAD/tree/

GCSORT supports a variety of sorting options, for example:

```
gcsort sort fields"(1,5,CH,A,11,4,CH,A)"
             use inputfile record f,391 org sq give outputfile org sq
```

Users of MFSORT may recognize the syntax. Explaining the above example, Angus posted:

```
This will sort the file "inputfile", a fixed length file (391 byte each
record, organization sequential), and create a file "outputfile" sorted
(which is of the same type). The sort fields are :
(start, length, type, direction)
=> start=1
=> length=5
=> type = character (you can sort on comp3 fields, but ocsort don't handle it)
=> direction = ascending (or descending)
It's like an order by.
The omit/include condition allow to remove record from the file (ex if
character number 5 of this record is 'F', omit the record). You can use and,
or, greater than...)
```

A run sample:

```
prompt$ cd trunk/tools/ocsort
prompt$ make

# Create a sample data set, 118 byte records
prompt$ base64 /dev/urandom | head -n 100 | dd conv=block cbs=118 >samp1.txt

# test out the sort, keys 1-5 character, ascending and 11-14, ascending char
prompt$ time ./gcsort sort fields"(1,5,CH,A,11,4,CH,A)" \
             use samp1.txt record f,118 org sq give samp1.sor org sq
INPUT FILE :
        samp1.txt FIXED (118,118) SQ
OUTPUT FILE :
        samp1.sor FIXED (0,0) SQ
SORT FIELDS : (1,5,CH,A,11,4,CH,A)
Sort OK

real    0m0.003s
user    0m0.000s
```

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```
sys     0m0.003s

prompt$ wc samp1.sor
0   100 11800 samp1.sor

prompt$ cobc -x verify.cob
prompt$ ./verify
done
```

Only sorting 100 records, less than blink time. Here's one million records:

```
...
118000000 bytes (118 MB) copied, 3.44348 s, 34.3 MB/s
prompt$ rm samp1.sor
prompt$ time ./gcsort sort fields"(1,5,CH,A,11,4,CH,A)" \
             use samp1.txt record f,118 org sq give samp1.sor org sq
INPUT FILE :
        samp1.txt FIXED (118,118) SQ
OUTPUT FILE :
        samp1.sor FIXED (0,0) SQ
SORT FIELDS : (1,5,CH,A,11,4,CH,A)
Sort OK

real    0m4.119s
user    0m1.413s
sys     0m2.700s

prompt$ time ./verify
done

real    0m0.541s
user    0m0.091s
sys     0m0.449s

prompt$ time wc samp1.sor
        0   1000000 118000000 samp1.sor

real    0m1.465s
user    0m1.427s
sys     0m0.036s
```

Respectable numbers. *(on a machine that reports 6800.08 bogomips)*. The sort was verified with a little COBOL program.

The secondary key (11,4,CH,A), gets very litte exercise with this /dev/urandom example. Not many random values spew out with duplicate primary keys (1,5,CH,A). Some, but not many per million; maybe 500ish tests with (by odds, some) 1000 duplicated keys per million urandom records generated. Odds of a triplet key are quite a bit lower.

Treat the code above as a rudimentary performance test, not so much a secondary key accuracy stress test. GCSORT has passed all tests here, however limited.

```
GCSORT*> ****************************************************************
       identification division.
       program-id. verify.

       environment division.
       input-output section.
```

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```
       file-control.
           select inputfile
           assign to "samp1.sor"
           organization is sequential.

       data division.
       file section.
       fd inputfile.
           01 indata pic x(118).

       working-storage section.
       01 lastrec pic x(118).

      *> ****************************************************************
       procedure division.
       open input inputfile
       move low-values to lastrec

       perform forever
           read inputfile
               at end
                   close inputfile
                   display "done" end-display
                   stop run
               not at end
                   if lastrec(1:5) greater than indata(1:5)
                       display
                           "out of ascending order,   primary: "
                           lastrec(1:5) ", " indata(1:32)
                           upon syserr
                       end-display
                   end-if
                   if (lastrec(1:5) equal indata(1:5)) and
                      (lastrec(11:4) greater than indata(11:4))
                       display
                           "out of ascending order, secondary: "
                           lastrec(11:4) ", " indata(1:32)
                           upon syserr
                       end-display
                   end-if
                   move indata to lastrec
           end-read
       end-perform

       goback.
       end program verify.
```

`trunk/tools/gcsort/parser.y` manages the GCSORT command language. Support includes:

```
USE         "USE clause"
GIVE        "GIVE clause"
SORT        "SORT clause"
MERGE       "MERGE clause"
FIELDS      "FIELDS instruction"
RECORD      "RECORD instruction"
ORG         "ORG instruction"
OUTREC      "OUTREC clause"
```

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```
SUM         "SUM clause"
INCLUDE     "INCLUDE clause"
OMIT        "OMIT clause"
COND        "COND clause"
NONE        "NONE clause"
AND         "AND clause"
OR          "OR clause"
```

Many of the those keywords have limited sub options compared to MFSORT or DFSORT.

This utility needs more documentation. Please try it out, before committing to production.

This blurb came in from Bill Woodger on a SourceForge Discussion page.

```
To execute a stand-alone Mainframe SORT, you have a file with a specific
DDName (SYSIN) and containing "Control Cards". Although sometime the DDName
varies, this is typical of a Mainframe Utility.

Micro Focus mimic SORT and other Mainframe utilities to enable
"off-the-Mainframe" development for a Mainframe target.

SORT Control Cards must start with at least one blank.

Generally, things go like this:

 INCLUDE/OMIT FIELDS=(...)
 INREC ....
 SORT/MERGE FIELDS=(...)
 SUM FIELDS=(...)
 OUTREC ...
 OUTFIL ... (which can be multiple)

INCLUDE/OMIT allows selection of the records required for the processing.

INREC allows processing before the SORT/MERGE/COPY takes place.

SORT/MERGE/COPY does what it says on the tin.

SUM does totalling of specified fields, or drops records entirely, for
duplicate keys.

OUTREC allows processing after the SORT/MERGE/COPY has taken place.

OUTFIL allows for final processing, one OUTFIL per file if multiples are
required, with futher selection possible (INCLUDE=/OMIT=).

To get an overview, locate the DFSORT: Getting Started manual with your
favourite search engine. To see the full power, have a look at the DFSORT:
Application Programming Guide.

On the Mainframe, a COBOL SORT or MERGE statement uses the installed SORT
product (usually DFSORT or SyncSORT).
```

Please keep in mind, GCSORT won't be quite as powerful as the software described in the books Bill mentioned. With recent updates by Sauro Menna on Cedric Issaly's original OCSort, GCSORT had become a production quality tool.

5.55 When is Easter?

A short program to display the day of Easter for a given year. *I found out later that this calculation is known as* **the Computus**.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      17-Nov-2008
      *> Purpose:   Display Easter Day for any given year, 1580 - 2050
      *> Tectonics: cobc -x easter.cob
      *>            ./easter [year]
      *> ************************************************************
       identification division.
       program-id. easter.

       data division.
       working-storage section.
       01 a    picture 9(8) usage comp-x.
       01 b    picture 9(8).
       01 c    picture 9(8).
       01 d    picture 9(8).
       01 z    picture 9(8).  *> Why z? COBOL has pi for pi and e for e
       01 f    picture 9(8).
       01 g    picture 9(8).
       01 h    picture 9(8).
       01 i    picture 9(8).
       01 j    picture 9(8).
       01 year picture 9(4).
       01 mo   picture 9(2).
       01 da   picture 9(2).
       01 args picture x(80).

      *> ************************************************************
       procedure division.

       accept args from command-line end-accept
       if args not equal spaces
           move args to year
       else
           display "Year: " with no advancing end-display
           accept year end-accept
       end-if

       compute a = function mod(year 19)           end-compute
       divide  year by 100 giving b remainder c    end-divide
       divide  b    by   4 giving d remainder z    end-divide
       compute f = (b + 8) / 25                    end-compute
       compute g = (b - f + 1) / 3                 end-compute
       compute h = (19 * a) + b - d - g + 15       end-compute
       compute h = function mod(h 30)              end-compute
       divide  c    by   4 giving i remainder j    end-divide
       compute c = (z + i) * 2 + 32 - h - j        end-compute
       compute c = function mod(c 7)               end-compute
       compute b = (a + (11 * h) + (22 * c)) / 451 end-compute
       compute a = h + c - (7 * b) + 114           end-compute
       compute da = function mod(a 31) + 1         end-compute
```

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```
       divide  a    by  31 giving mo               end-divide

       display  "yyyy/mm/dd: " year "/" mo "/" da  end-display
       goback.
       end program easter.

      *> ************************************************************
      *> Snagged from a REBOL script, easter-day.r by Didier Cadieu
      *> http://www.rebol.org/view-script.r?script=easter-day.r
      *>
      *> easter-day: func [
      *>     {Compute the easter date for the wanted year.}
      *>     year [integer!] {Year for whitch you want the easter date}
      *>     /local a b c d z f g h i k
      *> ] [
      *>     a: year // 19
      *>     b: to integer! year / 100
      *>     c: year // 100
      *>     d: to integer! b / 4
      *>     z: b // 4
      *>     f: to integer! b + 8 / 25
      *>     g: to integer! b - f + 1 / 3
      *>     h: 19 * a + b - d - g + 15 // 30
      *>     i: to integer! c / 4
      *>     k: c // 4
      *>     c: z + i * 2 + 32 - h - k // 7
      *>     b: to integer! a + (11 * h) + (22 * c) / 451
      *>     a: h + c - (7 * b) + 114
      *>     to date! reduce [
      *>         a // 31 + 1
      *>         to integer! a / 31
      *>         year
      *>     ]
      *> ]
```

Sample, with and without command line argument.

```
$ cobc -x easter.cob
$ ./easter 2011
yyyy/mm/dd: 2011/04/24
$ ./easter
Year: 2010
yyyy/mm/dd: 2010/04/04
```

5.55.1 Easter program critique

What follows is a warning to those people learning COBOL with the help of this document. The variable names used to implement the algorithm to find Easter day are near to useless as to intent and or reason. It's not good COBOL style and I got called on it. Take the critique for what you will, I took it as 'hey, come on, port better code if you're going to show it off'. Keep in mind that if you are ever fortunate enough to work with core business COBOL, what I got as a critique, could well be an embarrassing drumming from a boss and threats of firings. And as a side-note, be willing to take drummings and learn from them before the threats of firings occur. Programmers should never be defensive over code, but open and willing to better. In this case, the original REBOL is a port from another language based on the anonymous gregorian algorithm submitted to Nature in 1876.

I posted a link to the easter.cob source code above, as a Christmas post on a LinkedIn COBOL group, and got this feedback from Huib Klink; I respect his posts and opinions.

```
It would have been slightly more appropriate to share a COBOL source that
tells when its Christmas. Let my give it a try (Proc. div. only):

 accept args from command-line end-accept
 if args not equal spaces
 move args to year
 else
 display "Year: " with no advancing end-display
 accept year end-accept
 end-if

 move 12 to mo
 move 25 to da
 display "yyyy/mm/dd: " year "/" mo "/" da end-display
 goback.
 end program xmas.

 Hmmmmm. Lot less variables needed so it seems ... should clean up working
 storage, but since I copy/pasted this and don't want (are forbidden) to fix
 what ain't broke I will not change that piece of the program. For sure NOBODY
 will ever need to fix this program anymore so NOBODY will be sitting for hours
 wondering what a is for. Or b. or c. Or ... whatever, I am a programmer and
 thus I am lazy by definition, and I want to turn around that logic so doing no
 clean-up proves my professionalism and eases my job. After all if all
 programmers are lazy, I must be a very good one and

 ...
 (5 minutes contemplating on fuzzy lazy logic)
 ...

 Happy Xmas
```

So, I looked into it, and learned something I find very cool. The calculation has a name and its name is **The Computus**. That's awesome. Sadly, the Anonymous Gregorian algorithm detailed on Wikipedia uses the same useless variable names and the sample remains obfuscated, as I think the original sent into a newspaper in 1876 was intended. See https://en.wikipedia.org/wiki/Computus

5.55.2 A real COBOL Computus

From Paul Chandler during a discussion on LinkedIn in COBOL Profressionals.

This one is nice folks. Defensible.

```
000100 IDENTIFICATION DIVISION.                                         00010025
000200 PROGRAM-ID. RCEASTER.                                            00020025
000300 AUTHOR. PAUL CHANDLER, MARCH 2013.                               00030025
000400**********************************************************        00040025
000500*** THIS PROGRAM CALCULATES THE DATE OF EASTER FOR   ***          00050025
000600*** YEARS IN THE GREGORIAN CALENDAR. IT'S A PORT OF  ***          00060025
000700*** THE DONALD KNUTH ALGORITHM PUBLISHED IN VOLUME 1 ***          00070025
000800*** OF "THE ART OF COMPUTER PROGRAMMING".            ***          00080025
000900***                                                  ***          00090025
001000**********************************************************        00100025
001100 ENVIRONMENT DIVISION.                                            00110025
```

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```
001200 DATA DIVISION.                                                   00120025
001300 FILE SECTION.                                                    00130025
001400 WORKING-STORAGE SECTION.                                         00140025
001500 77  ACCEPT-YEAR            PIC 9(08).                          00150025
001600 01  WORKING-FIELDS     COMP.                                   00160025
001700     05 TGT-YEAR            PIC S9(08).                         00170025
001800     05 GOLDEN-NUMBER       PIC S9(08).                         00180025
001900     05 TGT-CENTURY         PIC S9(08).                         00190025
002000     05 LEAP-YEAR-CRCTN     PIC S9(08).                         00200025
002100     05 MOON-SYNC-CRCTN     PIC S9(08).                         00210025
002200     05 FIRST-SUNDAY        PIC S9(08).                         00220025
002300     05 EPACT               PIC S9(08).                         00230025
002400     05 FULL-MOON           PIC S9(08).                         00240025
002500     05 EASTER-SUNDAY       PIC S9(08).                         00250025
002600 01  DISPLAY-FIELDS.                                            00260025
002700     05 TGT-YEAR-DSP        PIC Z(08)-.                         00270025
002800     05 EASTER-MONTH        PIC X(06).                          00280025
002900     05 EASTER-SUNDAY-DSP   PIC Z(08)-.                         00290025
003000 PROCEDURE DIVISION.                                              00300025
003100     ACCEPT ACCEPT-YEAR.                                         00310025
003200     MOVE ACCEPT-YEAR TO TGT-YEAR TGT-YEAR-DSP                   00320025
003300     IF TGT-YEAR < 1583                                          00330025
003400        DISPLAY "YEAR MUST BE 1583 OR GREATER"                   00340025
003500        STOP RUN                                                 00350025
003600     ELSE                                                        00360025
003700        DISPLAY "EASTER DATE FOR:" TGT-YEAR-DSP                  00370025
003800     END-IF                                                      00380025
003900     COMPUTE GOLDEN-NUMBER   = FUNCTION MOD(TGT-YEAR, 19) + 1    00390025
004000     COMPUTE TGT-CENTURY     = (TGT-YEAR / 100) + 1              00400025
004100     COMPUTE LEAP-YEAR-CRCTN = (3 * TGT-CENTURY / 4) - 12        00410025
004200     COMPUTE MOON-SYNC-CRCTN = ((8 * TGT-CENTURY + 5) / 25) - 5  00420025
004300     COMPUTE FIRST-SUNDAY    =                                   00430025
004400         (5 * TGT-YEAR / 4)- LEAP-YEAR-CRCTN - 10                00440025
004500*****************************************************            00450025
004600*     TO MAKE THE EPACT CALCULATION MORE READABLE,    *           00460025
004700* THE COMPUTATION WILL BE DONE IN STAGES.             *           00470025
004800*****************************************************            00480025
004900*                                                                 00490025
005000* STAGE #1: GET THE RAW NUMBER.....                   *           00500025
005100*                                                                 00510025
005200     COMPUTE EPACT =                                             00520025
005300         (11 * GOLDEN-NUMBER)                                    00530025
005400        + 20                                                     00540025
005500        + MOON-SYNC-CRCTN                                        00550025
005600        - LEAP-YEAR-CRCTN                                        00560025
005700*                                                                00570025
005800* STAGE #2: GET THE MOD 30 VALUE...                   *           00580025
005900*                                                                 00590025
006000     COMPUTE EPACT = FUNCTION MOD(EPACT, 30)                     00600025
006100*                                                                00610025
006200* STAGE #3: TO ENSURE THAT EPACT IS A POSITIVE NBR,   *           00620025
006300*           ADD 30 AND MOD 30 AGAIN.                  *           00630025
006400*                                                                00640025
006500     ADD 30 TO EPACT                                             00650025
006600     COMPUTE EPACT = FUNCTION MOD(EPACT, 30)                     00660025
006700*                                                                00670025
006800* ADJUST FOR YEARS WHEN ORTHODOX DIFFERS              *           00680025
```

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```
006900*                                                                 00690025
007000     IF (EPACT = 25 AND GOLDEN-NUMBER > 11)                       00700025
007100     OR (EPACT = 24)                                              00710025
007200        ADD 1 TO EPACT                                            00720025
007300     END-IF                                                       00730025
007400*                                                                 00740025
007500* NEXT 2 STATEMENTS FIND FIRST FULL MOON AFTER MAR.21*            00750025
007600*                                                                 00760025
007700     SUBTRACT EPACT FROM 44 GIVING FULL-MOON                      00770025
007800     IF  EPACT  > 23                                              00780025
007900         ADD 30 TO FULL-MOON                                      00790025
008000     END-IF                                                       00800025
008100*                                                                 00810025
008200* ADVANCE SUNDAY TO THE FIRST SUNDAY AFTER FULL MOON *            00820025
008300*                                                                 00830025
008400     COMPUTE EASTER-SUNDAY =                                      00840025
008500         FULL-MOON                                                00850025
008600       + 7                                                        00860025
008700       - (FUNCTION MOD((FIRST-SUNDAY + FULL-MOON), 7))            00870025
008800*                                                                 00880025
008900* IF EASTER-SUNDAY > 31, EASTER IS IN APRIL - MOVE THE            00890025
009000* MONTH TO APRIL AND SUBTRACT 31 FROM EASTER-SUNDAY.              00900025
009100* OTHERWISE EASTER IS IN MARCH, USE THE DAY AS IS.                00910025
009200*                                                                 00920025
009300     IF  EASTER-SUNDAY > 31                                       00930025
009400         MOVE 'APRIL' TO EASTER-MONTH                             00940025
009500         SUBTRACT 31 FROM EASTER-SUNDAY                           00950025
009600     ELSE                                                         00960025
009700         MOVE 'MARCH' TO EASTER-MONTH                             00970025
009800     END-IF                                                       00980025
009900     MOVE EASTER-SUNDAY TO EASTER-SUNDAY-DSP                      00990025
010000     DISPLAY EASTER-MONTH EASTER-SUNDAY-DSP                       01000025
010100     STOP RUN.                                                    01010025
```

Tectonics are a simple **cobc -x rceaster.cob**. ACCEPTs the year.

```
$ ./rceaster
2013
EASTER DATE FOR:    2013
MARCH       31
```

Thanks Paul.

5.55.3 Another Computus

Thanks to daniel b, who listed a solution and the ensuing discussion on LinkedIn:

```
daniel b.:
... in a moment of madness ... about 20 years later ... compiles and runs
on your OpenCobol 1.1 ... now that I found out that I need gmp not to segfault
...  ;-)

Brian Tiffin:
daniel; Can I steal this for the OpenCOBOL FAQ?
Am I correct in assuming you wrote this Computus solution some 20 years
```

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```
ago, and this is a recent port to OpenCOBOL?

daniel b.:
@Brian Tiffin ? daniel; Can I steal this for the OpenCOBOL FAQ?

Sure

@Brian Tiffin ? Am I correct in assuming you wrote this Computus solution
some 20 years ago, and this is a recent port to OpenCOBOL?

No, I just looked at the table of the Meeus? book citation, in the wiki and
wrote it from scratch. 20 years ago is the last time I touched COBOL, but
since I used it for 15 years before, it kind like sticks, LOL.
```

Here is another COBOL solution to the Computus.

```
GCobol*
      * 2/15/2013 Adapted by daniel for OpenCobol 1.1 Compiler, from:
      * https://en.wikipedia.org/wiki/Computus#cite_note-otheralgs-45
      *
      * From Wikipedia: "Anonymous Gregorian algorithm:
      * 'A New York correspondent' submitted this algorithm for determining
      *   the Gregorian Easter to the journal Nature in 1876.[39][40]
      * It has been reprinted many times, in 1877 by Samuel Butcher in
      * The Ecclesiastical Calendar,[41]:225 in 1922 by H. Spencer Jones in
      * General Astronomy,[42] in 1977 by the Journal of the
      * British Astronomical Association,[43] in 1977 by The Old Farmer's Almanac,
      * in 1988 by Peter Duffett-Smith in Practical Astronomy with your Calculator,
      * and in 1991 by Jean Meeus in Astronomical Algorithms.[44]
      * Because of the Meeus' book citation, that is also called
      * 'Meeus/Jones/Butcher' algorithm"
      *
      * 2/16/2013 Added command line passing parameter, method from
      * Brian Tiffin example, hoping he won't mind ;-)
      * http://opencobol.add1tocobol.com/#when-is-easter
      *
      * 2/18/2013 Added rejection of years before 1582, on Paul Chandler
      * suggestion thank you, I missed that part
      *
      * 2/19/2013 Attempt to make more readable, reduced useless operations,
      * needs more work.
      * Changed names of some variables, based on:
      * http://www.linuxtopia.org/online_books/programming_books/
      *        python_programming/python_ch38.html
      *
      * 2/20/2013 Added comments on formula, eliminated all compute:
      * http://www.jones0086.freeserve.co.uk/b123sen.htm
      *
      * 2/22/2013 Added writeout to file complete table of easter occurrences,
      * selected using year 0000 as passing parameter
      *
      * 2/25/2013 Tried on windows
      *
       IDENTIFICATION DIVISION.
       PROGRAM-ID. easter.
      *
       ENVIRONMENT DIVISION.
```

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```
      *
       CONFIGURATION SECTION.
      *
       INPUT-OUTPUT SECTION.
      *
       FILE-CONTROL.
       SELECT OPTIONAL OUT-FILE ASSIGN TO "easter-out.txt"
           ORGANIZATION IS LINE SEQUENTIAL
           ACCESS MODE IS SEQUENTIAL.
      *
       I-O-CONTROL.
      *
       DATA DIVISION.
      *
       FILE SECTION.
      *
       FD  OUT-FILE
           LABEL RECORDS ARE STANDARD.
           01  OUT-RECORD.
           05  RECORD-DATA PIC X(11) VALUE SPACES.
           05  RECORD-END-RET PIC X VALUE X'0d'.
           05  RECORD-END-LF PIC X VALUE X'0a'.
      *
       WORKING-STORAGE SECTION.
      *
       77  SELECTED-YEAR PIC 9999 VALUE ZERO.
       77  X PIC 9999 VALUE ZERO.
       77  Y PIC 9999 VALUE ZERO.
       77  METONIC-GOLDEN-NUMBER PIC 99 VALUE ZERO.
       77  CENTURY PIC 99 VALUE ZERO.
       77  YEAR-IN-CENTURY PIC 99 VALUE ZERO.
       77  LEAP-TEST400 PIC 99 VALUE ZERO.
       77  LEAP-TEST40 PIC 99 VALUE ZERO.
       77  MOON-SYNC1 PIC 99 VALUE ZERO.
       77  MOON-SYNC2 PIC 99 VALUE ZERO.
       77  EPACT PIC 99 VALUE ZERO.
       77  LEAP4 PIC 99 VALUE ZERO.
       77  LEAP4-OFFSET PIC 99 VALUE ZERO.
       77  ADVANCE-TO-SUNDAY PIC 99 VALUE ZERO.
       77  M PIC 99 VALUE ZERO.
       77  COMPUTED-MONTH PIC 99 VALUE ZERO.
       77  COMPUTED-DAY PIC 99 VALUE ZERO.
      *
       01  WS-TABLE VALUE ZEROS.
               03 WS-MONTH PIC XXX
                   OCCURS 12 TIMES.
      *
       77  ARGS PIC X(80) VALUE SPACES.
      *
       77  LOOP-FLAG PIC 9 VALUE ZERO.
      *
       01 WS-OUT-RECORD.
           05 WS-OUT-DAY PIC XX VALUE SPACES.
                 05 FILLER PIC X VALUE "-".
           05 WS-OUT-MONTH PIC XXX VALUE SPACES.
           05 FILLER PIC X VALUE "-".
           05 WS-OUT-YEAR PIC XXXX VALUE SPACES.
```

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```
      *
       PROCEDURE DIVISION.
      *
       000-WS-TABLE-CTL.
       MOVE "JAN" TO WS-MONTH(1)
       MOVE "FEB" TO WS-MONTH(2)
       MOVE "MAR" TO WS-MONTH(3)
       MOVE "APR" TO WS-MONTH(4)
       MOVE "MAY" TO WS-MONTH(5)
       MOVE "JUN" TO WS-MONTH(6)
       MOVE "JUL" TO WS-MONTH(7)
       MOVE "AUG" TO WS-MONTH(8)
       MOVE "SEP" TO WS-MONTH(9)
       MOVE "OCT" TO WS-MONTH(10)
       MOVE "NOV" TO WS-MONTH(11)
       MOVE "DEC" TO WS-MONTH(12).
      *
       010-ARGS-CTL.
       ACCEPT ARGS FROM COMMAND-LINE.
       IF ARGS EQUAL 0000
           MOVE 1583 TO SELECTED-YEAR
           MOVE 1 TO LOOP-FLAG
           OPEN EXTEND OUT-FILE
           GO TO 105-METONIC-GOLDEN-NUMBER-CTL.
       IF ARGS NOT EQUAL SPACES
           MOVE ARGS TO SELECTED-YEAR
           GO TO 100-CHECK-YEAR-CTL.
       DISPLAY " " END-DISPLAY.
       DISPLAY "Gregorian Easter computation from year 1583 to 9999".
      *
       020-START-CTL.
       DISPLAY "Enter Year (YYYY): " WITH NO ADVANCING END-DISPLAY.
       ACCEPT SELECTED-YEAR FROM CONSOLE.
      *
       100-CHECK-YEAR-CTL.
       IF SELECTED-YEAR IS LESS THAN 1583
           DISPLAY "Invalid year, use year past 1582 " END-DISPLAY
           GO TO 020-START-CTL.
      *
       105-METONIC-GOLDEN-NUMBER-CTL.
       DIVIDE SELECTED-YEAR BY 19 GIVING X
           REMAINDER METONIC-GOLDEN-NUMBER
           ON SIZE ERROR GO TO 020-START-CTL END-DIVIDE.
      *
       110-CENTURY-CTL.
       DIVIDE SELECTED-YEAR BY 100 GIVING CENTURY
           REMAINDER YEAR-IN-CENTURY
           ON SIZE ERROR GO TO 020-START-CTL END-DIVIDE.
      *
       120-LEAP-TEST-CTL.
       DIVIDE CENTURY BY 4 GIVING LEAP-TEST400 REMAINDER LEAP-TEST40
           ON SIZE ERROR GO TO 020-START-CTL END-DIVIDE.
      *
       125-MOON-SYNC1-CTL.
      * formula MOON-SYNC1 = (CENTURY + 8) / 25
       ADD 8 TO CENTURY GIVING X
       DIVIDE X BY 25 GIVING MOON-SYNC1
```

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```
           ON SIZE ERROR GO TO 020-START-CTL.
      *
       130-MOON-SYNC2-CTL.
       COMPUTE MOON-SYNC2 = (CENTURY - MOON-SYNC1 + 1) / 3
           ON SIZE ERROR GO TO 020-START-CTL.
      *
       135-EPACT-SYNC-CTL.
      * formula EPACT = ((19 * METHONIC-GOLDEN-NUMBER) + CENTURY -
      *                   LEAP-TEST400  - MOON-SYNC2 + 15) mod 30
       MULTIPLY 19 BY METONIC-GOLDEN-NUMBER GIVING X
       ADD CENTURY TO X GIVING X
       SUBTRACT LEAP-TEST400 FROM X GIVING X
       SUBTRACT MOON-SYNC2 FROM X GIVING X
       ADD 15 TO X GIVING X
       DIVIDE X BY 30 GIVING X REMAINDER EPACT
           ON SIZE ERROR GO TO 020-START-CTL END-DIVIDE.
      *
       140-LEAP4-CTL.
       DIVIDE YEAR-IN-CENTURY BY 4 GIVING LEAP4
           REMAINDER LEAP4-OFFSET
           ON SIZE ERROR GO TO 020-START-CTL END-DIVIDE.
      *
       150-ADVANCE-TO-SUNDAY-CTL.
      * formula ADVANCE-TO-SUNDAY = (32 + 2 * (LEAP-TEST40 + 2) + 2 * (YEAR-IN-CENTURY
      * / 4) - EPACT - K) mod 7
       MULTIPLY 2 BY LEAP-TEST40 GIVING X
       ADD 32 TO X GIVING X
       MULTIPLY 2 BY LEAP4 GIVING Y
       ADD Y TO X GIVING X
       SUBTRACT EPACT FROM X GIVING X
       SUBTRACT LEAP4-OFFSET FROM X GIVING X
       DIVIDE X BY 7 GIVING X REMAINDER ADVANCE-TO-SUNDAY
           ON SIZE ERROR GO TO 020-START-CTL END-DIVIDE.
      *
       160-M-CTL.
      * formula M = (METONIC-GOLDEN-NUMBER + (11 * EPACT)
      *             + (22 * ADVANCE-TO-SUNDAY)) / 451
       MULTIPLY 11 BY EPACT GIVING X
       ADD METONIC-GOLDEN-NUMBER TO X GIVING X
       MULTIPLY 22 BY ADVANCE-TO-SUNDAY GIVING Y
       ADD Y TO X GIVING X
       DIVIDE X BY 451 GIVING M
           ON SIZE ERROR GO TO 020-START-CTL END-DIVIDE.
      *
       200-COMPUTED-MONTH-CTL.
      * formula COMPUTED-MONTH = ((EPACT + ADVANCE-TO-SUNDAY - (7 * M) + 114) / 31)
       MULTIPLY 7 BY M GIVING X
       ADD EPACT TO ADVANCE-TO-SUNDAY GIVING Y
       SUBTRACT X FROM Y GIVING Y
       ADD 114 TO Y GIVING X
       DIVIDE X BY 31 GIVING COMPUTED-MONTH
           ON SIZE ERROR GO TO 020-START-CTL END-DIVIDE.
      *
       300-COMPUTED-DAY-CTL.
      * formula COMPUTED-DAY = ((EPACT + ADVANCE-TO-SUNDAY - (7 * M) + 114) mod 31) +␣
↪1
       MULTIPLY 7 BY M GIVING X
```

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```
       ADD EPACT TO ADVANCE-TO-SUNDAY GIVING Y
       SUBTRACT X FROM Y GIVING Y
       ADD 114 TO Y GIVING X
       DIVIDE X BY 31 GIVING X REMAINDER Y
       ADD 1 TO Y GIVING COMPUTED-DAY
           ON SIZE ERROR GO TO 020-START-CTL.
      *
       400-PRINT-TABLE-CTL.
       MOVE COMPUTED-DAY TO WS-OUT-DAY.
       MOVE WS-MONTH(COMPUTED-MONTH) TO WS-OUT-MONTH.
       MOVE SELECTED-YEAR TO WS-OUT-YEAR.
       MOVE WS-OUT-RECORD TO OUT-RECORD.
       IF LOOP-FLAG EQUAL TO 1 WRITE OUT-RECORD.
       IF SELECTED-YEAR EQUAL TO 9999 AND LOOP-FLAG EQUAL TO 1
           CLOSE OUT-FILE.
      *
       500-LOOP-CTL.
       IF SELECTED-YEAR EQUAL TO 9999 AND LOOP-FLAG EQUAL TO 1
         MOVE 0 TO LOOP-FLAG
         GO TO 700-STOP.
       IF LOOP-FLAG EQUAL TO 1
           ADD 1 TO SELECTED-YEAR GIVING SELECTED-YEAR
           GO TO 105-METONIC-GOLDEN-NUMBER-CTL.
      *
       600-EXIT.
      *
       DISPLAY " " END-DISPLAY.
       DISPLAY "Easter day for year " SELECTED-YEAR ": " END-DISPLAY.
       DISPLAY COMPUTED-DAY "-" WS-MONTH(COMPUTED-MONTH) "-"
       SELECTED-YEAR END-DISPLAY.
       DISPLAY " " END-DISPLAY.
      *
       700-STOP.
       STOP RUN.
      *
```

Tectonics once again, a simple **cobc -x dbeaster.cob**.

```
$ ./dbeaster

Gregorian Easter computation from year 1583 to 9999
Enter Year (YYYY): 2013

Easter day for year 2013:
31-MAR-2013

$ ./dbeaster

Gregorian Easter computation from year 1583 to 9999
Enter Year (YYYY): 3013

Easter day for year 3013:
18-APR-3013
```

Thanks to Daniel. *Note, I already had easter.cob, so this one is dbeaster.cob for the FAQ.*

5.56 Does Vim support GnuCOBOL?

Very well. See *cobol.vim* (page 1334) for a syntax highlighter tuned for GnuCOBOL.

Vim's Visual Block mode can be very handy at reforming COBOL source code.

Author's choice. gcfaq.rst is edited using Vim, Bram Moolenaar's **vi** enhancement. See below for some settings that can make GnuCOBOL more productive.

5.56.1 vim code completion

For code completion (Ctrl-P while in insert mode) start by creating a reserved word list using your **cobc** command

```
$ cobc --list-reserved | tail -n+3 | cut -f1 >~/.vim/ocreserved.lis
```

followed by this change in ~/.vimrc

```
:set ignorecase
:set infercase
:set complete=k~/.vim/ocreserved.lis
```

5.56.2 freedom

To free the cursor (allowing the cursor to travel past line endings) use:

```
:set virtualedit=all
```

5.56.3 autoload a skeleton

For a quick template when starting a new file (in .vimrc, change the filename *~/lang/cobol/headfix.cob* to where you keep your favourite COBOL starter skeleton).

```
" Auto load COBOL template
autocmd BufNewFile  *.cob      0r ~/lang/cobol/headfix.cob
```

5.56.4 elvis

elvis is an early fork of **vi**, and heavily influenced the development of vim.

Vim has *surpassed* **elvis**, perhaps, but elvis includes features that can come in very handy for certain editing tasks. **elvis** includes different display modes, including html, tex, syntax, and even a hex edit mode.

See *Elvis support for GnuCOBOL* (page 1385) for a sytax highlighter for **elvis**.

Useful when hunting down misaligned UTF-8, and other hidden byte issues in text files, especially after a platform transfer. Anyone familiar with Vim, should have a copy of elvis installed, for those *special* times.

5.57 What is w3m?

w3m is a text based web browser. GnuCOBOL can leverage some of the power of this application by directly calling it with SYSTEM.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      30-Dec-2008
      *> Purpose:   Textualize a webpage
      *> Tectonics: cobc -x w3mcaller.cob
      *>            ./w3mcaller opencobol.org
      *> ************************************************************
       identification division.
       program-id. w3mcaller.

       data division.
       working-storage section.
       01 args         pic x(256).
       01 command      pic x(256).
       01 result       usage binary-long.

      *> ************************************************************
       procedure division.
       accept args from command-line.

       string
           "w3m -dump " delimited by size
           function trim(args) delimited by size
           into command
       end-string
       call "SYSTEM" using command returning result end-call

       goback.
       end program w3mcaller.
```

Sample run on 28-Feb-2010:

```
$ ./w3mcaller opencobol.org

[logo]
[arrow] HOME    [arrow] NEWS    [arrow] FORUM   [arrow] D       [arrow] LINK
                                                OWNLOAD
OpenCOBOL - an open-source COBOL compiler
                [arrow] Welcome to the OpenCOBOL Website!
                OpenCOBOL is an open-source COBOL compiler.
[arrow] Main    OpenCOBOL implements a substantial part of the
Menu            COBOL 85 and COBOL 2002 standards, as well as
Home News Wiki  many extensions of the existent COBOL
Forum Downloads compilers.
Links                                                           [arrow] Search
*               OpenCOBOL translates COBOL into C and compiles  [               ]
[arrow]         the translated code using the native C          [Search]
Download        compiler. You can build your COBOL programs on  Advanced Search
                various platforms, including Unix/Linux, Mac OS [arrow] Login
  • OpenCOBOL   X, and Microsoft Windows.                       Username:
    1.0                                                         [               ]
  • OpenCOBOL   The compiler is licensed under GNU General      Password:
    1.1         Public License.                                 [               ]
    pre-release The run-time library is licensed under GNU      [User Login]
                Lesser General Public License.                  Lost Password?
*
```

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```
[arrow]          [arrow] Recent News                                  Register now!
Documentation                                                         [arrow] Recent
                   • OpenCOBOL 1.0 released (2007/12/27)              Links
  • FAQ
  • Features     [arrow] Recent Topics                                  • J&C
  • Install        Forum       Topic      Replies Views     Last        Migrations
    Guide                                                  Post        (2008/12/10)
  • User Manual            using gui                     2010/2/     • COBOL Data
                 OpenCOBOL interface        18     733  28 10:12       Correlation
*                                                        federico      a... (2006/9
[arrow]                  SET index-var                  2010/2/       /21)
Development      OpenCOBOL TO DISP-FIELD     2     99   27 18:53     • COBOL User
                                                         wmklein       Groups :
  • SourceForge          implementation                 2010/2/       COBU...
  • Mailing      OpenCOBOL of ocsort         7     308   27 5:15      (2006/1/17)
    List                                                 btiffin     • The Kasten
  • Tasks                select fname                   2010/2/       COBOL Page
                 OpenCOBOL clause,           9     426  26 14:26      (2005/9/8)
*                        Variable value                    shaj     • Die COBOL
[arrow] Who's            as filename                                   Connection
Online                                                   2010/2/       (2005/9/8)
12 user(s) are   OpenCOBOL Benchmarks        5     285  24 23:45     • University
online                                                   btiffin       of Limerick
                                                         2010/2/       (2005/9/8)
Members: 1       OpenCOBOL Default Colour    7     327  21 15:32     • Stefans
Guests: 11                                                 jgt         kleiner
                         OpenCOBOL 1.1                   2010/2/       COBOL Wo...
clemcoll,        OpenCOBOL compiler          8     451  20 21:52      (2005/9/8)
more...                  listing                         btiffin     • COBOL Web
*                        MOVE loops                      2010/2/       Development
[arrow] Powered  OpenCOBOL when operands     9     443  20 20:39      (2005/6/8)
by                       are overlaying                    human     • Kobol
  SourceForge            [solved]                                      Kompany
                         0MQ (zeromq),                   2010/2/       (2005/6/8)
     Xoops       OpenCOBOL network           3     223  20 15:12     • CoCoLab
                         messaging and                   btiffin       (2005/6/8)
   Creative              OpenCOBOL
    Commons              Conversion
                         story from                      2010/2/
*                OpenCOBOL MicroFocus to    10     768  20 12:23
                         OC, on SUSE                       simrw
                         11.2
                 Visit Forums

        Copyright (C) 2005 The OpenCOBOL Project. All rights reserved.
                   Powered by Xoops2 | PHP | MySQL | Apache
                                ocean-net
```

5.58 What is COB_LIBRARY_PATH?

If the *DSO* (page 1319) files are not in the current working directory along with the executable, the COB_LIBRARY_PATH can be set to find them.

On GNU/Linux and bash it could be

```
export COB_LIBRARY_PATH=/home/developer/ocnewstuff:/home/developer/ocstuff
```

to search for *DSO* (page 1319) files in directories **ocnewstuff** then **ocstuff**, giving your testing versions priority during development.

5.59 Can GnuCOBOL interface with Rexx?

Yes, both Regina Rexx and Open Object Rexx can be embedded directly in GnuCOBOL and be extended with GnuCOBOL modules.

March 2017, update: There is a new branch of pre-release GnuCOBOL 2, it includes an option `./configure --with-rexx` that will build `REXX()` and `REXX-UNRESTRICTED()` Intrinsic Functions into the `cobc` compiler and `libcob` runtime.

The original integration trials that eventually led to inclusion of the REXX optional Intrinsic Functions are included below in *Open Object Rexx* (page 880) and *Regina Rexx* (page 907).

5.59.1 Intrinsic REXX

There are plans in motion to provide REXX scripting as a builtin GnuCOBOL intrinsic function.

Snag a copy of GnuCOBOL from SVN and change to the `gnucobol-builtin-script` branch. Follow most of the normal source build instructions with `--with-rexx` passed to `./configure`.

Prerequisites include Regina REXX (with the `libregina` dynamic shared object library in the linker search path). Regina REXX was started by Anders Christensen in 1992, and is currently maintained by Mark Hessling (of *THE* (page 166) fame, a mainframe inspired text editor with integrated REXX support).

See:

- http://regina-rexx.sourceforge.net/
- https://sourceforge.net/projects/regina-rexx/

For many systems binary installers already exist. Regina is a very well established and oft ported implementation of REXX. For example, with Ubuntu GNU/Linux it is as simple as:

```
prompt$ sudo apt install regina-rexx libregina3 libregina3-dev
```

Building Intrinsic REXX into GnuCOBOL is then:

```
prompt$ ./configure --with-rexx --with-vbisam
prompt$ make
prompt$ make check
prompt$ sudo make install
prompt$ sudo ldconfig
```

You will now have a REXX ready version of GnuCOBOL.

```
       identification division.
       program-id. intrinsic-rexx.
       author. Brian Tiffin.
       date-written. 2017-03-07/03:42-0500.
       date-modified. 2017-03-12/19:24-0400.
       date-compiled.
       installation. Requires a build with --with-rexx and libregina.
```

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```
       remarks. Rexx source evaluation, ALPHANUMERIC field returned.
       security. An embedded interpretter, use trusted sources.

       REPLACE ==newline== BY ==& x"0a" &==.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 answer pic 9(5).

      *> ****************************************************************
       procedure division.

      *> Hello, with an argument passed to Rexx
       perform 2 times
       display rexx("say 'Hello, REXX';" &
                    " parse arg a1; say arg(); say a1;" &
                    " return 'Hello, COBOL';", "test")
       end-perform
       display space

      *> invalid script data type
       display ":" rexx(1, 2) ":"
       perform soft-exception
       display space

      *> More arguments
       display rexx("say 'Hello, a second time';" &
                    " parse arg a1, a2, a3;" &
                    " say arg() a1 a2 a3;" &
                    " return 'Hello, again';", 1, 2, "abc")
       display space

      *> a little bit of realistic Rexx
       move rexx("delim = ';'" newline
           "parse arg theline" newline
           "do i = 1 by 1 while theline <> '' " newline
           "    parse var theline w.i (delim) theline" newline
           "end" newline
           "w.0 = i - 1" newline
           "do i = 1 to w.0" newline
           "    say w.i" newline
           "end" newline
           "return w.0",
           "this;is;a;test;of;parsing;to;a;stem;variable")
         to answer
       display answer " components"
       display space

      *> Some math
       move rexx("return arg(1) * 6", 7) to answer
       display "Ultimate answer: " answer
       display space
```

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```
      *> One way of sharing value between scripts is to use the stack
       display rexx(
           "a = 'abc'" newline
           "push a" newline
           "return a")
       display rexx(
           "pull a" newline
           "return a || 'def'")

      *> Some REXX date and string formatting features
       display rexx(
           "/* get year, month, and day of month */" newline
           "parse value date('Standard') with yr 5 ." newline
           "return right(time( 'Civil'), 8)," newline
           " || center(date('Month'), 38)," newline
           " || substr(yr, 3)'.'right(date('Dayofyear'), 3, '0')")

      *> And a system command
       display rexx("address SYSTEM; 'ls *.cob'; return 'Nice'")

       goback.
      *> ****************************************************************

       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:

       end program intrinsic-rexx.
      *> ****************************************************************
      *>****
>>ELSE
!doc-marker!
==============
intrinsic-rexx
==============
```

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```
.. contents::

Introduction
------------
Embedding Regina Rexx as a GnuCOBOL "intrinsic" function.

Tectonics
---------

::

    prompt$ ./configure --with-rexx
    prompt$ make
    prompt$ make check
    prompt$ sudo make install
    prompt$ sudo ldconfig

    prompt$ cobc -xj intrinsic-rexx.cob

Usage
-----

See http://regina-rexx.sourceforge.net/ for all the details of programming
with Regina Rexx.

Use rexx("script", ["args"...,]) as you would any other GnuCOBOL intrinsic
function (that returns an ALPHANUMERIC field).  For use with computational
COBOL verbs, wrap the REXX() function in NUMVAL().

.. codeblock:: cobolfree

    MOVE rexx("return arg(1) * arg(2)", 6, 7) TO answer
    COMPUTE answer = numval(rexx("return 42"))


Source
------

.. include::  intrinsic-rexx.cob
   :code: cobolfree
>>END-IF
```

Try that code out with:

```
prompt$ cobc -xj intrinsic-rexx.cob

Hello, REXX
1
test
Hello, COBOL
Hello, REXX
1
test
Hello, COBOL

::
```

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```
--Exception Report--
Time of exception:   2017031904160677-0400
Module:              intrinsic-rexx
Module-path:         /home/btiffin/wip/writing/gcfaq/listings/intrinsic-rexx
Module-source:       intrinsic-rexx.cob
Exception-file:      00
Exception-status:    EC-ARGUMENT-FUNCTION
Exception-location:
Exception-statement:

Hello, a second time
3 1 2 abc
Hello, again

this
is
a
test
of
parsing
to
a
stem
variable
00010 components

Ultimate answer: 00042

abc
ABCdef
  4:16am                March                 17.078
intrinsic-rexx.cob  libcobjna.cob  telco5.cob telco.cob
Nice
```

That is all that is required for adding programmability to a GnuCOBOL application now. No compile time options required, or special runtime settings, it's all built in.

Some notes: REXX is very much a string oriented scripting language. Parameters are passed as character data. Results are character data.

To use `rexx()` with computational verbs, simply wrap the result with *FUNCTION NUMVAL* (page 475).

```
01 taxrate pic 999v999.

compute taxrate = numval(rexx(
    "address REXX; 'fetchrates.rexx' ARG(1)",
    "Ontario")) / 100.0
```

RESTRICTED mode REXX

Safer REXX scripting is the default. Full featured REXX is available with the `rexx-unrestricted()` intrinsic function. RESTRICTED mode disables:

- LINEOUT, CHAROUT, POPEN, RXFUNCADD BIFs
- "OPEN WRITE", "OPEN BOTH" subcommands of STREAM BIF

- The "built-in" environments eg. SYSTEM, CMD or PATH of ADDRESS command
- Setting the value of a variable in the external environment with VALUE BIF.
- Calling external functions

BIF Built In Function

rexxapi.cpy

When configured with `--with-rexx`, a system copy book will be available in the default compiler search path. `rexxapi.cpy`. This defines constants for error codes and a special `EXTERNAL` variable that is set to the REXX result code from script evaluation. `SCRIPT-RETURN-CODE` is defined as a binary field, sized as a *C* `long`, `BINARY-C-LONG`.

REXX instructions

Regina REXX (since version 3.1) supports the current ANSI standard *ANSI X3.274–1996 "Information Technology – Programming Language REXX"*.

Along with the standard, Regina also includes some extensions.

The following instructions are all recognized, and handled according to ANSI standard:

- ADDRESS
- ARG
- CALL
- DO/END
- DROP
- EXIT
- IF/THEN/ELSE
- INTERPRET
- ITERATE
- LEAVE
- NOP
- NUMERIC
- OPTIONS
- PARSE
- PROCEDURE
- PULL
- PUSH
- QUEUE
- RETURN
- SAY
- SELECT/WHEN/OTHERWISE
- SIGNAL
- TRACE
- UPPER

Special Variables

Regina tracks the following local Scope special variables:

- RC
- RESULT

- SIGL

Regina also sets the following global scope read-only special variables:

- .MN
- .RC
- .RS
- .RESULT
- .LINE (extension)
- .FILE (extension)
- .ENDOFLINE (extension)

Functions

Regina supports the following ANSI 1996 standard functions:

- ABBREV
- ABS
- ADDRESS
- ARG
- B2X
- BITAND
- BITOR
- BITXOR
- C2D
- C2X
- CENTER
- CHANGESTR
- CHARIN
- CHAROUT
- CHARS
- COMPARE
- CONDITION
- COPIES
- COUNTSTR
- D2C
- D2X
- DATATYPE
- DATE
- DELSTR
- DELWORD
- DIGITS
- ERRORTEXT
- EXTERNALS
- FIND
- FORM
- FORMAT
- FUZZ
- INDEX
- INSERT
- JUSTIFY
- LASTPOS
- LEFT
- LENGTH
- LINEIN

- LINEOUT
- LINES
- LINESIZE
- MAX
- MIN
- OVERLAY
- POS
- QUALIFY
- QUEUED
- RANDOM
- REVERSE
- RIGHT
- SIGN
- SOURCELINE
- SPACE
- STREAM
- STRIP
- SUBSTR
- SUBWORD
- SYMBOL
- TIME
- TRACE
- TRANSLATE
- TRUNC
- USERID
- VALUE
- VERIFY
- WORD
- WORDINDEX
- WORDLENGTH
- WORDPOS
- WORDS
- X2B
- X2C
- X2D
- XRANGE

Along with the standard functions Regina supports a wide gamut of extensions.

- B2C
- BEEP
- BITCHG
- BITCLR
- BITCOMP
- BITSET
- BITTST
- BUFTYPE
- C2B
- CD
- CHDIR
- CLOSE
- COMPRESS
- CRYPT
- DESBUF
- DIRECTORY

- DROPBUF
- EOF
- EXISTS
- EXPORT
- FILESPEC
- FIND
- FORK
- FREESPACE
- GETCALLER
- GETCALLSTACK
- GETENV
- GETPID
- GETSPACE
- GETTID
- HASH
- IMPORT
- INDEX
- JUSTIFY
- LOWER
- MAKEBUF
- OPEN
- POOLID
- POPEN
- PUTENV
- RANDU
- READCH
- READLN
- RXFUNCADD
- RXFUNCDROP
- RXFUNCERRMSG
- RXFUNCQUERY
- RXQUEUE
- SEEK
- SHOW
- SLEEP
- STATE
- STORAGE
- TRIM
- UNAME
- UNIXERROR
- UPPER
- USERID
- WRITECH
- WRITELN

Many extensions to the Regina BIF list require explicit enabling via an `OPTIONS` instruction. Regina extensions are on by default, but the handy AREXX extensions require:

```
OPTIONS AREXX_BIFS
```

Regina REXX options

The `OPTIONS` instruction accepts:

- AREXX_BIFS
- AREXX_SEMANTICS
- BUFTYPE_BIF
- CACHEEXT
- CALLS_AS_FUNCS
- DESBUF_BIF
- DROPBUF_BIF
- EXT_COMMANDS_AS_FUNCS
- FAST_LINES_BIF_DEFAULT
- FLUSHSTACK
- HALT_ON_EXT_CALL_FAIL
- INTERNAL_QUEUES
- LINEOUTTRUNC
- MAKEBUF_BIF
- PRUNE_TRACE
- QUEUES_301
- REGINA_BIFS
- SINGLE_LINE_COMMENTS
- STDOUT_FOR_STDERR
- STRICT_ANSI
- STRICT_WHITE_SPACE_COMPARISONS
- TRACE_HTML

Combination OPTIONS include:

- ANSI (STRICT_ANSI, STRICT_WHITE_SPACE_COMPARISON)
- BUFFERS (BUFTYPE_BIF, DESBUF_BIF, DROPBUF_BIF, MAKEBUF_BIF)

Each of these can be proceeded by NO to turn off an option. For instance, REGINA_BIFS is on by default, and to disable the Regina extended built in functions, use

```
OPTIONS NOREGINA_BIFS
```

Conditions

The following condition names are recognized and can be trapped via `SIGNAL ON` and `CALL ON`:

- SYNTAX
- HALT
- ERROR
- FAILURE
- NOVALUE
- NOTREADY
- LOSTDIGITS

Regina does not support `CALL ON SYNTAX`. If you'd like to trap `rexx()` advanced feature usage, you either have to set fixed resume points or allow the script to fail (or use `rexx-unrestricted()`).

Examples

Here are few examples of using Intrinsic REXX.

An example for fetching a web resource:

```
      *> curl-it.cob, fetch a web resource and push lines to REXX stack
       identification division.
       program-id. curl-it.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       REPLACE ==newline== BY ==& x'0a' &==.

       data division.
       working-storage section.
       01 url              pic x(80).
       01 rexx-rc          pic 9(9).
       01 rexx-data        pic x(2048).

       procedure division.
       curl-it-main.

       accept url from command-line
       if url equal spaces then
           move "example.edu" to url
       end-if
       move rexx-unrestricted(
           "/* argument from parameter list */"                 newline
           "url = ARG(1)"                                       newline
           "/* use curl to read the url and queue results */"   newline
           "address system" &
           " 'curl -s -L' url with output stem data."           newline
           "do i = 1 to data.0"                                 newline
           "    queue data.i"                                   newline
           "end"                                                newline
           "push data.0; return data.0", trim(url))
         to rexx-rc
       display "<!- " rexx-rc " lines read from " trim(url) " ->"

      *> We already have rexx-rc with the item count
      *> Demonstrate nesting intrinsics to show the item count again
       display trim(rexx("pull data.0; return '<!-' data.0 '->'"))

      *> Now we have a FIFO queue of data lines
      *> Skip some and show some

      *> pull will wait for data from stdin if there is no queue
       perform varying tally from 1 by 1 until tally > 40 or rexx-rc
           move rexx(
               "if queued() > 0 then"                           newline
               "    pull dataline"                              newline
               "else"                                           newline
               "    dataline = 'queue empty'"                   newline
               "return dataline")
             to rexx-data
       end-perform

       perform varying tally from tally by 1 until tally > rexx-rc
           move rexx(
```

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```
               "if queued() > 0 then"                              newline
               "    pull dataline"                                 newline
               "else"                                              newline
               "    dataline = 'queue empty'"                      newline
               "return dataline")
             to rexx-data
           display trim(rexx-data)
       end-perform

       goback.
       end program curl-it.
```

A sample run, pulling data from http://example.com, skipping over some lines and then displaying some:

```
prompt$ cobc -xj curl-it.cob
<!- 000000046 lines read from example.edu ->
<!- 46 ->
<P>THIS DOMAIN IS FOR USE IN ILLUSTRATIVE EXAMPLES IN DOCUMENTS. YOU MAY USE THIS
DOMAIN IN LITERATURE WITHOUT PRIOR COORDINATION OR ASKING FOR PERMISSION.</P>
<P><A HREF="HTTPS://WWW.IANA.ORG/DOMAINS/EXAMPLE">MORE INFORMATION...</A></P>
</DIV>
</BODY>
</HTML>
```

An example showing the easy to use character manipulation features of REXX:

```
      *>
      *> REXX character translation, only return characters in arg 2
      *> Tectonics: cobc -xj only.cob
      *>
       identification division.
       program-id. only.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       REPLACE ==newline== BY ==& x'0a' &==.

       data division.
       working-storage section.
      *> translate only the given characters, effectively a filter
       01 rexx-only.
          05 value "only: return space(translate(arg(1),," &
                   "translate(xrange(),,arg(2))),0)"       newline
                   "return only(arg(1), arg(2))".

       procedure division.
       only-main.
      *> only digits
       display rexx(rexx-only,
                    "1997-01-01 was a great day", "0123456789")

      *> only vowels
       display rexx(rexx-only,
                    "1997-01-01 was a great day", "aeiouy")
```

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```
       goback.
       end program only.
```

A sample run, extracting digits and vowels from some character data:

```
prompt$ cobc -xj only.cob
19970101
aaeaay
```

`only` is a handy REXX one-liner.

Intrinsic REXX notes

- Remember to `return` a result back to GnuCOBOL or you get a zero length field from the intrinsic.
- `rexx()` returns a character field. Wrap in `numval()` for use in computational COBOL clauses. Reference modification is allowed.
- EC-IMP-SCRIPT will be raised when there is a problem.
- By including `rexxapi.cpy` in a source file, an *EXTERNAL* (page 259) variable is available as `SCRIPT-RETURN-CODE`.
- `rexx()` is a much safer function to use during testing, and for user scripting. It should be used more often than not, unless the extra features are required with `rexx-unrestricted()`.

5.59.2 Open Object Rexx

Courtesy of IBM, RexxLA, and currently a SourceForge project at

http://sourceforge.net/projects/oorexx/

A demonstration of embedding Open Object Rexx in GnuCOBOL.

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****J* gnucobol/oorexx
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20151021  Modified:  2015-10-26/07:36-0400
      *> LICENSE
      *>   Copyright 2015 Free Software Foundation, Inc.
      *>   GNU Lesser General Public License, LGPL, 3.1 (or greater)
      *>   No warranty, expressed or implied
      *> PURPOSE
      *>   Embed Open Object Rexx scripting.
      *> TECTONICS
      *>   cobc -m gnucobol-rexx.cob -g -debug $(oorexx-config --libs)
      *> ***************************************************************
       identification division.
       program-id. gnucobol-rexx.
       author. Brian Tiffin.
       date-compiled. Displayed with --version.
       date-written. 2015-10-26/07:36-0400.
```

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```
       installation. Copy gnucobol-rexx.so to library path.
       remarks.  Add Open Object Rexx to the mix.
       security. This embeds an interpreter, trusted source is implied.

       environment division.
       configuration section.
       source-computer. Ford.
       object-computer. Arthur.

       special-names.
       symbolic answer is 42
                hashtag is 36.

       repository.
           function rexx
           function all intrinsic.

       input-output section.
       file-control.
       i-o-control.

       data division.
       file section.

       working-storage section.

      *> Define some internal Rexx limits.  Change as needed.
       REPLACE ==:REXX-ARG-LIMIT:==     BY ==32==
               ==:REXX-ARG-SIZE:==      BY ==256==
               ==:REXX-CLI-SIZE:==      BY ==8192==
               ==:REXX-PROGNAME-SIZE:== BY ==128==
               ==:REXX-ENVNAME-SIZE:==  BY ==32==
               ==:REXX-EXITNAME-SIZE:== BY ==64==
               ==:REXX-RESULT-SIZE:==   BY ==32768==
       .

      *> cobcrun module testing options
       01 cli-option           pic x(9).
          88 helping           values "--help", "help", "-h".
          88 versioning        values "--version", "version", "-v".
          88 sourcing          values "--source", "source", "repo".
          88 shelling          values "--shell", "shell".
          88 demoing           values "--demo", "demo", "test", "check".

       01 built-on             pic xxxx/xx/xxBxx/xx/xxBxxxxxxx.

      *> ooRexx testing shell
       01 rexx-line            pic x(132).
          88 quitting           values "q", "quit", "exit".

      *> default script for testing instore, from callrexx2.c sample
       01 instore-script       pic x(426) value
           "call time 'Reset';" &
           "object1 = .example~new;" &
           "object2 = .example~new;" &
           "object3 = .example~new;" &
           "a.1 = object1~start('REPEAT', 4 , 'Object 1 running');" &
```

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```
           "say a.1~result;" &
           "say 'The result method waits till START has completed:';" &
           "a.2 = object2~start('REPEAT', 2, 'Object 2 running');" &
           "a.3 = object3~start('REPEAT', 2, 'Object 3 running');" &
           "say a.2~result;" &
           "say a.3~result;" &
           "say 'main ended';" &
           "say 'Elapsed time: ' time('E');" &
           "exit;" &
           "::REQUIRES 'example.rex'".

      *> calling Rexx
       01 rexx-buffer          pic x(:REXX-RESULT-SIZE:).
       01 printf-int           usage binary-long.

      *> the rexx-result-record definition
       COPY 'gnucobol-rexx.cpy' REPLACING ==:PREFIX:== BY ==rexx==.

      *> Rexx calling COBOL
       01 rexx-userdata        pic x(32).

      *> ooRexx supports 32 and 64 bit interfaces
       >>IF P64 IS SET
       01 REXX-SIZE-MOD        constant as 18.
       01 REXX-DISP-MOD        constant as 17.
       >>ELSE
       01 REXX-SIZE-MOD        constant as 8.
       01 REXX-DISP-MOD        constant as 7.
       >>END-IF
       01 rexx-dropauth        pic 9(REXX-SIZE-MOD) comp-5.

       01 rexx-regrc           usage binary-long.
       01 rexx-entry           usage program-pointer.

      *> pretty print the result display
       01 display-length       pic z(REXX-DISP-MOD)9.

       01 underlines pic x(77).

       local-storage section.
       linkage section.
       report section.
       screen section.

      *> ****************************************************************
       procedure division.
       self-test.

       move function when-compiled to built-on
       inspect built-on replacing
           all "/" by ":" after initial space
           all " " by "." after initial space
           all "/" by "-"
         first " " by "/"

       move hashtag to underlines
```

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```
      *> NOTE: requires rxapi daemon to be running
      *> Register an external GnuCOBOL subprogram
       call "RexxRegisterSubcomDll" using
           by content   z"extcob"
           by content   z"test-cobrexx"
           by content   z"extcommand"
           by reference rexx-userdata
           by value     rexx-dropauth
           returning    rexx-regrc
           on exception
               display "no RexxRegisterSubcomDll linkage" upon syserr
               perform soft-exception
       end-call
       if rexx-regrc not equal zero then
           display "RexxRegister failed, is rxapi daemon running?"
              upon syserr
       end-if

      *> Register a GnuCOBOL internal Rexx subprogram handler
       set rexx-entry to entry "rexxcommand"
       call "RexxRegisterSubcomExe" using
           by content   z"gnucobol"
           by value     rexx-entry
           returning    rexx-regrc
           on exception
               display "no RexxRegisterSubcomExe linkage" upon syserr
               perform soft-exception
       end-call
       if rexx-regrc not equal zero then
           display "RexxRegisterSub failed, is rxapi daemon running?"
              upon syserr
       end-if

      *> Register a function from a DSO
      *>   module test-cobrexx.so, Rexx name cobout, entry rexxternal
       call "RexxRegisterFunctionDll" using
           by content   z"cobout"
           by content   z"test-cobrexx"
           by content   z"rexxternal"
           returning    rexx-regrc
           on exception
               display "no RexxRegisterFunctionDll linkage" upon syserr
               perform soft-exception
       end-call
       if rexx-regrc not equal zero then
           display "RexxRegister failed, is rxapi daemon running?"
              upon syserr
       end-if

      *> Register a GnuCOBOL internal Rexx Call
       set rexx-entry to entry "fromrexx"
       call "RexxRegisterFunctionExe" using
           by content   z"cobol"
           by value     rexx-entry
           returning    rexx-regrc
           on exception
               display "no RexxRegisterFuncExe linkage" upon syserr
```

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```
            perform soft-exception
       end-call
       if rexx-regrc not equal zero then
           display "RexxRegisterFunc failed, is rxapi daemon running?"
              upon syserr
       end-if

      *> cobcrun testing options
       accept cli-option from command-line
       evaluate true
           when helping
               display "Open Object Rexx from GnuCOBOL"
               display "cobcrun gnucobol-rexx "
                       " [help version source shell] [[demo] args...]"
               display "  default action is to run demo, with args"
               display space
               display "  help or --help will display this help"
               display "  version will display version"
               display "  source  will display the COBOL for repository"
               display "  shell   will start up a small Rexx REPL shell"
               display "  demo or test will run self tests"
               goback
           when versioning
               display "gnucobol-rexx Version: 0.6 " built-on
               goback
           when sourcing
               display "      *> gnucobol-rexx repository"
               display "       repository."
               display "           function rexx"
               display "           function all intrinsic."
               goback
           when shelling
               perform rexx-repl
               goback
       end-evaluate

      *> default action is to run the self-test demo
       display "Invoke Open Object Rexx " with no advancing
       display "with filename, environment, two arguments"
       perform display-underlines

       move rexx(1, "gnucobol.rex", "gnucobol", "abc 123", rexx-buffer)
         to rexx-condition
       perform show-results

       display "Invoke Open Object Rexx " with no advancing
       display "default filename, environment, args from command line"
       perform display-underlines

       initialize rexx-buffer
       move rexx(1, null, null, null, rexx-buffer) to rexx-condition
       perform show-results

       display "Invoke Open Object Rexx " with no advancing
       display "with script, rexx environment, args ignored by script"
       perform display-underlines
```

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```
       initialize rexx-buffer
       move rexx(0, instore-script, "rexx", null, rexx-buffer)
         to rexx-condition
       perform show-results

       display "Invoke Open Object Rexx " with no advancing
       display "default script, default environment, two arguments"
       display "  script returns ooRexx version, and count of args"
       perform display-underlines

       initialize rexx-buffer
       move rexx(0, null, null, "ok 42", rexx-buffer) to rexx-condition
       perform show-results

       goback.

       show-results.
       move rexx-result-length to display-length
       display space
       display "Status : " rexx-rc ", " rexx-api-code
               ", " rexx-udf-code " Length: " trim(display-length)

      *> If the rexx result buffer was not large enough,
      *>   oorexx allocates a new one, which needs to be freed
       if rexx-result-pointer equal null then
           if rexx-result-length > 0 then
               display "Result :" rexx-buffer(1:rexx-result-length) ":"
           else
               display "Empty result"
           end-if
       else
           display "Address: " rexx-result-pointer with no advancing end-display

           call "printf" using
               by content " :%.*s:" & x"0a00"
               by value   rexx-result-length
               by value   rexx-result-pointer
               on exception
                   display "no printf linkage" upon syserr
                   perform soft-exception
           end-call


           *> This RexxFreeMemory must be called
           *>  if rexx-result-pointer is set
           call "RexxFreeMemory" using
               by value rexx-result-pointer
               on exception
                   display "No RexxFreeMemory linkage" upon syserr
                   perform soft-exception
           end-call
       end-if
       display space
       .

      *> An interactive test interpreter
       rexx-repl.
```

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```
       display "For testing in the shell:"
       display "  call cobol arg1,arg2; say result"
       display "  address gnucobol; with command; return rc"
       display "  call cobout 1,2,3; return result           **"
       display "  address extcob; command; return rc         **"
       display "     ** If libtest-cobrexx.so is in search path"
       display space
       display "  any Rexx instructions, default address is gnucobol"
       display "  q to quit"

       display space
       display "GnuCOBOL ooRexx test shell: " built-on
       perform forever
           display "ooRexx: " with no advancing
           accept rexx-line on exception set quitting to true end-accept
           if quitting then exit perform end-if

           initialize rexx-buffer
           move rexx(0, rexx-line, "gnucobol", null, rexx-buffer)
             to rexx-condition
           perform show-results
       end-perform
       .

      *> informationals, warnings and abends
       soft-exception.
         display "Module:              " module-id upon syserr
         display "Module path:         " module-path upon syserr
         display "Module source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       display-underlines.
       display underlines
       display space
       .

       end program gnucobol-rexx.
      *> ***************************************************************
      *>*****

      *> ***************************************************************
      *>****F* oorexx/rexx
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20151021  Modified:  2015-10-22/13:57-0400
      *> LICENSE
      *>   Copyright 2015 Free Software Foundation, Inc.
      *>   GNU Lesser General Public License, LGPL, 3.1 (or greater)
      *>   No warranty, expressed or implied
      *> PURPOSE
      *>   Call Rexx, as user defined function
      *> TECTONICS
```

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```
      *>   cobc -m -g -debug gnucobol-rexx.cob $(oorexx-config --libs)
      *>   move function rexx(mode, script, env, args, ws-buf) to rexx-r
      *> ************************************************************
       identification division.
       function-id. rexx.
       author. Brian Tiffin.
       date-compiled.
       date-written. 2015-10-22/13:57-0400.
       installation.
       remarks.  Add Open Object Rexx to the mix.
       security. This embeds an interpreter, trusted source is implied.

       environment division.
       configuration section.
       special-names.
       repository.
           function all intrinsic.
       input-output section.
       file-control.
       i-o-control.

       data division.
       file section.
       working-storage section.

      *> ooRexx supports 32 and 64 bit interfaces
       >>IF P64 IS SET
       01 REXX-SIZE-MOD   constant as 18.
       >>ELSE
       01 REXX-SIZE-MOD   constant as 8.
       >>END-IF

       01 RXCOMMAND        constant as 0.
       01 RXSUBROUTINE     constant as 1.
       01 RXFUNCTION       constant as 2.

       01 default-rexx     pic x(43) value
          'parse version v; return v || ", " || arg();'.

       01 rexx-all-args    pic x(:REXX-CLI-SIZE:).
       01 cli-arg          pic x(:REXX-ARG-SIZE:).

       local-storage section.
       01 rexx-arg-buffer.
          05 filler            occurs 0 TO :REXX-ARG-LIMIT: times
                               depending on rexx-arg-count.
             10 rexx-ws-arg    pic x(:REXX-ARG-SIZE:).

      *> RexxStart structure
       01 rexx-arg-count       pic 9(REXX-SIZE-MOD) comp-5.
       01 rexx-arguments.
          05 filler            occurs 0 TO :REXX-ARG-LIMIT: times
                               depending on rexx-arg-count.
             10 rexx-arg-len    pic 9(REXX-SIZE-MOD) comp-5.
             10 rexx-arg-ptr    usage pointer.
       01 rexx-program-name    pic x(:REXX-PROGNAME-SIZE:).
       01 rexx-instore.
```

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```
           05 rexx-in0-len      pic 9(REXX-SIZE-MOD) comp-5.
           05 rexx-in0-ptr      usage pointer value NULL.
           05 rexx-in1-len      pic 9(REXX-SIZE-MOD) comp-5.
           05 rexx-in1-ptr      usage pointer value NULL.
        01 rexx-environment     pic x(:REXX-ENVNAME-SIZE:).
        01 rexx-calltype        usage binary-long.
        01 rexx-exits.          *> Not yet supported
           05 rexx-exitname     pic x(:REXX-EXITNAME-SIZE:).
           05 rexx-exitcode     usage binary-long.
        01 rexx-return-code     usage binary-short.
        01 rexx-result.
           05 rexx-result-len   pic 9(REXX-SIZE-MOD) comp-5.
           05 rexx-result-ptr   usage pointer.
        01 rexx-call-return     usage binary-long.

      *> wordexp fields
        01 we-sub               usage binary-short.
        01 expanded-words       usage pointer.
        01 expand-flags         pic 9(REXX-SIZE-MOD) comp-5.
        01 expanded-structure.
           05 we-wordc          pic 9(REXX-SIZE-MOD) comp-5.
           05 we-wordv          usage pointer.
           05 we-offs           pic 9(REXX-SIZE-MOD) comp-5 value 0.
        01 we-words             based.
           05 filler            occurs 0 to :REXX-ARG-LIMIT: times
                                depending on we-wordc.
              10 we-word        usage pointer.
        01 wordexp-result       usage binary-long.

        linkage section.
        01 rexx-mode            pic 9.
        01 rexx-script          pic x any length.
        01 rexx-address         pic x any length.
        01 rexx-argument-line   pic x any length.
        01 rexx-buffer          pic x any length.
        COPY 'gnucobol-rexx.cpy' REPLACING ==:PREFIX:== BY ==rexx==.

        report section.
        screen section.

      *> ****************************************************************
        procedure division using
            rexx-mode
            rexx-script
            rexx-address
            rexx-argument-line
            rexx-buffer
            returning rexx-condition
        .
        rexx.

      *> mode 0 is script text, otherwise filename
        if rexx-mode equal zero then
            if address of rexx-script equal null then
                set rexx-in0-ptr to address of default-rexx
                move length(default-rexx) to rexx-in0-len
            else
```

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```
            set rexx-in0-ptr to address of rexx-script
            move length(rexx-script) to rexx-in0-len
        end-if
    else
        if address of rexx-script equal null then
            move z"gnucobol.rex" to rexx-program-name
        else
            move concatenate(trim(rexx-script), x"00")
              to rexx-program-name
        end-if
    end-if

   *> GnuCOBOL environment
    if address of rexx-address equal null then
        move z"gnucobol" to rexx-environment
    else
        move concatenate(trim(rexx-address), x"00")
          to rexx-environment
    end-if

   *> get arguments from frame, or command line
    if address of rexx-argument-line equal null then
        accept rexx-all-args from command-line
        call "wordexp" using
            by content   concatenate(rexx-all-args, x"00")
            by reference expanded-structure
            by value     expand-flags
            returning    wordexp-result
            on exception
                display "no wordexp linkage" upon syserr
                move wordexp-result to rexx-udf-code
                goback
        end-call
    else
        call "wordexp" using
            by content   concatenate(rexx-argument-line, x"00")
            by reference expanded-structure
            by value     expand-flags
            returning    wordexp-result
            on exception
                display "no wordexp linkage" upon syserr
                move wordexp-result to rexx-udf-code
                goback
        end-call
    end-if

    if wordexp-result > 0 then
        display "Error: wordexp " wordexp-result upon syserr
        if address of rexx-argument-line equal null then
            display "Given: " trim(rexx-all-args) upon syserr
        else
            display "Given: " trim(rexx-argument-line) upon syserr
        end-if
    end-if

   *> spin the we-words into the Rexx argument array
    set address of we-words to we-wordv
```

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```
       move we-wordc to rexx-arg-count

       move 1 to we-sub
       perform until we-sub > we-wordc
           if we-sub > :REXX-ARG-LIMIT: then
               display "Args limited to " :REXX-ARG-LIMIT: upon syserr
               exit perform
           end-if
           *> Rexx wants arg pointers and lengths, excluding null byte
           set rexx-arg-ptr(we-sub) to we-word(we-sub)
           call "strlen" using
               by value we-word(we-sub)
               returning rexx-arg-len(we-sub)
           end-call
           add 1 to we-sub
       end-perform

      *> set calltype, and the result buffer space
       move RXCOMMAND to rexx-calltype
       set rexx-result-ptr to address of rexx-buffer
       set rexx-result-len to length(rexx-buffer)

      *> Use instore (0) or program-name
       if rexx-mode equal 0 then
           call "RexxStart" using
               by value     rexx-arg-count
               by reference rexx-arguments
               by reference NULL
               by reference rexx-instore
               by reference rexx-environment
               by value     rexx-calltype
               by reference NULL
               by reference rexx-return-code
               by reference rexx-result
               returning    rexx-call-return
               on exception
                   display "no RexxStart linkage" upon syserr
                   perform soft-exception
           end-call
       else
           call "RexxStart" using
               by value     rexx-arg-count
               by reference rexx-arguments
               by reference rexx-program-name
               by reference NULL
               by reference rexx-environment
               by value     rexx-calltype
               by reference NULL
               by reference rexx-return-code
               by reference rexx-result
               returning    rexx-call-return
               on exception
                   display "no RexxStart linkage" upon syserr
                   perform soft-exception
           end-call
       end-if
```

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```
      *> clear any parsed word expansion array
       call "wordfree" using
           expanded-structure
           on exception
               display "no wordfree linkage" upon syserr
               perform soft-exception
       end-call

      *> If the rexx result buffer is not large enough,
      *>   inform caller of new address, which needs to be freed
       if rexx-result-len > length(rexx-buffer) then
           set rexx-result-pointer to rexx-result-ptr
       else
           set rexx-result-pointer to null
       end-if

       move rexx-result-len to rexx-result-length
       move rexx-return-code to rexx-rc
       move rexx-call-return to rexx-api-code
       move 0 to rexx-udf-code
       goback.
      *> ****************************************************************

      *> informational warnings and abends
       soft-exception.
         display "Module:              " module-id upon syserr
         display "Module path:         " module-path upon syserr
         display "Module source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       end function rexx.
      *> ****************************************************************
      *>****

      *> ****************************************************************
      *>****P* oorexx/rexxcommand
      *> PURPOSE
      *>   Add a gnucobol subcommand address to Rexx
      *> TECTONICS
      *>   RexxRegisterSubcomExe("gnucobol", entry)
      *>   In Rexx, address gnucobol; with commands
      *> ****************************************************************
       identification division.
       program-id. rexxcommand.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       >>IF P64 IS SET
```

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```
       01 REXX-SIZE-MOD        constant as 18.
       >>ELSE
       01 REXX-SIZE-MOD        constant as 8.
       >>END-IF

       01 buff         pic x(256) based.

       01 response.
          05 filler    pic x(35)
                       value "By your command. GnuCOBOL received ".
          05 in-msg    pic 999.
          05 filler    pic x(10) value " character".
          05 plural    pic x     value "s".

       linkage section.
       01 command.
          05 com-len   pic 9(REXX-SIZE-MOD) comp-5.
          05 com-ptr   usage pointer.
       01 flags        usage binary-short.
       01 rexx-rc.
          05 rc-len    pic 9(REXX-SIZE-MOD) comp-5.
          05 rc-ptr    usage pointer.

       procedure division using command flags rexx-rc.

      *> set the Rexx result buffer and length.
      *> Default space of 256 should be fine for most operations
       set address of buff to rc-ptr

       if com-len = 1 then
           move space to plural
       else
           initialize plural all to value
       end-if

       move com-len to in-msg
       move response to buff
       move length(trim(response trailing)) to rc-len

      *> if return-code is not 0, Rexx will complain,
      *>  and abort further processing
       move 0 to return-code
       goback.

       end program rexxcommand.
      *> ****************************************************************
      *>****


      *> ****************************************************************
      *>****P* oorexx/fromrexx
      *> PURPOSE
      *>   Call from Rexx into GnuCOBOL
      *> TECTONICS
      *>   RexxRegisterFunctionExe("name", entry)
      *>   In Rexx, call name args; say result
      *> ****************************************************************
```

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```
       identification division.
       program-id. fromrexx.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       >>IF P64 IS SET
       01 REXX-SIZE-MOD   constant as 18.
       >>ELSE
       01 REXX-SIZE-MOD   constant as 8.
       >>END-IF

      *> the argv is an array of len, ptr
       01 argv         based.
          05 arg-len   pic 9(REXX-SIZE-MOD) comp-5.
          05 arg-ptr   usage pointer.

       01 buff         pic x(256) based.
       01 response.
          05 filler    pic x(27) value "Hello from GnuCOBOL, Rexx. ".
          05 arg-msg   pic 99.
          05 filler    pic x(9)  value " argument".
          05 plural    pic x(10) value "s received".
       01 singular     pic x(9) value " received".

       linkage section.
       01 rexx-name    usage pointer.
       01 argc         usage binary-long.
       01 arg-list     usage pointer.
       01 queue-ptr    usage pointer.
       01 rexx-rc.
          05 rc-len    pic 9(REXX-SIZE-MOD) comp-5.
          05 rc-ptr    usage pointer.

       procedure division using
           by value rexx-name argc arg-list queue-ptr
           by reference rexx-rc.

      *> there is a fair amount of indirection going on
       set address of argv to arg-list

      *> set the Rexx result buffer and length.
      *> Default space of 256 should be fine for most operations
       set address of buff to rc-ptr

       if argc = 1 then
           move singular to plural
       else
           initialize plural all to value
       end-if
       move argc to arg-msg

       move response to buff
```

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```
       move length(trim(response trailing)) to rc-len

      *> if return-code is not 0, Rexx will complain,
      *>  and abort any further processing
       move 0 to return-code
       goback.

       end program fromrexx.
      *> ****************************************************************
      *>****
>>ELSE
```

The inline documentation block for gnucobol-rexx uses ReStructuredText and can be built with rst2html, or Sphinx, by extracting everything after an `!rst-marker!` line.

```
sed ':loop;/!rst.marker!/{d};N;b loop' gnucobol-rexx.cob | sed '$d'
    | rst2html >gnucobol-rexx.html
```

```
=============
gnucobol-rexx
=============

.. header:: GnuCOBOL and Open Object Rexx

.. sidebar:: GnuCOBOL and Open Object Rexx

   .. contents::

gnucobol-rexx
-------------

A user defined function repository for Open Object Rexx in GnuCOBOL

::

    cobcrun gnucobol-rexx [arguments...]

Command line options, when running the main module from the repository include

     help
     version
     source
     shell
     and the default, demo to run quick tests.

There is a Rexx CALL command, as "cobol", registered which sets RESULT.

There is a "gnucobol" subcommand handler registered, which sets RC.
This ADDRESS will be the default when in the shell and when running the
quick tests.


UDF as::

    move rexx(mode, script, environment, argument, buffer)
      to rexx-result-record
```

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```
Overview
--------

Call Open Object Rexx from GnuCOBOL.  Supports external and instore
scripts along with external or internal argument lists.

Uses a default external script of **gnucobol.rex** if no command is
given.

Uses the sample provided by RexxLA for **instore** scripting
which is paired with an external **example.rex** file. example.rex
includes the copyright notice to comply with the CPL v1.0 license.

Uses a default Rexx environment name address of "gnucobol".

Exit routines have not yet been tested.

Results are returned in the given working storage, or if necessary, a
buffer allocated by Rexx.

Prerequisites
-------------

Requires GnuCOBOL 2.0 and Open Object Rexx 4

::

    yum install oorexx oorexx-devel oorexx-libs oorexx-docs

rxapi
.....

The ``rxapi`` daemon MUST be running for many Open Object Rexx features
to properly operate.

::

    sudo /usr/bin/rxapid start

    or perhaps

    sudo /etc/init.d/rxapid start

function rexx usage
-------------------

The ``rexx`` function takes

::

    mode,   pic 9,     0 meaning script is internal, 1 meaning script is named
    script, pic x any, either the script text or filename
    env,    pic x any, the Rexx address environment
    args,   pic x any, a single string, parsed as shell word expansion
    buffer, pic x any, the Rexx result buffer
```

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```
and returns a record structure of

::

       01 rexx-status.
          05 rexx-result-pointer   usage pointer.
       >>IF P64 IS SET
          05 rexx-result-length    pic 9(18) comp-5.
       >>ELSE
          05 rexx-result-length    pic 9(8) comp-5.
       >>END-IF
          05 rexx-rc               usage binary-short.
          05 rexx-api-code         usage binary-long.
          05 rexx-udf-code         usage binary-long.

Which is compatible with both 32 bit and 64 bit ooRexx releases, as is
the rest of the gnucobol-rexx module.


For example::

    01 ws-rexx     pic x(256).

    move rexx(1, "script.rex", "gnucobol", "from $HOME", ws-rexx)
      to rexx-status

- mode determines if the script is specified as an internal character
  string or filename.  0 for internal text, non-zero for external file.

- script is *script text* or *filename*.  The rexx function keeps a
  default internal script that echos back the Rexx version string, with a
  count of passed in arguments appended.  This is triggered for mode 0 and
  a NULL for *script text*.  A default filename of ``gnucobol.rex`` is used
  when mode is non-zero and NULL is used as the script parameter.

- env is the Rexx environment, used in Rexx address statements. Defaults
  to ``gnucobol`` if NULL is passed.

- args is a single character string of arguments, parsed as a shell word
  expansion.  That means tilde is expanded to home directory, dollar
  variables are substituted, and certain characters, like angle brackets,
  will need backslash escapes.  Full rules can be found in ``man 3
  wordexp``.  When the command line is involved, double substitutions may
  occur, as the shell may expand a dollar variable, and if the replacement
  starts with a dollar, ``wordexp`` will attempt another round of
  substitution.  Backslash escapes can control this behaviour.  Also
  calls ``wordfree`` when finished with argument lists.

- buffer is a COBOL working storage character allocation.  Rexx will use
  this space to hold results.  If the buffer is not large enough, Rexx
  will internally allocate a new working space.  The
  ``rexx-return-record`` rexx function return includes a
  rexx-result-pointer field.  If this field in non null, then the Rexx
  result space has been reallocated and a call to ``RexxFreeMemory`` is
  required.

- The return value of the ``rexx`` function is a COBOL record with fields
```

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```
  for result-length, result-pointer, Rexx return code, RexxStart API
  result code, and a status value from the ``rexx`` UDF.

.. important:: Terminating zero bytes from C.
   Although Rexx returns a length, the result buffer may also include a
   terminating zero byte.  Use either reference modification when moving
   or displaying data in the Rexx result string buffer or change the
   character at rexx-buffer(rexx-result-length:1) to a space, when it
   is safe to do so.  (Modification of the terminating zero is **not**
   safe if Rexx reallocated the buffer space due to size overflow, so
   test rexx-result-pointer to make sure).

cobcrun
-------

The repository library includes a main module for self testing.  It
includes a demo program that exercises some features, and a small
interactive shell that allows typing in Rexx comands, and short
one line programs.

::

    Open Object Rexx from GnuCOBOL
    cobcrun gnucobol-rexx  [help version source shell] [[demo] args...]
      default action is to run demo, with args

      help or --help will display this help
      version will display version
      source  will display the COBOL for repository
      shell   will start up a small Rexx REPL shell
      demo or test will run self tests

libtest-cobrexx.cob
-------------------

Along with other testing features in the ``gnucobol-rexx`` module
default entry point, the code also links to two external sub-programs
for use withing Open Object Rexx.

``RexxRegisterSubcomDll`` is used to create an externally defined
command address of ``extcob``.

``RexxRegisterFunctionDll`` is used to define an external function, ``cobout``.

Both of the required GnuCOBOL subprograms as in libtest-rexx.cob.

Normal usage requires the rxapi_ daemon to be running, and the libary
must be part of the current shared library search path.

::

    LD_LIBRARY_PATH=. rlwrap cobcrun gnucobol-rexx shell

As that is a long command line, use the Makefile rule.

::
```

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```
    make test

``rlwrap`` is not mandatory, but makes the shell REPL a more pleasant
experience, by adding GNU ``readline`` features to the normal GnuCOBOL
ACCEPT verb, without changing any code.  make test will attempt to use
rlwrap if it is available.

ooRexx shell
------------

Use q, quit, or send a keyboard EOF to exit the little shell.

::

    prompt$ make
    cobc -m -g -debug `oorexx-config --libs` gnucobol-rexx.cob

    prompt$ cobcrun gnucobol-rexx shell
    ooRexx: parse version . level .; return level

    Status : +00000, +0000000000, +0000000000
    Length : 0000000000000000004
    Result :6.03:

    ooRexx: parse pull name; say "Hello, " || name; return name
    Rex
    Hello, Rex

    Status : +00000, +0000000000, +0000000000
    Length : 0000000000000000003
    Result :Rex:

    ooRexx: return 21 * 2

    Status : +00042, +0000000000, +0000000000
    Length : 0000000000000000002
    Result :42:

    ooRexx: q
    prompt$

gnucobol-rexx.cpy
-----------------

The ``rexx`` result record is defined in a copybook, and includes
replacable :PREFIX: pseudo-text.  There is also conditional compile
directives used to manage 32bit and 64bit Open Object Rexx issues.

The demonstration code uses

::

    COPY 'gnucobol-rexx.cpy' REPLACING ==:PREFIX:== BY ==rexx==.

giving:

.. sourcecode:: cobolfree
```

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```
    01 rexx-condition.
       05 rexx-result-pointer   usage pointer.
       05 rexx-result-length    pic 9(18) comp-5.
       05 rexx-rc               usage binary-short.
       05 rexx-api-code         usage binary-long.
       05 rexx-udf-code         usage binary-long.

where result-length will either be a pic 9(8) or pic 9(18) treated as
comp-5 giving a 4 byte or 8 byte allocation and keeping stack frames in
proper sync.  *This same conditional compile sequence is used internally
for interfacing with* ``RexxStart``.

RexxStart
---------

``callrexx.cob`` uses the "Classic" form of invoking Rexx, with a C
interface, using ``RexxStart``.

Version 4 (or greater) of Open Object Rexx supports either 32bit or
64bit stack frames.

.. sourcecode:: c

    int REXXENTRY RexxStart (
         size_t,                        /* Num of args passed to rexx  */
         PCONSTRXSTRING,                /* Array of args passed to rex */
         CONSTANT STRING,               /* [d:][path] filename[.ext]   */
         PRXSTRING,                     /* Loc of rexx proc in memory  */
         CONSTANT STRING,               /* ASCIIZ initial environment. */
         int,                           /* type [command,subrtn,funct] */
         PRXSYSEXIT,                    /* SysExit env. names &  codes */
         short *,                       /* Ret code from if numeric    */
         PRXSTRING );                   /* Retvalue from the rexx proc */

This bit sizing is handled in ``callrexx.cob`` by defining either an
``9(8) comp-5`` or ``9(18) comp-5`` as determined by conditional compiler
directives.

Call RexxStart
--------------

For external scripts use:

.. sourcecode:: cobolfree

    call "RexxStart" using
        by value     rexx-arg-count
        by reference rexx-arguments
        by reference rexx-program-name
        by reference NULL
        by reference rexx-environment
        by value     rexx-calltype
        by reference NULL
        by reference rexx-return-code
        by reference rexx-result
        returning    rexx-call-return
```

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```
        on exception
            display "no RexxStart linkage" upon syserr
            perform hard-exception
    end-call

or

.. sourcecode:: cobolfree

    call "RexxStart" using
        by value     rexx-arg-count
        by reference rexx-arguments
        by reference NULL
        by reference rexx-instore
        by reference rexx-environment
        by value     rexx-calltype
        by reference NULL
        by reference rexx-return-code
        by reference rexx-result
        returning    rexx-call-return
        on exception
            display "no RexxStart linkage" upon syserr
            perform hard-exception
    end-call

when scripts are held in working storage.

Reallocated Rexx
----------------

Here is some COBOL that attempts to handle reallocated buffer pointers.
The demo code just uses ``printf``.

Add a limiting value to the top REPLACE phrase.  256 meg is defined in
GnuCOBOL as the largest PIC size, even for BASED items.

.. sourcecode:: cobolfree

               ==:REXX-MAXIMUM-SIZE:==  BY ==268435455==

Add some based variables, and a pointer.

.. sourcecode:: cobolfree

      *> Handle reallocated Rexx result buffers
       01 based-rexx-ptr       usage pointer.
       01 based-rexx-buffer    pic x(:REXX-MAXIMUM-SIZE:) based.
       01 based-rexx-source    pic x(:REXX-MAXIMUM-SIZE:) based.

And some code to shuffle heap memory into working storage.

.. sourcecode:: cobolfree

           *> This display routine is only for demonstration
           *> Display the larger buffer
           if rexx-result-length > :REXX-MAXIMUM-SIZE: then
               move :REXX-MAXIMUM-SIZE: to rexx-result-length
```

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```
               display " truncated for display"
           else
               display space
           end-if

           *> allocate a buffer, then move from the heaped pointer
           free based-rexx-ptr
           allocate rexx-result-length characters
               returning based-rexx-ptr
           set address of based-rexx-buffer to based-rexx-ptr
           set address of based-rexx-source to rexx-result-pointer
           move based-rexx-source(1:rexx-result-length)
             to based-rexx-buffer(1:rexx-result-length)

           display ":" based-rexx-buffer(1:rexx-result-length) ":"

           free based-rexx-ptr
           set address of based-rexx-buffer to null
           set address of based-rexx-source to null

Reference modification keeps COBOL from touching unallocated BASED
memory.

For the demonstration self-test, all that code was replaced with a
simple call to printf, with a sized string format specifier.

.. sourcecode:: cobolfree

        01 printf-int           usage binary-long.

           call "printf" using
               by content "%.*s" & x"0a00"
               by value   rexx-result-length
               by value   rexx-result-pointer
               returning printf-int
               on exception
                   display "no printf linkage" upon syserr
                   perform soft-exception
           end-call
```

```
Sources
-------

gnucobol-rexx.cob
.................

The rexx function, a main test-head and two subprograms registered to ooRexx.

.. include:: gnucobol-rexx.cob
   :code: cobolfree
   :end-before: !rst-marker

gnucobol-rexx.cob inline documenation
.....................................

This gnucobol-rexx documentation, as ReStructuredText
```

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```
.. include:: gnucobol-rexx.cob
   :start-after: rst-marker!
   :code: rst

gnucobol-rexx.cpy
.................

The rexx function return structure.  32bit and 64bit ooRexx compatible.

.. include:: gnucobol-rexx.cpy
   :code: cobolfree

libtest-cobrexx.cob
...................

A sample exernal command, and external function. Optional when testing
gnucobol-rexx.

.. include:: libtest-cobrexx.cob
   :code: cobolfree

gnucobol.rex
............

Default script, customize to taste.

.. include:: gnucobol.rex
   :code: c

mycmd.rex
.........

Sample script for other testing.

.. include:: mycmd.rex
   :code: c

example.rex
...........

Example Rexx courtesy of IBM and RexxLA.  CPL 1.0 licence included.

Part of the self test in gnucobol-rexx.cob.

.. include:: example.rex
   :code: c

Makefile
........

The tectonics.

.. include:: Makefile
   :code: make

Sample run
```

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```
..........

``cobcrun gnucobol-rexx`` version, help, demo

.. include:: gnucobol-rexx.run
   :literal:
```

with

```
/* Default script for GnuCOBOL Open Object Rexx */
parse source program;
say "Evaluating " program;

total_args = arg();
say "Total arguments: " total_args;

do arg_index = 1 to total_args by 1 for total_args
    say arg(arg_index);
end
say;

parse Version ver;
say "Rexx version: " ver;
say;

address "bash";
'cobc --version';

return ver;
```

The instore (Rexx script passes from internal working-storage, and not as an external filename) sample, is straight from IBM and RexxLA shipped with ooRexx 4.1 and calls an external sample script, `example.rex`. Listed here to also satisfy the CPL 1.0 license requirements.

```
/*----------------------------------------------------------------------------*/
/*                                                                            */
/* Copyright (c) 1995, 2004 IBM Corporation. All rights reserved.             */
/* Copyright (c) 2005-2006 Rexx Language Association. All rights reserved.    */
/*                                                                            */
/* This program and the accompanying materials are made available under       */
/* the terms of the Common Public License v1.0 which accompanies this         */
/* distribution. A copy is also available at the following address:           */
/* http://www.oorexx.org/license.html                          */
/*                                                                            */
/* Redistribution and use in source and binary forms, with or                 */
/* without modification, are permitted provided that the following            */
/* conditions are met:                                                        */
/*                                                                            */
/* Redistributions of source code must retain the above copyright             */
/* notice, this list of conditions and the following disclaimer.              */
/* Redistributions in binary form must reproduce the above copyright          */
/* notice, this list of conditions and the following disclaimer in            */
/* the documentation and/or other materials provided with the distribution.   */
/*                                                                            */
/* Neither the name of Rexx Language Association nor the names                */
/* of its contributors may be used to endorse or promote products             */
```

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```
/* derived from this software without specific prior written permission.      */
/*                                                                            */
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/* SPECIAL, EXEMPLARY, OR CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED   */
/* TO, PROCUREMENT OF SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA,        */
/* OR PROFITS; OR BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY     */
/* OF LIABILITY, WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING    */
/* NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS         */
/* SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.               */
/*                                                                            */
/*----------------------------------------------------------------------------*/
/******************************************************************************/
/*                                                                            */
/*  File Name:          example                                               */
/*                                                                            */
/* ---------------------------------------------------------------------- */
/*                                                                            */
/*  Description:       script to test the REXX interpreter API               */
/*                                                                            */
/******************************************************************************/

::class example public
::method repeat
  expose loops
  use arg reps, msg
  do reps
     say msg
  end
  return 'Repeated' msg',' reps 'times.'
```

A flying carpet run of:

```
prompt$ make
cobc -m libtest-cobrexx.cob
cobc -m -g -debug `oorexx-config --libs` gnucobol-rexx.cob

prompt$ make sample
cobcrun gnucobol-rexx version >gnucobol-rexx.run
cobcrun gnucobol-rexx help >>gnucobol-rexx.run
cobcrun gnucobol-rexx >>gnucobol-rexx.run

prompt$ cat gnucobol-rexx.run
gnucobol-rexx Version: 0.6 2015-10-26/07:36:32.00-0400

Open Object Rexx from GnuCOBOL
cobcrun gnucobol-rexx  [help version source shell] [[demo] args...]
  default action is to run demo, with args

  help or --help will display this help
  version will display version
  source  will display the COBOL for repository
  shell   will start up a small Rexx REPL shell
  demo or test will run self tests
```

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```
Invoke Open Object Rexx with filename, environment, two arguments
################################################################################

Evaluating  LINUX COMMAND /home/btiffin/lang/rexx/gnucobol.rex
Total arguments:  2
abc
123
Rexx version:  REXX-ooRexx_4.1.0(MT) 6.03 17 Aug 2014
Address bash to echo shell
/bin/bash

Status : +00000, +0000000000, +0000000000 Length: 38
Result :REXX-ooRexx_4.1.0(MT) 6.03 17 Aug 2014:

Invoke Open Object Rexx default filename, environment, args from command line
################################################################################

Evaluating  LINUX COMMAND /home/btiffin/lang/rexx/gnucobol.rex
Total arguments:  0
Rexx version:  REXX-ooRexx_4.1.0(MT) 6.03 17 Aug 2014
Address bash to echo shell
/bin/bash

Status : +00000, +0000000000, +0000000000 Length: 38
Result :REXX-ooRexx_4.1.0(MT) 6.03 17 Aug 2014:

Invoke Open Object Rexx with script, rexx environment, args ignored by script
################################################################################

Object 1 running
Object 1 running
Object 1 running
Object 1 running
Repeated Object 1 running, 4 times.
The result method waits till START has completed:
Object 2 running
Object 3 running
Object 2 running
Object 3 running
Repeated Object 2 running, 2 times.
Repeated Object 3 running, 2 times.
main ended
Elapsed time:  0.000902

Status : +00000, +0000000000, +0000000000 Length: 0
Empty result

Invoke Open Object Rexx default script, default environment, two arguments
  script returns ooRexx version, and count of args
################################################################################


Status : +00000, +0000000000, +0000000000 Length: 41
Result :REXX-ooRexx_4.1.0(MT) 6.03 17 Aug 2014, 2:

prompt$ ./callrexx
```

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```
Evaluating  LINUX COMMAND /home/btiffin/lang/rexx/gnucobol.rex
Total arguments:  0

Rexx version:  REXX-ooRexx_4.1.0(MT) 6.03 17 Aug 2014

cobc (GNU Cobol) 2.0.0
Copyright (C) 2001,2002,2003,2004,2005,2006,2007 Keisuke Nishida
Copyright (C) 2006-2012 Roger While
Copyright (C) 2013-2015 Ron Norman
Copyright (C) 2009,2010,2012,2014,2015 Simon Sobisch
This is free software; see the source for copying conditions.  There is NO
warranty; not even for MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
Built     Sep 05 2015 20:43:10
Packaged  Mrz 29 2015 14:56:23 UTC
C version "4.9.2 20150212 (Red Hat 4.9.2-6)"

Rexx status: +00000, +0000000000
Rexx length: 000000000000000038
Rexx result:REXX-ooRexx_4.1.0(MT) 6.03 17 Aug 2014:
```

And a little shell pass. gnucobol-rexx.cob includes a small Read Evaulate Print Loop for testing Rexx instructions. This listing shows commands that test the internal and external function and command registration, allowing ooRexx access to GnuCOBOL subprograms.

The sample includes addessing an unknown host environment, `extcobol` instead of the actual `extcob` that was registered by gnucobol-rexx.

```
prompt$ make shell
LD_LIBRARY_PATH=. rlwrap cobcrun gnucobol-rexx shell
For testing in the shell:
  call cobol arg1,arg2; say result
  address gnucobol; with command; return rc
  call cobout 1,2,3; return result           **
  address extcob; command; return rc         **
     ** If libtest-cobrexx.so is in search path

  any Rexx instructions, default address is gnucobol
  q to quit

GnuCOBOL ooRexx test shell: 2015-10-26/20:10:50.00-0400
ooRexx: call cobol 1,abc,3,4; return result

Status : +00000, +0000000000, +0000000000 Length: 48
Result :Hello from GnuCOBOL, Rexx. 04 arguments received:

ooRexx: call cobout 1,abc,3,4,5; return result

Status : +00000, +0000000000, +0000000000 Length: 45
Result :05 arguments received. Second argument   :ABC:

ooRexx: address gnucobol; command string; return rc

Status : +00000, +0000000000, +0000000000 Length: 49
Result :By your command. GnuCOBOL received 014 characters:

ooRexx: address extcobol; command string; return rc
     1 *-* command string;
```

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```
       >>>   "COMMAND STRING"
       +++   "RC(30)"

Status : +00030, +0000000000, +0000000000 Length: 2
Result :30:

ooRexx: address extcob; command string; return rc

Status : +00000, +0000000000, +0000000000 Length: 67
Result :External command received 014 characters, first part:COMMAND STRING:

ooRexx: q
prompt$
```

With gnucobol-rexx, GnuCOBOL developers need only

```
move rexx(1, "script.rex", "gnucobol", "args from $HOME", ws-rexx)
  to rexx-status
```

or

```
move rexx(0, "parse version v; return v", "envofchoice",
             "args from $HOME and abroad", ws-rexx)
  to rexx-status
```

to leverage the powers of Open Object Rexx scripting.

5.59.3 Regina Rexx

Courtesy of Mike Cowlishaw, original designer of Rexx, and currently a SourceForge project at

http://sourceforge.net/projects/regina-rexx/

A Regina Rexx layer can be as simple as

ocrexx.c

```
/* GnuCOBOL interface to Regina Rexx Interpreter */
/* Requires regina3 and regina3-dev */
/* cobc -I/usr/include/regina -c ocrexx.c */

#include <stdio.h>
#include <string.h>
#include <rexxsaa.h>

int ocrexx(char *script, char *args, char *resfield, int reslen, short *result) {
    APIRET rexxapiret;
    RXSTRING retstr;
    RXSTRING arglist[1];
    short  rexxret = 0;

    int ignore = 0;

    /* Initialize the engine, run the script */
    retstr.strptr = NULL;
    retstr.strlength = 0;
```

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```
    arglist[0].strptr = args;
    arglist[0].strlength = strlen(args);

    rexxapiret = RexxStart(1, (PRXSTRING)&arglist, script, NULL, NULL,
        RXCOMMAND || RXRESTRICTED, NULL, &rexxret, &retstr);

    /* set result back to GnuCOBOL */
    memset(resfield, ' ', reslen);
    if (rexxapiret == 0) {
        memcpy(resfield, retstr.strptr,
               (retstr.strlength > reslen) ? reslen : retstr.strlength);
        *result = rexxret;
    }

    /* Let Rexx do all the memory alllocation */
    if (retstr.strptr != NULL) { ignore = RexxFreeMemory(retstr.strptr); }

    return (int)rexxapiret;
}

int ocrexxcmd(char *cmds, char *args, char *resfield, int reslen, short *result) {
    APIRET rexxapiret;
    RXSTRING retstr;
    RXSTRING arglist[1];
    RXSTRING instore[2];
    short rexxret = 0;

    int ignore = 0;

    /* For syntax check, no evaluate, taken from 8.4 of the Regina3.4 pdf */
    arglist[0].strptr = "//T";
    arglist[0].strlength = 3;

    arglist[0].strptr = args;
    arglist[0].strlength = strlen(args);

    /* Move the command(s) to the instore array */
    instore[0].strptr = cmds;
    instore[0].strlength = strlen(cmds);
    instore[1].strptr = NULL;
    instore[1].strlength = 0;

    /* Call Rexx. Use argcount 1 and &arglist to call syntax check */
    retstr.strptr = NULL;
    retstr.strlength = 0;
    rexxapiret = RexxStart(1, (PRXSTRING)&arglist, "FILLER",
                           (PRXSTRING)&instore, "COMMAND" /* NULL */,
        RXCOMMAND, NULL, &rexxret, &retstr);

    /* set result back to GnuCOBOL */
    memset(resfield, ' ', reslen);
    if (rexxapiret == 0) {
        memcpy(resfield, retstr.strptr,
               (retstr.strlength > reslen) ? reslen : retstr.strlength);
        *result = rexxret;
    }
```

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```
    /* Let Rexx do all the memory alllocation */
    if (instore[1].strptr != NULL) { ignore = RexxFreeMemory(instore[1].strptr); }
    if (retstr.strptr != NULL) { ignore = RexxFreeMemory(retstr.strptr); }

    return (int)rexxapiret;
}
/**/
```

with a usage example of

rexxcaller.cob

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *><* *****************
      *><* Rexx in GnuCOBOL
      *><* *****************
      *><*
      *><* :Author:    Brian Tiffin
      *><* :Date:      13-Nov-2008
      *><* :Purpose:   Very High Level Regina Rexx engine
      *><* :Requires:  regina-rexx, regina3, regina3-dev, OC 1.1 pre-rel
      *><* :Tectonics:
      *><*     | cobc -I/usr/include/regina -c ocrexx.c
      *><*     | cobc -x -lregina rexxcaller.cob ocrexx.o
      *><*     | ocdoc rexxcaller.cob rexxcaller.rst rexxcaller.html
      *> ****************************************************************
       identification division.
       program-id. rexxcaller.

       data division.
      *><*
      *><* =============
      *><* Working Store
      *><* =============
      *><*
      *><* ::
      *><*
      *><[
       working-storage section.
       01 newline constant as x"0a".
       01 trimmer              usage binary-long.
       01 apicode              usage binary-long.
       01 resultcode           usage binary-short.
       01 scriptname           pic x(12) value 'verrexx.cmd' & x'00'.
       01 argument             pic x(256) value 'OC1.1 args' & x"00".
       01 cmds                 pic x(1024).
       01 rexxstring           pic x(1048576).
      *><]

      *> ****************************************************************
       procedure division.

      *><*
      *><* ===
      *><* API
      *><* ===
```

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```
      *><*
      *><* ------
      *><* ocrexx
      *><* ------
      *><* Pass a null-term scriptname, a null-term argument string
      *><* the return value field and length, the return code and
      *><* returning the Rexx api result code.
      *><*
      *><* Usage::
      *><*
       compute
           trimmer = function length(function trim(scriptname))
       end-compute
       display
           "CALL Rexx with |" scriptname(1:trimmer - 1) "|"
       end-display
      *><[
       call "ocrexx"
           using
               by reference scriptname
               by reference argument
               by reference rexxstring
               by value function length(rexxstring)
               by reference resultcode
           returning apicode
       end-call
       display "|" apicode "|" resultcode with no advancing end-display
       display "|" function trim(rexxstring trailing) "|" end-display
      *><]

      *><*
      *><* ---------
      *><* ocrexxcmd
      *><* ---------
      *><* Usage::
      *><*
      *><[
       move "say 'Hello, world'; return 'From Rexx';" & x'00' to cmds.
       compute
           trimmer = function length(function trim(cmds))
       end-compute
       display newline
           "CALL Rexx command with |" cmds(1:trimmer - 1) "|"
       end-display
       call "ocrexxcmd"
           using
               by reference cmds
               by reference argument
               by reference rexxstring
               by value function length(rexxstring)
               by reference resultcode
           returning apicode
       end-call
       display "|" apicode "|" resultcode with no advancing end-display
       display "|" function trim(rexxstring trailing) "|" end-display
      *><]
      *><*
```

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```
      *><* or perhaps::
      *><*
      *><[
       move
           "parse arg argument; say '##' || argument || '##';" & x"0a" &
           "capture = '';" & x"0a" &
           "address system 'cat tectonic && cat verrexx.cmd && ls -l" &
           " && w3m rexxcaller.html'" &
           " with output fifo '';" & x"0a" &
           "DO i=1 WHILE queued() \= 0;" & x"0a" &
           "    parse pull line;" & x"0a" &
           "    capture = capture || line || '0a'x;" & x"0a" &
           "END;" & x'0a' &
           "return capture;" & x'00' to cmds
       compute
           trimmer = function length(function trim(cmds))
       end-compute
       display newline
           "CALL Rexx command with |" cmds(1:trimmer - 1) "|"
       end-display
       call "ocrexxcmd"
           using
               by reference cmds
               by reference argument
               by reference rexxstring
               by value function length(rexxstring)
               by reference resultcode
           returning apicode
       end-call
      *><]
       display "|" apicode "|" resultcode with no advancing end-display
       display "|" function trim(rexxstring trailing) "|" end-display
       goback.
       end program rexxcaller.
      *><*
```

And as a sample Rexx script

verrexx.cmd

```
Parse Version ver;
Say ver;
return ver;
```

With a sample run producing:

```
$ ./tectonic
CALL Rexx with |verrexx.cmd|
REXX-Regina_3.3(MT) 5.00 25 Apr 2004
ocrexx.c  ocrexx.o  rexxcaller  rexxcaller.cob  rexxcaller.html  rexxcaller.rst
    rexx.output  tectonic  verrexx.cmd
|+0000000000|+00000|REXX-Regina_3.3(MT) 5.00 25 Apr 2004|

CALL Rexx command with |say 'Hello, world'; return 'From Rexx';|
Hello, world
|+0000000000|+00000|From Rexx|
```

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```
CALL Rexx command with |parse arg argument; say '##' || argument || '##';
capture = '';
address system 'cat tectonic && cat verrexx.cmd && ls -l &&
                w3m rexxcaller.html' with output fifo '';
DO i=1 WHILE queued() \= 0;
    parse pull line;
    capture = capture || line || '0a'x;
END;
return capture;|
##OC1.1 args##
|+0000000000|+00000|cobc -I/usr/include/regina/ -c ocrexx.c
cobc -x -lregina rexxcaller.cob ocrexx.o
../ocdoc rexxcaller.cob rexxcaller.rst rexxcaller.html ../ocfaq.css
./rexxcaller
/* script for GnuCOBOL Regina Rexx */
Parse Version ver;
Say ver;
address system;
'ls';
return ver;
total 68
-rw-r--r-- 1 btiffin btiffin  2469 2008-11-16 11:09 ocrexx.c
-rw-r--r-- 1 btiffin btiffin  2568 2010-05-06 22:51 ocrexx.o
-rwxr-xr-x 1 btiffin btiffin 18128 2010-05-06 22:51 rexxcaller
-rw-r--r-- 1 btiffin btiffin  4477 2008-11-16 11:28 rexxcaller.cob
-rw-r--r-- 1 btiffin btiffin  9312 2010-05-06 22:51 rexxcaller.html
-rw-r--r-- 1 btiffin btiffin  3187 2010-05-06 22:51 rexxcaller.rst
-rw-r--r-- 1 btiffin btiffin  4131 2008-11-16 11:30 rexx.output
-rwxr-xr-x 1 btiffin btiffin   162 2008-11-16 11:21 tectonic
-rw-r--r-- 1 btiffin btiffin   101 2008-11-15 23:24 verrexx.cmd
Rexx in GnuCOBOL

 Author:   Brian Tiffin
  Date:    13-Nov-2008
 Purpose:  Very High Level Regina Rexx engine
Requires:  regina-rexx, regina3, regina3-dev, OC 1.1 pre-rel
           cobc -I/usr/include/regina -c ocrexx.c
Tectonics: cobc -x -lregina rexxcaller.cob ocrexx.o
           ocdoc rexxcaller.cob rexxcaller.rst rexxcaller.html

Working Store

working-storage section.
01 newline constant as x"0a".
01 trimmer              usage binary-long.
01 apicode              usage binary-long.
01 resultcode           usage binary-short.
01 scriptname           pic x(12) value 'verrexx.cmd' & x'00'.
01 argument             pic x(256) value 'OC1.1 args' & x"00".
01 cmds                 pic x(1024).
01 rexxstring           pic x(1048576).

API

ocrexx

Pass a null-term scriptname, a null-term argument string the return value field
```

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```
and length, the return code and returning the Rexx api result code.

Usage:

call "ocrexx"
    using
        by reference scriptname
        by reference argument
        by reference rexxstring
        by value function length(rexxstring)
        by reference resultcode
    returning apicode
end-call
display "|" apicode "|" resultcode with no advancing end-display
display "|" function trim(rexxstring trailing) "|" end-display

ocrexxcmd

Usage:

move "say 'Hello, world'; return 'From Rexx';" & x'00' to cmds.
compute
    trimmer = function length(function trim(cmds))
end-compute
display newline
    "CALL Rexx command with |" cmds(1:trimmer - 1) "|"
end-display
call "ocrexxcmd"
    using
        by reference cmds
        by reference argument
        by reference rexxstring
        by value function length(rexxstring)
        by reference resultcode
    returning apicode
end-call
display "|" apicode "|" resultcode with no advancing end-display
display "|" function trim(rexxstring trailing) "|" end-display

or perhaps:

move
    "parse arg argument; say '##' || argument || '##';" & x"0a" &
    "capture = '';" & x"0a" &
    "address system 'cat tectonic && cat verrexx.cmd && ls -l" &
    " && w3m rexxcaller.html'" &
    " with output fifo '';" & x"0a" &
    "DO i=1 WHILE queued() \= 0;" & x"0a" &
    "    parse pull line;" & x"0a" &
    "    capture = capture || line || '0a'x;" & x"0a" &
    "END;" & x'0a' &
    "return capture;" & x'00' to cmds
compute
    trimmer = function length(function trim(cmds))
end-compute
display newline
    "CALL Rexx command with |" cmds(1:trimmer - 1) "|"
```

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```
end-display
call "ocrexxcmd"
    using
        by reference cmds
        by reference argument
        by reference rexxstring
        by value function length(rexxstring)
        by reference resultcode
    returning apicode
end-call

|
```

The ocdoc output is available at rexxcaller.html

5.60 Does GnuCOBOL support table SEARCH and SORT?

Yep.

This is a two part example. A small tax table search, and a dictionary sort and lookup.

5.60.1 Linear SEARCH

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin, with some suggestions from human
      *> Date:      30-Nov-2008, 02-Dec-2008
      *> Purpose:   Demonstration of the SEARCH verb
      *> Tectonics: cobc -x searchlinear.cob
      *> ****************************************************************
       identification division.
       program-id. searchlinear.

       data division.

       working-storage section.
       01 taxinfo.
          05 tax-table occurs 4 times indexed by tt-index.
             10 province       pic x(2).
             10 taxrate        pic 999v9999.
             10 federal        pic 999v9999.
       01 prov                 pic x(2).
       01 percent              pic 999v9999.
       01 percentage           pic zz9.99.

      *> ****************************************************************
       procedure division.
       begin.

      *> ****************************************************************
      *> Sample for linear SEARCH, requires INDEXED BY table
      *> populate the provincial tax table; (not really, only a couple)
      *> populate Ontario and then PEI using different field loaders
```

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```
       move 'AB' to province(1)
       move 'ON' to province(2)
       move 0.08 to taxrate(2)
       move 0.05 to federal(2)
       move 'PE00014000000000' to tax-table(3)
       move 'YT' to province(4)

      *> Find Ontario tax rate
       move "ON" to prov
       perform search-for-taxrate

      *> Setup for Prince Edward Island
       move 'PE' to prov
       perform search-for-taxrate

      *> Setup for failure
       move 'ZZ' to prov
       perform search-for-taxrate

       goback.
      *> ****************************************************************

       search-for-taxrate.
           set tt-index to 1
           search tax-table
               at end display "no province: " prov end-display
               when province(tt-index) = prov
                   perform display-taxrate
           end-search
       .

       display-taxrate.
           compute percent = taxrate(tt-index) * 100
           move percent to percentage
           display
               "found: " prov " at " taxrate(tt-index)
               "," percentage "%, federal rate of " federal(tt-index)
           end-display
       .

       end program searchlinear.
```

A sample run producing:

```
$ cobc -x searchlinear.cob && ./searchlinear
found: ON at 000.0800,  8.00%, federal rate of 000.0500
found: PE at 000.1400, 14.00%, federal rate of 000.0000
no province: ZZ
```

5.60.2 SORT and binary SEARCH ALL

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin, with some suggestions from human
      *> Date:      30-Nov-2008, 02-Dec-2008
```

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```
      *> Purpose:   Demonstration of the SEARCH ALL verb and table SORT
      *> Tectonics: cobc -x -fdebugging-line searchbinary.cob
      *> ************************************************************
       identification division.
       program-id. searchbinary.

       environment division.
       input-output section.
       file-control.
           select optional wordfile
           assign to infile
           organization is line sequential.

       data division.
       file section.
       fd wordfile.
           01 wordrec          pic x(20).

       working-storage section.
       01 infile               pic x(256) value spaces.
          88 defaultfile       value '/usr/share/dict/words'.
       01 arguments            pic x(256).

      *> Note the based clause, this memory is initially unallocated
       78 maxwords            value 500000.
       01 wordlist             based.
          05 word-table occurs from 0 to maxwords times
              depending on wordcount
              descending key is wordstr
              indexed by wl-index.
             10 wordstr        pic x(20).
             10 wordline       usage binary-long.
       01 wordcount            usage binary-long.

       01 file-eof             pic 9 value low-value.
          88 at-eof            value high-values.

       01 word                 pic x(20).

      *> ************************************************************
       procedure division.
       begin.

      *> Get the word file filename
       accept arguments from command-line end-accept
       if arguments not equal spaces
           move arguments to infile
       else
           set defaultfile to true
       end-if

      *> ************************************************************
      *> Try playing with the words file and binary SEARCH ALL
      *>   requires KEY IS and INDEXED BY table description

      *> Point wordlist to valid memory
       allocate wordlist initialized
```

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```
     open input wordfile

     move low-value to file-eof
     read wordfile
         at end set at-eof to true
     end-read

     perform
         with test before
         until at-eof or (wordcount >= maxwords)
             add 1 to wordcount
             move wordrec to wordstr(wordcount)
             move wordcount to wordline(wordcount)
             read wordfile
                 at end set at-eof to true
             end-read
     end-perform

     close wordfile

    *> ensure a non-zero length table when allowing optional file
     evaluate true                  also file-eof
         when wordcount = 0         also any
             move 1 to wordcount
             display "No words loaded" end-display
         when wordcount >= maxwords also low-value
             display "Word list truncated to " maxwords end-display
     end-evaluate

   >>D display "Count: " wordcount ": " wordstr(wordcount) end-display

    *> Sort the words from z to a
     sort word-table on descending key wordstr

    *> fetch a word to search for
     display "word to find: " with no advancing end-display
     accept word end-accept

    *> binary search the words for word typed in and display
    *> the original line number if/when a match is found
     set wl-index to 1
     search all word-table
         at end
             display
                 word " not a word of " function trim(infile)
             end-display
         when wordstr(wl-index) = word
             display
                 word " sorted to " wl-index ", originally "
                 wordline(wl-index) " of " function trim(infile)
             end-display
     end-search

    *> Release memory ownership
     free address of wordlist
```

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```
       goback.
       end program searchbinary.
```

with some sample words and a Debian 5.0.4 system:

```
$ cobc -x searchbinary.cob
$ ./searchbinary
word to find: zygote
zygote   sorted to +000000018, originally +0000098552 of /usr/share/dict/words
$ ./searchbinary
word to find: abacus
abacus   sorted to +000080466, originally +0000018104 of /usr/share/dict/words
```

See *SORT* (page 403) for other examples.

5.61 Can GnuCOBOL handle named pipes?

Yes. Here is a sample, using a tongue-in-cheek **corncob** filename, and a more practical function repository to follow.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      10-Apr-2010
      *> Purpose:   playing with the corncob pipe
      *> Tectonics: mkfifo corncob
      *>            cobc -x popcorn.cob
      *>            ls >corncob & ./popcorn
      *> ***************************************************************
       identification division.
       program-id. popcorn.

       environment division.
       configuration section.

       input-output section.
       file-control.
           select corncob
           assign to 'corncob'
           organization is line sequential
           .

       data division.
       file section.
       fd corncob.
          01 tobacco pic x(32768).

       working-storage section.
       01 filestat pic x value low-value.
          88 done        value high-value.
       01 liner    pic 99999.
       01 looper   pic 99999.
       01 atmost   constant as 32768.
       01 bowl.
          02 popcorn occurs 0 to atmost times depending on liner
```

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```
             ascending key kernel.
           03 kernel pic x(132).

      *> ****************************************************************
       procedure division.

      *> Read from the pipe into a table
       open input corncob
       move zero to liner
       perform until done or (liner greater than or equal to atmost)
           read corncob
               at end
                   set done to true
               not at end
                   add 1 to liner end-add
                   move tobacco to kernel(liner)
           end-read
       end-perform
       close corncob

      *> Sort it descending and display
       sort popcorn on descending key kernel

       perform varying looper from 1 by 1 until looper > liner
           display
               "GnuCOBOL: " function trim(kernel(looper) trailing)
           end-display
       end-perform

       goback.
       end program popcorn.
```

With a sample run producing:

```
$ rm corncob
$ mkfifo corncob
$ ls -d n* >corncob & ./popcorn
[1] 5033
GnuCOBOL: nums.cob
GnuCOBOL: nums
GnuCOBOL: network
[1]+  Done                    ls -d n* > corncob
$ ls -d n*
network  nums  nums.cob
$ date >corncob & ./popcorn
[1] 5037
GnuCOBOL: Sun Apr 11 08:04:48 EDT 2010
[1]+  Done                    date > corncob
```

5.61.1 popen

There is a cobweb-pipes function repository, stored in contrib/trunk/tool/cobweb/ in the GnuCOBOL project Contributions SVN repository. Command pipes can make for some very handy, quick and mini, COBOL application development. The piggy bank example below, uses literals, a more realistic usage would be summary records from in house data tables.

Note: this version of the source listing uses a string referencing method that may be superseded by BASED OCCURS DEPENDING ON tables.

```
Gnu    >>SOURCE FORMAT IS FIXED
COBOL *> ***************************************************************
      *>  Copyright 2015 Brian Tiffin
      *>   License: GPL v2.1 or later
      *>      Date: 20150216
      *>   Purpose: pipe execute and read, or write
      *> Tectonics: cobc cobweb-pipes.cob substring.c
      *> ***************************************************************
       identification division.
       function-id. pipe-open.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.

       linkage section.
       01 pipe-command         pic x any length.
       01 pipe-mode            pic x any length.
       01 pipe-record.
          05 pipe-pointer      usage pointer.
          05 filler            usage binary-long.

      *> ***************************************************************
       procedure division using
           pipe-command
           pipe-mode
         returning pipe-record.

       call "popen" using
           by content concatenate(trim(pipe-command), x"00")
           by content concatenate(trim(pipe-mode), x"00")
         returning pipe-pointer
         on exception
             display "link error: popen" upon syserr end-display
             move 255 to return-code
             goback
       end-call

       if pipe-pointer equal null then
           display "exec error: popen" upon syserr end-display
           move 255 to return-code
           goback
       end-if

       goback.
       end function pipe-open.

      *> ***************************************************************
       identification division.
       function-id. pipe-read.
```

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```
       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 line-buffer-length   usage binary-long.

       linkage section.
       01 pipe-record-in.
          05 pipe-pointer      usage pointer.
          05 filler            usage binary-long.
       01 line-buffer          pic x any length.
       01 pipe-record-out.
          05 pipe-read-status  usage pointer.
          05 filler            usage binary-long.

      *> ****************************************************************
       procedure division using
           pipe-record-in
           line-buffer
         returning pipe-record-out.

       move length(line-buffer) to line-buffer-length
       call "fgets" using
           by reference line-buffer
           by value line-buffer-length
           by value pipe-pointer
         returning pipe-read-status
         on exception
             display "link error: fgets" upon syserr end-display
             move 255 to return-code
             goback
       end-call

       goback.
       end function pipe-read.

      *> ****************************************************************
       identification division.
       function-id. pipe-write.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 line-buffer-length   usage binary-long.

       linkage section.
       01 pipe-record-in.
          05 pipe-pointer      usage pointer.
          05 filler            usage binary-long.
       01 line-buffer          pic x any length.
```

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```
       01 pipe-record-out.
          05 filler            usage pointer.
          05 pipe-write-status usage binary-long.

      *> ****************************************************************
       procedure division using
           pipe-record-in
           line-buffer
         returning pipe-record-out.

       call "fputs" using
           by content concatenate(trim(line-buffer), x"00")
           by value pipe-pointer
         returning pipe-write-status
         on exception
             display "link error: fputs" upon syserr end-display
             move 255 to return-code
             goback
       end-call

       goback.
       end function pipe-write.

      *> ****************************************************************
       identification division.
       function-id. pipe-close.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.

       linkage section.
       01 pipe-record.
          05 pipe-pointer      usage pointer.
          05 filler            usage binary-long.
       01 pclose-status        usage binary-long.

      *> ****************************************************************
       procedure division using pipe-record returning pclose-status.

       call "pclose" using
           by value pipe-pointer
         returning pclose-status
         on exception
             display "link error: pclose" upon syserr end-display
             move 255 to return-code
             goback
       end-call

       goback.
       end function pipe-close.
```

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```
      *> ****************************************************************
       identification division.
       function-id. pinpoint.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 haystack-address     usage pointer.
       01 result-strstr        usage pointer.

       linkage section.
       01 haystack             pic x any length.
       01 needle               pic x any length.
       01 haystack-offset      usage binary-long.
       01 sub-location         usage binary-long value 0.

      *> ****************************************************************
       procedure division using
           haystack
           needle
           haystack-offset
         returning sub-location.

       call "substring" using
           by content concatenate(trim(haystack), x"00")
           by content concatenate(trim(needle), x"00")
           by value haystack-offset
           returning sub-location
           on exception
               display "link error: strstr" upon syserr end-display
bail           goback
       end-call

       goback.
       end function pinpoint.

      *> ****************************************************************
      *> if an integer is out of range, return a value in range
       identification division.
       function-id. entrammel.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.

       linkage section.
       01 unknown              usage binary-long.
       01 lowest-acceptable    usage binary-long.
       01 highest-acceptable   usage binary-long.
```

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```
       01 entrammelled         usage binary-long.

      *> ****************************************************************
       procedure division using
           unknown
           lowest-acceptable
           highest-acceptable
         returning entrammelled.

       if unknown less than lowest-acceptable then
           move lowest-acceptable to entrammelled
       else
           if unknown greater than highest-acceptable then
               move highest-acceptable to entrammelled
           else
               move unknown to entrammelled
           end-if
       end-if

done   goback.

       end function entrammel.
      *> ****************************************************************

      *> ****************************************************************
      *>****F* cobweb/cmove
      *> PURPOSE
      *>   un-c a C string, into a modified occurs depending on table
       identification division.
       function-id. cmove.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 unused-return usage pointer.

       01 peeker usage pointer.
       01 newline-tester pic x based.
          88 trailing-newline value x"0a".

       linkage section.
       01 c-string usage pointer.
       01 cobol-odo-xfield pic x any length.
       01 c-length-as-odo-modified usage binary-long.
       01 strip-newline pic 9.
       01 c-length usage binary-long.

      *> ****************************************************************
       procedure division using
           c-string
           cobol-odo-xfield
           c-length-as-odo-modified
           optional strip-newline
```

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```
          returning c-length.

      *> copy c-string to working store, limited by incoming odo
       if c-string not equal null then
           call "strlen" using by value c-string returning c-length
               on exception display "no strlen" upon syserr end-display
           end-call

           *> fence in the odo
           if c-length-as-odo-modified greater than
                                       length(cobol-odo-xfield) then
               move length(cobol-odo-xfield) to c-length-as-odo-modified
           end-if

           call "strncpy" using
               by reference cobol-odo-xfield
               by value c-string
               by value c-length-as-odo-modified
               returning unused-return
               on exception display "no strncpy" upon syserr end-display
           end-call
       end-if

      *> modifiy the odo field
       move c-length to c-length-as-odo-modified

      *> handle trailing newlines?
       if not strip-newline omitted then
           if strip-newline not equal zero then
               set peeker to address of cobol-odo-xfield
               set peeker up by c-length
               set peeker down by 1
               set address of newline-tester to peeker
               if trailing-newline then
                   subtract 1 from c-length-as-odo-modified
               end-if
           end-if
       end-if

       goback.
       end function cmove.
      *>****
```

Function repositories allow for very concise application development and nice, short, procedure divisions.

```
*> graph to X
if graphing then
    move pipe-open(
        "graph -TX -x 1 13 -y -1000 6000" &
        " -X 'Month' -Y 'Pennies' -S 4", "w")
      to pipe-record
    move pipe-write(pipe-record,
        "1 1234 2 2345 3 3456 4 1234" &
        " 5 4567 6 3456 7 5678 8 2345" &
        " 9 4567 10 3456 11 5678 12 -500")
      to pipe-record-out
    move pipe-close(pipe-record) to return-code
```

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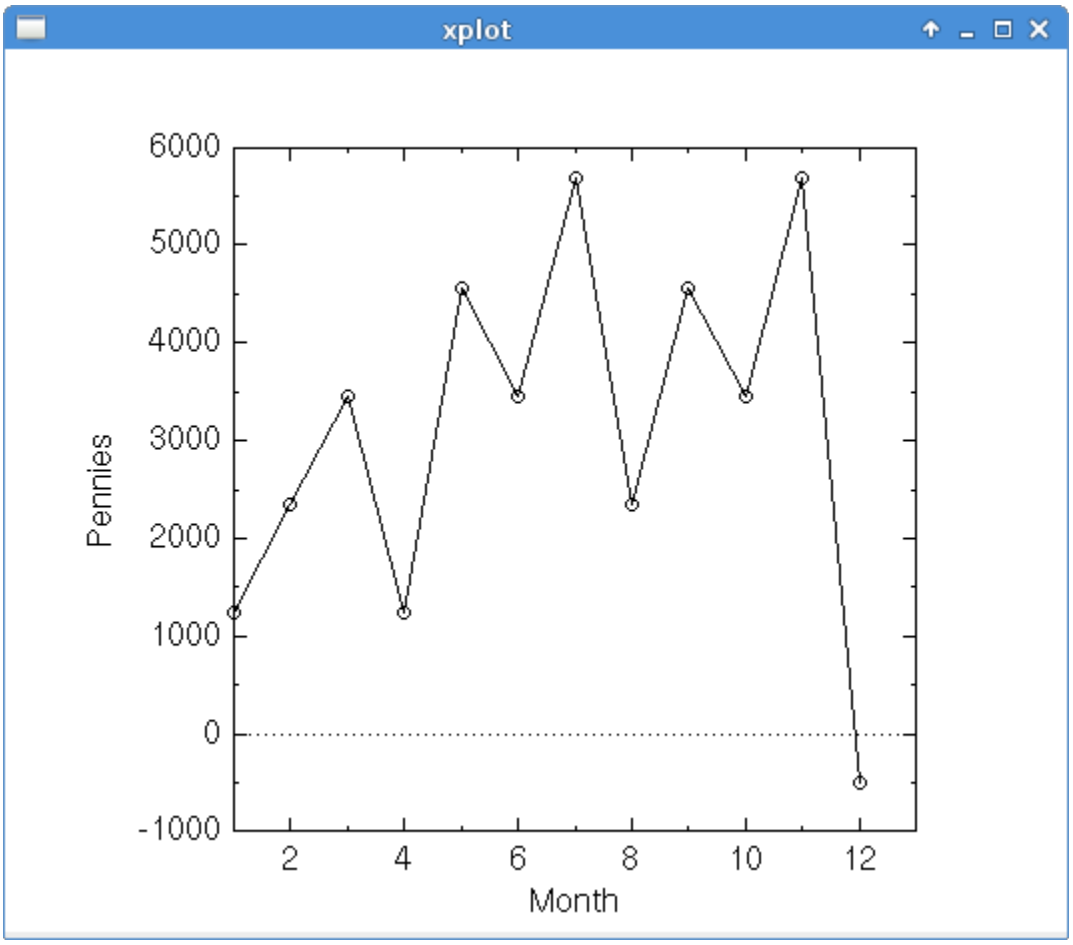
```
    if return-code not equal 0 then
        display "return-code: " return-code
    end-if
    goback
end-if
```

giving a quick pop up X display. If **graph** knows the X and Y ranges on invocation, it will plot data *live*, as it is piped to the **graph** command. Custom ticker applications in, 40 lines of source?



Plotting data; in three MOVE statements.

Decrypting the graph command line, a little:

```
-TX             type is X plot, lots of -T types.
-x 1 13         x range is low 1, high 13
-y -1000 6000   y range
-X 'Month'      x-axis label
-Y 'Pennies'    y-axis label
-S 4            sets a Symbol mode 4, the little circles
```

The data pairs are month number, x, and penny count, y.

The graph command is invoked, with a "w" write pipe, so the child process takes standard input from the GnuCOBOL parent program, and writes its output to standard out. The standard output of `graph` is irrelevant in this case, the objective is the pop-up X11 plot window, but it is a pipe, the output can be ignored, or passed on to further commands

in a tool chain.

Note that the plot clearly shows that someone had to borrow $5 from their big sister to get through December.

5.62 Can GnuCOBOL interface with ROOT/CINT?

Yes. The Feburary 2009 pre-release generates C code that can be loaded by the ROOT/CINT framework. ROOT is a high energy physics data analysis framework released by CERN. ROOT/CINT embeds the CINT C/C++ interactive interpreter.

See https://root.cern.ch/drupal/content/cint for details.

GnuCOBOL programmers can use ROOT/CINT for interactive testing of COBOL subprograms.

Given

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20101119
      *> Purpose:   Pass arguments to ROOT/CINT invoked subprograms
      *> Tectonics: cobc -fimplicit-init -C cobparams.cob
      *> ***************************************************************
       identification division.
       program-id. cobparams.

       data division.
       linkage section.
       01 a-number usage binary-long.

      *> ***************************************************************
       procedure division using by reference a-number.
       display a-number end-display
       move a-number to return-code
       goback.
       end program cobparams.
```

and the command line

```
$ cobc -fimplicit-init -C cobparams.cob
```

gives a set of C source code output for cobparams.

ROOT/CINT can then be used to play with the program.

```
$ cobc -fimplicit-init -C cobparams.cob
$ root -l
root [0] gSystem->Load("/usr/local/lib/libcob.so");
root [1] .L cobparams.c+
root [2] int a = 0;
root [3] int d = 42;
root [4] a = cobparams((unsigned char*)&d);
+0000000042
root [5] printf("%d\n", a);
42
root [6]
```

There is some magic in the above snippet. ROOT preloads the runtime libcob.so. Then its .L command is used with the plus + option to interpret and link load the cobc generated cobparams.c file.

The ROOT/CINT console now has access to the cobparams "function", defined by GnuCOBOL to have an unsigned char pointer as its BY REFERENCE access; A cast of the integer d's address allows CINT to call up the COBOL subprogram, passing the 42 for DISPLAY and then returning the same value as the result. The interactively defined integer a, gets this 42 from GnuCOBOL's RETURN-CODE.

5.62.1 Graphing sample

ROOT/CINT is built for analysis. So, plotting and graphing are built-in.

Given

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20101119
      *> Purpose:   Pass arguments to ROOT/CINT invoked subprograms
      *> Tectonics: cobc -fimplicit-init -C cobparams.cob
      *> ***************************************************************

       REPLACE ==ARRAYSIZE== BY ==450==.

       identification division.
       program-id. cobfloats.

       data division.
       working-storage section.
       01 cnt pic 999.
       01 val usage float-long.
       01 xes.
          02 an-x usage float-long occurs ARRAYSIZE times.
       01 yes.
          02 an-y usage float-long occurs ARRAYSIZE times.

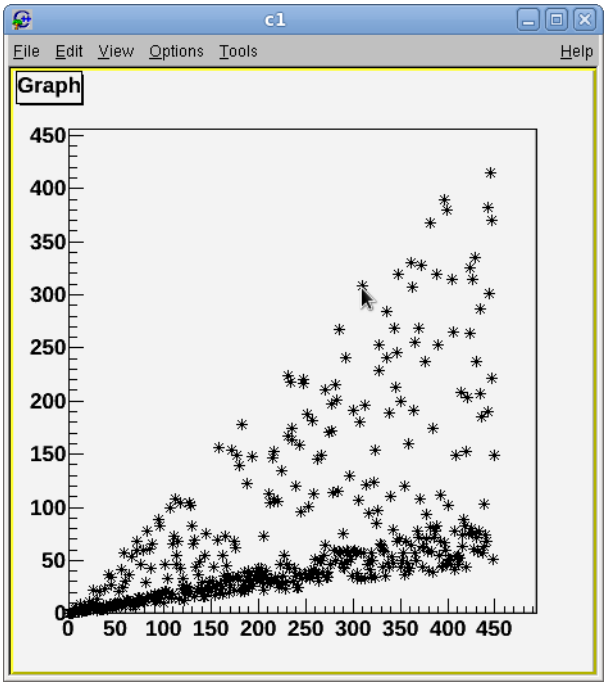
       linkage section.
       01 vxes.
          02 an-x usage float-long occurs ARRAYSIZE times.
       01 vyes.
          02 an-y usage float-long occurs ARRAYSIZE times.

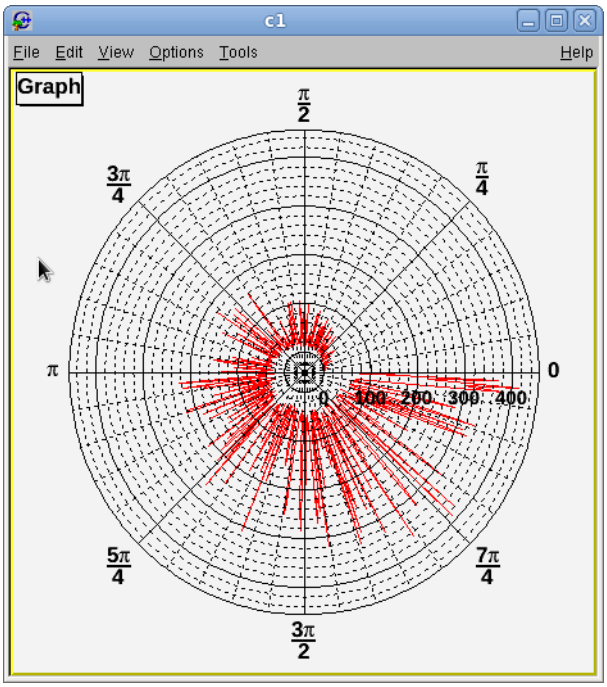
      *> ***************************************************************
       procedure division using by reference vxes, vyes.
       perform varying cnt from 1 by 1 until cnt >= ARRAYSIZE
           compute val = cnt * function random() end-compute
           move cnt to an-x in xes(cnt)
           move val to an-y in yes(cnt)
       end-perform
       move xes to vxes
       move yes to vyes
       move cnt to return-code
       goback.
       end program cobfloats.
```

And then a console session of:

```
$ cobc -fimplicit-init -C cobparams.cob
$ vi cobparams.c
... add a single line
...   #pragma K&R
... to lighten up CINT's type safety for ease of use at the console
$ root -l
root [0] gSystem->Load("/usr/local/lib/libcob.so");
root [1] .L cobparams.c+
root [2] int a = 0; double x[450]; double y[450];
root [3] a = cobfloats(&x, &y);
root [4] a
(int)450
root [5] printf("%f %f\n", x[42], y[42]);
43.000000 8.232543
root [6] TGraph *graph1 = new TGraph(450, x, y);
root [7] graph1->Draw("A*");
root [8] TGraphPolar *polar1 = new TGraphPolar(450, x, y);
root [9] polar1->SetLineColor(2);
root [10] polar1->Draw("AOL");
```

produces the following graphs; some constrained random numbers, and a circular view of those random numbers. *Nerd heaven*.





5.63 Can GnuCOBOL be used to serve HTTP?

Not directly, COBOL preceding the World Wide Web by some 35 years, but yes.

5.63.1 GNU libmicrohttpd

There is a GNU project, a C library, designed to allow for an embedded HTTP server in applications. Works well with GnuCOBOL.

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20140420
      *> Copyright (c) 2014, Brian Tiffin
      *> This free software is licensed under the GPL 2 without warranty
      *> Purpose:   GnuCOBOL minimal micro web server
      *> Tectonics: cobc -x gnucobol-microhttpd.cob -lmicrohttpd
      *> ***************************************************************
       identification division.
       program-id. gnucobol-microhttpd.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 MHD_HTTP_OK                constant   as 200.
       01 MHD_USE_SELECT_INTERNALLY constant   as 8.
```

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```
       01 MHD_RESPMEM_PERSISTENT    constant   as 0.
       01 MHD_OPTION_END            constant   as 0.

       01 star-daemon               usage pointer.
       01 connection-handler-entry  usage program-pointer.

       01 server-command            pic x(80).

      *> ****************************************************************
       procedure division.
       set connection-handler-entry to
         entry "gnucobol-connection-handler"
       call "MHD_start_daemon" using
           by value MHD_USE_SELECT_INTERNALLY
           by value 8888
           by value 0
           by value 0
           by value connection-handler-entry
           by value 0
           by value MHD_OPTION_END
           returning star-daemon
           on exception
               display
                   "gnucobol-microhttpd: libmicrohttpd failure"
                   upon syserr
               end-display
       end-call
       display "wow, server.  help, info, quit" end-display
       perform until server-command = "quit"
           display "server: " with no advancing end-display
           accept server-command end-accept
           if server-command = "help" then
               display
                   "gnucobol-microhttpd: help, info, quit"
               end-display
           end-if
           if server-command = "info" then
               display
                   "gnucobol-microhttpd: info? help, quit"
               end-display
           end-if
       end-perform

       call "MHD_stop_daemon" using
           by value star-daemon
           on exception
               display
                   "gnucobol-microhttpd: libmicrohttpd failure"
                   upon syserr
               end-display
       end-call

       goback.
       end program gnucobol-microhttpd.
      *> ****************************************************************

      *> ****************************************************************
```

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```
       identification division.
       program-id. gnucobol-connection-handler.

       data division.
       working-storage section.
       01 MHD_HTTP_OK               constant   as 200.
       01 MHD_RESPMEM_PERSISTENT    constant   as 0.
       01 webpage              pic x(132) value
          "<html><body>" &
          "Hello, world<br/>" &
          "from <b>GnuCOBOL</b> and <i>libmicrohttpd</i>" &
          "</body></html>".
       01 star-response                        usage pointer.
       01 mhd-result                           usage binary-long.

       linkage section.
       01 star-cls                             usage pointer.
       01 star-connection                      usage pointer.
       01 star-url                             usage pointer.
       01 star-method                          usage pointer.
       01 star-version                         usage pointer.
       01 star-upload-data                     usage pointer.
       01 star-upload-data-size                usage pointer.
       01 star-star-con-cls                    usage pointer.
       procedure division using
           by value star-cls
           by value star-connection
           by value star-url
           by value star-method
           by value star-version
           by value star-upload-data
           by value star-upload-data-size
           by reference star-star-con-cls
       .


       display "wow, connection handler" upon syserr end-display
       call "MHD_create_response_from_buffer" using
           by value length of webpage
           by reference webpage
           by value MHD_RESPMEM_PERSISTENT
           returning star-response
           on exception
               display
                   "gnucobol-microhttpd: libmicrohttpd failure"
                   upon syserr
               end-display
       end-call
       call "MHD_queue_response" using
           by value star-connection
           by value MHD_HTTP_OK
           by value star-response
           returning mhd-result
           on exception
               display
                   "gnucobol-microhttpd: libmicrohttpd failure"
                   upon syserr
```

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```
               end-display
           end-call
           call "MHD_destroy_response" using
               by value star-response
           end-call

           move mhd-result to return-code

           goback.
           end program gnucobol-connection-handler.

      *> ****************************************************************
      *> from libmicrohttpd hellobrowser.c tutorial example
      *> ****************************************************************
      *> #include <sys/types.h>
      *> #include <sys/select.h>
      *> #include <sys/socket.h>
      *> #include <microhttpd.h>
      *>
      *> #define PORT 8888
      *>
      *> static int
      *> answer_to_connection(void *cls, struct MHD_Connection *connection,
      *>                      const char *url, const char *method,
      *>                      const char *version, const char *upload_data,
      *>                      size_t * upload_data_size, void **con_cls)
      *> {
      *>     const char *page = "<html><body>Hello, browser!</body></html>";
      *>     struct MHD_Response *response;
      *>     int ret;
      *>     response =
      *>        MHD_create_response_from_buffer(strlen(page), (void *) page,
      *>                                        MHD_RESPMEM_PERSISTENT);
      *>     ret = MHD_queue_response(connection, MHD_HTTP_OK, response);
      *>     MHD_destroy_response(response);
      *>     return ret;
      *> }
      *>
      *> int main()
      *> {
      *>     struct MHD_Daemon *daemon;
      *>     daemon = MHD_start_daemon(MHD_USE_SELECT_INTERNALLY, PORT, NULL, NULL,
      *>                               &answer_to_connection, NULL, MHD_OPTION_END);
      *>     if (NULL == daemon)
      *>        return 1;
      *>     getchar();
      *>     MHD_stop_daemon(daemon);
      *>     return 0;
      *> }
```

And a side by side terminal session capture; `emacs` is pretty handy.

```
$ cobc -x gnucobol-microhttpd.cob -lmicrohttpd    |$
$ ./gnucobol-microhttpd                           |$ curl http://localhost:8888
wow, server.  help, info, quit                    |<html><body>Hello, world<br/>from <b>GnuCOBOL</b>
server: wow, connection handler                   |and <i>libmicrohttpd</i></body></html>
quit                                              |$
$                                                 |$ curl http://localhost:8888
                                                  |curl: (7) Failed connect to localhost:8888; Connect
```

```
|ion refused
|$
```

5.63.2 libsoup HTTP server

Vala and libsoup is another way to embed a server.

Given `soupserver.vala`

```
// vala .10 specific.  .11 changes string to uint8 array
// valac -c --pkg libsoup-2.4 --thread soupserver.vala

// Give the server a default
void default_handler (Soup.Server server, Soup.Message msg, string path,
                      GLib.HashTable? query, Soup.ClientContext client)
{
    string response_text = """
        <html>
          <body>
            <p>Current location: %s</p>
            <p><a href="/xml">Test XML</a></p>
            <p><a href="/cobol">Test COBOL</a></p>
            <p><a href="/exit">Tell server to exit</a></p>
          </body>
        </html>""".printf (path);

    msg.set_response ("text/html", Soup.MemoryUse.COPY,
                      response_text, response_text.size ());
    msg.set_status (Soup.KnownStatusCode.OK);
}


void xml_handler (Soup.Server server, Soup.Message msg, string path,
                  GLib.HashTable? query, Soup.ClientContext client)
{
    string response_text = "<node><subnode>test</subnode></node>";
    msg.set_response ("text/xml", Soup.MemoryUse.COPY,
                      response_text, response_text.size ());
}

void cobol_handler (Soup.Server server, Soup.Message msg, string path,
                    GLib.HashTable? query, Soup.ClientContext client)
{
    string response_text = """
        <html>
          <body>
            <p>Current location: %s</p>
            <p><a href="/xml">Test XML</a></p>
            <p><a href="/">Home</a></p>
            <p><a href="/exit">Tell server to exit</a></p>
          </body>
        </html>""".printf (path);

    msg.set_response ("text/html", Soup.MemoryUse.COPY,
                      response_text, response_text.size ());
    msg.set_status (Soup.KnownStatusCode.OK);
}
```

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```
void exit_handler (Soup.Server server, Soup.Message msg, string path,
                   GLib.HashTable? query, Soup.ClientContext client)
{
    server.quit();
}

int CBL_OC_SOUPSERVER(ref Soup.Server* ss, int port) {
    var server = new Soup.Server(Soup.SERVER_PORT, port);
    server.add_handler("/", default_handler);
    server.add_handler("/xml", xml_handler);
    server.add_handler("/cobol", cobol_handler);
    server.add_handler("/exit", exit_handler);
    ss = (owned)server;
    stdout.printf("ss: %X\n", (uint)ss);
    return 0;
}

int CBL_OC_SOUPRUN(Soup.Server ss) {
    ss.run();
    return 0;
}
```

and **ocsoup.cob**

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20101205
      *> Purpose:   An HTTP server with libsoup
      *> Tectonics: valac -c --pkg libsoup-2.4 --thread soupserver.vala
      *>            cobc -x ocsoup.cob soupserver.vala.o -lglib-2.0
      *>                 -lsoup-2.4 -lgobject-2.0
      *> ****************************************************************
       identification division.
       program-id. ocsoup.

       data division.
       working-storage section.
       01 soup-server usage pointer.
       01 port usage binary-long value 8088.
       01 result usage binary-long.

      *> ****************************************************************
       procedure division.
       call "g_type_init" end-call
       display "Initialize soup HTTP server on port " port end-display
       call "CBL_OC_SOUPSERVER" using
           by reference soup-server
           by value port
           returning result
       end-call
       display "Result: " result " Server at: " soup-server end-display

       display "About to run server, ^C to terminate" end-display
       call "CBL_OC_SOUPRUN" using
           by value soup-server
```

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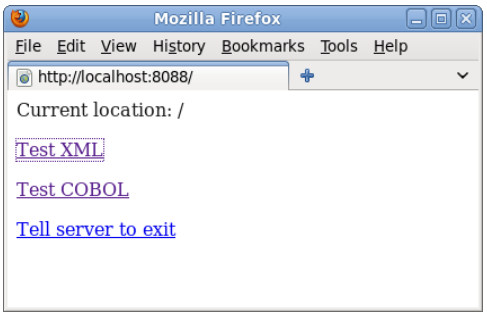
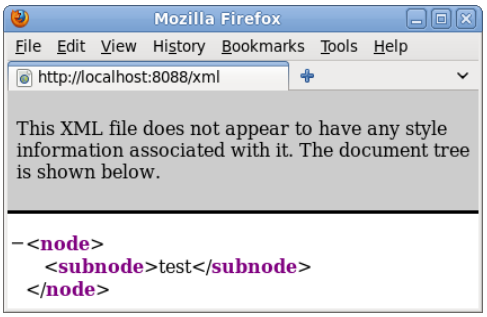
```
            returning result
        end-call

        goback.
        end program ocsoup.
```

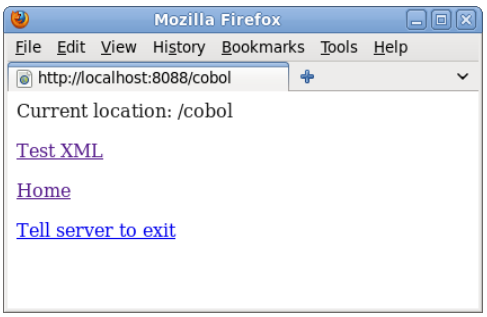
and a little bash

```
$ valac -c --pkg libsoup-2.4 --thread soupserver.vala
$ ... some warnings about unused methods ...
$ cobc -x ocsoup.cob soupserver.vala.o -lglib-2.0 -lsoup-2.4 -lgobject-2.0
$ ./ocsoup
Initialize soup HTTP server on port +0000008088
ss: 21CF060
Result: +0000000000 Server at: 0x00000000021cf060
About to run server, ^C to terminate
```





The next steps are getting the add_handler callbacks into COBOL, and then play with the template and replace model.



5.64 Is there a good SCM tool for GnuCOBOL?

In this author's opinion, yes. **Fossil**.

Where SCM is *Software Configuration Management*, and not simply *Source Code Management*, which Fossil does quite well.

See the Fossil site, snag a tar ball, make, and move the binary to /usr/bin.

Then, to start up your next GnuCOBOL COBOL project:

```
# Create the fossil distributed repository
$ mkdir ~/fossils
$ cd ~/fossils
$ fossil new nextbigthing.fossil

# Serve it up on the localhost port 8080
$ fossil server . &

# browse to the admin panel and do a little nicey nice config
$ opera http://localhost:8080/nextbigthing

# set up the working copy
$ cd ~/projects
$ mkdir nextbigthing
$ cd nextbigthing
$ fossil clone http://localhost:8080/nextbigthing nbt.fossil

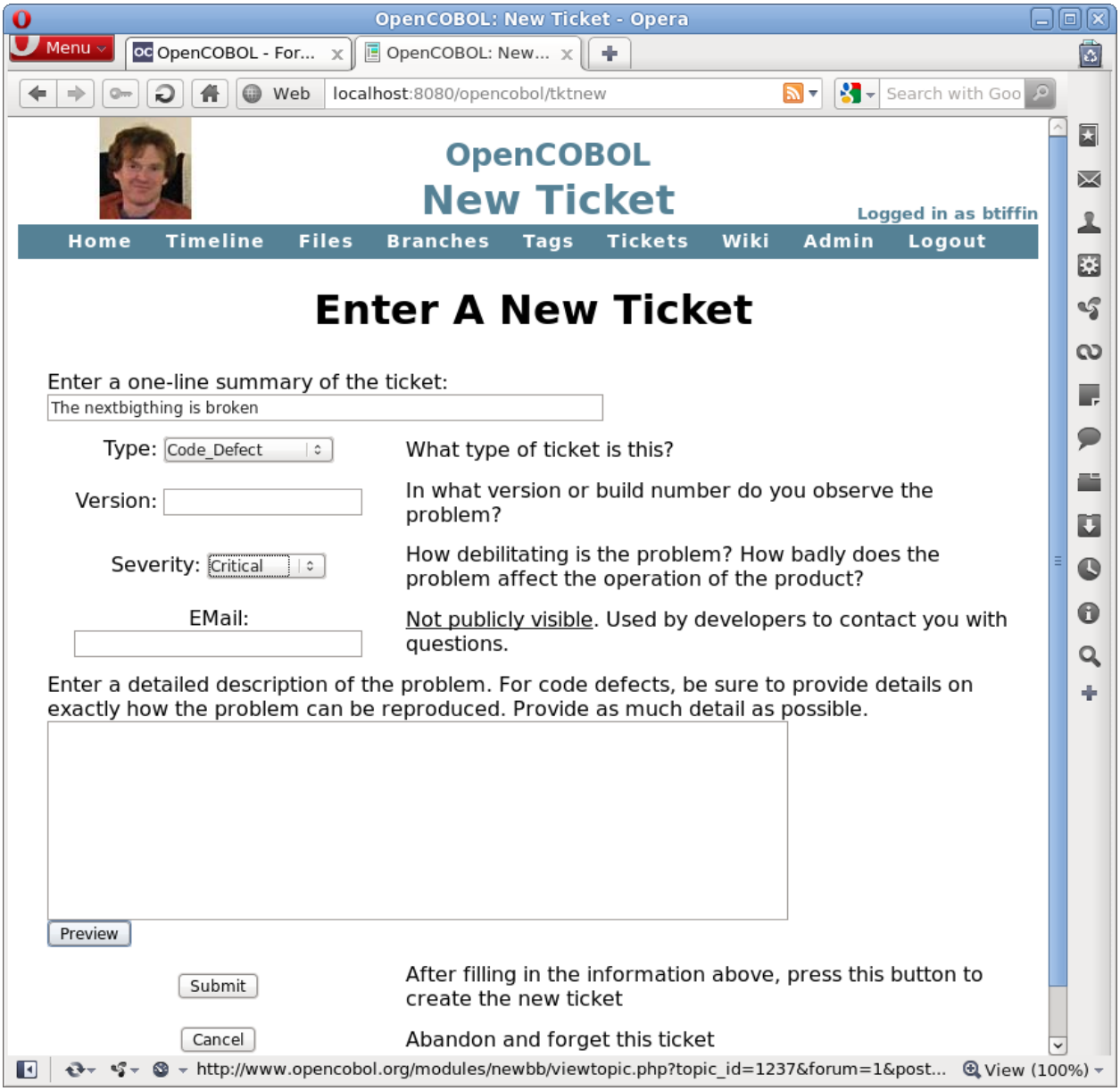
# now look at the shiny copy of nextbig
$ ls
$ vi nextbigthing.cob
$ fossil add nextbigthing.cob
$ fossil ci -m "On to the next big thing"

# browse to the repo and create some wiki pages for morale boosting
$ opera http://localhost:8080/nextbigthing

# compile and run the next big thing
$ cobc -x nextbigthing.cob
$ ./nextbigthing

# browse again, and create the bug tickets
$ opera http://localhost:8080/nextbigthing/tktnew
```

Ahh, morale boosting bugs. :)



5.64.1 cobweb-words

There is a long term goal to provide a COBOL reference system using Fossil and its many features. An initial, nearly empty, prototype is hosted on SourceForge at

http://gnucobol.sourceforge.net/cgi-bin/gnucobol

The idea is to provide online (and local) access to COBOL help features. Statement explanations, notes, idioms, starter COBOL source templates, and anything else that can make life easier for COBOL developers, young and old. The system will allow any and all interested parties to update these documents to ensure the help is the best COBOL help that the internet can provide. These help files will be accessibe from the command line, the browser, and eventually from graphical applications.

Fossil natively supports its own internal wiki formatting, and Markdown. The embedded documentation feature of Fossil can deliver over 200 known internet MIME types, so `cobweb-words` will have access to full multimedia files

as the help system is built up over time.

TH1

Fossil has a Tcl-like language interpreter built into it, originally for controlling and customizing the Ticket sub-system, and then for header and footer webpage output. Now it allows for "programmable" documentation pages. TH1 can (and will) be used to provide dynamic documentation.

See http://www.hwaci.com/cgi-bin/fossil/doc/tip/www/th1.md for some technical details.

5.65 Does GnuCOBOL interface with FORTRAN?

Yes. Quite well in the GNU land. `gfortran` produces C ABI object code that plays very well with `cobc` and CALL.

For example; snuggled away at http://fortranwiki.org/fortran/show/jucolor is a color unit converter; RGB to HLS, HSV to RGB, etc...

And with a simple Makefile ala

```
all: rgbcobol

libcolors.so: colors.for
    gfortran -ffree-form -shared -fPIC -o libcolors.so colors.for

rgbcobol: rgbcobol.cob libcolors.so
    cobc -g -debug -x rgbcobol.cob -lcolors -L .
```

and some COBOL

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20110411
      *> Purpose:   Call a FORTRAN color unit converter, rgb, hsv, ...
      *> Tectonics: gfortran -ffree-form -shared -fPIC
      *>                -o libcolors.so colors.for
      *>            cobc -x rgbcobol.cob -lcolors -L .
      *> ************************************************************
       identification division.
       program-id. rgbcobol.

       data division.
       working-storage section.
       01 r usage float-short.
       01 g usage float-short.
       01 b usage float-short.

       01 h usage float-short value 12.21.
       01 l usage float-short value 21.12.
       01 s usage float-short value 23.32.

       01 st usage binary-long.

      *> ************************************************************
       procedure division.
       move 000.0 to h
       move 050.0 to l
```

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```
       move 100.0 to s
       display "Calling FORTRAN with " h space l space s end-display
       call "jucolor_" using 'hls', h, l, s, 'rgb', r, g, b, st end-call
       display "Returned              " r space g space b end-display
       display "Status of " st end-display
       call "showit_" end-call
       goback.
       end program rgbcobol.
```

which produces

```
[btiffin@home fortran]$ ./rgbcobol
Calling FORTRAN with 0.000000000000000000 50.000000000000000000 100.000000000000000000
 inside jucolor_:    0.0000000       0.0000000       50.000000       0.0000000       100.00000       0.0000000
Returned            100.000000000000000000 0.000000000000000000 0.000000000000000000
Status of +0000000000
 inside jucolor_:    0.0000000       0.0000000       50.000000       595.19684       100.00000      4.57103559E-41
 INPUT HLS PURE RED ==> OUTPUT RGB values are    100.00000       0.0000000       0.0000000
================================================================================
 inside jucolor_:    120.00000       100.00000       50.000000       0.0000000       100.00000       0.0000000
 INPUT HLS PURE GREEN OUTPUT RGB values are    0.0000000       100.00000       0.0000000
================================================================================
 inside jucolor_:    240.00000       0.0000000       50.000000       100.00000       100.00000       0.0000000
 INPUT HLS PURE BLUE OUTPUT RGB values are    0.0000000       0.0000000       100.00000
================================================================================
 inside jucolor_:    100.00000       0.0000000       0.0000000       0.0000000       0.0000000       0.0000000
 INPUT RGB PURE RED OUTPUT HLS values are    0.0000000       50.000000       100.00000
================================================================================
 inside jucolor_:    0.0000000       0.0000000       100.00000       50.000000       0.0000000       100.00000
 INPUT RGB PURE GREEN OUTPUT HLS values are    120.00000       50.000000       100.00000
================================================================================
 inside jucolor_:    0.0000000       120.00000       0.0000000       50.000000       100.00000       100.00000
 INPUT RGB PURE BLUE OUTPUT HLS values are    240.00000       50.000000       100.00000
 values are    240.00000       50.000000       100.00000
================================================================================
```

The weird numbers on the second "inside jucolor_" are uninitialized gfortran variables, displayed before being set, not great, but safe enough for a one off.

5.66 Does GnuCOBOL interface with APL?

See *Does GnuCOBOL interface with J?* (page 940)

5.67 Does GnuCOBOL interface with J?

Yes, kinda, but not really, yet. Jsoftware posted GPL 3 licensed source code for the J programming language in 2011. J was designed by the creator of APL, the late Kenneth Iverson, along with Roger Hui. The torch now carried by his son, Eric Iverson, of Jsoftware.

J is a synthesis of APL, using only *ASCII* (page 207) characters combined with dots and colons to represent the special symbols used in APL. APL, *A Programming Language*, developed in the 1960's, is very terse, using a graphical symbol set, requiring special keyboards, that allowed for mathematical notion in source code. J "simplifies" the symbol set to ASCII characters, paired with . and : to form inflections (or digraphs).

Initial tests have proven somewhat successful, but there is more work required before integration with **libj** in GnuCOBOL is ready for prime-time. In particular, I/O is not functional with the listing given below.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20110711
      *> Purpose:   Attempt calling a J sentence. APL in COBOL.
      *> Tectonics: cobc -x callj.cob -lj
      *> ****************************************************************
       identification division.
       program-id. callj.

       data division.
       working-storage section.
       77 jptr usage pointer.
       77 result usage binary-long.

      *> ****************************************************************
       procedure division.
       call "JInit" returning jptr end-call
       display jptr end-display

       call "JDo"
           using by value jptr
           by content z"a =. 1 + 1"
           returning result
       end-call
       display result end-display

       call "JDo"
           using by value jptr
           by content z"2 + 2"
           returning result
       end-call
       display result end-display

       call "JDo"
           using by value jptr
           by content z"('Test Data',CR,LF) 1!:2 <'temp.dat'"
           returning result
       end-call
       display result end-display

       call "JDo"
           using
             by value jptr
             by content z"load 'jgplsrc/test/test.ijs'"
           returning result
       end-call
       display result end-display

       call "JDo"
           using
             by value jptr
             by content z"bad=: TEST ddall"
           returning result
       end-call
       display result end-display
```

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```
       call "JDo"
           using
             by value jptr
             by content z"BAD ddall"
           returning result
       end-call
       display result end-display
       goback.
       end program callj.
```

produces:

```
$ cobc -x callj.cob -lj
$ ./callj
0x00007f3b6ead7010
+0000000000
+0000000000
+0000000003
+0000000021
+0000000000
+0000000000
```

So libj inits, and can JDo J sentences, but there is a little more background effort to properly set J I/O and PATH settings into an array of callbacks. Doable, just have to ask the good folk at Jsoftware for a little assistance. More coming soon.

The GPL 3 J version 7.01b source code can be found at http://www.jsoftware.com/ Compiling the sources took a little reading, but built clean on 64bit Fedora 14 after a quick edit of jgplsrc/bin/jconfig. Needed to set BITS to 64 and added readline support, as command line recall is more fun than no command line recall when running **jconsole**. After that bin/build_libj bin/build_jconsole all went smooth as silk. **libj.so** was copied to /usr/lib64 and the above code compiled and linked just fine.

As did:

```
$ bin/build_defs
$ bin/build_tsdll

A test suite validates a J system. Read test/test.ijs and test/tsu.ijs for
more info.

$ j/bin/jconsole
   load 'test/test.ijs'
   bad=: TEST ddall NB. run all tests
   BAD ddall NB. report tests that failed
```

with a full test suite pass, all successful. Once the callbacks are properly installed in the sample GnuCOBOL above, I'm sure the error 3 will be resolved for 1:!2 write to file as well as running the test suite from within JDo, which currently reports error 21. The above GnuCOBOL listing is the poor man's 10 minute guide to integrating J.

5.68 What is COBOLUnit?

A well documented, full featured Unit testing framework for COBOL, written in GnuCOBOL with a GPL license.

http://sites.google.com/site/cobolunit/

- Tutorials

- Installation instructions, with videos
- Open sources

Test suite configuration files look like:

```
<INIT>
    <SETNAME> SUITE-DELIVERY-COST
    <SETDESC> Tests Suite for delivery costs
<ADDSUITE>
       * Add a test
       <SETNAME> FRANCE-TO-ITALY
       <SETPROG> TS000011
       <SETDESC> IF FROM='FR' and TO='IT' then TAXES=120€
<ADDTEST>
<RUN>
```

and *with the scaffolding in place*, a success report looking like:

```
******************************************************************************
COBOL UNIT : A COBOL FRAMEWORK FOR UNIT TESTS.
******************************************************************************


COBOL UNIT Current release  : REL 1.00
COBOL UNIT Release date     : 2009-10-31
Language used for Logging   : EN
Verbosity Level of Log      : 1
End of the 'Testing Strategy Set up' Phase
Starting the 'Test Execution' Phase
|--- SUITE ' SUITE-DELIVERY-COST ' Running
|--- | TEST ' FRANCE-TO-ITALY ' Running
|    |- Assert ' FR => IT:TAX=120 ' success
|    |==> Test ' FRANCE-TO-ITALY ' * SUCCESS *
|    |      ( 000000001 Assertions, 000000000 Failures, 0 errors).
|==> SUITE ' SUITE-DELIVERY-COST ' SUCCESS
|    ( 000000000 test cases, 000000001 success, 000000000 failures, 000000000 errors)

******************************************************************************
* SUCCESS * ( 000000001 Suites run, 000000001 succeed, 000000000 failed)
******************************************************************************
( 00 min: 00 sec: 00 ms)
```

5.69 Can GnuCOBOL interface with Gambas?

Yes. See http://code.google.com/p/gambascobolgui/downloads/list for a working sample.

As a taster, the Gambas (http://gambas.sourceforge.net/en/main.html) sample calls GnuCOBOL coded as

```
GCobol
         ENTRY "startGrid".
         MOVE FCHIUSO TO GRID-FILE-STATE.
         ACCEPT SOLODATA FROM DATE YYYYMMDD.
         ACCEPT ORA FROM TIME.
         MOVE DATAEORA TO STARTINGPOINT, PRMR-KEY-OF-LIGNE (GAP),
            DATAEORA-KR.
```

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```
           PERFORM RWDWN.
           MOVE 0 TO RETURN-CODE.
           GOBACK.

           ENTRY "fillrow" USING BY REFERENCE pRiga,
                                 BY VALUE     numRiga.
           ADD 1 TO numRiga.
           MOVE SUPER-LIGNE-PMP (numRiga) TO ROW-OUT.
           SET pRiga TO ADDRESS OF ROW-OUT.
           MOVE 0 TO RETURN-CODE.
           GOBACK.
```

which this author found to be a pretty neat way of packaging GnuCOBOL *other language* callables.

The Gambas is nicely clean. Below being a snippet from the sample.

```
Extern cob_init(argc As Integer, argv As Integer) As Integer In "libcob"
Extern startGrid() As Integer In "SCONTO:69"
```

5.70 Does GnuCOBOL work with LLVM?

Yes. Almost first try for the February 2009 pre-release of 1.1. The compiler sources has a conditional use of a -fno-gcse switch that tripped warnings in clang causing some unit test failure reports. One change to compile out the -fno-gcse in cobc/cobc.c, and a simple:

```
$ sudo yum install llvm clang clang-analyzer clang-devel
$ export CC=clang
$ ./configure
GnuCOBOL Configuration:
  CC                   clang
  COB_CC               clang
  CFLAGS                -O2
  COB_CFLAGS           -I/usr/local/include
  COB_EXTRA_FLAGS
  LDFLAGS
  COB_LDFLAGS
  COB_LIBS             -L${exec_prefix}/lib -lcob -lm -lgmp -lncurses -ldb
  COB_CONFIG_DIR       ${prefix}/share/open-cobol/config
  COB_COPY_DIR         ${prefix}/share/open-cobol/copy
  COB_LIBRARY_PATH     ${exec_prefix}/lib/open-cobol
  COB_MODULE_EXT       so
  COB_SHARED_OPT       -shared
  COB_PIC_FLAGS        -fPIC -DPIC
  COB_EXPORT_DYN       -Wl,--export-dynamic
  COB_STRIP_CMD        strip --strip-unneeded
  Dynamic loading      System

$ scan-build make
scan-build: Removing directory '/tmp/scan-build-2012-05-23-2'
   because it contains no reports.

$ make check

# I had to make one change to cobc/cobc.c to remove -fno-gcse to avoid a
```

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```
#  bunch of make check 'failures' due to a warning about unused -fno-gcse

$ sudo make install
$ sudo ldconfig

# cobc is built with clang, and uses clang when compiling
#   the .c generated from the .cob.

[btiffin@cobol]$ scan-build cobc -v -x hello.cob
scan-build: 'clang' executable not found in
    '/usr/lib64/clang-analyzer/scan-build/bin'.
scan-build: Using 'clang' from path: /usr/bin/clang
preprocessing hello.cob into /tmp/cob18158_0.cob
translating /tmp/cob18158_0.cob into /tmp/cob18158_0.c
clang -pipe -c -I/usr/local/include   -Wno-unused -fsigned-char
    -Wno-pointer-sign  -o /tmp/cob18158_0.o /tmp/cob18158_0.c
clang -pipe  -Wl,--export-dynamic -o hello /tmp/cob18158_0.o
    -L/usr/local/lib -lcob -lm -lgmp -lncurses -ldb
scan-build: Removing directory '/tmp/scan-build-2012-05-23-2'
    because it contains no reports.

[btiffin@cobol]$ ./hello
Hello
[btiffin@cobol]$ ls -la hello
-rwxrwxr-x. 1 btiffin btiffin 9630 May 23 12:37 hello
```

And GnuCOBOL is good to go with clang and the LLVM universe. The above compiles GnuCOBOL with clang, and the installed cobc will use clang as the compiler after processing the COBOL sources. This is grand news in terms of anyone worried about GnuCOBOL viability into the future. The existent C ABI space and now the growing LLVM software pool. Nice.

5.71 Does GnuCOBOL interface with Python?

Yes. Either by using an optional builtin intrinsic function, by writing code for the Python C API, or by using SWIG.

5.71.1 Intrinsic Python

In the SVN source tree on SourceForge, there is now a `gnu-cobol-builtin-script` branch. It started with REXX (see *Intrinsic REXX* (page 868)) and now includes *FUNCTION PYTHON* (page 480).

This is an optional component of GnuCOBOL, configured during compiler build.

To start, once you have the source tree and set gnu-cobol-builtin-script as the working directory:

```
prompt$ ./configure --with-python
prompt$ make
prompt$ make check
prompt$ sudo make install
prompt$ sudo ldconfig
```

In my local site case, I also build in REXX and VBISAM, the first line looks like:

```
prompt$ ./configure --with-vbisam --with-rexx --with-python
```

You will now have a Python ready version of GnuCOBOL.

```
      *>
      *> withpython.cob, embedded Python intrinsic
      *> Tectonics: cobc -xj withpython.cob
      *>
       >>SOURCE FORMAT IS FREE
       identification division.
       program-id. withpython.

       REPLACE ==newline== BY ==& x'0a' &==.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 answer                       pic x(80).

       procedure division.
       sample-main.
       move python(
           "from time import time,ctime"                          newline
           "print('Python: Today is', ctime(time()))"              newline
           " "                                                    newline
           "def func(arg):"                                       newline
           "    return [ctime(time()), arg/2, arg, arg*2]"        newline
           " "                                                    newline
           "result = func(42)") to answer
       display "COBOL: " trim(answer)
       goback.
       end program withpython.
```

Try that code out with:

```
prompt$ cobc -xj withpython.cob
Python: Today is Sun Apr 23 01:49:07 2017
COBOL: ['Sun Apr 23 01:49:07 2017', 21.0, 42, 84]
```

A list return (in printable form).

The interface requires a `result` variable in the Python global dictionary to retrieve the value produced by the `python()` intrinsic function.

At time of writing, optional argument handling from COBOL to Python is yet to be completed. Although the intrinsic will accept `python(script, arg, arg,...)` form, the arguments are ignored until this feature is complete.

Return data is in character form, just like the Python console. The result converted to display form by the `repr` printable representation function and any `__repr__()` method that may be supported by the Python data type or object.

Reference modification is allowed using `python(script)(start:len)` COBOL syntax.

Another example, numeric data and a dictionary return:

```
       identification division.
       program-id. numbers.
```

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```
       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 result pic s9(9).

       procedure division.
       display ":" python("print(6 * 7 * -1)") ":"

       move python("result = 6 * 7 * -1") to result
       display ":" result ":"

       display ":" python("result = {'value': 6 * 7 * -1}") ":"
       goback.
       end program numbers.
```

That sample demonstrates an empty result (Python print side effect), a number placed in COBOL `s9(9)` format and a Python <dict> return (in printable representation form).

```
prompt$ cobc -xj python-number.cob
-42
::
:-000000042:
:{'value': -42}:
```

Initial -42 line is from Python `print`, then COBOL return and display values surrounded by enclosing colons.

Python scripting as an Intrinsic Function.

Unlike REXX and Tcl, there is no real way to make random Python scripts "safe".

FUNCTION PYTHON is *not* recommended for general purpose end user application scripting, unless you can completely trust the people that will be writing the scripts. Reserve intrinsic Python for application developers or somehow implement a screening process for user land scripts.

Having said that, in the hands of a programmer, Python is extremely powerful and the Python ecosystem is vast. Immensely vast. Tap into those resources easily with FUNCTION PYTHON.

5.71.2 Embedding Python

Embedding Python can also be accomplished using purely COBOL sources coded to the C API.

Extending Python, to allow calling COBOL modules, will usually require a small amount of glue code written in C. See *Embedding Python* (page 947) below for these lower level details.

Very high level Python embedding is pretty straight forward, been there, done that.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ******************************************************
      *> Author:    Brian Tiffin
      *> Date:      20130126
      *> Purpose:   Embed Python
      *> Tectonics: cobc -x cobpy.cob -lpython2.6
```

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```
      *> ******************************************************
       identification division.
       program-id. cobpy.

       procedure division.
       call "Py_Initialize"
           on exception
               display "link cobpy with -lpython2.6" end-display
       end-call
       call "PyRun_SimpleString" using
           by reference
               "from time import time,ctime" & x"0a" &
               "print('Today is', ctime(time()))" & x"0a" & x"00"
           on exception continue
       end-call
       call "Py_Finalize" end-call
       goback.
       end program cobpy.
```

Giving:

```
$ cobc -x cobpy.cob -lpython2.6
$ ./cobpy
('Today is', 'Sat Jan 26 20:01:41 2013')
```

Python dutifully displayed the tuple. But what fun is Python if it is just for high level script side effects? Lots, but still.

Pure embedding.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ******************************************************
      *> Author:    Brian Tiffin
      *> Date:      20130126
      *> Modified:  2016-03-08/00:02-0500
      *> Copyright 2013,2016 Brian Tiffin
      *> Licensed under the GNU Library Public License, LGPL 2+
      *> Purpose:   Embed Python
      *> Tectonics: cobc -x cobkat.cob -lpython2.7
      *>     NOTES:    leaks, no Py_DECREF macros called.
      *> ******************************************************
       identification division.
       program-id. cobkat.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       77 python-name          usage pointer.
       77 python-module        usage pointer.
       77 python-dict          usage pointer.
       77 python-func          usage pointer.
       77 python-stringer      usage pointer.
       77 python-args          usage pointer.
       77 python-value         usage pointer.
```

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```
       01 cobol-buffer-pointer usage pointer.
       01 cobol-buffer         pic x(80)               based.
       01 cobol-string         pic x(80).

       01 cobol-integer        usage binary-long.
       01 command-line-args    pic x(80).
       01 python-path          pic x(256).

      *> ******************************************************
       procedure division.

       REPLACE ==:CALL-EXCEPTION:== BY
       ==
           on exception
               display "internal python call problem" upon syserr
               perform soft-exception
       ==.

      *> Set the python search path to include current working dir first
       accept python-path from environment "PYTHONPATH"
       move concatenate(".:" python-path) to python-path
       set environment "PYTHONPATH" to python-path

      *> if python init fails, just bail
       call "Py_Initialize"
           on exception
               display "link cobpy with -lpython" upon syserr
               perform hard-exception
       end-call

      *> Python likes module names in Unicode
       call "PyUnicodeUCS4_FromString" using
           by reference "pythonfile" & x"00"
           returning python-name
           :CALL-EXCEPTION:
       end-call

      *> import the module, using PYTHONPATH
       call "PyImport_Import" using
           by value python-name
           returning python-module
           on exception
               display "module import failure" upon syserr
               perform hard-exception
       end-call
       call "Py_DecRef" using
           by value python-name
           :CALL-EXCEPTION:
       end-call

       if python-module equal null
           display "no pythonfile.py in PYTHONPATH" end-display
           goback
       end-if

      *> within the module, an attribute is "pythonfunction"
```

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```
       call "PyObject_GetAttrString" using
           by value python-module
           by reference "pythonfunction" & x"00"
           returning python-func
           :CALL-EXCEPTION:
       end-call

      *> pythonfunction takes a single argument
       call "PyTuple_New" using
           by value 1
           returning python-args
           :CALL-EXCEPTION:
       end-call

      *> of type long, hard coded to the ultimate answer
       call "PyLong_FromLong" using
           by value 42
           returning python-value
           :CALL-EXCEPTION:
       end-call

      *> set first (only) element of the argument tuple
       call "PyTuple_SetItem" using
           by value python-args
           by value 0
           by value python-value
           :CALL-EXCEPTION:
       end-call

       display "Call pythonfunction from pythonfile.py with 42"

      *> call the function, arguments marshalled for Python
       call "PyObject_CallObject" using
           by value python-func
           by value python-args
           returning python-value
           :CALL-EXCEPTION:
       end-call

      *> we know we get a long back, hopefully 1764
       call "PyLong_AsLong" using
           by value python-value
           returning cobol-integer
           :CALL-EXCEPTION:
       end-call
       display "Python returned: " cobol-integer end-display

      *> Clean up the long, tuple, and function handle
       call "Py_DecRef" using
           by value python-value
           :CALL-EXCEPTION:
       end-call
       call "Py_DecRef" using
           by value python-args
           :CALL-EXCEPTION:
       end-call
       call "Py_DecRef" using
```

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```
           by value python-func
           :CALL-EXCEPTION:
       end-call

      *> ******************************************************
      *> a function taking string and returning string
       call "PyObject_GetAttrString" using
           by value python-module
           by reference "pythonstringer" & x"00"
           returning python-stringer
           :CALL-EXCEPTION:
       end-call

       call "PyTuple_New" using
           by value 1
           returning python-args
           :CALL-EXCEPTION:
       end-call

      *> Use the GnuCOBOL command argument
       accept command-line-args from command-line end-accept
       display "Call 'pythonstringer' from pythonfile.py with " quote
           trim(command-line-args) quote

       call "PyString_FromString" using
           by reference
               function concatenate(
                   function trim(command-line-args)
                   x"00")
           returning python-value
           :CALL-EXCEPTION:
       end-call

      *> Set the function argument tuple to the cli args
       call "PyTuple_SetItem" using
           by value python-args
           by value 0
           by value python-value
           :CALL-EXCEPTION:
       end-call

      *> call the "pythonstringer" function
       call "PyObject_CallObject" using
           by value python-stringer
           by value python-args
           returning python-value
           :CALL-EXCEPTION:
       end-call

      *> return as String (with the MD5 hex digest tacked on)
       call "PyString_AsString" using
           by value python-value
           returning cobol-buffer-pointer
           :CALL-EXCEPTION:
       end-call

      *> one way of removing null while pulling data out of C
```

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```
       set address of cobol-buffer to cobol-buffer-pointer
       string
           cobol-buffer delimited by x"00"
           into cobol-string
       end-string
       display "Python returned: " cobol-string end-display

      *> Clean up the string, tuple, function and the module
       call "Py_DecRef" using
           by value python-value
           :CALL-EXCEPTION:
       end-call
       call "Py_DecRef" using
           by value python-args
           :CALL-EXCEPTION:
       end-call
       call "Py_DecRef" using
           by value python-stringer
           :CALL-EXCEPTION:
       end-call
       call "Py_DecRef" using
           by value python-module
           :CALL-EXCEPTION:
       end-call

      *> and clear out
       call "Py_Finalize" :CALL-EXCEPTION: end-call
       goback.

      *> ******************************************************
       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:
       end program cobkat.
```

With **pythonfile.py**

```
#
# Simple Python sample for GnuCOBOL embedding trial
#
def pythonfunction(i):
    return i * i

import hashlib
def pythonstringer(s):
    sum = hashlib.md5()
    sum.update(s)
    return s + ": " + sum.hexdigest()
```

Giving:

```
prompt$ cobc -x -debug cobkat.cob -lpython2.7
prompt$ ./cobkat
Call pythonfunction from pythonfile.py with 42
Python returned: +0000001764
Call 'pythonstringer' from pythonfile.py with ""
Python returned: : d41d8cd98f00b204e9800998ecf8427e

prompt$ ./cobkat Python will use this for MD5 hash
Call pythonfunction from pythonfile.py with 42
Python returned: +0000001764
Call 'pythonstringer' from pythonfile.py with "Python will use this for MD5 hash"
Python returned: Python will use this for MD5 hash: c5577e3ab8dea11adede20a1949b5fb3
```

Oh, in case you're reading along, 1764 is the ultimate answer, squared.

The GnuCOBOL source line of

```
set environment "PYTHONPATH" to "."
```

called before `Py_Initialize`, saves an oops when you need to find current working directory Python scripts.

Although there was a sample written to demonstrate extending Python with GnuCOBOL sub-programs, an easier alternative is using `SWIG`. See *Does GnuCOBOL work with SWIG?* (page 1046) for an example of integrating COBOL modules with Python scripts. `SWIG` makes extending Python a very easy thing to do.

5.72 Can GnuCOBOL interface with Forth?

Yes, ficl, Forth Inspired Command Language embeds nicely.

Ok, I said, easy, I meant almost easy, as I had to hunt down a sysdep.h file and could not get 4.10 to go, but 4.0.31 works the beauty, once the sysdep.h was put in place.

First, the license compliance.

```
/*******************************************************
** f i c l . h
** Forth Inspired Command Language
** Author: John Sadler (john_sadler@alum.mit.edu)
** Created: 19 July 1997
** Dedicated to RHS, in loving memory
** $Id: //depot/gamejones/ficl/ficl.h#33 $
*******************************************************
```

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```
**
** Copyright (c) 1997-2001 John Sadler (john_sadler@alum.mit.edu)
** All rights reserved.
**
** Get the latest Ficl release at http://ficl.sourceforge.net
**
** I am interested in hearing from anyone who uses Ficl. If you have
** a problem, a success story, a defect, an enhancement request, or
** if you would like to contribute to the Ficl release, please
** contact me by email at the address above.
**
** L I C E N S E  and  D I S C L A I M E R
**
** Redistribution and use in source and binary forms, with or without
** modification, are permitted provided that the following conditions
** are met:
** 1. Redistributions of source code must retain the above copyright
**    notice, this list of conditions and the following disclaimer.
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**    notice, this list of conditions and the following disclaimer in the
**    documentation and/or other materials provided with the distribution.
**
** THIS SOFTWARE IS PROVIDED BY THE AUTHOR AND CONTRIBUTORS ``AS IS'' AND
** ANY EXPRESS OR IMPLIED WARRANTIES, INCLUDING, BUT NOT LIMITED TO, THE
** IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE
** ARE DISCLAIMED.  IN NO EVENT SHALL THE AUTHOR OR CONTRIBUTORS BE LIABLE
** FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR CONSEQUENTIAL
** DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF SUBSTITUTE GOODS
** OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR BUSINESS INTERRUPTION)
** HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY, WHETHER IN CONTRACT, STRICT
** LIABILITY, OR TORT (INCLUDING NEGLIGENCE OR OTHERWISE) ARISING IN ANY WAY
** OUT OF THE USE OF THIS SOFTWARE, EVEN IF ADVISED OF THE POSSIBILITY OF
** SUCH DAMAGE.
*/
```

And then the COBOL, **callficl.cob**

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ******************************************************
      *> Author:    Brian Tiffin
      *> Date:      20130220
      *> Purpose:   Embed ficl
      *> Tectonics: cobc -x callficl.cob -lficl -L.
      *>            LD_LIBRARY_PATH=. ./callficl
      *> ******************************************************
       identification division.
       program-id. callficl.

       data division.
       working-storage section.
       01 ficl-result usage binary-long.
       01 ficl-system usage pointer.
       01 ficl-vm     usage pointer.

      *> ******************************************************
       procedure division.
       call "ficlSystemCreate" using
```

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```
           by value 0
           returning ficl-system
       end-call

       display ficl-system end-display

       call "ficlSystemCompileExtras" using
           by value ficl-system
       end-call

       call "ficlSystemCreateVm" using
           by value ficl-system
           returning ficl-vm
       end-call

       display ficl-vm end-display

       call "ficlVmEvaluate" using
           by value ficl-vm
           by reference ".ver cr quit" & x"00"
           returning ficl-result
       end-call

       display ficl-result end-display

       call "ficlVmEvaluate" using
           by value ficl-vm
           by reference
               ".( loading ooptest.fr ) cr load ooptest.fr" &
               x"0a" & " cr" & x"00"
           returning ficl-result
       end-call

       display ficl-result end-display

       goback.
       end program callficl.
```

and the test file **ooptest.fr**

```
\ OOP test stuff

only
also oop definitions

object subclass c-aggregate
c-byte obj: m0
c-byte obj: m1
c-4byte obj: m2
c-2byte obj: m3
end-class

object --> sub class1

cell: .a
cell: .b
: init
```

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```
    locals| class inst |
    0 inst class --> .a !
    1 inst class --> .b !
;
end-class

class1 --> new c1inst

class1 --> sub class2
cell: .c
cell: .d

: init
    locals| class inst |
    inst class --> super --> init
    2 inst class --> .c !
    3 inst class --> .d !
;
end-class

class2 --> new c2inst

object subclass c-list
c-list ref: link
c-ref  obj: payload
end-class

\ test stuff from ficl.html
.( metaclass methods ) cr
metaclass --> methods

cr .( c-foo class ) cr
object --> sub c-foo
cell: m_cell1
    4 chars: m_chars
    : init   ( inst class -- )
        locals| class inst |
        0 inst class --> m_cell1 !
        inst class --> m_chars 4 0 fill
        ." initializing an instance of c_foo at " inst x. cr
    ;
end-class

.( c-foo instance methods... ) cr
c-foo --> new foo-instance
cr
foo-instance --> methods
foo-instance --> pedigree
cr
foo-instance 2dup
    --> methods
    --> pedigree
cr
c-foo --> see init
cr
foo-instance --> class --> see init
```

and finally, **the run**. The first two commands building up ficl and the libficl shared library, the next two for COBOL:

```
$ make -f Makefile.linux
$ make -f Makefile.linux main

$ cobc -g -debug -x callficl.cob -lficl -L .
$ LD_LIBRARY_PATH=. ./callficl
loading CORE EXT words
loading SEARCH & SEARCH-EXT words
loading Johns-Hopkins locals
loading MARKER
loading ficl O-O extensions
loading ficl utility classes
loading ficl string class
0x080569c0
0x08057928
Ficl version 4.0.31

-0000000056
loading ooptest.fr
metaclass methods
metaclassmethods:
debug   see     pedigree        methods id      offset-of       sub
resume-class    ref     allot-array     allot   alloc-array     alloc
new-array       new     array   instance        get-super       get-wid
get-size        .size   .wid    .super  .do-instance
Dictionary: 24 words, 7786 cells used of 12288 total



c-foo class
c-foo instance methods...
initializing an instance of c_foo at 806043C

c-foomethods:
init    m_chars m_cell1 .do-instance
Dictionary: 4 words, 7893 cells used of 12288 total

objectmethods:
debug   prev    next    index   methods size    pedigree        super
free    array-init      init    class   .do-instance
Dictionary: 13 words, 7893 cells used of 12288 total


c-foo object

c-foomethods:
init    m_chars m_cell1 .do-instance
Dictionary: 4 words, 7893 cells used of 12288 total

objectmethods:
debug   prev    next    index   methods size    pedigree        super
free    array-init      init    class   .do-instance
Dictionary: 13 words, 7893 cells used of 12288 total


c-foo object

```

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```
: init
   0   (link) (instruction 136)
   1   2 (instruction 2)
   2   (toLocal) (instruction 140), with argument 0 (0)
   4   (toLocal) (instruction 140), with argument 1 (0x1)
   6   0 (instruction 17)
   7   (@local1) (instruction 146)
   8   (@local0) (instruction 142)
   9   s" m_cell1"
  13   exec-method
  14   ! (instruction 57)
  15   (@local1) (instruction 146)
  16   (@local0) (instruction 142)
  17   s" m_chars"
  21   exec-method
  22   4 (instruction 4)
  23   0 (instruction 17)
  24   fill (instruction 111)
  25   s" initializing an instance of c_foo at "
  36   type
  37   (@local1) (instruction 146)
  38   x.
  39   cr
  40   (unlink) (instruction 137)
;

: init
   0   (link) (instruction 136)
   1   2 (instruction 2)
   2   (toLocal) (instruction 140), with argument 0 (0)
   4   (toLocal) (instruction 140), with argument 1 (0x1)
   6   0 (instruction 17)
   7   (@local1) (instruction 146)
   8   (@local0) (instruction 142)
   9   s" m_cell1"
  13   exec-method
  14   ! (instruction 57)
  15   (@local1) (instruction 146)
  16   (@local0) (instruction 142)
  17   s" m_chars"
  21   exec-method
  22   4 (instruction 4)
  23   0 (instruction 17)
  24   fill (instruction 111)
  25   s" initializing an instance of c_foo at "
  36   type
  37   (@local1) (instruction 146)
  38   x.
  39   cr
  40   (unlink) (instruction 137)
;

-0000000257
```

Turns out that return codes -56 and -257 are ok codes, (from **ficl.h**)

```
/* like FICL_VM_STATUS_ERROR_EXIT, but leave dataStack & base alone */
#define FICL_VM_STATUS_QUIT         ( -56)
#define FICL_VM_STATUS_OUT_OF_TEXT  (-257)   /* hungry - normal exit */
```

GnuCOBOL does Forth.

http://ficl.sourceforge.net/

p.s. One small note. The ficl load word, load ooptest.fr needed a newline after the filename. Normally Forth uses a straight up space delimited word parser, but ficl accounts for filenames with spaces in them. Nice feature.

5.73 Can GnuCOBOL interface with Shakespeare?

Yes. The reference implementation of the Shakespeare Programming Language builds into GnuCOBOL applications that can CALL SPL modules.

Technicals: I downloaded Marlowe which fixes the reference implementation problem with Roman Numerals.

https://bitbucket.org/kcartmell/marlowe/downloads

Then inside a working dir (*/lang/cobol/cobill/* for instance) create spl, untar, and make SPL. *I assume the spl/ sub directory in the Makefile listed below*.

What is happening here isn't runtime link loading, it is simply building the SPL engine into COBOL, and then CALL the result of **spl2c**.

This first cut **lacks art**. Lacks. Sad, so verily verily sad.

cobill.cob

```
GCobol*> ********************************************************
      *> Author:    Brian Tiffin
      *> Date:      20130224
      *> Purpose:   COBOL meets Shakespeare
      *> Tectonics: cobc -x -Ispl cobill.cob ocshake.c
      *>                    spl/libspl.c spl/strutils.c
      *>   pre-req: spl2c ocshake.spl and an spl/ distribution
      *> ********************************************************
       identification division.
       program-id. cobill.
       procedure division.
       call "ocshake" end-call
       goback.
       end program cobill.
```

Then some cowardly SPL, **ocshake.spl**

```
The derp in SPL from GnuCOBOL.

Ajax, the loud mouth.

Dorcas, the d.
Escalus, the e.
Rosalind, the r.
Prospero, the p.
The Archbishop of Canterbury, the new line.
```

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```
                    Act I: derping.

                    Scene I: derp.

[Enter Ajax and Dorcas]

Ajax:
    You amazing beautiful fine charming gentle delicious door.
    You are as honest as the sum of a bold brave hard proud
        noble stone wall and thyself.
    You are as trustworthy as the sum of a proud rich tree and thyself.
    Speak your mind.

[Exit Dorcas]
[Enter Escalus]

Ajax:
    You bluest peaceful smooth lovely warm embroidered summer's day.
    You are as beautiful as the sum of a fine honest
        fair sweet gentle wind and thyself.
    You are as lovely as the sum of a reddest sunny flower and thyself.
    You are as mighty as the sum of the sky and thyself.
    Speak your mind.

[Exit Escalus]
[Enter Rosalind]

Ajax:
    You fair reddest sweet rich smooth blossoming red rose.
    You are as rich as the difference between thyself and
        a golden gentle clearest wind.
    You are as rich as the difference between thyself and a proud white lantern.
    You are as rich as the difference between thyself and a honest morning.
    Speak your mind.

[Exit Rosalind]
[Enter Prospero]

Ajax:
    You proud prompt pretty loving gentle warm purple pony.
    You are as bold as the difference between thyself and an amazing
        cute delicious pretty purse.
    Speak your mind.

[Exeunt]

                    Scene II: a new line.

[Enter Ajax and The Archbishop of Canterbury]

Ajax:
    You are nothing.
    You are a bold beautiful blossoming wind.
    You are as cunning as the sum of thyself and a tiny thing.
    Speak your mind!

[Exeunt]
```

A **Makefile** of:

```
cobill: ocshake.spl cobill.cob
    spl/spl2c <ocshake.spl >ocshake.c
    sed -i 's/int main(void)/int ocshake(void)/' ocshake.c
    cobc -x -Ispl cobill.cob ocshake.c spl/libspl.c spl/strutils.c
```

Then a run of:

```
$ make
spl/spl2c <ocshake.spl >ocshake.c
sed -i 's/int main(void)/int ocshake(void)/' ocshake.c
cobc -x -Ispl cobill.cob ocshake.c spl/libspl.c spl/strutils.c
$ ./cobill
derp
$
```

derp, in a 20K binary, from 2K of source.

I am kinda proud of Scene II, it reads well. The rest of this Shakespeare program needs some Fahrenheit 451.

5.74 Can GnuCOBOL interface with Ruby?

Yes. Ruby 1.8 links without issue.

This example is only calling Ruby for side effect, without data exchange.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20130226
      *> Purpose:   Embed Ruby for effect, no data exchange yet
      *> Tectonics: cobc -x callruby.cob -lruby1.8
      *> ***************************************************************
       identification division.
       program-id. callruby.

       procedure division.
       display "GnuCOBOL: initialize ruby" end-display
       call "ruby_init"
           on exception
               display "hint: link with -lruby1.8" end-display
               stop run giving 1
       end-call

       display "GnuCOBOL: evaluate ruby string" end-display
       call "rb_eval_string" using
           by content "puts 'Hello, world'" & x"00"
       end-call

       display "GnuCOBOL: evaluate ruby script.rb" end-display
       call "ruby_init_loadpath" end-call
       call "rb_load_file" using
           by content "script.rb" & x"00"
       end-call
       call "ruby_exec" end-call
```

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```
       call "ruby_finalize" end-call
       display "GnuCOBOL: finalized ruby" end-display

       goback.
       end program callruby.
```

and **script.rb**

```
puts 'Hello, script'
puts 6*7
puts 'Goodbye, script'
```

and a run test of:

```
$ cobc -x callruby.cob
$ ./callruby
GnuCOBOL: initialize ruby
hint: link with -lruby1.8

$ cobc -x callruby.cob -lruby1.8
$ ./callruby
GnuCOBOL: initialize ruby
GnuCOBOL: evaluate ruby string
Hello, world
GnuCOBOL: evaluate ruby script.rb
Hello, script
42
Goodbye, script
GnuCOBOL: finalized ruby
```

5.74.1 mruby

Turns out the code listing above broke with Ruby 1.9.

And it also turns out that embedding Ruby got a lot easier, with Mini Ruby.

A project by Yukihiro Matsumoto, mruby is the new "by design" way of embedding Ruby. mruby 1.2 supports Ruby 2.1 core.

The default `make` creates a statically linked library, `libmruby.a`. So, CALL static comes into play. This can lead to some warnings during the C compile phase of the GnuCOBOL toolchain, as there is no way (currently) for the COBOL sources to know about the `mruby.h` header files. *These warnings can be suppressed, by cobc once initial issues have been verified as ok.*

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****J* gnucobol/callmruby
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20151217  Modified: 2015-12-17/06:35-0500
      *> LICENSE
      *>   Copyright 2015 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or greater)
```

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```
      *> PURPOSE
      *>   callmruby program.
      *> TECTONICS
      *>   cobc -x -g -debug callmruby.cob -L. -lmruby
      *> ****************************************************************
       identification division.
       program-id. callmruby.
       author. Brian Tiffin.
       date-written. 2015-12-17/04:49-0500.
       date-modified. 2015-12-17/06:35-0500.
       installation. Requires libmruby.a in working dir
       remarks. May cause warnings from CALL static
       security. Script evaluator, so...

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 mrb-state usage pointer.
       01 mrb-result usage binary-long.

       01 mruby-code.
          05 value '4.times {|i| print "looping mruby #{i+1} time";' &
                   z"puts i+1 == 1 ? '.' : 's.'}".

      *> ****************************************************************
       procedure division.
       call static "mrb_open" returning mrb-state

       if mrb-state equal null then
           display "Error starting mruby" upon syserr
           perform hard-exception
       end-if
       call static "mrb_load_string" using
           by value mrb-state by reference mruby-code
           returning mrb-result

       call static "mrb_close" using by value mrb-state

       goback.
      *> ****************************************************************

      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
```

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```
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .

       end program callmruby.
      *> ****************************************************************
      *>****
>>ELSE
!doc-marker!
=========
callmruby
=========

.. contents::

Introduction
------------

Tectonics
---------

::

    prompt$ cobc -x callmruby.cob -L. -lmruby

For less warnings, due to CALL static::

    prompt$ cobc -xj callmruby.cob -L. -lmruby -A '-Wno-implicit-function-declaration
-Wno-int-to-pointer-cast'

Usage
-----

::

    prompt$ ./callmruby

Source
------

.. include::  callmruby.cob
   :code: cobolfree
   :end-before: !doc-marker
>>END-IF
```

With a sample run of:

```
prompt$ cobc -xj callmruby.cob -L. -lmruby -A '-Wno-implicit-function-declaration
-Wno-int-to-pointer-cast'
looping mruby 1 time.
looping mruby 2 times.
looping mruby 3 times.
looping mruby 4 times.
```

Anyone serious about mixing Ruby with GnuCOBOL programming should take a look at `mruby`. http://www.mruby.org/

5.75 Can GnuCOBOL interface with Pure?

Yes. Yes it can.

Pure is a term rewriting functional programming language by Albert Graef. Influenced by Haskell, the system uses LLVM just in time features as part of the compiler, which can produce link ready native binaries or evaluation ready byte code. Pure is the successor of Q, another language by Albert.

Given Fedora with LLVM installed, install Pure with:

```
prompt$ sudo yum install pure pure-devel pure-gen pure-doc
```

For Debian, or other distributions, you'll need to follow the installation instructions at https://github.com/agraef/pure-lang

The Git repository is an all-in collection of Pure and over 35 extension libraries, including bindings for Tk, GTK, Octave, sqlite3, XML, ODBC, to name a few. Dr. Graef is the Head of the Computer Music Research Group in the Institute of Art History and Musicology at Johannes Gutenberg-University Mainz, so Pure also has a wide selection of Midi, Audio, and other signal processing extensions.

Below is a little test program, to see if Pure can call GnuCOBOL:

hellooc.pure

```
#!/usr/bin/pure -x
using system;
puts "Hello, world";

using "lib:hellocobol";
extern int hellocobol();

hellocobol;
```

And a little snippet of COBOL introduction

hellocobol.cob

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************
      *> Author:    Brian Tiffin
      *> Date:      20130612
      *> Purpose:   Call this COBOL program from pure
      *> Tectonics: cobc -fimplicit-init hellocobol.cob
      *>            pure -L. hellooc.pure
      *> ************************************************
       identification division.
       program-id. hellocobol.

       procedure division.
       display "S'up?" end-display

       goback.
       end program hellocobol.
```

With a first try of:

```
$ cobc hellocobol.cob
$ pure -L. hellooc.pure
Hello, world
Segmentation fault
```

Oops. Kept the error above in, to show the fix. The object code needs to initialize GnuCOBOL:

```
$ cobc -fimplicit-init hellocobol.cob
$ pure -L. hellooc.pure
Hello, world
S'up?
```

Yayy, success one. Pure can call GnuCOBOL.

And then to leverage Pure power from GnuCOBOL, *as things should be, power balance wise*.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************
      *> Author:    Brian Tiffin
      *> Date:      20130612
      *> Purpose:   Call pure.  Nice.
      *> Tectonics: pure -o hello.o -c -x hello.pure 8
      *             cobc -x callpurefact.cob hello.o -lpure
      *> ************************************************
       identification division.
       program-id. callpurefact.

       data division.
       working-storage section.
       01 pure-arg-pointer       usage pointer.
       01 fact-function-pointer  usage program-pointer.
       01 fact-result-pointer    usage pointer.
       01 pure-result            usage binary-long.
       01 fact-answer            usage binary-long.

      *> ************************************************

       procedure division.

      *> Initialize pure, with empty argc argv.
       call "__pure_main__" using
           by value 0 by value 0
       end-call

      *> convert a 9 to a pure expression pointer argument
       call "pure_int" using
           by value 9
           returning pure-arg-pointer
       end-call

      *> resolve the link address to the function, "fact"
       set fact-function-pointer to entry "fact"

      *> call the pure function "fact"
      *>   using the program pointer
      *>   1 as the number of argumments
      *>   the address of the argument expression
      *>   returing a result expression pointer
```

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```
       call "pure_funcall" using
           by value fact-function-pointer
           by value 1
           by value pure-arg-pointer
           returning fact-result-pointer
       end-call

      *> convert the result expression back to integer
       call "pure_is_int" using
           by value fact-result-pointer
           by reference fact-answer
           returning pure-result
       end-call
       display "fact 9 expecting 362880" end-display
       display "fact 9 result is " fact-answer end-display

       goback.
       end program callpurefact.
      *><*
```

Below is the tutorial hello program for Pure. `pure` is used to compile this, and in this example, is passed an initial argument of 8 for the ubiquitous factorial functional hello.

GnuCOBOL will call this main, mapping out 8 factorial results, then will call the defined `fact` function with an argument of 9.

hello.pure

```
using system;

fact n = if n>0 then n*fact (n-1) else 1;

main n = do puts ["Hello, world!", str (map fact (1..n))];

const n = if argc>1 then sscanf (argv!1) "%d" else 10;
if compiling then () else main n;
```

And then:

```
$ pure -o hello.o -c -x hello.pure 8
$ cobc -g -debug -W -x callpurefact.cob -lpure hello.o
$ ./callpurefact
Hello, world!
[1,2,6,24,120,720,5040,40320]
fact 9 expecting 362880
fact 9 result is +0000362880
```

So, yayy, success. GnuCOBOL can handle `Pure` integration. Pure looks pretty sweet.

Pure at Wikipedia

Pure upstream

5.76 Can GnuCOBOL process null terminated strings?

Yes. With care.

One aspect of interfacing with C, is the indeterminate length of data blocks. C strings assume a zero null byte terminator. No need to know length before hand. This does not align with the fixed length requirements of COBOL.

There are various ways to handle this situation, old, and new.

A new way, for display, with *BASED* (page 212) allocation, and a sliding pointer.

```
01 c-char-star    usage pointer.
01 cobol-char     pic x based.
01 previous-char  pic x.

call "c-function" returning c-char-star end-call
if c-char-star equal null then
    display "all that work, for nothing?" end-display
    goback
end-if

set address of cobol-char to c-char-star
if cobol-char not equal to low-value
    move cobol-char to previous-char

    perform until cobol-char equal low-value
        set c-char-star up by 1
        set address of cobol-char to c-char-star

        if cobol-char equal low-value then
            display previous-char end-display
        else
            display previous-char with no advancing end-display
            move cobol-char to previous-char
        end-if
    end-perform
end-if
```

Most of that dance is to allow GnuCOBOL to decide how to flush the output buffer, as there is no current support for

```
display OMITTED end-display
```

There should/will be, just like *ACCEPT* (page 187) which will wait and discard input. `display omitted` would be a buffer flush end of line without the space.

Zero length items are another issue.

There is also

- z"null byte quoted string literal"
- "string literal with append of null" & x"00"
- "string literal with append of null in most character sets" & low-value

And some *STRING* (page 414) code when you need data in COBOL *working-storage* (page 433)

```
set address of c-char-buffer to c-char-star
string c-char-buffer delimited by x"00"
    into cobol-space
end-string
```

Note that *NULL* (page 327) is NOT the same as x"00" or *LOW-VALUE* (page 319). `NULL` is a pointer category item, not a value.

5.77 Can GnuCOBOL display the process environment space?

Yes, almost. One small snippet of C code is required to get at a global variable, `char **environ`.

```
/**
 * Access a C external variable for the environment space
 */

#include <unistd.h>
extern char **environ;

char **value_of_environ() {
    return environ;
}
```

and then COBOL that processes the array of character string pointers.

```
GNU    >>SOURCE FORMAT IS FIXED
Cobol *> ************************************************
      *> Author:    Brian Tiffin
      *> Date:      20140321
      *> Purpose:   Display the process environment space
      *> License:   This source code is placed in the Public Domain
      *> Tectonics: cobc -x printenv.cob value-of-environ.c
      *> ************************************************
       identification division.
       program-id. printenv.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 environ              usage pointer.
       01 envptr               usage pointer based.
       01 envbuf               pic x(8388608) based.
       01 charindex            usage index.

       >>DEFINE WINDIR PARAMETER
       >>IF WINDIR IS DEFINED
       01 newline              pic xx value x"0d0a".
       >>ELSE
       01 newline              pic x value x"0a".
       >>END-IF

      *> ************************************************
       procedure division.
       call "value_of_environ" returning environ
           on exception
               display
                   "could not get value of environ" upon syserr
               end-display
       end-call

      *> Dereference the pointer to the array of pointers
```

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```
       set address of envptr to environ
       perform until exit
           if envptr equal null then
               exit perform
           end-if

           set address of envbuf to envptr
           set charindex to 1
           perform until exit
               if envbuf(charindex:1) equal x"00" then
                   display newline with no advancing end-display
                   exit perform
               end-if
               display envbuf(charindex:1) with no advancing end-display
               set charindex up by 1
           end-perform

           *> Point to the next envvar pointer
           set environ up by byte-length(environ)
           set address of envptr to environ
       end-perform
       goback.
       end program printenv.
```

and a run sample of:

```
$ cobc -x printenv.cob value-of-environ.c
$ ./printenv

XDG_VTNR=1
SSH_AGENT_PID=xxxxx
XDG_SESSION_ID=1
HOSTNAME=local
DM_CONTROL=/var/run/xdmctl
IMSETTINGS_INTEGRATE_DESKTOP=yes
GPG_AGENT_INFO=/home/btiffin/...
GLADE_PIXMAP_PATH=:
SHELL=/bin/bash
TERM=xterm-256color
XDG_MENU_PREFIX=xfce-
XDG_SESSION_COOKIE=somemagicookievaluethatneednotbepublic
HISTSIZE=1000
LUA_INIT=@/home/btiffin/.local/luainit.lua
XDM_MANAGED=method=classic
KONSOLE_DBUS_SERVICE=:1.34
KONSOLE_PROFILE_NAME=Shell
PLAN9=/home/btiffin/inst/plan9port
WINDOWID=2936...
QTDIR=/usr/lib64/qt-3.3
GNOME_KEYRING_CONTROL=/run/user/500/keyring-idval
SHELL_SESSION_ID=anothermagicvalue
QTINC=/usr/lib64/qt-3.3/include
IMSETTINGS_MODULE=none
QT_GRAPHICSSYSTEM_CHECKED=1
USER=btiffin
LS_COLORS=rs=0:di=00;34:ln=00;36:mh=00:pi=40;33:so=00;35:do=00;35:
GLADE_MODULE_PATH=:
```

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```
SSH_AUTH_SOCK=/tmp/andanothermagicvalue
SESSION_MANAGER=local/unix:@/tmp/.ICE-unix/12345,unix/unix:/tmp/.ICE-unix/12345
XDG_CONFIG_DIRS=/etc/xdg:/usr/local/etc/xdg
DESKTOP_SESSION=xfce
MAIL=/var/spool/mail/btiffin
PATH=/usr/local/firebird/bin:/home/btiffin/inst/unicon12/bin:/home/btiffin/bin
QT_IM_MODULE=xim
PWD=/home/btiffin/lang/cobol
XMODIFIERS=@im=none
KONSOLE_DBUS_WINDOW=/Windows/2
LANG=en_US.UTF-8
GNOME_KEYRING_PID=12345
KDE_IS_PRELINKED=1
KDEDIRS=/usr
KONSOLE_DBUS_SESSION=/Sessions/32
HISTCONTROL=erasedups
SSH_ASKPASS=somedirectory
HOME=/home/btiffin
COLORFGBG=0;15
XDG_SEAT=seat0
SHLVL=3
LANGUAGE=
GDL_PATH=+/usr/share/gnudatalanguage
LESS=-QX
LOGNAME=btiffin
CVS_RSH=ssh
QTLIB=/usr/lib64/qt-3.3/lib
XDG_DATA_DIRS=/usr/local/share:/usr/share
DBUS_SESSION_BUS_ADDRESS=unix:abstract=/tmp/andmoresensitivedata
LESSOPEN=||/usr/bin/lesspipe.sh %s
WINDOWPATH=1
PROFILEHOME=
XDG_RUNTIME_DIR=/run/user/500
DISPLAY=:0
QT_PLUGIN_PATH=/usr/lib64/kde4/plugins:/usr/lib/kde4/plugins
GLADE_CATALOG_PATH=:
XAUTHORITY=/tmp/.Xauth...
CCACHE_HASHDIR=
_=./printenv
OLDPWD=/home/btiffin/lang
```

5.78 Can GnuCOBOL generate callable programs with void returns?

Yes. GnuCOBOL builds after March 2016 can generate code for subprograms with no return value. For GnuCOBOL 1.1 and early 2.0 releases, the answer is no.

```
PROCEDURE DIVISION RETURNING OMITTED
```

GnuCOBOL can *CALL* (page 219) void functions, and can generate functions with a void return signature. This is normally not an issue, but becomes a problem when using GnuCOBOL with certain frameworks, that require particular signatures for call backs.

For builds of GnuCOBOL previous to March 2016, a small piece of C code may help.

For instance, many GTK+ features support a call back handler for reacting to events. Unfortunately, most of these

functions are expected to return void. Fortunately, GTK+ also supports `userdata` pointers with most of the call back signatures. This `userdata` field can be used to allow for GnuCOBOL source code that manages *GUI* (page 1385) event call backs.

5.78.1 voidcall_gtk.c

```
/****F* cobweb/voidcall_gtk
 *  NAME
 *    voidcall_gtk
 *  PURPOSE
 *    wrapping void C returns in callbacks for use with COBOL and GTK+
 *  INPUT
 *    GTK callback, (in this case always, voidcall_gtk)
 *    Actual COBOL callback program-pointer
 *  OUTPUT
 *    Eat the COBOL handler stack value and return as void
 *  SYNOPSIS
 *    voidcall_gtk(void *gtk, int (*cobfunc)(void *))
 *  SOURCE
*/
void
voidcall_gtk(void *gtk, int (*cobfunc)(void *))
{
    if ((cobfunc) && (cobfunc(gtk))) return; else return;
}
/*
 ****
*/
```

This can then be used to wrap a call back, allowing GnuCOBOL to take part in GTK+ event handling, without a specific C wrapper written for each case.

With `PROCEDURE DIVISION RETURNING OMITTED`, this becomes unneccessary.

5.78.2 A GTK+ calendar

The above code was used as a generic wrapper for practising with GTK+ calendar features.

```
*> Start up the GIMP/Gnome Tool Kit
 cobgtk.
 call "gtk_init" using
     by value 0                          *> argc int
     by value 0                          *> argv pointer to pointer
     returning omitted                   *> void return, requires cobc 2010+
     on exception
         display
             "hellogtk link error, see pkg-config --libs gtk+-2.0"
             upon syserr
         end-display
         stop run returning 1
 end-call

*> Create a new window, returning handle as pointer
 call "gtk_window_new" using
     by value GTK-WINDOW-TOPLEVEL        *> it's a zero or a 1 popup
```

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```
     returning gtk-window               *> and remember the handle
 end-call

*> More fencing, skimped on after this first test
 if gtk-window equal null then
     display
         "hellogtk service error, gtk_window_new"
         upon syserr
     end-display
     stop run returning 1
 end-if

*> Hint to not let the sample window be too small
 call "gtk_window_set_default_size" using
     by value gtk-window                *> by value is used to get the C address
     by value 270                       *> a rectangle, wider than tall
     by value 90
     returning omitted                  *> another void
 end-call

*> Put in the title, it'll be truncated in a size request window
 call "gtk_window_set_title" using
     by value gtk-window                *> pass the C handle
     by reference hello-msg             *> obligatory, with new Z strings
     returning omitted
 end-call

*> Connect a signal.  GnuCOBOL's SET ... TO ENTRY is AWESOME
 set gtk-quit-callback to entry "gtk_main_quit"
 call "g_signal_connect_data" using
     by value gtk-window
     by reference z"destroy"            *> with inline Z string
     by value gtk-quit-callback         *> function call back pointer
     by value 0                         *> pointer to data
     by value 0                         *> closure notify to manage data
     by value 0                         *> connect before or after flag
     returning gtk-quit-handler-id      *> not used in this sample
 end-call

*> Define a container. Boxey, but nice.
 call "gtk_box_new" using
     by value GTK-ORIENTATION-VERTICAL
     by value 8                         *> pixels between widgets
     returning gtk-box
 end-call

*> Add the label
 call "gtk_label_new" using
     by reference hello-msg
     returning gtk-label
 end-call

*> Add the label to the box
 call "gtk_container_add" using
     by value gtk-box
     by value gtk-label
     returning omitted
```

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```
 end-call

*> Add a calendar widget
 call "gtk_calendar_new" returning gtk-calendar end-call
 call "gtk_container_add" using
     by value gtk-box
     by value gtk-calendar
     returning omitted
 end-call

*> Connect a signal.  GnuCOBOL doesn't generate void returns
*>  so this calls a C function two-liner that calls the
*>  COBOL entry, but returns void to the runtime stack frame
 set cob-calendar-callback to entry "calendarclick"
 set gtk-calendar-callback to entry "voidcall_gtk"
 call "g_signal_connect_data" using
     by value gtk-calendar
     by reference z"day_selected"        *> with inline Z string
     by value gtk-calendar-callback      *> function call back pointer
     by value cob-calendar-callback      *> pointer to COBOL proc
     by value 0                          *> closure notify to manage data
     by value 0                          *> connect before or after flag
     returning gtk-quit-handler-id       *> not used in this sample
 end-call

*> Add the box to the window
 call "gtk_container_add" using
     by value gtk-window
     by value gtk-box
     returning omitted
 end-call

*> ready to display
 call "gtk_widget_show_all" using
     by value gtk-window
     returning omitted
 end-call

*> Enter the GTK event loop
 call "gtk_main"
     returning omitted
 end-call

*> Control can pass back and forth to COBOL subprograms,
*>  but control flow stops above, until the window
*>  is torn down and the event loop exits
 display
     "GnuCOBOL: GTK main eventloop terminated normally"
     upon syserr
 end-display

 accept venue from environment "GDK_BACKEND" end-accept
 if broadway then
     display "Ken sends his regards" upon syserr end-display
 end-if
 .
```

and the handler entry point.

```
GNU    >>SOURCE FORMAT IS FIXED
Cobol *> ******************************************************
  cob *> Author:    Brian Tiffin
  web *> Date:      20140201
 call *> Purpose:   Support cobweb callbacks
backs *> Tectonics: cobc -x -C gnucobol-cobweb.cob
      *>            sed -i 's/stdio.h/fcgi_stdio.h/' gnucobol-cobweb.c
      *>            cobc -x gnucobol-cobweb.c -lfcgi buccaneer.so \
      *>                $(pkg-config --libs gtk+-2.0) voidcall_gtk.c \
      *>                support-cobweb.cob
      *>   Move gnucobol-cobweb to the cgi-bin directory
      *>   supporting libraries in the COB_LIBRARY_PATH
      *>   browse http://localhost/cgi-bin/gnucobol-cobweb
      *> ******************************************************
      *> Callbacks
       identification division.
       program-id. supporting-callbacks.
       data division.
       working-storage section.
       01 gtk-calendar-data.
          05 gtk-calendar-year  usage binary-long sync.
          05 gtk-calendar-month usage binary-long sync.
          05 gtk-calendar-day   usage binary-long sync.
       01 gtk-calendar-display.
          05 the-year           pic 9999.
          05 filler             pic x value "/".
          05 the-month          pic 99.
          05 filler             pic x value "/".
          05 the-day            pic 99.
       linkage section.
       01 gtk-widget usage pointer.

       procedure division.
       entry 'calendarclick' using
           by value gtk-widget
       call "gtk_calendar_get_date" using
           by value gtk-widget
           by reference gtk-calendar-year
           by reference gtk-calendar-month
           by reference gtk-calendar-day
       end-call
       move gtk-calendar-year to the-year
       move gtk-calendar-month to the-month
       move gtk-calendar-day to the-day
       display
           "In the year " the-year
           " somebody clicked "
           gtk-calendar-display
       end-display
       goback.
```

which will come in handy as GTK features are extended, especially with the new Broadway backend to the GDK part of GTK+, which allows desktop GTK applications to be seamlessly integrated with a browser.

5.79 Can GnuCOBOL interface with Jim TCL?

Yes. *One unsafe cheat in the prototype, assumes result is first element of the Jim Interp structure.*

gnucobol-jim.cob

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20140517
      *> License:   Licensed under the GNU GPL 2 (or later)
      *> Purpose:   Hello Jim
      *> Tectonics: cobc -x gnucobol-jim.cob -ljim
      *> ****************************************************************
       identification division.
       program-id. gnucobol-jim.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 jim-interpreter      usage pointer.
       01 cli-arguments        pic x(1024).

      *> quick cheat into the interp structure
       01 jim-result-object    usage pointer based.
       01 jim-string           usage pointer.
       01 jim-length           usage binary-long.
       01 jim-answer           pic x(1024) based.
       01 jim-as-numeric       pic 9(18).

      *> ****************************************************************

       procedure division.
       accept cli-arguments from command-line end-accept

       call "Jim_CreateInterp" returning jim-interpreter
           on exception
               display
                   "error: Jim_CreateInterp failure, needs -ljim"
                   upon syserr
               end-display
bail           goback
       end-call

       call "Jim_RegisterCoreCommands" using
           by value jim-interpreter
       end-call

       call "Jim_InitStaticExtensions" using
           by value jim-interpreter
       end-call

      *> Use a default hello script if no command arguments
```

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```
       if cli-arguments equal spaces then
           call "Jim_Eval" using
               by value jim-interpreter
               by content z"return {Hello, COBOL}"
           end-call

      *> Jim_Result is a macro, boo, but it's the first address in the
      *>   Interp structure, snag it here as a quick cheat
      *>      jim-interpret is the address of a structure
      *>        jim-result-object pointer is first element
      *>   NOT A PORTABLE WAY, if you see this code, keep looking,
      *>        it should be updated to a proper implementation

           set address of jim-result-object to jim-interpreter
           call "Jim_GetString" using
               by value jim-result-object
               by reference jim-length
               returning jim-string
           end-call
           set address of jim-answer to jim-string
           display "Jim says: " jim-answer(1:jim-length) end-display

       else

      *> Evaluate a file
           call "Jim_EvalFile" using
               by value jim-interpreter
               by content trim(cli-arguments)
           end-call

           set address of jim-result-object to jim-interpreter
           call "Jim_GetString" using
               by value jim-result-object
               by reference jim-length
               returning jim-string
           end-call
           set address of jim-answer to jim-string
           display "Jim says: " jim-answer(1:jim-length) end-display

           move jim-answer(1:jim-length) to jim-as-numeric
           display "COBOL 9s: " jim-as-numeric end-display
       end-if

       call "Jim_FreeInterp" using
           by value jim-interpreter
       end-call

done   goback.
       end program gnucobol-jim.
```

with **hello.tcl**

```
return "S'up?"
```

and from the Jim TCL jimtcl-master/example directory, **timedread.tcl** (modified to return the count of bytes read in 0.5 seconds, which Jim does, as a string).

```
# Tests that SIGALRM can interrupt read
set f [open "/dev/urandom" r]

set count 0
set error NONE

signal handle SIGALRM
catch -signal {
        alarm 0.5
        while {1} {
                incr count [string bytelength [read $f 100]]
        }
        alarm 0
        signal default SIGALRM
} error

puts "Read $count bytes in 0.5 seconds: Got $error"

$f close
return $count
```

and a run sample of:

```
[root]# yum install jimtcl jimtcl-devel

[jim]$ cobc -x gnucobol-jim.cob -ljim
[jim]$ ./gnucobol-jim
Jim says: Hello, COBOL
[jim]$ ./gnucobol-jim hello.tcl
Jim says: S'up?
COBOL 9s: 000000000000000000
[jim]$ ./gnucobol-jim timedread.tcl
Read 5505000 bytes in 0.5 seconds: Got SIGALRM
Jim says: 5505000
COBOL 9s: 000000000005505000
```

Umm, reading a whole bunch of stuff off /dev/urandom is not the smartest of moves if the motherboard is also (or is about to be) executing code that requires system entropy.

Depletion of the system entropy pool can cause encryption systems to halt, waiting for enough mouse movement, or program runs, or other externally random events, that code breakers can't predict or easily replicate.

So, fair warning, don't run the above on systems that can't risk depletion of the entropy pool. (If you ever do get stuck, wiggling the mouse can actually help, along with keyclicks, network activity and other signs of unpredictable seed values).

Not bad though, some 10 million bytes of encryption quality random numbers a second.

5.80 Can GnuCOBOL interface with RLIB?

Yes. RLIB version 1.3.7 hosted on SourceForge at http://sourceforge.net/projects/rlib/ (from 2006) builds from source, just fine on a recent Fedora 19 (2014) system.

Nice support for PDF and HTML report generation. XML control files, *along with (among others) XML input sources*.

```
GCobol >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20140610
      *> Purpose:   RLIB integration from GnuCOBOL, XML datasources
      *> License:   RLIB is licenced GPL 2.0, this source is too
      *> Tectonics: cobc -x gnucobol-rlib-xml.cob -lr
      *>   displays PDF output to standard out
      *> ************************************************************
       identification division.
       program-id. rlib-xml.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

data   data division.
       working-storage section.

      *> see libsrc/rlib.h in the RLIB distribution
       01 rlib                 usage pointer.

      *> ************************************************************
code   procedure division.

      *> Initialize an RLIB structure
       call "rlib_init" returning rlib on exception continue end-call
       if rlib equal null then
           display "No rlib_init, try -lr" upon syserr end-display
bail       goback
       end-if

      *> add in a new XML datasource, by the name of local_xml
       call "rlib_add_datasource_xml" using
           by value rlib
           by content z"local_xml"
       end-call

      *> add a query (xml data file) to the RLIB local_xml structure
       call "rlib_add_query_as" using
           by value rlib
           by content z"local_xml"
           by content z"data.xml"
           by content z"data"
       end-call

      *> add a report to the queue
       call "rlib_add_report" using
           by value rlib
           by content z"graph.xml"
       end-call

      *> set output form; "pdf", "html", "csv", "txt"
       call "rlib_set_output_format_from_text" using
           by value rlib
           by content z"pdf"
```

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```
       end-call

      *> execute the rlib queue to buffer a report
       call "rlib_execute" using
           by value rlib
       end-call

      *> spool to stdout
       call "rlib_spool" using
           by value rlib
       end-call

      *> and free the structure
       call "rlib_free" using
           by value rlib
       end-call

done   goback.
       end program rlib-xml.
```

supporting files of data.xml as the aggregate data source, and graph.xml, a report definition file

```
<?xml version="1.0"?>
<data>
    <rows>
        <row>
            <col>Bob</col>
            <col>Doan</col>
            <col>blue</col>
            <col>8</col>
            <col>3</col>
            <col>Green Eggs And Spam I Am I Am</col>
        </row>
        <row>
            <col>Eric</col>
            <col>Buruschkin</col>
            <col>green</col>
            <col>5</col>
            <col>5</col>
            <col>Green Eggs And Spam I Am I Am</col>
        </row>
        <row>
            <col>Mike</col>
            <col>Roth</col>
            <col>yellow</col>
            <col>9</col>
            <col>3</col>
            <col>Green Eggs And Spam I Am I Am</col>
        </row>
        <row>
            <col>Bob</col>
            <col>Kratz</col>
            <col>pink</col>
            <col>7</col>
            <col>6</col>
            <col>Green Eggs And Spam I Am I Am</col>
        </row>
```

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```
        <row>
            <col>Steve</col>
            <col>Tilden</col>
            <col>purple</col>
            <col>9</col>
            <col>1</col>
            <col>Dude</col>
        </row>
    </rows>
    <fields>
        <field>first_name</field>
        <field>last_name</field>
        <field>color</field>
        <field>max</field>
        <field>min</field>
        <field>breakfast</field>
    </fields>
</data>
```

The fields, `max` and `min` are used in the report graphic, with the RLIB team member first names being the x axis labels.

```
<?xml version="1.0"?>
<!DOCTYPE report >
<Part layout="'flow'" fontSize="14" orientation="landscape">
    <PageHeader>
        <Output>
            <Line fontSize="26" bgcolor="'yellow'">
                <literal link="'http://rlib.sicompos.com'">
                 RLIB IS Graphing       </literal>
                <literal>YES!</literal>
            </Line>
            <HorizontalLine size="4" bgcolor="'black'"/>
            <HorizontalLine size="10" bgcolor="'white'"/>
        </Output>
    </PageHeader>
    <pr>
        <pd width="98">
            <Report fontSize="12" orientation="landscape" query="'data'">
                <Graph type="'line'" subtype="'normal'" width="740" height="250"
                       title="'Double Y Axix!'" x_axis_title="'Team RLIB'"
                       y_axis_title="'Big $$$'" y_axis_title_right="'Small $'">
                    <Plot axis="'x'" field="first_name"/>
                    <Plot axis="'y'" field="val(max)" label="'Max'" side="'left'"/>
                    <Plot axis="'y'" field="val(min)" label="'Min'" side="'right'"/>
                </Graph>
            </Report>
        </pd>
    </pr>
    <PageFooter>
        <Output>
            <Line>
                <literal>Page: </literal>
                <field value="r.pageno" width="3" align="right"/>
                <literal>/</literal>
                <field value="r.totpages" width="3" align="right" delayed="yes"/>
```

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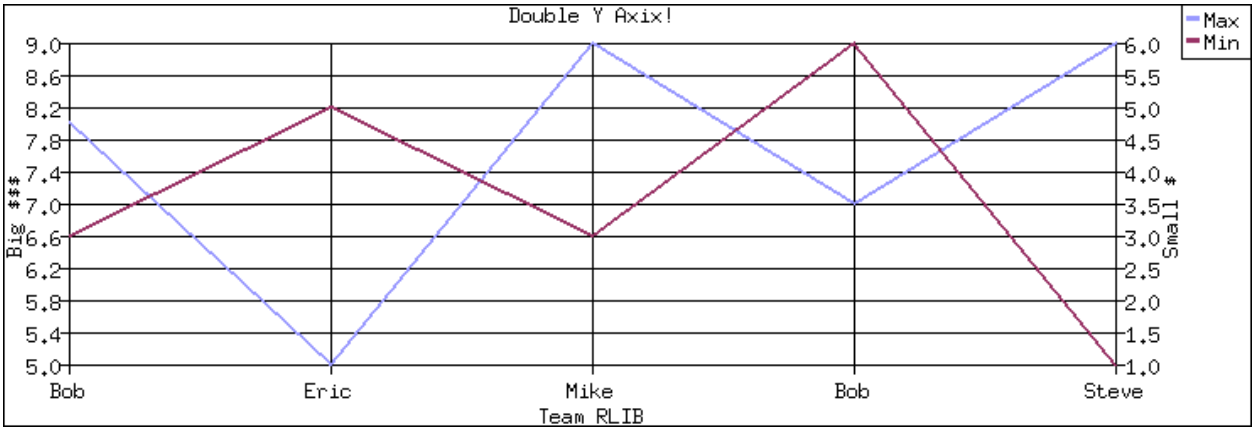
```
            </Line>
        </Output>
    </PageFooter>
</Part>
```

with a run sample of

```
$ cobc -x rlib-xml.cob -lr -g -debug
$ export COB_SET_TRACE=YES
$ ./rlib-xml >rlib-xml-graph.pdf
Source:     'rlib-xml.cob'
Program-Id: rlib-xml         Entry:     rlib-xml              Line: 27
Program-Id: rlib-xml         Section:   (None)                Line: 27
Program-Id: rlib-xml         Paragraph: (None)                Line: 27
Program-Id: rlib-xml         Statement: CALL                  Line: 27
Program-Id: rlib-xml         Statement: IF                    Line: 28
Program-Id: rlib-xml         Statement: CALL                  Line: 34
Program-Id: rlib-xml         Statement: CALL                  Line: 40
Program-Id: rlib-xml         Statement: CALL                  Line: 48
Program-Id: rlib-xml         Statement: CALL                  Line: 54
Program-Id: rlib-xml         Statement: CALL                  Line: 60
Program-Id: rlib-xml         Statement: CALL                  Line: 65
Program-Id: rlib-xml         Statement: CALL                  Line: 70
Program-Id: rlib-xml         Statement: GOBACK                Line: 74
Program-Id: rlib-xml         Exit:      rlib-xml
```

producing a PDF containing a graph ala



Actually, the image was generated during an HTML output pass, the PDF is more PDFey

A made up and misleading graph by the way. Two scales, left and right Y-Axis, red and blue lines are not on the same scale. For instance; Eric has both a Min and Max of 5, but the Min line, right hand axis (in red, Small dollar day) is scaled from 1 to 6, differently than the range of the blue, Big dollar day line) That can easily be *fixed*, but is shown for that Wall Streeet flair of illusion and perception, wrapped in legally defensible numbers. *a lorem ipsum graph*.

5.81 Can GnuCOBOL interface with Perl?

Yes. With some caveats. The API for Perl 5 is heavily layered in macros. It is worth writing some wrapper code, for safety (and sanity).

A getting to grips sample, *so, it might be wrong headed*

```
/** Perl support for GnuCOBOL */
/* tectonics: cobc -x perlcob.cob perlsupport.c -lperl -L/usr/lib64/perl/CORE */

#include <EXTERN.h>
#include <perl.h>

/** needed for the macros */
static PerlInterpreter *my_perl;

/** return scalar value as an integer */
int CBL_OC_SvIV(PerlInterpreter *perl_instance, char *name) {
    my_perl = perl_instance;
    return SvIV(get_sv(name, 0));
}

/** GnuCOBOL doesn't support double on the return stack frame*/
static double CBL_OC_SvNV_intermediate;

/** return scalar value as float */
double * CBL_OC_SvNV(PerlInterpreter *perl_instance, char *name) {
    my_perl = perl_instance;
    CBL_OC_SvNV_intermediate = SvNV(get_sv(name, 0));
    return &CBL_OC_SvNV_intermediate;
}

/** return scalar value as char pointer */
char * CBL_OC_SvPV_nolen(PerlInterpreter *perl_instance, char *name) {
    my_perl = perl_instance;
    return SvPV_nolen(get_sv(name, 0));
}
```

and

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20140407
      *> Purpose:   cobweb embedded Perl
      *> Tectonics: cobc -x perlcob.cob -lperl -L/usr/lib64/perl5/CORE
      *>   -or- the Perl documented way of getting to the right paths
      *>            cobc -x -g -debug perlcob.cob \
      *>              `perl -MExtUtils::Embed -e ccopts -e ldopts`
      *> ***************************************************************
       identification division.
       program-id. perlcob.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

data   data division.
       working-storage section.
       01 perl-interpreter         usage pointer.
       01 perl-null                usage pointer value null.
       01 perl-scalar-reference    usage pointer.
       01 perl-result-int          usage binary-long.
```

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```
       01 perl-integer             usage binary-long.

       01 perl-floater             usage pointer.
       01 perl-float               usage float-long based.

       01 perl-pointer             usage pointer.
       01 perl-char                pic x based.
       01 next-char                pic x based.

       01 perl-start-args.
          05 perl-argv             usage pointer sync.
          05 argv0                 usage pointer sync.
          05 argv1                 usage pointer sync.
          05 argv2                 usage pointer sync.
          05 argv3                 usage pointer sync.
       01 perl-strings.
          05 empty-string          pic x value x"00".
          05 express-string        pic xxx value "-e" & x"00".
          05 one-liner             pic x(80)
                value 'print "Hello, COBOL\nThis is process $$' &
                      ' on $^O\n";' & x"00".


      *> ****************************************************************
code   procedure division.
       call "Perl_sys_init" using
           by value 0
           by reference null
           on exception
               display
                   "perlcob: Perl_sys_init failure" upon syserr
               end-display
       end-call

       call "perl_alloc"
           returning perl-interpreter
           on exception
               display
                   "perlcob: perl_alloc failure" upon syserr
               end-display
       end-call
       if perl-interpreter equal null then
           display
               "perlcob: perl-interpreter null" upon syserr
           end-display
       end-if

       call "perl_construct" using by value perl-interpreter end-call

      *> Set up a fake argc, argv
       set perl-argv to address of argv0.
       set argv0 to address of empty-string.
       set argv1 to address of express-string.
       set argv2 to address of one-liner.
       set argv3 to null
```

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```
       call "perl_parse" using
           by value perl-interpreter
           by value perl-null
           by value 3
           by value perl-argv
           by value perl-null
           returning perl-result-int
       end-call
       display
           "perlcob parse result:       " perl-result-int
       end-display

       call "perl_run" using
           by value perl-interpreter
           returning perl-result-int
       end-call
       display
           "perlcob run result:         " perl-result-int
       end-display

      *> a floating point evaluation
       call "Perl_eval_pv" using
           by value perl-interpreter
           by content '$a = 3.14; $a **= 2;' & x"00"
           by value 0
           returning perl-scalar-reference
           on exception
               display
                   "perlcob: Perl_eval_pv failure" upon syserr
               end-display
       end-call

       call "CBL_OC_SvNV" using
           by value perl-interpreter
           by content z"a"
           returning perl-floater
       end-call
       set address of perl-float to perl-floater
       display "perlcob 3.14**2 from perl:  " perl-float end-display

      *> scalar as integer evaluation
       call "Perl_eval_pv" using
           by value perl-interpreter
           by content '$a = 3; $a **= 2;' & x"00"
           by value 0
           returning perl-scalar-reference
           on exception
               display
                   "perlcob: Perl_eval_pv failure" upon syserr
               end-display
       end-call

       call "CBL_OC_SvIV" using
           by value perl-interpreter
           by content z"a"
           returning perl-integer
       end-call
```

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```
       display "perlcob 3**2 from perl:     " perl-integer end-display

      *> a floating point evaluation
       call "Perl_eval_pv" using
           by value perl-interpreter
           by content '$a = 3.14; $a **= 20;' & x"00"
           by value 0
           returning perl-scalar-reference
           on exception
               display
                   "perlcob: Perl_eval_pv failure" upon syserr
               end-display
       end-call
       call "CBL_OC_SvNV" using
           by value perl-interpreter
           by content z"a"
           returning perl-floater
       end-call
       set address of perl-float to perl-floater
       display "perlcob 3.14**20 from perl: " perl-float end-display

       compute perl-float = 3.14 ** 20 end-compute
       display "COBOL   computed 3.14**20 : " perl-float end-display

      *> scalar as a null terminated string
       call "Perl_eval_pv" using
           by value perl-interpreter
           by content
               '$a = "rekcaH lreP rehtonA tsuJ"; ' &
               "$a = reverse($a);" & x"00"
           by value 1
           returning perl-scalar-reference
           on exception
               display
                   "perlcob: Perl_eval_pv failure" upon syserr
               end-display
       end-call
       call "CBL_OC_SvPV_nolen" using
           by value perl-interpreter
           by content z"a"
           returning perl-pointer
       end-call
       display "perlcob pointer from perl:  " perl-pointer end-display

       set address of perl-char to perl-pointer
       perform until perl-char equal x"00"
           set perl-pointer up by 1
           set address of next-char to perl-pointer

           if next-char not equal x"00" then
               display perl-char with no advancing end-display
           else
               display perl-char end-display
           end-if

           set address of perl-char to perl-pointer
       end-perform
```

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```
      *> and just for fun, remove blank lines from CRUNCHME.txt
       call "Perl_eval_pv" using
           by value perl-interpreter
           by content
               'open FH, "CRUNCHME.txt" or die $!;'        & x"0a" &
               'while (<FH>) {'                            & x"0a" &
               '    print unless /^$/;'                    & x"0a" &
               '};'                                        & x"0a" &
               'close(FH);' & x"00"
           by value 0
           returning perl-scalar-reference
           on exception
               display
                   "perlcob: Perl_eval_pv failure" upon syserr
               end-display
       end-call

       call "CBL_OC_SvIV" using
           by value perl-interpreter
           by content z"a"
           returning perl-integer
       end-call
       display "perlcob from perl:     " perl-integer end-display

      *> cleanup
       call "perl_destruct" using by value perl-interpreter end-call
       call "perl_free" using by value perl-interpreter end-call

       call "Perl_sys_term" end-call
       goback.
       end program perlcob.
```

Gives:

```
$ make perlcob
cobc -x -g -debug perlcob.cob perlsupport.c
     -I/usr/lib64/perl5/CORE -lperl -L/usr/lib64/perl5/CORE

$ export LD_LIBRARY_PATH=/usr/lib64/perl5/CORE/
$ ./perlcob
perlcob parse result:       +0000000000
Hello, COBOL
This is process 30917 on linux
perlcob run result:         +0000000000
perlcob 3.14**2 from perl:  9.8596
perlcob 3**2 from perl:     +0000000009
perlcob 3.14**20 from perl: 8681463855.993662
COBOL   computed 3.14**20 : 8681463855.993654
perlcob pointer from perl:  0x00000000019d4720
Just Another Perl Hacker
Perl will
remove
the empty
lines of
this file
perlcob from perl:     +0000000000
```

COBOL programmers will likely need to take notice of the rounding difference in the floating point data for 3.14 to the power of 20, *just because*.

5.82 Can GnuCOBOL interface with BASIC?

Yes, and no. At least two forms of BASIC have been proven, but there are other BASIC dialects and environments that won't be suited for integration with GnuCOBOL. If a BASIC implementation plays well with the C ABI and/or link libraries, it will very likely play well with GnuCOBOL.

5.82.1 Gambas

Linking to Gambas is documented at *Can GnuCOBOL interface with Gambas?* (page 943)

5.82.2 BaCon

The BASIC Converter. A shell script (yeah, *shell*) that converts BASIC to C, then compiles the C. A transcompiler, similar in nature to GnuCOBOL itself.

The author, Peter van Eerten has refined a reference implementation of bacon.bac. The script runs in Bash, Ksh, PDKSH, MKSH, Zshell. This is only a stepping stone now that the bacon.bac is compiled. BaCon installs both `bacon` and `bacon.sh`.

During ./configure ; make, the `bacon.sh` shell program translates bacon.bac to C and compiles the generated source. Providing a binary executable for BaCon, written in BaCon that is tranlated by BaCon. Nicely done. Not a toy.

http://www.basic-converter.org/

Initial tests went very smoothly.

```
tar xvf bacon-3.0.1.tar.gz
cd bacon-3.0.1
./configure
make
sudo make install
```

With some BASIC

```
REM BaCon from GnuCOBOL, Take 1

REM a little bit of logic programming ala Proglog
FUNCTION mortals()
    DECLARE human, mortal ASSOC int
    RELATE human TO mortal

    human("socrates") = TRUE
    human("sappho") = TRUE
    human("august") = TRUE

    PRINT "Mortals are:"
    LOOKUP mortal TO member$ SIZE amount
    FOR x = 0 TO amount - 1
        PRINT member$[x]
    NEXT
    RETURN 0
```

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```
END FUNCTION


REM and times five
FUNCTION timesfive (NUMBER n)
    LOCAL i
    i = 5 * n
    RETURN i
END FUNCTION
```

and then a library build, (and install, to help with later linkage)

```
$ bacon -f libdemo.bac
Converting 'libdemo.bac'... done, 26 lines were processed in 0.006 seconds.
Compiling 'libdemo.bac'... cc  -fPIC -c libdemo.bac.c
cc -o libdemo.so libdemo.bac.o -lbacon -lm -ldl -shared -rdynamic
Done, program 'libdemo.so' ready.

$ sudo cp -vi libdemo.so /usr/local/lib/
$ sudo ldconfig
```

and some COBOL

```
GnuCOB >>SOURCE FORMAT IS FIXED
      *> TECTONICS
      *>   bacon -f libdemo.bac
      *>   sudo cp libdemo.so /usr/local/lib/
      *>   sudo ldconfig
      *>   cobc -x ldemo callbacon.cob -g -debug
       identification division.
       program-id. callbacon.

       data division.
       working-storage section.
       01 basic-result       usage binary-long.

       procedure division.
       call "mortals" end-call

       call "timesfive" using by value 8 returning basic-result end-call
       display basic-result space return-code end-display

       goback.
       end program callbacon.
```

and putting it all together, calling BASIC library functions from GnuCOBOL:

```
$ cobc -x -g -debug callbacon.cob -ldemo
$ ./callbacon
Mortals are:
socrates
sappho
august
+0000000040 +000000040
```

Painless. BASIC from COBOL. BaCon seems like an easy to use programming system, with some surprising powers.

Here is a SQLite linkage sample, by Peter van Eerten. sqlite3.bac is some 100 lines of BaCon and the 20 odd lines to

demo it.

```
'
' Demonstration program for SQlite3
'
' PvE - May 2010, GPL.
' ---------------------------------------------------------------------

' Include the binding
INCLUDE "sqlite3.bac"

' Name of the data file
CONST datafile$ = "data.sdb"

' Print version
PRINT NL$, "Using SQLite version: ", DB_VERSION$()

' Create a database
mydb = DB_OPEN(datafile$)

' Create table and add data
DB_SQL(mydb, "CREATE TABLE demo(someval INTEGER,  sometxt TEXT);")
DB_SQL(mydb, "INSERT INTO demo VALUES (123, 'Hello');")
DB_SQL(mydb, "INSERT INTO demo VALUES (234, 'BaCon');")
DB_SQL(mydb, "INSERT INTO demo VALUES (345, 'world');")
DB_SQL(mydb, "COMMIT;")

' Fetch some data
res = DB_SQL(mydb, "SELECT * FROM demo;")
IF res IS 0 THEN PRINT NL$, DB_RESULT$
ELSE PRINT NL$, DB_ERROR$

' Count the records
DB_SQL(mydb, "SELECT COUNT(*) FROM demo;")
PRINT "Amount of records: ", MID$(DB_RESULT$, INSTR(DB_RESULT$, NL$) + 1)

' Close database
res = DB_CLOSE(mydb)

' Print some info
PRINT "Size of data file is: ", FILELEN(datafile$), " bytes.", NL$

' Delete data file again
DELETE FILE datafile$
```

with a trial run of

```
$ bacon sql.bac
Converting 'sql.bac'... done, 212 lines were processed in 0.032 seconds.
Compiling 'sql.bac'... cc  -c sql.bac.c
cc -o sql sql.bac.o -lbacon -lm -ldl
Done, program 'sql' ready.

$ ./sql

Using SQLite version: 3.8.3

someval sometxt
```

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```
123     Hello
234     BaCon
345     world

Amount of records: 3

Size of data file is: 2048 bytes.
```

5.83 Can GnuCOBOL interface with Nim?

Yes. Directly, with some complexity in tectonics.

Nim, once called Nimrod, is a trans-compiler, transpiler, as is GnuCOBOL. Leveraging C as a step in the compile chain. This C can be included in `cobc` command lines, from source or link library. Nim emits the equivalent of libcob run-time in a system.c file for each compile. Nice.

The Makefile below, shows the sample, `nicenim` and then the two different ways Nim code can be integrated. Directly with generated C sources, or through linkage (static in this case) to Nim object files and libraries.

`callnim` was an original trial. It called an exponentially recursive Nim fibonacci calculation. An expensive use of electricity for a proof of concept. Replaced with nicenim, and a simple, not overly productive, loop.

`ultimate.nim`

```
# nim c --noMain --noLinking --header:ultimate.h ultimate.nim
proc ultimate(a: cint): cint {.exportc.} =
  result = 1
  var days = a
  while days > 1:
    days -= 1
    result *= 42
```

`nicenim.cob`

```
GCOBOL
      *> LICENSE
      *>   Copyright 2015 Brian Tiffin
      *>   GNU General Public License, GPL, 3.0 (or greater)
      *> PURPOSE
      *>   nicenim program. Original callnim used fibonacci,
      *>   an overly resource intensive proof of concept sample
      *> TECTONICS
      *> nicenim-static: nicenim.cob ultimate.nim
      *>  nim compile --app:staticlib --noMain --header ultimate.nim
      *>  cobc -x nicenim.cob -g -debug libultimate.nim.a
      *> nicenim: nicenim.cob ultimate.nim
      *>  nim compile --noMain --noLinking\
      *>      --header:ultimate.h ultimate.nim
      *>  cobc -x nicenim.cob nimcache/ultimate.c nimcache/system.c -g\
      *>      -debug -A '-I/home/btiffin/inst/langs/nim-0.10.2/lib'
      *>  The include directive needs to find nim dev headers, in lib
       identification division.
       program-id. nicenim.

       environment division.
```

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```
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 num usage binary-long.
       01 ans usage binary-long.
       01 chq pic $zzz,zzz,zz9.99.

       procedure division.
       display "a week on the hitchhiker's pay scale" end-display

       call "NimMain" end-call

       perform varying num from 1 by 1 until num > 5
           display "Pay for " with no advancing end-display
           evaluate num
             when 1 display "Monday   " with no advancing end-display
             when 2 display "Tuesday  " with no advancing end-display
             when 3 display "Wednesday" with no advancing end-display
             when 4 display "Thursday " with no advancing end-display
             when 5 display "Friday   " with no advancing end-display
           end-evaluate

           call "ultimate" using by value num returning ans end-call
           move ans to chq
           display " would be " chq end-display
       end-perform

       goback.
       end program nicenim.
```

`makefile` (needs tabs)

```
# integrate Nim, using generated C sources
nicenim: nicenim.cob ultimate.nim
    nim compile -d:release --noMain --noLinking --header:ultimate.h ultimate.nim
    cobc -x nicenim.cob nimcache/ultimate.c nimcache/system.c \
         -g -debug -A '-I/home/btiffin/inst/langs/nim-0.10.2/lib'

# integrate Nim, static linkages
callnim-static: callnim.cob fib.nim
    nim compile --app:staticlib --noMain --header fib.nim
    cobc -x -K'NimMain' -K'fib' callnim.cob -g -debug libfib.nim.a

# integrate Nim, using generated C sources
callnim: callnim.cob fib.nim
    nim compile -d:release --noMain --noLinking --header:fib.h fib.nim
    cobc -x callnim.cob nimcache/fib.c nimcache/system.c \
         -g -debug -A '-I/home/btiffin/inst/langs/nim-0.10.2/lib'
```

`$ make`:

```
nim compile -d:release --noMain --noLinking --header:ultimate.h ultimate.nim
config/nim.cfg(45, 2) Hint: added path: '/home/btiffin/.babel/pkgs/' [Path]
config/nim.cfg(46, 2) Hint: added path: '/home/btiffin/.nimble/pkgs/' [Path]
```

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```
Hint: used config file '/home/btiffin/inst/langs/nim-0.10.2/config/nim.cfg' [Conf]
Hint: system [Processing]
Hint: ultimate [Processing]
Hint: operation successful (8759 lines compiled; 0.118 sec total; 10.102MB) [SuccessX]
cobc -x nicenim.cob nimcache/ultimate.c nimcache/system.c
     -g -debug -A '-I/home/btiffin/inst/langs/nim-0.10.2/lib'
```

`$ ./nicenim`:

```
a week on the hitchhiker's pay scale
Pay for Monday    would be           $1.00
Pay for Tuesday   would be          $42.00
Pay for Wednesday would be       $1,764.00
Pay for Thursday  would be      $74,088.00
Pay for Friday    would be   $3,111,696.00
```

Based on samples from http://nim-lang.org/backends.html which is subject to change, as Nim approaches a 1.0 reference implementation.

Nim also outputs Javascript, C++ and Objective-C. GnuCOBOL developers can leverage just about all of these targets. C and js, or C++ with GnuCOBOL-CPP, and perhaps the Objective-C for the adventurous.

See http://nim-lang.org

As mentioned, the fib.nim fibonacci function

```
# nim c --noMain --noLinking --header:fib.h fib.nim
proc fib(a: cint): cint {.exportc.} =
  if a <= 2:
    result = 1
  else:
    result = fib(a - 1) + fib(a - 2)
```

5.84 What is COBJAPI?

László Erdős wrapped the japi C library in User Define Functions.

http://sourceforge.net/p/gnucobol/contrib/HEAD/tree/trunk/tools/cobjapi/

What is japi? A **j**ava **a**pplication **p**rogramming **i**nterface

A C library interface to the Java Advanced Window Toolkit. Yes, Java. This library is a bridge to the Java AWT from the C *ABI* (page 1350). With COBJAPI now providing a bridge from COBOL to the Java Virtual Machine space. The author of japi is Dr. Merten Joost (University of Koblenz-Landau). http://www.japi.de

László wanted to highlight the choice selector example. A worthy demonstration of how easy it can be to develop graphical user interface programs with COBJAPI and GnuCOBOL.

```
*>*****************************************************************************
*>  This file is part of cobjapi.
*>
*>  choice.cob is free software: you can redistribute it and/or
*>  modify it under the terms of the GNU Lesser General Public License as
*>  published by the Free Software Foundation, either version 3 of the License,
*>  or (at your option) any later version.
*>
```

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```
*>  choice.cob is distributed in the hope that it will be useful,
*>  but WITHOUT ANY WARRANTY; without even the implied warranty of
*>  MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.
*>  See the GNU Lesser General Public License for more details.
*>
*>  You should have received a copy of the GNU Lesser General Public License
*>  along with choice.cob.
*>  If not, see <http://www.gnu.org/licenses/>.
*>*****************************************************************************

*>*****************************************************************************
*> Program:      choice.cob
*>
*> Purpose:      Example GnuCOBOL program for JAPI
*>
*> Author:       Laszlo Erdos - https://www.facebook.com/wortfee
*>
*> Date-Written: 2014.12.24
*>
*> Tectonics:    Example for static link.
*>               cobc -x -free choice.cob cobjapi.o \
*>                                        japilib.o \
*>                                        imageio.o \
*>                                        fileselect.o
*>
*> Usage:        ./choice.exe
*>
*>*****************************************************************************
*> Date       Name / Change description
*> ========== ============================================================
*> 2003.02.26 This comment is only for History. The latest Version (V1.0.6) of
*>            JAPI was released on 02/26/2003. Homepage: http://www.japi.de
*>-----------------------------------------------------------------------------
*> 2014.12.24 Laszlo Erdos:
*>            - GnuCOBOL support for JAPI added.
*>            - choice.c converted into choice.cob.
*>*****************************************************************************

 IDENTIFICATION DIVISION.
 PROGRAM-ID. choice.
 AUTHOR.     Laszlo Erdos.

 ENVIRONMENT DIVISION.
 CONFIGURATION SECTION.
 REPOSITORY.
    FUNCTION J-SETDEBUG
    FUNCTION J-START
    FUNCTION J-FRAME
    FUNCTION J-CHOICE
    FUNCTION J-ADDITEM
    FUNCTION J-SETPOS
    FUNCTION J-SELECT
    FUNCTION J-SETNAMEDCOLORBG
    FUNCTION J-SHOW
    FUNCTION J-NEXTACTION
    FUNCTION J-GETSELECT
    FUNCTION J-QUIT
```

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```
    FUNCTION ALL INTRINSIC.

 DATA DIVISION.

 WORKING-STORAGE SECTION.
*> function return value
 01 WS-RET                            BINARY-INT.

*> GUI elements
 01 WS-FRAME                          BINARY-INT.
 01 WS-OBJ                            BINARY-INT.
 01 WS-CHOICE                         BINARY-INT.

*> function args
 01 WS-DEBUG-LEVEL                    BINARY-INT.
 01 WS-XPOS                           BINARY-INT.
 01 WS-YPOS                           BINARY-INT.
 01 WS-ITEM                           BINARY-INT.

*> Constants for the cobjapi wrapper
 COPY "cobjapi.cpy".

 PROCEDURE DIVISION.

*>-------------------------------------------------------------------------------
 MAIN-CHOICE SECTION.
*>-------------------------------------------------------------------------------

*>  MOVE 5 TO WS-DEBUG-LEVEL
*>  MOVE J-SETDEBUG(WS-DEBUG-LEVEL) TO WS-RET

    MOVE J-START() TO WS-RET
    IF WS-RET = ZEROES
    THEN
       DISPLAY "can't connect to server"
       STOP RUN
    END-IF

*>  Generate GUI Objects
    MOVE J-FRAME("select a color") TO WS-FRAME

    MOVE J-CHOICE(WS-FRAME) TO WS-CHOICE

    MOVE J-ADDITEM(WS-CHOICE, "Red")     TO WS-RET
    MOVE J-ADDITEM(WS-CHOICE, "Green")   TO WS-RET
    MOVE J-ADDITEM(WS-CHOICE, "Blue")    TO WS-RET
    MOVE J-ADDITEM(WS-CHOICE, "Yellow")  TO WS-RET
    MOVE J-ADDITEM(WS-CHOICE, "White")   TO WS-RET
    MOVE J-ADDITEM(WS-CHOICE, "Black")   TO WS-RET
    MOVE J-ADDITEM(WS-CHOICE, "Magenta") TO WS-RET
    MOVE J-ADDITEM(WS-CHOICE, "Orange")  TO WS-RET

    MOVE 150 TO WS-XPOS
    MOVE 120 TO WS-YPOS
    MOVE J-SETPOS(WS-CHOICE, WS-XPOS, WS-YPOS) TO WS-RET

*>  Makes the given item the selected one for the choice.
```

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```
    MOVE 3 TO WS-ITEM
    MOVE J-SELECT(WS-CHOICE, WS-ITEM) TO WS-RET

    MOVE J-SETNAMEDCOLORBG(WS-FRAME, J-YELLOW) TO WS-RET
    MOVE J-SETNAMEDCOLORBG(WS-CHOICE, J-WHITE) TO WS-RET

    MOVE J-SHOW(WS-FRAME) TO WS-RET

*>  Waiting for actions
    PERFORM FOREVER
       MOVE J-NEXTACTION() TO WS-OBJ

       IF WS-OBJ = WS-CHOICE
       THEN
          MOVE J-GETSELECT(WS-CHOICE) TO WS-ITEM

          EVALUATE WS-ITEM
             WHEN 0 MOVE J-SETNAMEDCOLORBG(WS-FRAME, J-RED)     TO WS-RET
             WHEN 1 MOVE J-SETNAMEDCOLORBG(WS-FRAME, J-GREEN)   TO WS-RET
             WHEN 2 MOVE J-SETNAMEDCOLORBG(WS-FRAME, J-BLUE)    TO WS-RET
             WHEN 3 MOVE J-SETNAMEDCOLORBG(WS-FRAME, J-YELLOW)  TO WS-RET
             WHEN 4 MOVE J-SETNAMEDCOLORBG(WS-FRAME, J-WHITE)   TO WS-RET
             WHEN 5 MOVE J-SETNAMEDCOLORBG(WS-FRAME, J-BLACK)   TO WS-RET
             WHEN 6 MOVE J-SETNAMEDCOLORBG(WS-FRAME, J-MAGENTA) TO WS-RET
             WHEN 7 MOVE J-SETNAMEDCOLORBG(WS-FRAME, J-ORANGE)  TO WS-RET
          END-EVALUATE

          MOVE J-SETNAMEDCOLORBG(WS-CHOICE, J-WHITE) TO WS-RET
       END-IF

       IF WS-OBJ = WS-FRAME
       THEN
          EXIT PERFORM
       END-IF
    END-PERFORM

    MOVE J-QUIT() TO WS-RET

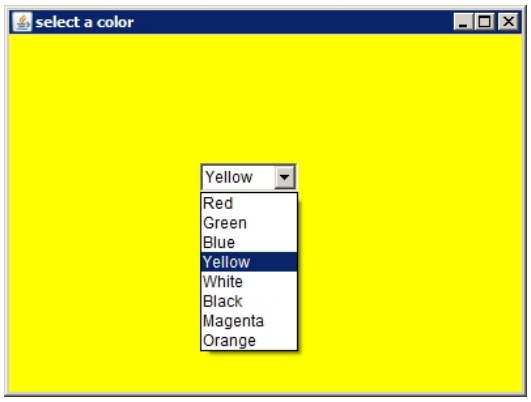
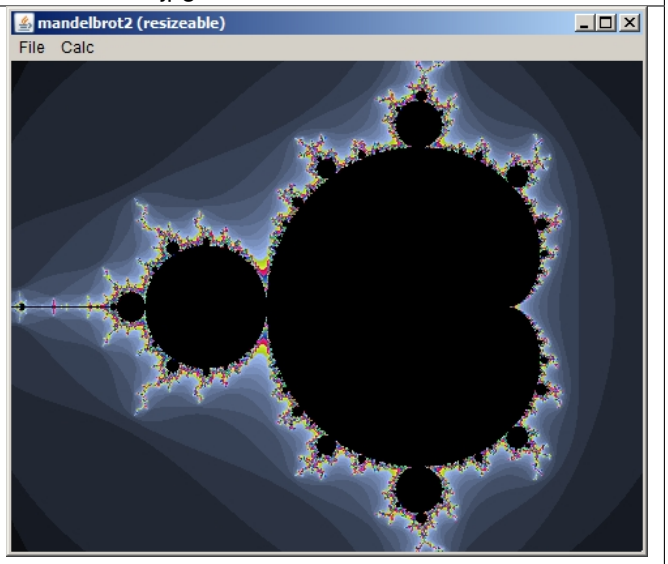
    STOP RUN

    .
 MAIN-CHOICE-EX.
    EXIT.
 END PROGRAM choice.
```

This puts up a color selector that modifies the example window background with each choice.

COBJAPI is one of the nicer entries in the contrib/ tree. A beautiful example of how function COBOL is good COBOL, and how function repositories can shorten procedure division source code burdens, by nearly an order of magnitude.

Some screen captures (all the COBJAPI samples, come with pictures).

choice.jpg		mandelbrot2.jpg
		
A simple, yet powerful choice selector		Resizeable, Mandelbrot set computed in GnuCOBOL

Well documented, ready to go, *as a work in progress*, with plenty of practical examples. Check out the source tree, on the forge using the link at the top of the entry. Well worth the look. At a glance:

as of April 2015, there are 55 examples; (*meaning a lot of boiler plate code is readily available, for a leg up on application development*).

This quick list showing lines of comments, and lines of code.

```
$ cloc exam* --by-file | grep \\.cob | sort | \
   awk '{printf "%-40s %3s, %3s\n",$1,$3,$4}'
examples/digits/digits.cob                56,  96
examples/imageviewer/imageviewer.cob      55, 126
examples/mandelbrot/mandelbrot1.cob       60, 168
examples/mandelbrot/mandelbrot2.cob       60, 168
examples/mandelbrot/mandelbrot3.cob       61, 268
examples_simple/alert.cob                 53,  85
examples_simple/borderlayout.cob          54,  60
examples_simple/borderpanel.cob           54,  80
examples_simple/button.cob                54, 104
examples_simple/canvas.cob                59, 114
examples_simple/checkbox.cob              55, 116
examples_simple/choice.cob                55,  84
examples_simple/colors1.cob               59, 112
examples_simple/colors.cob                56, 108
examples_simple/componentlistener.cob     55, 110
examples_simple/cursor.cob                60, 118
examples_simple/daemon.cob                50,  28
examples_simple/dialog.cob                55,  94
examples_simple/dialogmodal.cob           57,  98
examples_simple/filedialog.cob            54,  69
examples_simple/flowlayout.cob            54, 125
examples_simple/flowsimple.cob            56,  73
examples_simple/focuslistener.cob         61,  65
examples_simple/font.cob                  64, 179
examples_simple/frame.cob                 53,  52
```

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```
examples_simple/graphicbutton.cob          56,  84
examples_simple/graphic.cob                77, 282
examples_simple/graphiclabel.cob           53,  70
examples_simple/gridlayout.cob             54, 114
examples_simple/image.cob                  59, 128
examples_simple/insets.cob                 54, 111
examples_simple/keylistener.cob            54,  71
examples_simple/label.cob                  53, 123
examples_simple/lines.cob                  54,  70
examples_simple/list.cob                   55,  88
examples_simple/listmultiple.cob           55, 116
examples_simple/menu.cob                   55, 134
examples_simple/mousebuttons.cob           54,  64
examples_simple/mouselistener.cob          54, 165
examples_simple/panel.cob                  53, 136
examples_simple/popupmenu.cob              53,  67
examples_simple/print.cob                  54,  97
examples_simple/radiobutton.cob            54,  77
examples_simple/rubberband.cob             54, 126
examples_simple/scaledimage.cob            57,  93
examples_simple/scrollbar.cob              55,  94
examples_simple/scrollpane.cob             54, 104
examples_simple/simple.cob                 53,  36
examples_simple/simplemenu.cob             53,  51
examples_simple/textfield.cob              53,  80
examples_simple/vumeter.cob                54, 103
examples_simple/window.cob                 54, 102
examples_simple/windowlistener.cob         54, 114
examples/texteditor/texteditor.cob         56, 163
examples/video/video.cob                   61, 117
```

117 lines of COBOL for the animated video display example. Function repositories allow for very concise COBOL application listings. This will only get better, as more and more function libraries become available.

5.85 Does GnuCOBOL support source code macros?

GnuCOBOL supports nearly the full gamut of the COBOL 2014 Standard Text Manipulation, and Compiler Directive Facilities, with *COPY* (page 237) *REPLACING* (page 369), REPLACE and the >> directives. Macros are a little bit different.

As of May 2015, GnuCOBOL can also be used with an actual macro preprocessor, supporting a syntax developed for HP COBOL II/XL for e3000 systems.

A contribution by Robert W. Mills, `cobolmac`

http://sourceforge.net/p/gnucobol/contrib/HEAD/tree/trunk/tools/cobolmac/

The program acts as stdin stdout filter, and supports

- $DEFINE
- $INCLUDE
- $PREPROCESSOR

along with

- $IF

- $SET
- $PAGE
- $TITLE
- $CONTROL
- $VERSION
- $COPYRIGHT

which are HPe3000 specific, and are currently removed during `cobolmac` processing.

Defined macros support up to 9 parameters passed to each expansion.

Usage:

```
cobolmac [options] <input >output [2>messages]
```

options include:

```
--help       Display this text and exit.
--version    Display the preprocessor version and exit.
--hardwarn   Treat all warnings like an error.
--verbose    Include Macro Begin/End comment lines.
--debug      Display additional error information.
--maclib     List the contents of the Macro Library.
```

By convention, Robert uses `.cob` for input names, and `.cbl` for the post processed files that are passed to `cobc`. This is just a convention, and developers can use any naming they feel comfortable with.

For example, one the sample macro definitions that ships with `cobolmac`; a macro to assist in moving data to formatted numerics.

```
    *> ***************************************************************************
    *>  %MoveNumber(Number#,Destination#,Column#,Format#)
    *> ---------------------------------------------------------------------------
    *>  Convert Number to the format specified by Format (available formats are
    *>  listed in this macros working-storage). Converted number is then moved
    *>  to Destination starting at the location specified by Column.
    *> ***************************************************************************

    01  MoveNumber-macro.
      05  MoveNumber-pointer           pic s9(04) comp.
      05  MoveNumber-edits.
        *>             vvv - This is the value supplied in Format parameter.
        10  MoveNumber-4v0             pic z(3)9.
        10  MoveNumber-7v2             pic z(6)9.99.
        10  MoveNumber-9v2             pic z(8)9.99.

$define %MoveNumber=
move !3 to MoveNumber-column
add !1 to zero giving MoveNumber-!4 end-add

string
  MoveNumber-!4 delimited by size
  into !2 with pointer MoveNumber-column
end-string#
```

and used in an application with

```
%MoveNumber(123#, output-field#, 1#, 4v0#)
```

with `cobolmac program.cob`, the one line of source expands to

```
move 1 to MoveNumber-column
add 123 to zero giving MoveNumber-4v0 end-add

string
    MoveNumber-4v0 delimited by size
    into output-field with pointer MoveNumver-column
end-string
```

Building up a Macro include file, can reduce development efforts, ensure consistency, and perhaps remove some of the routine typing faced by many COBOL developers.

Some downsides of macro programming is the need for the `cobolmac` utility in the compiler tool chain, and sources, as read, are not always the sources passed to the compiler.

Robert's macro preprocessor plays well with the `cobc -Xref` cross reference feature (by Vince Coen), so that developers can read over nicely formatted source listings from the post processed source files. See *What is CobXRef?* (page 761).

`cobolmac` also supports a `--maclib` command line option to display the macros available during the preprocessing pass.

Another great option is now available for GnuCOBOL development.

5.86 What is the largest known prime number?

Not sure, but as of 2013, a Mersenne prime with 17,425,170 digits was registered at https://primes.utm.edu/largest.html#biggest

$2^{57,885,161} - 1$

And now, thanks to László Erdős, there is a COBOL program to help in the search for large primes.

http://sourceforge.net/p/gnucobol/contrib/HEAD/tree/trunk/samples/prothsearch

As always with László's code, `prothsearch` is a well documented contribution. A large prime number search algorithm, implemented in COBOL. A cash prize for finding verified large primes is still quite substantial. Large primes are powerful and valuable seeds for many, many algorithms.

In May of 2015, it's $100,000 for a ten million digit prime, and a cool quarter million for 1 billion digits of prime number. The `prothsearch` documentation explains it more, along with ways to set up check point runs. Idle machine time can be put toward finding a huge Proth prime, with the chance of reward a few years in the future, while still being able to be turned on and off, without losing the algorithm state.

5.87 Is there an assembler interface to GnuCOBOL?

Yes. Almost directly, through the C *ABI* (page 1350) and the wonders of `gcc` integration with the `cobc` compiler. Assembler, assembly, used interchangeably here.

First a short diversion

WARNINGS AND DIRE CONSEQUENCES

Don't ever name C source code or assembler .s files the same as GnuCOBOL source code files. This is basename, without extension. Don't write a `hello.c` or `hello.s` file along with `hello.cob`, `cobc` may overwrite your .c and .s files, break your heart and lose you time. Don't ever. It's heart breaking. Seriously.

It is easy to avoid name collision, so back to the assembly.

This is **chello**, a C hello. COBOL gets hello, C gets a different first name.

```
#include <stdio.h>
int chello() {
    printf("%s\n", "Whassup, earth, whatya lookin for?");
    return 41;
}
```

Then generating assembly, from `chello.c` with `gcc -S chello.c`

```
        .file   "chello.c"
        .section        .rodata
        .align 8
.LC0:
        .string "Whassup, earth, whatya lookin for?"
        .text
        .globl  chello
        .type   chello, @function
chello:
.LFB0:
        .cfi_startproc
        pushq   %rbp
        .cfi_def_cfa_offset 16
        .cfi_offset 6, -16
        movq    %rsp, %rbp
        .cfi_def_cfa_register 6
        movl    $.LC0, %edi
        call    puts
        movl    $41, %eax
        popq    %rbp
        .cfi_def_cfa 7, 8
        ret
        .cfi_endproc
.LFE0:
        .size   chello, .-chello
        .ident  "GCC: (GNU) 4.9.2 20150212 (Red Hat 4.9.2-6)"
        .section        .note.GNU-stack,"",@progbits
```

And some GnuCOBOL. `cobc` makes this pretty easy integration.

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20150617
      *> Purpose:   An assembler integration sample
      *> Tectonics: gcc -S chello.c
      *>            cobc -x hello.cob chello.s
      *> ***************************************************************
       identification division.
       program-id. hello.

       environment division.
       configuration section.
```

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```
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 pretty-42 pic 99.

      *> ****************************************************************
       procedure division.

       display "Hello, world" end-display

       call "chello" on exception display "earth?" end-display end-call
       move return-code to pretty-42
       display pretty-42 end-display

       if pretty-42 not equal 42 then
           display "universally unfulfilled" upon syserr end-display
       end-if

       goback.
       end program hello.
```

```
prompt$ cobc -x hello.cob chello.s
Command line:   cobc -x -v hello.cob chello.s
Preprocessing:  hello.cob -> /tmp/cob29021_0.cob
Return status:  0
Parsing:        /tmp/cob29021_0.cob (hello.cob)
Return status:  0
Translating:    /tmp/cob29021_0.cob -> /tmp/cob29021_0.c (hello.cob)
Executing:      gcc -std=gnu99 -c -I/usr/local/include -pipe -Wno-unused
                -fsigned-char -Wno-pointer-sign -o "/tmp/cob29021_0.o"
                "/tmp/cob29021_0.c"
Return status:  0
Executing:      gcc -std=gnu99 -c -I/usr/local/include -pipe -Wno-unused
                -fsigned-char -Wno-pointer-sign -fPIC -DPIC -o
                "/tmp/cob29021_1.o" "chello.s"
Return status:  0
Executing:      gcc -std=gnu99 -Wl,--export-dynamic -o "hello"
                "/tmp/cob29021_0.o" "/tmp/cob29021_1.o" -L/usr/local/lib -lcob
                -lm -lvbisam -lgmp -lncursesw -ldl
Return status:  0
prompt$ ./hello
Hello, world
Whassup, earth, whatya lookin for?
41
universally unfulfilled
```

The `.s` gas file passed on to `gcc` as part of `cobc` processing.

And here's the hand patch assembler file. 41 is not the correct value, and needs to be fixed. *The original chello.c has this bug, on purpose*, the `return 41;`.

Around line 20 of the assembler source:

```
call    puts
movl    $41, %eax
```

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```
popq    %rbp
```

changes to:

```
call    puts
movl    $42, %eax
popq    %rbp
```

```
        .file   "chello.c"
        .section        .rodata
        .align 8
.LC0:
        .string "Whassup, earth, whatya lookin for?"
        .text
        .globl  chello
        .type   chello, @function
chello:
.LFB0:
        .cfi_startproc
        pushq   %rbp
        .cfi_def_cfa_offset 16
        .cfi_offset 6, -16
        movq    %rsp, %rbp
        .cfi_def_cfa_register 6
        movl    $.LC0, %edi
        call    puts
        movl    $42, %eax
        popq    %rbp
        .cfi_def_cfa 7, 8
        ret
        .cfi_endproc
.LFE0:
        .size   chello, .-chello
        .ident  "GCC: (GNU) 4.9.2 20150212 (Red Hat 4.9.2-6)"
        .section        .note.GNU-stack,"",@progbits
```

Now, just happier, less whiny code, albeit a contrived, to be simple patch example. The .s file is simply passed on to `gcc` as part of the `cobc` compile tool chain.

```
prompt$ cobc -x hello.cob chello.s
prompt$ ./hello
Hello, world
Whassup, earth, whatya lookin for?
42
```

The sample COBOL program no longer complains about being unfulfilled with its galactic role in the universe.

If you are writing hand crafted assembly, and get stuck on how it interfaces with your particular operating system, running some C code through `gcc -S` can be a great way of getting some technical hints on how things work together.

5.87.1 cpuid

Ok, and now some handrolled x86_64 assembler, using the AT&T syntax supported by the GNU compiler toolchain, `as` and `gdb`, in particular.

We'll also leverage the ability to list .s filenames when invoking `cobc`.

There is an opcode in the x64_64 instruction set that provides access to chip and hardware information, `CPUID`, and there is an excellent article on Wikipedia, that is the root source for most of what follows.

https://en.wikipedia.org/wiki/CPUID

There are a ton of features in CPUID, but we'll focus on two aspects, Vendor ID and Brand.

First some top level COBOL.

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ************************************************************
      *>****J* project/cpuid
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20150405  Modified: 2015-11-13/11:54-0500
      *> LICENSE
      *>   Public Domain sample
      *> PURPOSE
      *>   Exercise the CPUID opcode.
      *> TECTONICS
      *>   cobc -xjg -debug cpuid.cob vendor.s brand.s fixunsign.s
      *> ************************************************************
       identification division.
       program-id. cpuid.
       author. Brian Tiffin.
       date-written. 2015-11-13/11:54-0500.
       remarks. GnuCOBOL with x86_64 assembler, NOT cross-platform

       environment division.
       configuration section.
       source-computer.
       object-computer.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 maximum-function     usage unsigned-long.

      *> ************************************************************
       procedure division.

       call "vendorid" returning maximum-function
           on exception
               display "no vendorid linkage" upon syserr
               perform soft-exception
       end-call
       display "CPUID normal maximum  : " maximum-function

       call "brand" returning maximum-function
           on exception
               display "no brand linkage" upon syserr
               perform soft-exception
       end-call
```

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```
      *> Bug in GnuCOBOL is casting unsigned to signed
      *> This fixes the returned value in place
       call "negate" using
           by value maximum-function
           by reference maximum-function
           on exception
               display "no signextend linkage" upon syserr
               perform soft-exception
       end-call
       display "CPUID extended maximum: " maximum-function
          with no advancing
       call "printf" using
           by content ", 0x%X" & x"0a00"
           by value maximum-function
           on exception
               display "no printf linkage" upon syserr
               perform soft-exception
       end-call
       move 0 to return-code
       goback.
      *> ****************************************************************

      *> informational warnings and abends
       soft-exception.
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .

       end program cpuid.
      *> ****************************************************************
      *>****
```

```
>>ELSE
!rst-marker!
=====
cpuid
=====

cobc -xjg -debug -A '-Wa\,--defsym,DEBUG=1' cpuid.cob vendor.s brand.s fix-unsign.s
Vendor                : AuthenticAMD, with highest CPUID function: 13
CPUID normal maximum  : 0000000000000000013
Processor Brand string: AMD A10-5700 APU with Radeon(tm) HD Graphics
      **DEBUG** Number: 7fffffe2, Address: 0x603200
      **DEBUG** Number: 8000001e, Address: 0x603200
CPUID extended maximum: 00000000002147483678, 0x8000001E
```

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```
Introduction
------------

CPUID is an opcode providing manufacturer and system configuration.

Source
------

cpuid.cob

.. include:: cpuid.cob
   :code: cobolfree
   :end-before: !rst-marker

vendor.s

.. include:: vendor.s
   :code: gas

brand.s

.. include:: brand.s
   :code: gas

fix-unsign.s

.. include:: fix-unsign.s
   :code: gas

>>END-IF
```

And some assembler, two useful functions, and one, hopefully temporary, fixer.

```
# Peek into CPUID to get basic chip vendor info
# x86_64 ABI
# Author: Brian Tiffin, with starter code from CPUID wikipedia page
# Public Domain sample
# Modified: 2015-11-13/15:20-0500

# cobc -x cpuinfo.cob vendor.s

    .data

# Display the Vendor tag (3 4byte registers)
#  and the highest CPUID function available
msg:
    .asciz "Vendor                : %.12s, with highest CPUID function: %i\n"

    .text
    .align  32

# setup the vendor entry point
    .globl  vendor

vendor:
```

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```
# setup a local variable space
    pushq   %rbp
    pushq   %rbx
    movq    %rsp,%rbp
    subq    $24,%rsp

# call CPUID with function 0
    xorl    %eax,%eax
    cpuid

# save the max function number
    movl    %eax, 16(%rsp)

# move the Vendor tag to the local stack frame
    movl    %ebx,0(%rsp)
    movl    %edx,4(%rsp)
    movl    %ecx,8(%rsp)

# prep the printf call, args are rdi, rsi, rdx and rax
    movq    $msg, %rdi
    movq    %rsp, %rsi
    movl    %eax, %edx
    xorb    %al,%al
    call    printf

# return value is the highest CPUID function code allowed
    movl    16(%rsp), %eax

# restore the callers stack, rbx and rbp registers
    movq    %rbp,%rsp
    popq    %rbx
    popq    %rbp

    ret
```

```
# Peek into CPUID to get Vendor branding
# x86_64 ABI
# Author: Brian Tiffin, with starter code from CPUID wikipedia page
# Public Domain sample
# Modified: 2015-11-13/08:41-0500

# cobc -x callasm.cob brand.s

.section .data

msg: .asciz "Processor Brand string: %.48s\n"
err: .asciz "Processor Brand feature unsupported.\n"

.section .text

.globl brand
#.type brand,@function
.align 32

# set the brand entry point, and set aside local space
brand:
```

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```
    pushq   %rbp
    movq    %rsp,   %rbp
    subq    $54,    %rsp
    pushq   %rbx

# call CPUID, for extended information
#   returning the highest extended code allowed
    movl    $0x80000000,    %eax
    cpuid

# save the result for return to COBOL
    movl    %eax, 48(%rsp)

# If not supported, display a message
    cmpl    $0x80000004,    %eax
    jl  error

# 48 bytes of data, three operations; subcode 80000002, 3 and 4
# 16 bytes returned on each CPUID operation
# ASCII data loaded in EAX, EBX, ECX, EDX
    movl    $0x80000002,    %esi
    movq    %rsp,   %rdi

.align 16
get_brand:
    movl    %esi,   %eax
    cpuid

    movl    %eax, (%rdi)
    movl    %ebx, 4(%rdi)
    movl    %ecx, 8(%rdi)
    movl    %edx, 12(%rdi)

    addl    $1, %esi
    addq    $16, %rdi
    cmpl    $0x80000004, %esi
    jle get_brand

# display the concatenated string
print_brand:
    movq    $msg, %rdi
    movq    %rsp, %rsi
    xorb    %al, %al
    call    printf

    jmp end

.align 16
error:
    movq    $err, %rdi
    xorb    %al, %al
    call    printf

.align 16
end:
# return with max extended code in eax
    movl    48(%rsp), %eax
```

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```
    popq    %rbx
    movq    %rbp, %rsp
    popq    %rbp

    ret
```

```
# negate a bug, correct values cast from unsigned to signed
# x86_64 ABI
# Author: Brian Tiffin
# Public Domain sample
# Modified: 2015-11-13/15:10-0500

# cobc -x cpuid.cob vendor.s brand.c fix-unsign.s

.ifdef DEBUG
# fixed data space
    .data
msg:
    .asciz "      **DEBUG** Number: %x, Address: %p\n"
.endif

# code section
    .text
    .align  32

# setup the unsign-clip negate entry point
    .globl  fixunsign

fixunsign:

# setup a local variable space
    pushq   %rbp
    pushq   %rbx
    movq    %rsp,%rbp
    subq    $16,%rsp

# save the given numbers
    movl    %edi, 0(%rsp)
    movq    %rsi, 8(%rsp)

.ifdef DEBUG
# prep the printf call, args are rdi, rsi, rdx and rax
    movq    $msg, %rdi
    movl    0(%rsp), %esi
    movq    8(%rsp), %rdx
    xorb    %al,%al
    call    printf
.endif

# negate the value in place
    movl    0(%rsp), %edx
    negl    %edx
    movq    8(%rsp), %rax
    movl    %edx, (%rax)
```

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```
.ifdef DEBUG
# prep the printf call, args are rdi, rsi, rdx and rax
    movq    $msg, %rdi
    movl    %edx, %esi
    movq    8(%rsp), %rdx
    xorb    %al,%al
    call    printf
.endif

# give back the number, which will suffer cast to int
    movl    0(%rsp), %eax

# restore the callers stack, rbx and rbp registers
    movq    %rbp,%rsp
    popq    %rbx
    popq    %rbp

    ret
```

And a fairly straight forward Makefile

```
.RECIPEPREFIX = >

cpuid: cpuid.cob
> cobc -xjg -debug -A '-Wa\,--defsym,DEBUG=1' \
    cpuid.cob vendor.s brand.s fix-unsign.s
```

`cobc` just does the right thing when given `.s` filenames, and passes them through the C compile toolchain.

Running `make -B` or `./cpuid` once compiled, and you'll see details of the machine, and a couple of debug lines from the `fix-unsign.s` file.

```
prompt$ make -B

cobc -xjg -debug -A '-Wa\,--defsym,DEBUG=1' cpuid.cob vendor.s brand.s fix-unsign.s
Vendor                : AuthenticAMD, with highest CPUID function: 13
CPUID normal maximum  : 0000000000000000013
Processor Brand string: AMD A10-5700 APU with Radeon(tm) HD Graphics
      **DEBUG** Number: 7fffffe2, Address: 0x603200
      **DEBUG** Number: 8000001e, Address: 0x603200
CPUID extended maximum: 0000000002147483678, 0x8000001E
```

The argument following the ''-A cobc'' option is passed to ''gcc'', which then passes the ''-Wa'' option that follows it through to ''as'', and the DEBUG conditional assembly directive is set true.

Handrolled assembly might just get you out of a sticky situation someday, and cobc will be ready to assist. Thanks to the editors on Wikipedia for the code listings for CPUID. *Gotta love CUPID, errm, CPUID.*

There may not be many times that a GnuCOBOL programmer needs assembly, but it is pretty hard to get at opcodes like CPUID without it.

5.87.2 GNU lightning

Not only is `cobc` a very capable assembler front end, but with GNU lightning

https://www.gnu.org/software/lightning/manual/

GnuCOBOL can be used to dynamically generate assembled functions, *at runtime*.

Below is a port of the rpn calculator sample that is part of the GNU lightning documentation by Paulo Andrade.

This sample also puts Robert's COBOLMAC to use.

See *Does GnuCOBOL support source code macros?* (page 998) for more details on COBOLMAC.

As this is fairly heady build up, let's start with the installs:

```
prompt$ sudo apt-get install libiberty-dev
```

Was the only pre-req that I required here, on a semi-loaded development Xubuntu box.

Then:

```
prompt$ tar xvf lightning-2.1.0.tar.gz
prompt$ cd lightning-2.1.0
prompt$ ./configure --enable-disassembler
prompt$ make
prompt$ make check
prompt$ sudo make install
prompt$ sudo ldconfig
```

The default configuration prefix is `/usr/local` so things will get installed in the same place as GnuCOBOL development versions, which is awesome.

So, now we have `/usr/local/lib/liblightning.so` and `/usr/local/include/lightning.h`. Good to go.

First up is a simple incrementor. A call frame is setup to pass an integer argument, and then return the value incremented by one.

This is the C code example, from the GNU Lightning docs.

```
#include <stdio.h>
#include <lightning.h>

static jit_state_t *_jit;

typedef int (*pifi)(int);    /* Pointer to Int Function of Int */

int main(int argc, char *argv[])
{
  jit_node_t  *in;
  pifi         incr;

  init_jit(argv[0]);
  _jit = jit_new_state();

  jit_prolog();                    /*      prolog              */
  in = jit_arg();                  /*      in = arg            */
  jit_getarg(JIT_R0, in);          /*      getarg R0           */
  jit_addi(JIT_R0, JIT_R0, 1);     /*      addi   R0, R0, 1    */
  jit_retr(JIT_R0);                /*      retr   R0           */

  incr = jit_emit();
  jit_clear_state();

  /* call the generated code, passing 5 as an argument */
  printf("%d + 1 = %d\n", 5, incr(5));
```

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```
  jit_destroy_state();
  finish_jit();
  return 0;
}
```

Not too too bad, so let's try that:

```
prompt$ gcc -o incr incr.c -llightning
prompt$ ./incr
5 + 1 = 6
prompt$
```

Yayy, 5 plus 1. But, let's take a little closer look at what's going on. GNU Lightning has two features, `jit_print` and `jit_disassemble` for us to try out, to get used to Lightning.

```
#include <stdio.h>
#include <lightning.h>

static jit_state_t *_jit;

typedef int (*pifi)(int);    /* Pointer to Int Function of Int */

int main(int argc, char *argv[])
{
  jit_node_t  *in;
  pifi         incr;

  init_jit(argv[0]);
  _jit = jit_new_state();

  jit_prolog();                     /*      prolog              */
  in = jit_arg();                   /*      in = arg            */
  jit_getarg(JIT_R0, in);           /*      getarg R0           */
  jit_addi(JIT_R0, JIT_R0, 1);      /*      addi   R0, R0, 1    */
  jit_retr(JIT_R0);                 /*      retr   R0           */

  jit_print();               /* show me the code */

  incr = jit_emit();
  jit_clear_state();

  /* call the generated code, passing 5 as an argument */
  printf("%d + 1 = %d\n", 5, incr(5));

  jit_destroy_state();
  finish_jit();
  return 0;
}
```

With a second build of:

```
prompt$ gcc -o incr incr.c -llightning
prompt$ ./incr
L0: /* prolog */
        arg 0x0
```

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```
        movr %rax %rdi
        addi %rax %rax 0x1
        live %rax
    jmpi L0
5 + 1 = 6
```

Ok, so it took the function calls, and built up the Lightning instruction set. Cool, but this is a x86_64 processor, so now for the gravy.

```
#include <stdio.h>
#include <lightning.h>

static jit_state_t *_jit;

typedef int (*pifi)(int);    /* Pointer to Int Function of Int */

int main(int argc, char *argv[])
{
  jit_node_t  *in;
  pifi         incr;

  init_jit(argv[0]);
  _jit = jit_new_state();

  jit_prolog();                     /*      prolog              */
  in = jit_arg();                   /*      in = arg            */
  jit_getarg(JIT_R0, in);           /*      getarg R0           */
  jit_addi(JIT_R0, JIT_R0, 1);      /*      addi   R0, R0, 1    */
  jit_retr(JIT_R0);                 /*      retr   R0           */

  jit_print();               /* show me the code */

  incr = jit_emit();
  jit_clear_state();

  /* call the generated code, passing 5 as an argument */
  printf("%d + 1 = %d\n", 5, incr(5));

  jit_disassemble();        /* now show me the real code */

  jit_destroy_state();
  finish_jit();
  return 0;
}
```

And:

```
prompt$ gcc -o incr incr.c -llightning
prompt$ ./incr
L0: /* prolog */
        arg 0x0
        movr %rax %rdi
        addi %rax %rax 0x1
        live %rax
    jmpi L0
5 + 1 = 6
```

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```
    0x7f86af1b3000      sub    $0x30,%rsp
    0x7f86af1b3004      mov    %rbp,(%rsp)
    0x7f86af1b3008      mov    %rsp,%rbp
    0x7f86af1b300b      sub    $0x18,%rsp
    0x7f86af1b300f      mov    %rdi,%rax
    0x7f86af1b3012      add    $0x1,%rax
    0x7f86af1b3016      mov    %rbp,%rsp
    0x7f86af1b3019      mov    (%rsp),%rbp
    0x7f86af1b301d      add    $0x30,%rsp
    0x7f86af1b3021      retq
```

Yeah, now we're talking. The Lightning instruction set mapped to the hardware in play. `movr %rax %rdi` became the Intel instruction `mov %rdi,%rax` and `addi %rax %rax 0x1` mapped to `add $0x01,%rax`. Seems sane enough, although I do like the Lightning form of source, dest more than the AT&T style output of dest, source; but that is just syntax. And from the `printf` statement `incr(5)` is displaying a `6` so it looks reasonable, and it didn't catch on fire. Always a good thing with initial testing.

Now for a COBOL layer.

First we need to initialize the engine and get a JIT state handle.

```
*> TECTONICS
*>   cobc -x -g -debug inc.cob -llightning
*> ************************************************************
 identification division.
 program-id. inc.

 data division.
 working-storage section.
 01 jit    usage pointer.

*> ************************************************************
 procedure division.

 call "init_jit" using by content z"inc"
 call "jit_new_state" returning jit

 display jit
 goback.
```

And trying that:

```
prompt$ export COB_LDFLAGS='-Wl,--no-as-needed'
prompt$ cobc -xjdg inc.cob -llightning
0x00000000015b2d80
```

Yayy, we got a pointer, and not a null. Good sign.

By the way, on Ubuntu, that first line setting COB_LDFLAGS is required, otherwise the object code will not know to look for ''liblightning.so''. All further cobc compiles in this entry will assume that setting is in the environment.

Next, we lay down a prolog, for Lightning to start in on doing its thing.

```
*> TECTONICS
*>   cobc -x -g -debug inc.cob -llightning
*> ************************************************************
 identification division.
```

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```
 program-id. inc.

 data division.
 working-storage section.
 01 jit    usage pointer.

*> ****************************************************************
 procedure division.

 call "init_jit" using by content z"inc"
 call "jit_new_state" returning jit

 call "jit_prolog"

 display jit
 goback.
```

And:

```
prompt$ cobc -jxdg inc.cob -llightning
inc.cob: 17: libcob: Cannot find module 'jit_prolog'
```

Boo, `jit_prolog` is likely a macro. So, now over to the header file. *Instead of grep, I usually use* `ag` *the Silver Searcher.*

```
prompt$ ag jit_prolog /usr/local/include/lightning.h
191:#define jit_prolog()                _jit_prolog(_jit)
538:     * to get a label just before a jit_prolog() call */
890:extern void _jit_prolog(jit_state_t*);
```

Yeah, as expected. It bodes not well for an easy translation to COBOL for the rest of this code. All that C is likely more macro than function call, hidden under a convenience layer. Ok, been there, have to do that.

```
*> TECTONICS
*>   cobc -x -g -debug inc.cob -llightning
*> ****************************************************************
 identification division.
 program-id. inc.

 data division.
 working-storage section.
 01 jit    usage pointer.

*> ****************************************************************
 procedure division.

 call "init_jit" using by content z"inc"
 call "jit_new_state" returning jit

 call "_jit_prolog" using by value jit returning omitted

 display jit
 goback.
```

```
prompt$ cobc -jxdg inc.cob -llightning
0x0000000001161d80
```

Well, no fires, another step forward. Now for some actually reading...

```
prompt$ vi /usr/local/include/lightning.h
...
700 hours later
...
```

No, it wasn't that bad, a few minutes. All the macros follow the same pattern, starting with an underscore and with an implied `_jit` handle.

We use the more COBOL friendly `jit` pointer, but it'll have to carry through explicitly to all of the function calls. A worse fate is the enums; all the instructions, registers and fiddly bits are integers, and we'll need those numbers to continue. One way of doing that is 700 hours of reading, counting fingers, and hand translating the constants. *Or, write a program.*

```
/*
* Short program to convert GNU Lightning JIT enums to GnuCOBOL constants
*  tectonics: gcc -o find-jit-enums find-jit-enums.c
*             ./find-jit-enums >lightning-enums.cpy
*/

#include <stdio.h>
#include <lightning.h>

#define display(NAME) printf("       01 %-28s constant as %d.\n", #NAME, NAME)

int
main(int argc, char **argv)
{
    display(JIT_R0);
    display(jit_code_addi);
}
```

And:

```
prompt$ gcc -o find-jit-enums find-jit-enums.c
prompt$ ./find-jit-enums
       01 JIT_R0                       constant as 0.
       01 jit_code_addi                constant as 11.
```

Ok, cool, we have data for the working storage section.

And, *7 odd minutes later*, we have some better source code.

```
*> TECTONICS
*>   cobc -x -g -debug inc.cob -llightning
*> ************************************************************
 identification division.
 program-id. inc.
 installation. Requires GNU Lightning
 remarks. Create an incrementing function at runtime
 security. Writes new code at runtime

 environment division.
 configuration section.
 repository.
     function all intrinsic.
```

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```
 data division.

 working-storage section.
 01 args   usage pointer value null.
 01 jit    usage pointer.
 01 inarg  usage pointer.
 01 incr   usage program-pointer.

*> Enums from lightning.h
 01 JIT_R0        constant as 0.
 01 jit_code_addi constant as 10.

 01 answer usage binary-long.

*> ****************************************************************
 procedure division.

 call "init_jit" using by content z"inc"
 call "jit_new_state" returning jit

 call "_jit_prolog" using by value jit

 call "_jit_arg" using by value jit returning inarg
 call "_jit_getarg_l" using by value jit JIT_R0 inarg

 call "_jit_new_node_www" using
     by value jit jit_code_addi JIT_R0 JIT_R0 1

 call "_jit_retr" using by value jit JIT_R0
 call "_jit_emit" using by value jit returning incr
 call "_jit_clear_state" using by value jit

 call incr using by value 5 returning answer
 display answer
 call incr using by value 41 returning answer
 display answer

 call "_jit_disassemble" using by value jit
 call "_jit_destroy_state" using by value jit
 call "finish_jit"
 goback.
```

Add, drum roll:

```
prompt$ cobc -xjd inc.cob -llightning
+0000000006
+0000000042
    0x7f6dbc2d1000      sub    $0x30,%rsp
    0x7f6dbc2d1004      mov    %rbp,(%rsp)
    0x7f6dbc2d1008      mov    %rsp,%rbp
    0x7f6dbc2d100b      sub    $0x18,%rsp
    0x7f6dbc2d100f      mov    %rdi,%rax
    0x7f6dbc2d1012      add    $0x1,%rax
    0x7f6dbc2d1016      mov    %rbp,%rsp
    0x7f6dbc2d1019      mov    (%rsp),%rbp
    0x7f6dbc2d101d      add    $0x30,%rsp
    0x7f6dbc2d1021      retq
```

The ball is rolling. `5+1 is 6`, `41+1 is 42`. But, it's fairly labour intensive, time for some COBOL convenience macros, and a Makefile to make the iterations go a little faster.

The first one to look at is the whole `_jit_new_node_www` and instruction data thing. The next example is a Reverse Polish Notation expression solver, so there will likely be a few more instructions to lay down. One line of COBOLMAC macro code per instruction seems smarter than seven lines of COBOL per call (thanks, Robert).

```
   *> jit-code3(instruction, dest-reg, source-reg, operand)
    $define %jit-code3i=
    call "_jit_new_node_www" using
        by value jit
        by value jit_code_!1
        by value JIT_!2
        by value JIT_!3
        by value !4
    end-call
    #
```

Now, laying down the `addi` instruction is just

```
%jit-code3i(addi, R0, R0, 1)
```

and Robert's `cobolmac` can do some of the heavy lifting.

Now, with most of the preliminaries out of the way, some proof that things actually work, it's time to worry about a more methodical development plan.

There are lot of details, so (being small brained) it seems wise to codify some of those details, and then forget them.

A Makefile:

```
# Makefile for cobweb-jit, gas and GNU Lightning integration
.RECIPEPREFIX = >

rpnasm: rpnasm.cbl lightning-enums.cpy
> cobolmac -q <rpnasm.cbl >rpnasm.cob
ifdef show
> cobc -x -g -debug -fdebugging-line rpnasm.cob -llightning
else
>cobc -x rpnasm.cob -llightning
endif
#> cobolmac -q <rpnasm.cbl | cobc - -x -llightning

lightning-enums.cpy: find-jit-enums.c /usr/local/include/lightning.h
> gcc -o find-jit-enums find-jit-enums.c
> ./find-jit-enums >lightning-enums.cpy
```

That will build a copybook for all the pesky enums from `/usr/local/include/lightning.h` that we are going to need, then run the `cobolmac` preprocessor, and then run a compile pass; with or without debug lines, depending on how `make` is invoked.

From looking over the `RPN calculator` sample, the symbols we'll need are put into `find-jit-enums.c` and that will pump out a copybook.

```
/*
* Short program to convert GNU Lightning JIT enums to GnuCOBOL constants
*  tectonics: gcc -o find-jit-enums find-jit-enums.c
*             ./find-jit-enums >lightning-enums.cpy
*/
```

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```
#include <stdio.h>
#include <lightning.h>

#define display(NAME) printf("       01 %-28s constant as %d.\n", #NAME, NAME)

int
main(int argc, char **argv)
{
    display(JIT_R0);
    display(JIT_R1);
    display(JIT_R2);
    display(JIT_FP);
    display(jit_code_addi);
    display(jit_code_addr);
    display(jit_code_subr);
    display(jit_code_mulr);
    display(jit_code_divr);
    display(jit_code_movi);
    display(jit_code_movr);
    display(jit_code_stxi_i);
    display(jit_code_ldxi_i);
}
```

And finally, a testhead COBOL program.

```
 GCobol >>SOURCE FORMAT IS FREE
 >>IF docpass NOT DEFINED
       *> ****************************************************************
       *>****J* project/rpnasm
       *> AUTHOR
       *>   Brian Tiffin
       *> DATE
       *>   20151126  Modified: 2016-07-21/06:56-0400
       *> LICENSE
       *>   Copyright 2015 Brian Tiffin
       *>   GNU General Public License, GPL, 3.0 (or greater)
       *> PURPOSE
       *>   Generates temp conversion calculator functions, on the fly.
       *> TECTONICS
       *>   cobolmac <rpnasm.cbl >rpnasm.cob
       *>   cobc -x -g -debug rpnasm.cob
       *> ****************************************************************
       *> ****** Macro definitions ******

       *> init-jit and create new state
        $define %init-jit=
        call "init_jit" using
            by content z"rpnasm"
            on exception
                display "error: no liblightning" upon syserr
                perform hard-exception
        end-call

        call "jit_new_state" returning jit end-call
        if jit equal null then
            display "error: jit_new_state retuned null" upon syserr
```

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```
            perform hard-exception
        end-if
        #

      *> emit, emits current jit buffer
        $define %emit=
     >>D call "_jit_print" using by value jit end-call
        call "_jit_emit" using by value jit end-call
        #

      *> address, resolve the function addresses
        $define %address=
        call "_jit_address" using by value jit !1 returning !2 end-call
        #

      *> clear-jit, clear GNU Lightning work space
        $define %clear-jit=
        call "_jit_clear_state" using by value jit end-call
     >>D call "_jit_disassemble" using by value jit end-call
        #

      *> finish-jit, destroy and finish with GNU Lightning
        $define %finish-jit=
        call "_jit_destroy_state" using by value jit end-call
        call "finish_jit" end-call
        #

      *> Compile in an rpn calculator expression
        $define %compile-rpn=
        call "compile-rpn" using
            jit
            by content !1
            returning !2
        end-call
        #

      *> ****************************************************************
        identification division.
        program-id. rpnasm.
        author. Brian Tiffin.
        date-written. 2015-11-25/23:39-0500.
        date-modified. 2016-07-21/03:07-0400.
        date-compiled.
        installation. Requires COBOLMAC and GNU lightning.
        remarks. Generate simple calculator function dynamically.
        security. Self modifying code.

        environment division.
        configuration section.
        source-computer.
        object-computer.
        special-names.
        repository.
            function all intrinsic.

        input-output section.
        file-control.
```

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```
       i-o-control.

       data division.
       file section.

       working-storage section.
       01 args                 usage pointer value null.
       01 jit                  usage pointer.

       01 jit-nc               usage pointer.
       01 jit-nf               usage pointer.
       01 jit-one              usage pointer.

       01 c2f                  usage program-pointer.
       01 f2c                  usage program-pointer.

       01 one-off              usage program-pointer.
       01 expression.
          05                  value z"x 123 + 456 * x - x *".

       01 cli                  pic x(80).
       01 jit-user             usage pointer.
       01 user-program         usage program-pointer.

       01 answer               usage binary-long.
       01 temp                 pic s999.
       01 show                 pic -999.

       local-storage section.
       linkage section.
       report section.
       screen section.


      *> ****************************************************************
       procedure division.
       accept cli from command-line

       %init-jit

      *> Compile in a Celsius to Fahrenheit calculator
       %compile-rpn(z"32 x 9 * 5 / +"#, jit-nc#)

      *> Compile in an F to C calculator
         *> **** try without a zstring, see if it still works ****
       %compile-rpn(z"x 32 - 5 * 9 /"#, jit-nf#)

      *> Compile in a one off
       %compile-rpn(expression#, jit-one#)

      *> compile in user entered expression
       if cli not equal spaces then
           call "compile-rpn" using
               jit
               by content concatenate(trim(cli), x"00")
               returning jit-user
           end-call
```

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```
        end-if

        %emit

       *> lighting has the entry point addresses
        %address(jit-nc#, c2f#)
        %address(jit-nf#, f2c#)

        %address(jit-one#, one-off#)

        if jit-user not equal null then
            %address(jit-user#, user-program#)
        end-if

        %clear-jit

       *> Show some results
        display "Celsius   : " with no advancing
        perform varying temp from -100 by 20 until temp > 100
            display temp space with no advancing
        end-perform
        display space

        display "Fahrenheit: " with no advancing
        perform varying temp from -100 by 20 until temp > 100
            call c2f using by value temp returning answer
            move answer to show
            display show space with no advancing
        end-perform
        display space
        display space

        display "Fahrenheit: " with no advancing
        perform varying temp from -100 by 20 until temp > 140
            display temp space with no advancing
        end-perform
        display space

        display "Celsius   : " with no advancing
        perform varying temp from -100 by 20 until temp > 140
            call f2c using by value temp returning answer
            move answer to show
            display show space with no advancing
        end-perform
        display space
        display space

        call one-off using by value 42 returning answer
        display "(rpn x=42) :" trim(substitute(expression, x"00", space))
                ": is " answer

        if jit-user not equal null then
            call user-program using by value 42 returning answer
            display "(user rpn x=42) :" trim(cli) ": is " answer
        end-if

        %finish-jit
```

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```
       goback.
      *> ****************************************************************

      *> informational warnings and abends
       soft-exception.
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .

       end program rpnasm.
      *> ****************************************************************
      *>*****

      *>*****P* rpnasm/compile-rpn
      *> PURPOSE
      *>   Compiles calculator functions on the fly
      *> ****************************************************************
      *> ****** Macro definitions ******

       $define %note=
       call "_jit_note" using
           by value jit
           by reference NULL by value 0
           returning jit-node
       end-call
       #

       $define %prolog=
       call "_jit_prolog" using by value jit
       end-call
       #

       $define %arg=
       call "_jit_arg" using by value jit returning !1
       end-call
       #

       $define %getarg=
       call "_jit_getarg_l" using by value jit JIT_!1 returning !2
       end-call
       #

       $define %allocai=
       call "_jit_allocai" using by value jit !1 returning !2
       end-call
       #
```

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```
       $define %ret=
       call "_jit_retr" using by value jit JIT_!1
       end-call
       #

       $define %epilog=
       call "_jit_epilog" using by value jit
       end-call
       #

      *> stack-push(register, stack-pointer)
       $define %stack-push=
       set address of inter to !2
       move inter to solid
       call "_jit_new_node_www" using
           by value jit
           by value jit_code_stxi_i
           by value size 8 solid
           by value JIT_FP
           by value JIT_!1
       end-call
       add 4 to inter
       #

      *> stack-pop(register, stack-pointer)
       $define %stack-pop=
       set address of inter to !2
       subtract 4 from inter
       move inter to solid
       call "_jit_new_node_www" using
           by value jit
           by value jit_code_ldxi_i
           by value JIT_!1
           by value JIT_FP
           by value size 8 solid
       end-call
       #

      *> jit-code1(instruction, reg)
       $define %jit-code1=
       call "_jit_new_node_ww" using
           by value jit
           by value jit_code_!1
           by value JIT_!2
       end-call
       #

      *> jit-code1i(instruction, operand)
       $define %jit-code1i=
       call "_jit_new_node_ww" using
           by value jit
           by value jit_code_!1
           by value !2
       end-call
       #
```

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```
      *> jit-code2(instruction, dest-reg, source-reg)
       $define %jit-code2=
       call "_jit_new_node_ww" using
           by value jit
           by value jit_code_!1
           by value JIT_!2
           by value JIT_!3
       end-call
       #

      *> jit-code2i(instruction, dest-reg, source) with immediate
       $define %jit-code2i=
       call "_jit_new_node_ww" using
           by value jit
           by value jit_code_!1
           by value JIT_!2
           by value !3
       end-call
       #

      *> jit-code3(instruction, dest-reg, source-reg, operand)
       $define %jit-code3=
       call "_jit_new_node_www" using
           by value jit
           by value jit_code_!1
           by value JIT_!2
           by value JIT_!3
           by value JIT_!4
       end-call
       #

      *> ****** End macros ******

      *> ****************************************************************
       identification division.
       program-id. compile-rpn.
       remarks. Compile simple calculator function.
       environment division.
       configuration section.
       source-computer.
       object-computer.
       special-names.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
      *> Enums from lightning.h
       COPY lightning-enums.

       01 inarg                usage pointer.
       01 stack                usage pointer.
       01 stack-size           usage binary-long.
       01 inter                usage binary-long based.
       01 solid                usage binary-double.

       01 expr                 usage pointer.
```

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```
       01 chr                  pic x based.
       01 buff                 pic x(32).
       01 intval               usage binary-long.
       01 n                    usage binary-long.
       01 result               usage binary-long.

       01 jit-node-record.
          05 jit-node          usage pointer.

       linkage section.
       01 jit        usage pointer.
       01 expression pic x any length.

      *> ****************************************************************
       procedure division using
           jit expression
           returning jit-node-record.

       %note

       %prolog
       %arg(inarg#)

       *> allocate enough stack for 32 4 byte integers
       %allocai(128#, stack-size#)

       set stack to address of stack-size

       %getarg(R2#, inarg#)

       set expr to address of expression
       set address of chr to expr

       perform until chr equal x"00"
           call "sscanf" using by value expr
               by content z"%[0-9]%n"
               by reference buff
               by reference n
               returning result

           if result not equal zero
               move buff(1:n) to intval
               set expr up by n
               set expr down by 1
               %stack-push(R0#, stack#)
               %jit-code2i(movi#, R0#, intval#)
           else
               evaluate true
                   when chr equal 'x'
                       %stack-push(R0#, stack#)
                       %jit-code2(movr#, R0#, R2#)
                   when chr equal '+'
                       %stack-pop(R1#, stack#)
                       %jit-code3(addr#, R0#, R1#, R0#)
                   when chr equal '-'
                       %stack-pop(R1#, stack#)
                       %jit-code3(subr#, R0#, R1#, R0#)
```

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```
                    when chr equal '*'
                        %stack-pop(R1#, stack#)
                        %jit-code3(mulr#, R0#, R1#, R0#)
                    when chr equal '/'
                        %stack-pop(R1#, stack#)
                        %jit-code3(divr#, R0#, R1#, R0#)
                    when chr equal space
                        continue
                    when other
                        display "cannot compile: " expression upon syserr
                        stop run
                end-evaluate
            end-if

            set expr up by 1
            set address of chr to expr
        end-perform

        %ret(R0#)
        %epilog

    >>D call "_jit_disassemble" using by value jit

        goback.
        end program compile-rpn.
 >>ELSE
 !doc-marker!
```

```
======
rpnasm
======

.. contents::

Introduction
------------

Reverse Polish Notation  calculators generated on the fly
with GNU lightning, and COBOLMAC macros.

The calculator is then used to produce temperature conversion charts.
and a simple one-off expression.

Tectonics
---------

    prompt$ cobolmac rpnasm.cbl >rpnasm.cob
    prompt$ cobc -x -g -debug rpnasm.cob -llightning

Usage
-----

    prompt$ ./rpnasm

Source
------
```

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```
.. include::  rpnasm.cbl
   :code: cobolfree
```

```
>>END-IF
```

Plus the generated `lightning-enums.cpy` file

```
01 JIT_R0                       constant as 0.
01 JIT_R1                       constant as 1.
01 JIT_R2                       constant as 2.
01 JIT_FP                       constant as 15.
01 jit_code_addi                constant as 11.
01 jit_code_addr                constant as 10.
01 jit_code_subr                constant as 16.
01 jit_code_mulr                constant as 23.
01 jit_code_divr                constant as 29.
01 jit_code_movi                constant as 76.
01 jit_code_movr                constant as 75.
01 jit_code_stxi_i              constant as 127.
01 jit_code_ldxi_i              constant as 109.
```

and a quick build and run. The run, on an AMD 64bit machine, includes calls to lightning jit_print and jit_disassemble, and the output is coloured with `GNU as` syntax highlighting:

```
prompt$ make show=yes
cobolmac -q <rpnasm.cbl >rpnasm.cob
cobc -x -g -debug -fdebugging-line rpnasm.cob -llightning
prompt$ time ./rpnasm 'x x + 2 *'
```

```
        #note
L0: # prolog
        arg 0x0
        movr %r11 %rdi
        stxi_i 0xfffffffffffffff78 %rbp %rax
        movi %rax 0x20
        stxi_i 0xfffffffffffffff7c %rbp %rax
        movr %rax %r11
        stxi_i 0xfffffffffffffff80 %rbp %rax
        movi %rax 0x9
        ldxi_i %r10 %rbp 0xfffffffffffffff80
        mulr %rax %r10 %rax
        stxi_i 0xfffffffffffffff80 %rbp %rax
        movi %rax 0x5
        ldxi_i %r10 %rbp 0xfffffffffffffff80
        divr %rax %r10 %rax
        ldxi_i %r10 %rbp 0xfffffffffffffff7c
        addr %rax %r10 %rax
        live %rax
    jmpi L1
L1: # epilog
        #note
L2: # prolog
        arg 0x0
        movr %r11 %rdi
        stxi_i 0xfffffffffffffff78 %rbp %rax
```

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```
        movr %rax %r11
        stxi_i 0xfffffffffffff7c %rbp %rax
        movi %rax 0x20
        ldxi_i %r10 %rbp 0xfffffffffffff7c
        subr %rax %r10 %rax
        stxi_i 0xfffffffffffff7c %rbp %rax
        movi %rax 0x5
        ldxi_i %r10 %rbp 0xfffffffffffff7c
        mulr %rax %r10 %rax
        stxi_i 0xfffffffffffff7c %rbp %rax
        movi %rax 0x9
        ldxi_i %r10 %rbp 0xfffffffffffff7c
        divr %rax %r10 %rax
        live %rax
    jmpi L3
L3: # epilog
        #note
L4: # prolog
        arg 0x0
        movr %r11 %rdi
        stxi_i 0xfffffffffffff78 %rbp %rax
        movr %rax %r11
        stxi_i 0xfffffffffffff7c %rbp %rax
        movi %rax 0x7b
        ldxi_i %r10 %rbp 0xfffffffffffff7c
        addr %rax %r10 %rax
        stxi_i 0xfffffffffffff7c %rbp %rax
        movi %rax 0x1c8
        ldxi_i %r10 %rbp 0xfffffffffffff7c
        mulr %rax %r10 %rax
        stxi_i 0xfffffffffffff7c %rbp %rax
        movr %rax %r11
        ldxi_i %r10 %rbp 0xfffffffffffff7c
        subr %rax %r10 %rax
        stxi_i 0xfffffffffffff7c %rbp %rax
        movr %rax %r11
        ldxi_i %r10 %rbp 0xfffffffffffff7c
        mulr %rax %r10 %rax
        live %rax
    jmpi L5
L5: # epilog
        #note
L6: # prolog
        arg 0x0
        movr %r11 %rdi
        stxi_i 0xfffffffffffff78 %rbp %rax
        movr %rax %r11
        stxi_i 0xfffffffffffff7c %rbp %rax
        movr %rax %r11
        ldxi_i %r10 %rbp 0xfffffffffffff7c
        addr %rax %r10 %rax
        stxi_i 0xfffffffffffff7c %rbp %rax
        movi %rax 0x2
        ldxi_i %r10 %rbp 0xfffffffffffff7c
        mulr %rax %r10 %rax
        live %rax
    jmpi L7
```

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```
L7: # epilog

      sub    $0x30,%rsp
      mov    %rbp,(%rsp)
      mov    %rsp,%rbp
      sub    $0x98,%rsp
      mov    %rdi,%r11
      mov    %eax,-0x88(%rbp)
      mov    $0x20,%eax
      mov    %eax,-0x84(%rbp)
      mov    %r11,%rax
      mov    %eax,-0x80(%rbp)
      mov    $0x9,%eax
      movslq -0x80(%rbp),%r10
      imul   %r10,%rax
      mov    %eax,-0x80(%rbp)
      mov    $0x5,%eax
      movslq -0x80(%rbp),%r10
      mov    %rax,%r12
      mov    %r10,%rax
      cqto
      idiv   %r12
      movslq -0x84(%rbp),%r10
      add    %r10,%rax
      mov    %rbp,%rsp
      mov    (%rsp),%rbp
      add    $0x30,%rsp
      retq
      sub    $0x30,%rsp
      mov    %rbp,(%rsp)
      mov    %rsp,%rbp
      sub    $0x98,%rsp
      mov    %rdi,%r11
      mov    %eax,-0x88(%rbp)
      mov    %r11,%rax
      mov    %eax,-0x84(%rbp)
      mov    $0x20,%eax
      movslq -0x84(%rbp),%r10
      sub    %r10,%rax
      neg    %rax
      mov    %eax,-0x84(%rbp)
      mov    $0x5,%eax
      movslq -0x84(%rbp),%r10
      imul   %r10,%rax
      mov    %eax,-0x84(%rbp)
      mov    $0x9,%eax
      movslq -0x84(%rbp),%r10
      mov    %rax,%r12
      mov    %r10,%rax
      cqto
      idiv   %r12
      mov    %rbp,%rsp
      mov    (%rsp),%rbp
      add    $0x30,%rsp
      retq
      sub    $0x30,%rsp
      mov    %rbp,(%rsp)
```

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```
      mov    %rsp,%rbp
      sub    $0x98,%rsp
      mov    %rdi,%r11
      mov    %eax,-0x88(%rbp)
      mov    %r11,%rax
      mov    %eax,-0x84(%rbp)
      mov    $0x7b,%eax
      movslq -0x84(%rbp),%r10
      add    %r10,%rax
      mov    %eax,-0x84(%rbp)
      mov    $0x1c8,%eax
      movslq -0x84(%rbp),%r10
      imul   %r10,%rax
      mov    %eax,-0x84(%rbp)
      mov    %r11,%rax
      movslq -0x84(%rbp),%r10
      sub    %r10,%rax
      neg    %rax
      mov    %eax,-0x84(%rbp)
      mov    %r11,%rax
      movslq -0x84(%rbp),%r10
      imul   %r10,%rax
      mov    %rbp,%rsp
      mov    (%rsp),%rbp
      add    $0x30,%rsp
      retq
      sub    $0x30,%rsp
      mov    %rbp,(%rsp)
      mov    %rsp,%rbp
      sub    $0x98,%rsp
      mov    %rdi,%r11
      mov    %eax,-0x88(%rbp)
      mov    %r11,%rax
      mov    %eax,-0x84(%rbp)
      mov    %r11,%rax
      movslq -0x84(%rbp),%r10
      add    %r10,%rax
      mov    %eax,-0x84(%rbp)
      mov    $0x2,%eax
      movslq -0x84(%rbp),%r10
      imul   %r10,%rax
      mov    %rbp,%rsp
      mov    (%rsp),%rbp
      add    $0x30,%rsp
      retq
```

```
Celsius   : -100 -080 -060 -040 -020 +000 +020 +040 +060 +080 +100
Fahrenheit: -148 -112 -076 -040 -004  032  068  104  140  176  212

Fahrenheit: -100 -080 -060 -040 -020 +000 +020 +040 +060 +080 +100 +120 +140
Celsius   : -073 -062 -051 -040 -028 -017 -006  004  015  026  037  048  060

(rpn x=42) :x 123 + 456 * x - x *: is +0003158316
(user rpn x=42) :x x + 2 *: is +0000000168

real    0m0.009s
```

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```
user    0m0.008s
sys     0m0.004s
```

Some Celsius/Fahrenheit conversion tables, a hard coded expression and a final piece of RPN assembly, from an expression passed in on the command line.

All in just under 9 1000ths of a second.

GNU lightning supports quite a few native chip backends, covering aarch64, alpha, arm, hppa, ia64, mips, powerpc, s390, sparc and x86 architectures.

Now we might be able to pester someone on big iron to take a chance with some JIT assembly, impress the mainframe crowd (or not, as the case may be, and the person's job description).

```
Programmer: "Well, look at that, I can generate assembly on the fly."
Security:   "No you can't."
Programmer: "Sure, look, it's right here, a reverse polish calculator.
             I just have to type it in and try it on the EC12."
Security:   "Maybe you didn't hear me; no you can't and no you won't."
Programmer: "Oh, ..., right.  I'll try it on my Hercules z/Linux node
             at home tonight."
Security:   "Much better thinking. We're good here, right?"
Programmer: "Yes, Ma'am. Sorry, lost view of the forest from the tree."
Security:   "All right then. It is pretty cool. Tell me how it goes."
```

5.88 Can GnuCOBOL interface with D?

Yes. D supports the C *ABI* (page 1350) with a little care, and GnuCOBOL can call D, and be called from D. `extern(C)` informs the D compiler to generate code for C stack frames, with C naming conventions.

Originally intended to be named `Mars` by Walter Bright, early adopters nicknamed it D, as a step up from C++, and the nickname stuck.

dmd uses Phobos for run-time support, and you will almost always need to initialize the library space when calling D functions. From C with `rt_init()` or from inside D, with no main, using `initialize()`.

`calld.cob`

```
*> ****************************************************************
*> LICENSE
*>   Public domain sample
*> PURPOSE
*>   Demonstrate interfacing to the D programming language
*> TECTONICS
*>   dmd -c hellod.d
*>   cobc -x -g -debug calld.cob hellod.o -lphobos2
*> ****************************************************************
 identification division.
 program-id. calld.

 data division.
 file section.
 working-storage section.
 01 aug usage binary-long.
 01 ans usage binary-long.
```

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```
 procedure division.
*> Initialize D
 call "rt_init"
      on exception display "no -lphobos2" upon syserr end-display
 end-call
 if return-code not equal 1 then
     display "D phobos initialize failed" upon syserr end-display
 end-if

*> dynamic call, returns 42 plus the value in the augend
 call "dadd" using by value aug returning ans end-call
 display ans end-display

*> and a static call, for no reason really, other than testing
*>   would segfault without the rt_init call above
 call static "hellod" returning omitted end-call

*> run down D support
 call "rt_term"
     on exception display "no phobos2" upon syserr end-display
 end-call

 goback.
 end program calld.
*>*****
```

`hellod.d`

```
// Hello D
import std.stdio;

// these functions are setup for the C ABI
extern (C) {
    void hellod() {
        writeln("Hello, D");
    }

    int dadd(int aug) {
        return aug + 42;
    }
}
```

Giving:

```
prompt$ dmd -c hellod.d
prompt$ cobc -x -g -debug calld.cob hellod.o -lphobos2
prompt$ ./calld
+0000000042
Hello, D
prompt$
```

The augend was never set in `calld.cob`, defaulting to 0, with the `ans` returned from `dadd` being 42, as expected.

Proper `D` programming would have literate documentation as well as in source `unittests`. Both features, and more, are natively supported by D compilers.

```
prompt$ dmd --help
DMD64 D Compiler v2.067.1
Copyright (c) 1999-2014 by Digital Mars written by Walter Bright
Documentation: http://dlang.org/
Config file: /etc/dmd.conf
Usage:
  dmd files.d ... { -switch }

  files.d        D source files
  @cmdfile       read arguments from cmdfile
  -allinst       generate code for all template instantiations
  -c             do not link
  -color[=on|off]   force colored console output on or off
  -conf=path     use config file at path
  -cov           do code coverage analysis
  -cov=nnn       require at least nnn% code coverage
  -D             generate documentation
  -Dddocdir      write documentation file to docdir directory
  -Dffilename    write documentation file to filename
  -d             silently allow deprecated features
  -dw            show use of deprecated features as warnings (default)
  -de            show use of deprecated features as errors (halt compilation)
  -debug         compile in debug code
  -debug=level   compile in debug code <= level
  -debug=ident   compile in debug code identified by ident
  -debuglib=name    set symbolic debug library to name
  -defaultlib=name  set default library to name
  -deps          print module dependencies (imports/file/version/debug/lib)
  -deps=filename write module dependencies to filename (only imports)
  -fPIC          generate position independent code
  -dip25         implement http://wiki.dlang.org/DIP25 (experimental)
  -g             add symbolic debug info
  -gc            add symbolic debug info, optimize for non D debuggers
  -gs            always emit stack frame
  -gx            add stack stomp code
  -H             generate 'header' file
  -Hddirectory   write 'header' file to directory
  -Hffilename    write 'header' file to filename
  --help         print help and exit
  -Ipath         where to look for imports
  -ignore        ignore unsupported pragmas
  -inline        do function inlining
  -Jpath         where to look for string imports
  -Llinkerflag   pass linkerflag to link
  -lib           generate library rather than object files
  -m32           generate 32 bit code
  -m64           generate 64 bit code
  -main          add default main() (e.g. for unittesting)
  -man           open web browser on manual page
  -map           generate linker .map file
  -boundscheck=[on|safeonly|off]   bounds checks on, in @safe only, or off
  -noboundscheck no array bounds checking (deprecated, use -boundscheck=off)
  -O             optimize
  -o-            do not write object file
  -odobjdir      write object & library files to directory objdir
  -offilename    name output file to filename
  -op            preserve source path for output files
```

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```
  -profile       profile runtime performance of generated code
  -property      enforce property syntax
  -release       compile release version
  -run srcfile args...   run resulting program, passing args
  -shared        generate shared library (DLL)
  -transition=id show additional info about language change identified by 'id'
  -transition=?  list all language changes
  -unittest      compile in unit tests
  -v             verbose
  -vcolumns      print character (column) numbers in diagnostics
  --version      print compiler version and exit
  -version=level compile in version code >= level
  -version=ident compile in version code identified by ident
  -vtls          list all variables going into thread local storage
  -vgc           list all gc allocations including hidden ones
  -verrors=num   limit the number of error messages (0 means unlimited)
  -w             warnings as errors (compilation will halt)
  -wi            warnings as messages (compilation will continue)
  -X             generate JSON file
  -Xffilename    write JSON file to filename
```

Walter and Andrei Alexandrescu are building up a nice programming language.

Here is a more complete version, with a failed unit test.

```
/// Hello D from GnuCOBOL
/// License: use freely for any purpose
/// Date: 20150707
/// Tectonics: dmd -D hellod.d -unittest -main calld.o -L'-lcob'
module hellod;

import std.stdio;

/// hellogc is declared with C calling conventions
/// and defined in calld.cob
extern (C) int hellogc();

// Inner D functions, callable from GnuCOBOL with C conventions
extern (C) {

    /// ubiquitous hello, and call to GnuCOBOL
    void hellod() {
        writeln("Hello, D");
        hellogc();
    }

    /// Add 42 to a given augend
    /// Returns: the given integer increased by 42
    int dadd(int aug) {
        return aug + 42;
    }

    ///
    unittest {
        assert(dadd(0) == 41);
        assert(dadd(42) == 84);
    }
```

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```
}
```

Due to the desire to run unit tests, a D main must be available, but then it will attempt a link pass and will need to know about the `hellogc` function defined in `calld.cob`, listed below. **`cobc`** is used to generate an object file for D to link to. And the **`dmd`** linker is passed a hint to link in the `libcob` run-time support.

A purposely failed `dadd(0)` unit test run sample *(0 + 42 is not 41)*

```
prompt$ cobc -c calld.cob
prompt$ dmd hellod.d -unittest -main calld.o -L'-lcob'
prompt$ ./hellod
core.exception.AssertError@hellod.d(30): unittest failure
----------------
./hellod(void hellod.__unittest_fail(int)+0x2f) [0x493bf7]
./hellod(void hellod.__unittestL29_1()+0x1a) [0x4700ca]
./hellod(void hellod.__modtest()+0x9) [0x493b91]
./hellod(int core.runtime.runModuleUnitTests().__foreachbody3(object.ModuleInfo*)+0x34) [0x4a1cb0]
./hellod(int object.ModuleInfo.opApply(scope int delegate(object.ModuleInfo*)).__lambda2(immutable(object.ModuleInfo*))+0x1c) [0x49693c]
./hellod(int rt.minfo.moduleinfos_apply(scope int delegate(immutable(object.ModuleInfo*))).__foreachbody2(ref rt.sections_elf_shared.DSO)+0x47) [0x49b7df]
./hellod(int rt.sections_elf_shared.DSO.opApply(scope int delegate(ref rt.sections_elf_shared.DSO))+0x42) [0x49b856]
./hellod(int rt.minfo.moduleinfos_apply(scope int delegate(immutable(object.ModuleInfo*)))+0x25) [0x49b775]
./hellod(int object.ModuleInfo.opApply(scope int delegate(object.ModuleInfo*))+0x25) [0x496915]
./hellod(runModuleUnitTests+0xa8) [0x4a1b44]
./hellod(void rt.dmain2._d_run_main(int, char**, extern (C) int function(char[][])*).runAll()+0x17) [0x498477]
./hellod(void rt.dmain2._d_run_main(int, char**, extern (C) int function(char[][])*).tryExec(scope void delegate())+0x2a) [0x49842a]
./hellod(_d_run_main+0x1dc) [0x4983a4]
./hellod(main+0x17) [0x493c1f]
/usr/lib64/libc.so.6(__libc_start_main+0xf0) [0x375481ffe0]
prompt$
```

So, now, let's put that right. Asserting that 0 + 42 is indeed 42.

```
/// Hello D from GnuCOBOL
/// License: use freely for any purpose
/// Date: 20150707
/// Tectonics: cobc -c calld.cob $(BR) dmd -D hellod.d
///                 -unittest -main calld.o -L'-lcob'
module hellod;

import std.stdio;

/// hellogc is declared with C calling conventions and defined in $(B calld.cob)
extern (C) int hellogc();

// Inner D functions, callable from GnuCOBOL with C conventions
extern (C) {

    /// ubiquitous hello, and call to GnuCOBOL
    void hellod() {
        writeln("Hello, D");
        hellogc();
    }

    /// Add 42 to a given augend
    /// Returns: the given integer increased by 42
    int dadd(int aug) {
        return aug + 42;
    }

    ///
    unittest {
        assert(dadd(0) == 42);
        assert(dadd(42) == 84);
    }
}
```

With a successful run, given that 0 + 42 asserts to be equal to 42. The unittest pass also includes an automaically generated `main` function, and the automatic documentation generation, as a bonus, to highlight the powers of the **dmd** compiler:

```
prompt$ dmd -D hellod.d -unittest -main calld.o -L'-lcob'
prompt$ ./hellod
prompt$
```

And a fancy two step `calld.cob` run.

```
Gnu    *> ****************************************************************
COBOL *> LICENSE
calls *>   Public domain sample
D      *> PURPOSE
and    *>   Demonstrate interfacing to the D programming language
D      *> TECTONICS
calls *>   dmd -c hellod.d
COBOL *>   cobc -x -g -debug calld.cob hellod.o -lphobos2
       *> ****************************************************************
        identification division.
        program-id. calld.

        data division.
        file section.
        working-storage section.
        01 aug usage binary-long.
        01 ans usage binary-long.

        procedure division.
       *> Initialize D
        call "rt_init"
             on exception display "no -lphobos2" upon syserr end-display
        end-call
        if return-code not equal 1 then
            display "D phobos initialize failed" upon syserr end-display
        end-if

       *> dynamic call, returns 42 plus the value in the augend
        call "dadd" using by value aug returning ans end-call
        display ans end-display

       *> and a static call, for no reason really, other than testing
       *>   would segfault without the rt_init call above
        call static "hellod" returning omitted end-call

       *> run down D support
        call "rt_term"
            on exception display "no phobos2" upon syserr end-display
        end-call

        goback.
        end program calld.
       *>*****

       *> ****************************************************************
       *> D will call this subprogram
        identification division.
        program-id. hellogc.
```

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```
       procedure division.

       display "Hello, GnuCOBOL" end-display

       goback.
       end program hellogc.
```

With GnuCOBOL calling D, which turns around and invokes the `hellogc` COBOL sub-progam:

```
prompt$ dmd -c hellod.d
prompt$ cobc -x -g -debug calld.cob hellod.o -lphobos2
prompt$ ./calld
+0000000042
Hello, D
Hello, GnuCOBOL
prompt$
```

The auto generated documentation, from **`dmd -D`** is linked at http://opencobol.add1tocobol.com/sources/hellod.html

Turns out D is quite the thing. Worthy of any developers attention. Along with GnuCOBOL, and both languages natively supporting the C *ABI* (page 1350), it won't take much to make sufficiently advanced programming magic.

5.89 Can you run GnuCOBOL programs from Node.js?

Yes. Ionică Bizău has written a bridging layer, node-cobol hosted at https://github.com/IonicaBizau/node-cobol that allows embedded COBOL sources to take part in Node.js socket ready applications.

Works best with a version of GnuCOBOL `cobc` that accepts dash (-) as an input filename, allowing the compiler to read from standard input. Revision 632 or greater of gnu-cobol-2.0. But will also work with older releases, reading the source from a filename. The COBOL npm package is also required. `npm i cobol`.

From Ionică's gihub page,

index.js

```
// Dependencies
var Cobol = require("cobol");

// Execute some COBOL snippets
Cobol(function () { /*
       IDENTIFICATION DIVISION.
       PROGRAM-ID. HELLO.
       ENVIRONMENT DIVISION.
       DATA DIVISION.
       PROCEDURE DIVISION.

       PROGRAM-BEGIN.
           DISPLAY "Hello world".

       PROGRAM-DONE.
           STOP RUN.
*/ }, function (err, data) {
    console.log(err || data);
});
// => "Hello World"
```

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```
Cobol(__dirname + "/args.cbl", {
    args: ["Alice"]
}, function (err, data) {
    console.log(err || data);
});
// => "Your name is: Alice"
```

args.cbl

```
IDENTIFICATION DIVISION.
PROGRAM-ID. CLIOPTIONS.
ENVIRONMENT DIVISION.
DATA DIVISION.
WORKING-STORAGE SECTION.

01 argv                pic x(100) value spaces.

PROCEDURE DIVISION.
ACCEPT argv FROM argument-value
DISPLAY "Your name is:" argv
STOP RUN.
```

Just in case you are reading this quickly. What this means is that GnuCOBOL can now take part in Node.js socket ready applications, embedded as source code in Node.js programs. In 2015, that is pretty much leading edge modern. COBOL, modern, web ready, free. And it plays well with others.

See the `node-cobol` GitHub repository linked above for more samples and examples.

The code for `node-cobol` made it into an Ars Technica article shortly after it was published. By Sean Gallagher. http://arstechnica.com/information-technology/2015/08/ calling-1959-from-your-web-code-a-cobol-bridge-for-node-js/

And yes, the article was soon riddled with comments from people that don't understand the strengths of COBOL programming, but oh well, that would be their problem.

5.90 What is cobol-unit-test?

cobol-unit-test is a well documented, paragraph level unit testing program suite, written by Dave Nicolette, hosted on GitHub at https://github.com/neopragma/cobol-unit-test

See the complete documentation set at https://github.com/neopragma/cobol-unit-test/wiki

The goal of the cobol-unit-test project is to enable isolated unit testing of individual paragraphs in COBOL programs, in a standalone environment with no connection to a zOS system.

Dave set this up to give z/OS programmers a chance to unit test individual COBOL paragraphs on personal computers while off the mainframe. The system uses a very well thought out DSL, Domain Specific Language, reminiscent of COBOL itself, along with a preprocessor that generates a new source COBOL program, compiles it under controlled conditions and evaluates tests defined by the cobol-unit-test DSL.

All written in GnuCOBOL, the ZUTZCPC preprocessor program and DSL includes

- AFTER-EACH
- BEFORE-EACH
- EXPECT

- IGNORE
- MOCK
- TESTCASE
- TESTSUITE
- VERIFY

keywords. The DSL is very COBOL in nature, and should feel very comfortable for GnuCOBOL and z/OS mainframe programmers alike.

For example, the VERIFY keyword includes clauses such as

```
VERIFY FILE INVOICE-FILE READ HAPPENED 24 TIMES
VERIFY FILE INVOICE-FILE OPEN HAPPENED ONCE
VERIFY FILE ERROR-LOG WRITE NEVER HAPPENED
VERIFY FILE INPUT-FILE OPEN HAPPENED NO MORE THAN ONCE
VERIFY FILE MASTER-FILE READ HAPPENED AT LEAST 2 TIMES
VERIFY CICS START TRANSID('TR01') HAPPENED ONCE
VERIFY PARAGRAPH 1000-PARA-A WAS PERFORMED 4 TIMES
VERIFY PARA 2000-PARA-B PERFORMED AT LEAST 3 TIMES
VERIFY PARAGRAPH 3000-PARA-C WAS NEVER PERFORMED
VERIFY PARA 4000-PARA-D NEVER PERFORMED
```

5.90.1 cobol-unit-test examples

There are multiple samples that ship with cobol-unit-test. Each test definition is set up in a controlled directory tree, with `compile` and `run-ut` scripts that manage the build and test run.

The introductory sample includes a purposely failed test, from a simple program.

src/test/resources/SAMPLEC, the unit test run and compile resource list

```
ZUTZCWS
SAMPLET
```

src/test/cobol/SAMPLET, unit test definition (the DSL)

```
TESTSUITE 'GREETING AND FAREWELL (FAREWELL WILL FAIL)'

TESTCASE 'IT RETURNS HELLO, WORLD! AS GREETING'
MOVE 'GREETING' TO WS-MESSAGE-TYPE
PERFORM 2000-SPEAK
EXPECT WS-MESSAGE TO BE 'HELLO, WORLD!'

TESTCASE 'IT RETURNS GOODBYE, CRUEL WORLD! AS FAREWELL'
MOVE 'FAREWELL' TO WS-MESSAGE-TYPE
PERFORM 2000-SPEAK
EXPECT WS-MESSAGE TO BE 'GOODBYE, CRUEL WORLD!'
```

and **src/main/cobol/SAMPLE.CBL**, the actual COBOL being tested

```
SAMPLE
       IDENTIFICATION DIVISION.
       PROGRAM-ID.  SAMPLE.
      *****************************************************************
      * TRIVIAL PROGRAM TO EXERCISE ZUTZCPC.
```

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```
      ******************************************************************
       ENVIRONMENT DIVISION.
       INPUT-OUTPUT SECTION.
       FILE-CONTROL.
       DATA DIVISION.
       WORKING-STORAGE SECTION.
       01  FILLER.
           05  WS-MESSAGE-TYPE          PIC X(08) VALUE SPACES.
           05  WS-MESSAGE               PIC X(40) VALUE SPACES.
       PROCEDURE DIVISION.

       2000-SPEAK.
           IF WS-MESSAGE-TYPE IS EQUAL TO 'GREETING'
               MOVE 'HELLO, WORLD!' TO WS-MESSAGE
           END-IF
           IF WS-MESSAGE-TYPE IS EQUAL TO 'FAREWELL'
               MOVE 'SEE YOU LATER, ALLIGATOR!' TO WS-MESSAGE
           END-IF
           .

       9999-END.
           .
```

src/main/cobol/copy/ZUTZCWS.CPY is a working-storage copy book included in the generated test COBOL program.

A sample run of

```
echo 'SAMPLE'
echo 'This example demonstrates a minimal unit test setup'
echo
./run-ut SAMPLEC SAMPLE SAMPLET

SAMPLE
This example demonstrates a minimal unit test setup

================================================
Running: ./run-ut SAMPLEC SAMPLE SAMPLET

TEST SUITE:
GREETING AND FAREWELL (FAREWELL WILL FAIL)

     PASS:   1. IT RETURNS HELLO, WORLD! AS GREETING
**** FAIL:   2. IT RETURNS GOODBYE, CRUEL WORLD! AS FAREWELL
    EXPECTED <GOODBYE, CRUEL WORLD!                                    >,
         WAS <SEE YOU LATER, ALLIGATOR!                                >

  2 TEST CASES WERE EXECUTED
  1 PASSED
  1 FAILED
================================================
```

Other examples that ship with cobol-unit-test demonstrate more of the DSL feature set.

Such as **src/test/cobol/unit-tests/CICSDEMT** which shows how to test mock up CICS commands, when no CICS engine actually exists.

The initial MOCKUP line was added solely for the benefit of the FAQ indent based source highlighter and is not part

of the actual test definition file.

```
MOCKUP
            TESTSUITE 'DEMONSTRATE CICS COMMAND MOCKS'

       ******************************************************************
       * DEMONSTRATE MOCKING EXEC CICS COMMANDS WITH ZUTZCPC.
       ******************************************************************

            TESTCASE 'Mock behavior of EXEC CICS READ DATASET'
            MOCK
                CICS READ DATASET('MYFILE')
                     RIDFLD('AAAAA')
                     INTO(WS-RECORD)
                MOVE 'AAAAABBBBBCCCCCDDDDDEEEEE' TO WS-RECORD
            END-MOCK
            PERFORM 0100-READ-DATASET
            EXPECT WS-FIELD-3 TO BE 'CCCCC'
            EXPECT EIBRESP TO BE NUMERIC ZERO
            VERIFY
                CICS READ DATASET('MYFILE')
                     RIDFLD('AAAAA')
                     INTO(WS-RECORD)
                HAPPENED ONCE


            TESTCASE 'Mock behavior of EXEC CICS WRITE DATASET'
            MOCK
                CICS WRITE DATASET('YOURFILE')
                     RIDFLD('AAAAA')
                     FROM(WS-RECORD)
            END-MOCK
            PERFORM 0200-WRITE-DATASET
            EXPECT EIBRESP TO BE NUMERIC ZERO
```

The full example script test runner script demonstrates the other features, with a run sample of:

```
$ ./run-examples
SAMPLE
This example demonstrates a minimal unit test setup

================================================
Running: ./run-ut SAMPLEC SAMPLE SAMPLET

TEST SUITE:
GREETING AND FAREWELL (FAREWELL WILL FAIL)

     PASS:   1. IT RETURNS HELLO, WORLD! AS GREETING
**** FAIL:   2. IT RETURNS GOODBYE, CRUEL WORLD! AS FAREWELL
    EXPECTED <GOODBYE, CRUEL WORLD!                                    >,
         WAS <SEE YOU LATER, ALLIGATOR!                                >

  2 TEST CASES WERE EXECUTED
  1 PASSED
  1 FAILED
================================================
FIZZBUZZ
This example demonstrates a unit test suite for
```

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```
an implementation of FizzBuzz

================================================
Running: ./run-ut FIZZBUZC FIZZBUZZ FIZZBUZT

TEST SUITE:
UNIT TESTS FOR FIZZBUZZ.CBL

     PASS:   1. IT RETURNS FIZZ FOR THE NUMBER 3 (DIVISIBLE BY 3)
     PASS:   2. IT RETURNS FIZZ FOR THE NUMBER 6 (DIVISIBLE BY 3)
     PASS:   3. IT RETURNS FIZZ FOR THE NUMBER 12 (DIVISIBLE BY 3)
     PASS:   4. IT RETURNS BUZZ FOR THE NUMBER 5 (DIVISIBLE BY 5)
     PASS:   5. IT RETURNS BUZZ FOR THE NUMBER 25 (DIVISIBLE BY 5)
     PASS:   6. IT RETURNS BUZZ FOR THE NUMBER 10 (DIVISIBLE BY 5)
     PASS:   7. IT RETURNS FIZZBUZZ FOR THE NUMBER 15 (DIV BY 3 AND 5)
     PASS:   8. IT RETURNS FIZZBUZZ FOR THE NUMBER 30 (DIV BY 3 AND 5)
     PASS:   9. IT RETURNS FIZZBUZZ FOR THE NUMBER 45 (DIV BY 3 AND 5)
     PASS:  10. IT RETURNS 4 FOR THE NUMBER 4 (NOT DIV BY 3 OR 5)
     PASS:  11. IT RETURNS BAZ FOR THE NUMBER 7 (DIV BY 7)

 11 TEST CASES WERE EXECUTED
 11 PASSED
  0 FAILED
================================================
CONVERT
This example demonstrates unit tests for a batch program
that processes files. It shows how to organize the code
so that file access is not necessary to support the
automated unit tests

================================================
Running: ./run-ut CONVERTC CONVERT CONVERTT

TEST SUITE:
CONVERT COMMA-DELIMITED FILE TO FIXED FORMAT

     PASS:   1. IT CONVERTS TEXT FIELD 1 TO UPPER CASE
     PASS:   2. IT CONVERTS TEXT FIELD 1 TO UPPER CASE
     PASS:   3. IT HANDLES EMPTY TEXT FIELD 1
     PASS:   4. IT CENTERS TEXT FIELD 2 AND CAPITALIZES FIRST LETTER
     PASS:   5. IT HANDLES EMPTY TEXT FIELD 2
     PASS:   6. IT FINDS THE STATE NAME FOR A VALID STATE CODE
     PASS:   7. IT RETURNS SPACES FOR AN INVALID STATE CODE
     PASS:   8. IT CONVERTS DECIMAL VALUE 10.45 TO 010.4500
     PASS:   9. IT CONVERTS AN EMPTY DECIMAL VALUE TO ZEROES

  9 TEST CASES WERE EXECUTED
  9 PASSED
  0 FAILED
================================================
CONVER2
Same as CONVERT, but the program under test is written in
"classic" Cobol style (period after every statement)

================================================
Running: ./run-ut CONVERTC CONVER2 CONVERTT
```

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```
TEST SUITE:
CONVERT COMMA-DELIMITED FILE TO FIXED FORMAT

     PASS:   1. IT CONVERTS TEXT FIELD 1 TO UPPER CASE
     PASS:   2. IT CONVERTS TEXT FIELD 1 TO UPPER CASE
     PASS:   3. IT HANDLES EMPTY TEXT FIELD 1
     PASS:   4. IT CENTERS TEXT FIELD 2 AND CAPITALIZES FIRST LETTER
     PASS:   5. IT HANDLES EMPTY TEXT FIELD 2
     PASS:   6. IT FINDS THE STATE NAME FOR A VALID STATE CODE
     PASS:   7. IT RETURNS SPACES FOR AN INVALID STATE CODE
     PASS:   8. IT CONVERTS DECIMAL VALUE 10.45 TO 010.4500
     PASS:   9. IT CONVERTS AN EMPTY DECIMAL VALUE TO ZEROES

  9 TEST CASES WERE EXECUTED
  9 PASSED
  0 FAILED
================================================
INVDATE
This example demonstrates unit test cases that have a
dependency on the system clock

================================================
Running: ./run-ut INVDATEC INVDATE INVDATET

TEST SUITE:
UNIT TESTS FOR INVDATE.CBL

     PASS:   1. IT DETERMINES THE NEXT INVOICE DATE IN A 30-DAY MONTH
     PASS:   2. IT DETERMINES THE NEXT INVOICE DATE IN A 31-DAY MONTH
     PASS:   3. IT DETERMINES THE NEXT INVOICE DATE IN FEB, NON LEAP
     PASS:   4. IT DETERMINES THE NEXT INVOICE DATE IN FEB, LEAP

  4 TEST CASES WERE EXECUTED
  4 PASSED
  0 FAILED
================================================
FILEDEMO
This example demonstrates mocking batch file accesses

================================================
Running: ./run-ut FILEDEMC FILEDEMO FILEDEMT

TEST SUITE:
DEMONSTRATE FILE MOCKS

     PASS:   1. IT MOCKS SUCCESSFUL FILE OPEN INPUT
     PASS:   2. IT MOCKS READING AFTER EOF
     PASS:   3. IT MOCKS FILE-NOT-FOUND ON OPEN INPUT
     PASS:   4. IT MOCKS ERROR ON FILE OPEN INPUT
     PASS:   5. VERIFY     0 ACCESSES

  5 TEST CASES WERE EXECUTED
  5 PASSED
  0 FAILED
================================================
CALLDEMO
This example demonstrates mocking CALL statements
```

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```
================================================
Running: ./run-ut CALLDEMC CALLDEMO CALLDEMT

TEST SUITE:
DEMONSTRATE CALL STATEMENT MOCKS

     PASS:   1. Mock behavior of basic CALL statement
     PASS:   2. Mock behavior of basic CALL statement
     PASS:   3. VERIFY     1 ACCESS
     PASS:   4. Mock behavior of classic CALL statement
     PASS:   5. Mock behavior of classic CALL statement
     PASS:   6. Mock CALL to dynamic subprogram
     PASS:   7. Mock CALL to dynamic subprogram

  7 TEST CASES WERE EXECUTED
  7 PASSED
  0 FAILED
================================================
PARADEMO
This example demonstrates mocking paragraphs

================================================
Running: ./run-ut PARADEMC PARADEMO PARADEMT

TEST SUITE:
DEMONSTRATE FILE MOCKS

     PASS:   1. IT MOCKS PARAGRAPH 2000-PARA-B
     PASS:   2. IT MOCKS PARAGRAPH 2000-PARA-B
     PASS:   3. VERIFY     1 ACCESS
     PASS:   4. IT MOCKS PARAGRAPH 1000-PARA-A
     PASS:   5. IT MOCKS PARAGRAPH 1000-PARA-A
     PASS:   6. VERIFY     1 ACCESS

  6 TEST CASES WERE EXECUTED
  6 PASSED
  0 FAILED
================================================
SUBPROG
This example demonstrates how to set up unit tests for
a called subprogram

================================================
Running: ./run-ut SUBPROGC SUBPROG SUBPROGT SUBPROGD

TEST SUITE:
DEMONSTRATE UNIT TESTING A CALLED SUBPROGRAM

     PASS:   1. IT RETURNS VALUE A TO THE CALLER
     PASS:   2. IT RETURNS VALUE B TO THE CALLER

  2 TEST CASES WERE EXECUTED
  2 PASSED
  0 FAILED
================================================
CICSDEMO
```

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```
This example demonstrates isolated unit tests for a
CICS application program. It does not require a CICS
environment to run.

================================================
Running: ./run-ut CICSDEMC CICSDEMO CICSDEMT CICSDRIV

TEST SUITE:
DEMONSTRATE CICS COMMAND MOCKS

     PASS:   1. Mock behavior of EXEC CICS READ DATASET
     PASS:   2. Mock behavior of EXEC CICS READ DATASET
     PASS:   3. VERIFY     1 ACCESS
     PASS:   4. Mock behavior of EXEC CICS WRITE DATASET

  4 TEST CASES WERE EXECUTED
  4 PASSED
  0 FAILED
================================================
```

5.90.2 cobol-unit-test credits

cobol-unit-test, isolated paragraph testing with GnuCOBOL. Includes instructions and scripts to support moving source files from z/OS to and from a GnuCOBOL workstation, for unit testing mainframe programs.

A worthy addition to any GnuCOBOL developer's arsenal.

Thanks to Dave Nicolette.

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5.91 Does GnuCOBOL work with SWIG?

Yes, due to the intermediate C generation. SWIG, the Simplified Wrapper and Interface Generator, does not directly support COBOL, but it is designed to allow other languages to call into C functions. This means other languages can easily call into GnuCOBOL subprograms and ENTRY points. There are caveats, as some COBOL names are not valid C names, so there are some name transformations that `cobc` performs that may need to be accounted for.

SWIG is a very well documented tool set, and has direct support for calling into GnuCOBOL from

- Allegro CL
- C#
- CFFI
- CLISP
- Chicken
- D
- Go
- Guile
- Java

- Javascript
- Lua
- Modula-3
- Mzscheme
- OCAML
- Octave
- Perl
- PHP
- Python
- R
- Ruby
- Scilab
- Tcl
- UFFI

And this support will work for both the C and C++ versions of the GnuCOBOL intermediates.

Most, if not all, of the SWIG interface definitions are normal and will not require modification to work with GnuCOBOL, *aside from name compatibility issues*. The major difference from the documented C interfaces will be in the *tectonics* (page 1350), minor changes to how the wrapper code is linked.

For example, a small GnuCOBOL program, polyglot.cob, and calling `polyglot` from Java, Perl, Python and Tcl. A single SWIG interface file and some make rules.

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****J* SWIG/polyglot
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20150924
      *>   Modified: 2015-10-02/20:11-0400
      *> LICENSE
      *>   Copyright 2015 Brian Tiffin
      *>   GNU General Public License, GPL, 3.0 (or greater)
      *> PURPOSE
      *>   polyglot programming with SWIG.
      *> TECTONICS
      *>   requires polyglot-swig.i and the Makefile
      *>   make [java | perl | python | tcl]
      *> ***************************************************************
       identification division.
       program-id. polyglot.
       author. Brian Tiffin.

       environment division.
       configuration section.
       repository.
           function all intrinsic.
```

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```
       data division.
       working-storage section.
       01 datetime             pic XXXX/XX/XXBXX/XX/XX.

      *> ****************************************************************
       procedure division.

       move function current-date to datetime
       inspect datetime replacing all "/" by ":" after initial space

       display "Hello from GnuCOBOL" end-display
       display "It is now " datetime end-display

       move 42 to return-code
       goback.
      *>****
>>ELSE
```

```
==============
polyglot usage
==============

Indistinguishable from magic.

Introduction
------------

Assembling a polyglot GnuCOBOL application can be as simple as:

    prompt$ make perl
    prompt$ perl
    use polyglot;
    polyglot::polyglot;

    prompt$ make tcl
    prompt$ tclsh
    % load polyglot.so polyglot
    % polyglot

    prompt$ make python
    prompt$ python
    py> import _polyglot
    py> _polyglot.polyglot()

    prompt$ make java
    prompt$ java main


Source
------

.. code-include::  polyglot.cob
   :language: cobol

.. code-include::  polyglot-swig.i
   :language: c
```

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```
.. code-include::  Makefile
   :language: makefile

.. code-include::  main.java
   :language: java
>>END-IF
```

The plan is to use the generated C files to facilitate a wrapper for each of the target languages.

```
/* Polyglot programming with GnuCOBOL and SWIG */
/* Brian Tiffin, 20150924 */
%module polyglot
%{
int polyglot();
%}

int polyglot();
```

Normally, SWIG interface files can have the same name as the program, but seeing as GnuCOBOL may generate .i files for the internal preprocessor, with `cobc -E`, it is safer to avoid any possible name collision, and this sample is called, `polyglot-swig.i`.

And then, a suite of make rules. In particular, **libcob** is included in the linkage phase when generating the wrapped shared resources.

```
# polyglot programming with GnuCOBOL and SWIG

help:
    @echo "Targets include: java, perl, python, tcl, and contract"

java: polyglot.cob main.java polyglot-swig.i
    swig -java polyglot-swig.i
    cobc -fimplicit-init -C polyglot.cob
    gcc -c -fPIC polyglot.c polyglot-swig_wrap.c \
        -I/usr/lib/jvm/java-1.8.0-openjdk-1.8.0.60-14.b27.fc21.x86_64/include \
        -I/usr/lib/jvm/java-1.8.0-openjdk-1.8.0.60-14.b27.fc21.x86_64/include/linux
    gcc -shared -lcob polyglot.o polyglot-swig_wrap.o -o libpolyglot.so
    javac main.java
    @echo "Now do: java main"

perl: polyglot.cob polyglot-swig.i
    swig -perl5 polyglot-swig.i
    cobc -fimplicit-init -C polyglot.cob
    gcc -c `perl -MConfig -e 'print join(" ", \
        @Config{qw(ccflags optimize cccdlflags)}, "\
        -I$$Config{archlib}/CORE")'` polyglot.c polyglot-swig_wrap.c
    gcc `perl -MConfig -e 'print $$Config{lddlflags}'` \
        -lcob polyglot.o polyglot-swig_wrap.o -o polyglot.so
    @echo "Now do: perl; use polyglot; polyglot::polyglot;"

python: polyglot.cob polyglot-swig.i
    swig -python polyglot-swig.i
    cobc -fimplicit-init -C polyglot.cob
    gcc -fpic -c polyglot.c polyglot-swig_wrap.c -I/usr/include/python2.7
    ld -shared -lcob polyglot.o polyglot-swig_wrap.o -o _polyglot.so
    @echo "Now do: python; import _polyglot; _polyglot.polyglot()"
```

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```
tcl: polyglot.cob polyglot-swig.i
    swig -tcl polyglot-swig.i
    cobc -fimplicit-init -C polyglot.cob
    gcc -fpic -c polyglot.c polyglot-swig_wrap.c
    gcc -shared -lcob polyglot.o polyglot-swig_wrap.o -o polyglot.so
    @echo "Now do: tclsh; load ./polyglot.so polyglot; polyglot"

contract: contract.cob contract-swig.i
    swig -python contract-swig.i
    cobc -fimplicit-init -C contract.cob
    gcc -fpic -c contract.c contract-swig_wrap.c -I/usr/include/python2.7
    ld -shared -lcob contract.o contract-swig_wrap.o -o _contract.so
    @echo "Now do: python; import _contract; _contract.contract(42)"
```

With make targets for Java, Perl, Python, Tcl, and one to demonstrate SWIG contract programming suppport.

The Java target also requires a small bit of Java for a main entry point, in this case `main.java`.

```
/* polyglot programming with GnuCOBOL, SWIG and Java */
import java.lang.reflect.Field;

public class main {
  public static void main(String argv[]) throws Exception {
    // set the library path, and invalidate the sys path cache
    System.setProperty("java.library.path", ".");
    Field fieldSysPath = ClassLoader.class.getDeclaredField("sys_paths");
    fieldSysPath.setAccessible(true);
    fieldSysPath.set(null, null);

    // and now we can load the library in current working dir
    System.loadLibrary("polyglot");
    polyglot.polyglot();
  }
}
```

`main.java` is slightly more complicated than it needs to be, as this sample includes runtime code to override the default `java.library.path` system variable, to include the current working directory, ".", when searching for the `polyglot` shared library. This search path could have been set externally, but was done at runtime in this small example.

5.91.1 Using SWIG

Taking the Perl sample, the first step is using SWIG to generate source code for perl5 that wraps the GnuCOBOL `polyglot` entry point. The next step is using `cobc` to generate C source code from the COBOL source, including code that will initialize the GnuCOBOL run-time library. `gcc` is then used to create object code from the COBOL generated C source, along with the SWIG wrapper, with information on where to find the perl5 header file includes. A final step is then using the object code to build a shared library that can be imported into a Perl interpreter space.

Then it becomes a simple matter of:

```
prompt$ make perl
swig -perl5 polyglot-swig.i
cobc -fimplicit-init -C polyglot.cob
gcc -c `perl -MConfig -e 'print join(" ", \
```

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```
    @Config{qw(ccflags optimize cccdlflags)}, \
    "-I$Config{archlib}/CORE")'` polyglot.c polyglot-swig_wrap.c
gcc `perl -MConfig -e 'print $Config{lddlflags}'` \
    -lcob polyglot.o polyglot-swig_wrap.o -o polyglot.so
Now do: perl; use polyglot; polyglot::polyglot;
```

With a run test of:

```
prompt$ perl
use polyglot;
my $rc = polyglot::polyglot;
print($rc, "\n");
```

giving:

```
Hello from GnuCOBOL
It is now 2015/09/25 06:32:36
42
```

The $rc variable is set, by calling the GnuCOBOL `polyglot` function. The Hello message is displayed (by COBOL), and the return value from the module is placed in the Perl $rc scalar variable, which is then printed with a newline.

GnuCOBOL called from Perl, without knowing anything about the API details that would normally be required for this integration. An example of those details is listed in *Can GnuCOBOL interface with Perl?* (page 982). In this case, the SWIG development team filled in the nitty gritty details, and the application developer need only worry about creating an interface definition, and some build rules. *The build rules are mostly boilerplate, with some site local information on where to find headers and support libraries*.

Given the same COBOL source, and the same SWIG definition, the Makefile allows for the `polyglot` COBOL subprogram to be called from Java:

```
prompt$ make java
swig -java polyglot-swig.i
cobc -fimplicit-init -C polyglot.cob
gcc -c -fPIC polyglot.c polyglot-swig_wrap.c \
    -I/usr/lib/jvm/java-1.8.0-openjdk-1.8.0.60-14.b27.fc21.x86_64/include \
    -I/usr/lib/jvm/java-1.8.0-openjdk-1.8.0.60-14.b27.fc21.x86_64/include/linux
gcc -shared -lcob polyglot.o polyglot-swig_wrap.o -o libpolyglot.so
javac main.java
Now do: java main

prompt$ java main
Hello from GnuCOBOL
It is now 2015/09/25 06:32:00
```

From Python:

```
prompt$ make python
swig -python polyglot-swig.i
cobc -fimplicit-init -C polyglot.cob
gcc -fpic -c polyglot.c polyglot-swig_wrap.c -I/usr/include/python2.7
ld -shared -lcob polyglot.o polyglot-swig_wrap.o -o _polyglot.so
Now do: python; import _polyglot; _polyglot.polyglot()

prompt$ python
Python 2.7.8 (default, Jul  5 2015, 14:16:16)
[GCC 4.9.2 20150212 (Red Hat 4.9.2-6)] on linux2
```

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```
Type "help", "copyright", "credits" or "license" for more information.
>>> import _polyglot
>>> a = _polyglot.polyglot()
Hello from GnuCOBOL
It is now 2015/09/25 06:33:21
>>> print(a)
42
```

And from Tcl:

```
prompt$ make tcl
swig -tcl polyglot-swig.i
cobc -fimplicit-init -C polyglot.cob
gcc -fpic -c polyglot.c polyglot-swig_wrap.c
gcc -shared -lcob polyglot.o polyglot-swig_wrap.o -o polyglot.so
Now do: tclsh; load ./polyglot.so polyglot; polyglot

prompt$ tclsh
% load ./polyglot.so polyglot
% polyglot
Hello from GnuCOBOL
It is now 2015/09/25 06:34:12
42
```

With some other build rules, the same code could be used from over 20 SWIG supported languages, listed at the top of this entry, and fully documented by the SWIG project at http://www.swig.org/doc.html. No change to the COBOL or the interface definition would be required for any of these integrations.

5.91.2 Contract programming with SWIG

SWIG supports more than simple wrappers. There are features included with SWIG that allow for contract style programming, where inputs and outputs can be validated on function entry and exit.

Given this GnuCOBOL program, contract.cob:

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****J* SWIG/contract
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20150924
      *>   Modified: 2015-09-25/07:33-0400
      *> LICENSE
      *>   Copyright 2015 Brian Tiffin
      *>   GNU General Public License, GPL, 3.0 (or greater)
      *> PURPOSE
      *>   polyglot contract programming with SWIG.
      *> TECTONICS
      *>   requires contract-swig.i and the Makefile
      *>   make contract
      *> ***************************************************************
       identification division.
       program-id. contract.
```

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```
       author. Brian Tiffin.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 datetime             pic XXXX/XX/XXBXX/XX/XX.

       linkage section.
       01 argument             usage binary-long.

      *> ****************************************************************
       procedure division using by value argument.

       display argument end-display
       move function current-date to datetime
       inspect datetime replacing all "/" by ":" after initial space

       display "Hello from GnuCOBOL" end-display
       display "It is now " datetime end-display

       add 42 to argument giving return-code
       goback.
      *>****
>>ELSE
```

```
==============
contract usage
==============

Indistinguishable from magic.

Introduction
------------

Assembling a polyglot GnuCOBOL application with contracts, can be as
simple as::

    prompt$ make contract
    prompt$ python
    py> import _contract
    py> _contract.contract(2)
    py> _contract.contract(-1)

Source
------

.. code-include::  contract.cob
      :language: cobol

.. code-include::  contract-swig.i
      :language: c
```

(continues on next page)

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```
.. code-include::  Makefile
      :language: makefile
>>END-IF
```

And this interface definition, contract-swig.i:

```
/* Contract programming with GnuCOBOL and SWIG */
/* Brian Tiffin, 20150924 */
%module contract
%{
int contract(int argument);
%}

%contract contract(int argument) {
require:
    argument >= 0;
ensure:
    contract == argument + 42;
}

int contract(int argument);
```

contract-swig.i includes a SWIG `%contract` clause, and builds code that requires that the input argument is a number greater than 0, and ensures the return value is the given number plus 42.

Demonstrated with this Python pass:

```
prompt$ make contract
swig -python contract-swig.i
cobc -fimplicit-init -C contract.cob
gcc -fpic -c contract.c contract-swig_wrap.c -I/usr/include/python2.7
ld -shared -lcob contract.o contract-swig_wrap.o -o _contract.so
Now do: python; import _contract; _contract.contract()

prompt$ python
Python 2.7.8 (default, Jul  5 2015, 14:16:16)
[GCC 4.9.2 20150212 (Red Hat 4.9.2-6)] on linux2
Type "help", "copyright", "credits" or "license" for more information.
>>> import _contract
>>> _contract.contract(3)
+0000000003
Hello from GnuCOBOL
It is now 2015/10/03 07:08:01
45

>>> _contract.contract(-1)
Traceback (most recent call last):
  File "<stdin>", line 1, in <module>
RuntimeError: Contract violation: require: (arg1>=0)

>>> _contract.contract(0)
+0000000000
Hello from GnuCOBOL
It is now 2015/10/03 07:08:21
42
```

The interface definition caused code to be built that raised an exception in Python when passed a negative value to the

GnuCOBOL `contract` subprogram. Once again, all the nitty gritty details handled by SWIG.

5.91.3 SWIG in summary

SWIG will allow just about any and all existing GnuCOBOL programs to be wrapped for use by a plethora of other programming languages. And that means GnuCOBOL can easily take part in "modernization" efforts, pretty much at whim, and without change to underlying COBOL sources.

There is a lot more to SWIG than what is shown here, a sufficiently advanced technology, *indistinguishable from magic*.

5.92 What is small s.c.r.i.p.t.?

small s.c.r.i.p.t. is a Single Character Read Interpret Programming Toyol.

Toyol A toy programming tool; toil, for the fun of it.

Here is small s.c.r.i.p.t. program, called from the shell, that saves byte codes from 0 to 127, 7bit ASCII, as binary values in codes.txt

```
small '128[@.+]' >codes.txt
```

And one that saves byte values from 0 to 255, as binary, in allbytes.txt.

```
small '.+[.+]' >allbytes.txt
```

6 bytes of small s.c.r.i.p.t. source code.

To get a list of formatted values, from 0 to 15:

```
small '16[0@# +]'
000 001 002 003 004 005 006 007 008 009 010 011 012 013 014 015
```

Unformatted:

```
small '16[@# +]'
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
```

And a program to display all the words from 99 bottles of beer on the wall, including proper plurals and no for zero. Saved in file 99bottles.small

```
:Bbottle-{2!}s+ of beer;:Oon the wall;:Mmore;099+[# B O\, # B\.
Take one down and pass it around\, -{no M2!}# B O\.

]No M B O\, no M B\.
Go to the store and buy some M4\, 99 B O\.
```

Giving:

```
prompt $ ./small -f 99bottles.small
99 bottles of beer on the wall, 99 bottles of beer.
Take one down and pass it around, 98 bottles of beer on the wall.

98 bottles of beer on the wall, 98 bottles of beer.
Take one down and pass it around, 97 bottles of beer on the wall.
```

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```
...

2 bottles of beer on the wall, 2 bottles of beer.
Take one down and pass it around, 1 bottle of beer on the wall.

1 bottle of beer on the wall, 1 bottle of beer.
Take one down and pass it around, no more bottles of beer on the wall.

No more bottles of beer on the wall, no more bottles of beer.
Go to the store and buy some more, 99 bottles of beer on the wall.
```

182 bytes of source for 99 bottles, a correct version.

A little printable ASCII chart, as asciichart.small

```
0[Printable Ascii Chart in small s.c.r.i.p.t., by Brian Tiffin]
10[ ]Printable ASCII Chart
10[ ]21[=]
032+:~0@# .  ;15[~5[16+~]10.79-]~4[16+~]10.
```

Invoked with

```
prompt$ small -f asciichart.small
```

Giving:

```
          Printable ASCII Chart
          =====================
032    048 0  064 @  080 P  096 `  112 p
033 !  049 1  065 A  081 Q  097 a  113 q
034 "  050 2  066 B  082 R  098 b  114 r
035 #  051 3  067 C  083 S  099 c  115 s
036 $  052 4  068 D  084 T  100 d  116 t
037 %  053 5  069 E  085 U  101 e  117 u
038 &  054 6  070 F  086 V  102 f  118 v
039 '  055 7  071 G  087 W  103 g  119 w
040 (  056 8  072 H  088 X  104 h  120 x
041 )  057 9  073 I  089 Y  105 i  121 y
042 *  058 :  074 J  090 Z  106 j  122 z
043 +  059 ;  075 K  091 [  107 k  123 {
044 ,  060 <  076 L  092 \  108 l  124 |
045 -  061 =  077 M  093 ]  109 m  125 }
046 .  062 >  078 N  094 ^  110 n  126 ~
047 /  063 ?  079 O  095 _  111 o
```

An interpreter, written in COBOL, using GO TO DEPENDING ON.

The small s.c.r.i.p.t. source code:

```
COBOL  >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20130730, 20130810
      *> Purpose:   small s.c.r.i.p.t.
      *> Tectonics: ./configure; make; make check && sudo make install
      *>              or, cobc -x small.cob
```

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```
      *> License:   As with all entries on esolang.org
      *>            small s.c.r.i.p.t. is dedicated to the Public Domain
      *> ***************************************************************
       identification division.
       program-id. small.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       input-output section.
       file-control.

           select program-channel
           assign to program-filename
           organization is line sequential
           status is program-channel-status
           .

      *> Magic numbers
       replace ==SMALL-BUFFER== by  ==32768==
                ==BIG-BUFFER==  by ==1048576==.

       data division.
       file section.
       fd program-channel.
           01 source-line      pic x(SMALL-BUFFER).


       working-storage section.
       01 argv                 pic x(BIG-BUFFER).
       01 current-arg          pic x(256).
          88 helping             value "-h", "--h", "--help".
          88 versioning          value "-v", "--v", "--version".
          88 use-file            value "-f", "--f", "--file".
          88 done-arguments      value high-value.
       01 file-used            pic x.
          88 file-loaded         value high-value.

       01 program-source.
          05 source-tape       pic x
                                 occurs 0 to BIG-BUFFER times
                                 depending on tape-length.
       01 tape-length          usage index.
       01 tape-position        usage index.
       01 ascii-value          pic 999.

       01 program-filename     pic x(256).

      *> Support single quote call
       01 first-quote          usage index.
       01 second-quote         usage index.
       01 symbol-len           pic 999.

      *> Memory.
       01 main-memory.
```

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```
           05 memory-cell       usage binary-char unsigned
                                  occurs 0 to SMALL-BUFFER times
                                  depending on maximum-cell.
         01 maximum-cell         usage index value 1.
         01 current-cell         usage index value 1.
         01 fetch-cell           usage index value 1.
         01 character-value      pic x.

        *> numeric literal modes
         01 zero-context         pic x.
            88 leading-zero        value high-value
                                  when set to false is low-value.
         01 number-content       pic x.
            88 numbering           value high-value
                                  when set to false is low-value.
         01 last-number          usage binary-char unsigned.
         01 default-value        usage binary-char unsigned.
         01 zeroed-number        pic 999.
         01 formatted-number     pic zz9.

         01 colon-dictionary.
            05 colon-offsets     usage index occurs 256 times.

         01 colon-callstack.
            05 colon-returns     usage index
                                  occurs 0 to SMALL-BUFFER times
                                  depending on colons.
         01 colons               usage index.

         01 loop-stack.
            05 loop-offsetlimits  occurs 0 to 256 times
                                   depending on this-loop.
               10 loop-offsets   usage index.
               10 loop-is-numbered   pic x.
               10 loop-limits    usage index.
         01 this-loop            usage index.
         01 loop-limit           usage index.
         01 bracket-counter      usage binary-long.
         01 enter-block          usage index.

        *> I/O channels
         01 program-channel-status.
            88 no-more-source          value high-value.
            05 source-status-one     pic 9.
            05 filler                pic 9.

        *> for comma
         01 user-line            pic x(SMALL-BUFFER).
         01 current-char         usage index.

        *> fsync output
         01 flush-status         usage binary-long.

        *> unix newline, should test for the other two kinds.
         01 newline pic x value x"0a".

        *> ****************************************************************
```

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```
       procedure division.
       start-here.

      *> Parse command line options if any
           move high-values to current-arg
           accept current-arg from argument-value end-accept
           perform until done-arguments
               evaluate true
                   when helping
                       perform show-help
                   when versioning
                       perform show-version
                   when use-file
                       perform read-program-from-file
               end-evaluate

               move high-values to current-arg
               accept current-arg from argument-value end-accept
           end-perform

      *> Accept program text from command line
           if not file-loaded then
               accept argv from command-line end-accept
               set tape-length to BIG-BUFFER

               if argv not equal spaces then
                   move argv to program-source
               else
                   move "small s\.c\.r\.i\.p\.t\.10."
                     to program-source
               end-if
           end-if

           set tape-length to length(trim(program-source))
           set tape-position to 1
       .

      *>
      *> The big goto
      *>
       process-next.
           if tape-position greater than tape-length then
               go to script-end
           end-if

           compute
               ascii-value = ord(source-tape(tape-position))
           end-compute

           go to
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo

               echo L034 L035 L036 echo echo echo L040
               echo echo echo L044 L045 L046 L047 echo
```

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```
               L049 L050 L051 L052 L053 L054 L055 L056
               L057 L058 L059 L060 L061 echo L063 L064

               L065 echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo L092 L093 L094 echo echo

               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo L124 echo L126 echo echo

               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo

               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo

               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo

               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
               echo echo echo echo echo echo echo echo
           depending on ascii-value
       .

      *> If we get here, the small engine is broken, and it would be
      *>  uncool to fall through to the stepper.
       fail-safe.
           display
               "small engine problem. You get to laugh, and yell FAIL"
           end-display
           go script-end
       .

      *> we get here by jumping.  Handles digits and symbols that
      *>  need to pass literal value context to the next symbol
      *>  all other symbols reset context registers
       next-step.
           set tape-position up by 1
           go to process-next
       .

      *> or here for most symbols
       next-reset.
           move 0 to last-number
           set leading-zero numbering to false
           set tape-position up by 1
```

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```
           go to process-next
       .

      *> The end.  s.c.r.i.p.t. complete.
       script-end.
      *> single quote CALL sets return-code, so clear it just in case
           move 0 to return-code
           goback.
      *> ****************************************************************

      *> The opcodes
      *> Ordinals start at 1
      *> Default runtime is to check for and execute colon defs, or echo
       echo.
           if colon-offsets(ascii-value) equal zero then
               display
                   source-tape(tape-position) with no advancing
               end-display
               move 0 to last-number
               set leading-zero numbering to false
           else
               set colons up by 1
               set colon-returns(colons) to tape-position
               set tape-position to
                   colon-offsets(ascii-value)
           end-if
           compute
               ascii-value = ord(source-tape(tape-position))
           end-compute

      *> Call step instead of reset so colon definitions can assume a
      *>  literal context when called.
           go to next-step
       .

      *> GOTO tape position
       L034.
     >>D    display " STORE " end-display
           if numbering then
               if leading-zero then
                   move last-number to tape-position
                   set tape-position down by 1
               else
                   add last-number to tape-position end-add
               end-if
           else
               move memory-cell(current-cell) to tape-position
           end-if

      *> When small implements audio, this will play some Grateful Dead
      *>                       SPACE
      *> as the tape position would be beyond the program source
           if (tape-position greater than tape-length)
           or (tape-position less than zero) then
               set tape-length to tape-position
           end-if
```

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```
           go to next-reset
       .

      *> Quote in a string
       L035.
     >>D    display " QUOTE " end-display
           if numbering then
               move last-number to current-cell
               if current-cell is greater than maximum-cell then
                   set maximum-cell to current-cell
               end-if
           end-if

           perform until tape-position is greater than tape-length
               set tape-position up by 1
               if source-tape(tape-position) = '"' then
                   exit perform
               end-if
               move source-tape(tape-position) to character-value
               if leading-zero then
                   perform rot13-convert
               end-if
               compute memory-cell(current-cell) =
                   ord(character-value) - 1
               end-compute

      *> Do a little dance, to avoid cell advance if no more characters
               set tape-position up by 1
               if (tape-position less than or equal to tape-length) and
                  (source-tape(tape-position) not = '"') then
                   set current-cell up by 1
                   if current-cell is greater than maximum-cell then
                       set maximum-cell to current-cell
                   end-if
               end-if
               set tape-position down by 1
           end-perform

           go to next-reset
       .

      *> Display as number
       L036.
     >>D    display " OCTOTHORP " end-display
           if numbering then
               move last-number to default-value
           else
               move memory-cell(current-cell) to default-value
           end-if
           if leading-zero then
               move default-value to zeroed-number
               display zeroed-number with no advancing end-display
           else
               move default-value to formatted-number
               display
                   trim(formatted-number leading) with no advancing
               end-display
```

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```
           end-if

           go to next-reset
       .

      *> single quote CALL
       L040.
      >>D     display " CALL " end-display
           set first-quote to tape-position
           set second-quote to tape-position
           set second-quote up by 1
           perform until second-quote > tape-length
               if source-tape(second-quote) equal "'" then
                   set tape-position to second-quote
                   exit perform
               end-if
               set second-quote up by 1
           end-perform

           set second-quote down by 1
           compute
               symbol-len = second-quote - first-quote
           end-compute
           set first-quote up by 1

      *> If numbering, then set cell to last-number
           if numbering then
               set current-cell to last-number
               if current-cell greater than maximum-cell then
                   set maximum-cell to current-cell
               end-if
           end-if

      *> For leading zero, pass address, leave status in last-number
           if leading-zero then
               call program-source(first-quote : symbol-len) using
                   by value address of memory-cell(current-cell)
                   returning last-number
                   on exception
                       display "failed: "
                           program-source(first-quote : symbol-len)
                       end-display
               end-call
           else
               call program-source(first-quote : symbol-len) using
                   by value memory-cell(current-cell)
                   returning memory-cell(current-cell)
                   on exception
                       display "failed: "
                           program-source(first-quote : symbol-len)
                       end-display
              end-call
           end-if

           go to next-step
       .
```

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```
      *> Add
       L044.
   >>D     display " PLUS " end-display
           if leading-zero then
               move zero to memory-cell(current-cell)
           end-if
           if numbering then
               move last-number to default-value
           else
               move 1 to default-value
           end-if
           add default-value to memory-cell(current-cell) end-add

           go to next-reset
       .

      *> Accept input
       L045.
   >>D     display " COMMA " end-display
           accept user-line end-accept

           if numbering then
               move last-number to default-value
           else
               move 1 to default-value
           end-if

           set current-char to 1
           perform until default-value equal zero
               compute memory-cell(current-cell) =
                   ord(user-line(current-char:1)) - 1
               end-compute
               set default-value down by 1
               if default-value greater than zero then
                   set current-char up by 1
                   set current-cell up by 1
                   if current-cell greater than maximum-cell then
                       set maximum-cell to current-cell
                   end-if
               end-if
           end-perform

           go to next-reset
       .

      *> Subtract
       L046.
   >>D     display " MINUS " end-display
           if leading-zero then
               move zero to memory-cell(current-cell)
           end-if
           if numbering then
               move last-number to default-value
           else
               move 1 to default-value
           end-if
           subtract
```

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```
               default-value from memory-cell(current-cell)
           end-subtract

           go to next-reset
       .

      *> Output as ASCII
       L047.
      >>D     display " DOT " end-display
           if numbering then
               move last-number to default-value
           else
               move memory-cell(current-cell) to default-value
           end-if
           move char(default-value + 1) to character-value
           if leading-zero then
               perform rot13-convert
           end-if
           if character-value not equal 10 then
               display character-value with no advancing end-display
           else
               call "fsync" using by value 1
                   returning flush-status
                   on exception display "fsync fail" end-display
               end-call
           end-if

           go to next-reset
       .

      *> Zero, with special rules for leading
       L049.
      >>D     display " Zero " end-display
           if numbering then
               multiply
                   last-number by 10 giving last-number
               end-multiply
           else
              set last-number to zero
              set leading-zero numbering to true
           end-if
           go to next-step
       .

      *> Digits, build up number
       L050.
      >>D     display " One " end-display
           perform prep-digit
           add 1 to last-number end-add
           go to next-step
       .

       L051.
      >>D     display " Two " end-display
           perform prep-digit
           add 2 to last-number end-add
           go to next-step
```

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```
      .

      L052.
   >>D    display " Three " end-display
          perform prep-digit
          add 3 to last-number end-add
          go to next-step
      .

      L053.
   >>D    display " Four " end-display
          perform prep-digit
          add 4 to last-number end-add
          go to next-step
      .

      L054.
   >>D    display " Five " end-display
          perform prep-digit
          add 5 to last-number end-add
          go to next-step
      .

      L055.
   >>D    display " Six " end-display
          perform prep-digit
          add 6 to last-number end-add
          go to next-step
      .

      L056.
   >>D    display " Seven " end-display
          perform prep-digit
          add 7 to last-number end-add
          go to next-step
      .

      L057.
   >>D    display " Eight " end-display
          perform prep-digit
          add 8 to last-number end-add
          go to next-step
      .

      L058.
   >>D    display " Nine " end-display
          perform prep-digit
          add 9 to last-number end-add
          go to next-step
      .

      L059.
   >>D    display " COLON " end-display
          if numbering then
             move last-number to default-value
             add 1 to default-value end-add
          else
```

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```
            set tape-position up by 1
            if tape-position not greater than tape-length
                move ord(source-tape(tape-position)) to default-value
            else
                go to next-reset
            end-if
        end-if

        set colon-offsets(default-value) to tape-position
        perform until source-tape(tape-position) = ";"
            set tape-position up by 1
            if tape-position greater than tape-length then
                display "end of tape before ;" end-display
                exit perform
            end-if
        end-perform

        go to next-reset
    .

    L060.
>>D     display " SEMI-COLON " end-display
        if colons greater than zero then
            set tape-position to colon-returns(colons)
            set colons down by 1
        else
  *> no colon, semi-colon can suck it, and be ignored.
            continue
        end-if

        go to next-reset
    .

    L061.
>>D     display " LESS-THAN " end-display
        if leading-zero then
            set current-cell to maximum-cell
        end-if
        if numbering then
            move last-number to default-value
        else
            move 1 to default-value
        end-if

        subtract default-value from current-cell end-subtract

        go to next-reset
    .

    L063.
>>D     display " GREATER-THAN " end-display
        if leading-zero then
            move zero to current-cell
        end-if
        if numbering then
            move last-number to default-value
        else
```

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```
            move 1 to default-value
        end-if

        add default-value to current-cell end-add
        if current-cell greater than maximum-cell then
            set maximum-cell to current-cell
        end-if

        go to next-reset
    .

    L064.
>>D     display " QUESTIONMARK " end-display
        if leading-zero then
            display "Debug" end-display
        end-if
        if numbering then
            move last-number to default-value
        else
            compute last-number = random() * 1000 end-compute
            compute
                last-number = mod(last-number, 255) + 1
            end-compute
        end-if

        move last-number to memory-cell(current-cell)
        go to next-reset
    .

    L065.
>>D     display " FETCH " end-display
        if numbering then
            add
                last-number to current-cell giving fetch-cell
            end-add
        else
            move current-cell to fetch-cell
            set numbering to true
        end-if
        if leading-zero then
            if last-number equal zero then
                move current-cell to fetch-cell
            else
                move last-number to fetch-cell
            end-if
        end-if

        if fetch-cell greater than maximum-cell then
            set maximum-cell to fetch-cell
        end-if

        move memory-cell(fetch-cell) to last-number

        go to next-step
    .

    L092.
```

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```
    >>D     display " BRACKET " end-display
            set this-loop up by 1
            if numbering then
                move last-number to loop-limit
            else
                if loop-is-numbered(this-loop) equal high-value then
                    move loop-limits(this-loop) to loop-limit
                else
                    move memory-cell(current-cell) to loop-limit
                end-if
            end-if

      *> If current is zero, skip to end of the (nested) loop
            move 0 to bracket-counter
            if loop-limit equal zero then
                move low-value to loop-is-numbered(this-loop)
                set this-loop down by 1
                perform until tape-position greater than tape-length
                    set tape-position up by 1
                    if source-tape(tape-position) = '[' then
                        add 1 to bracket-counter end-add
                    end-if
                    if source-tape(tape-position) = "]" then
                        if bracket-counter = zero then
                            exit perform
                        end-if
                        subtract 1 from bracket-counter end-subtract
                    end-if
                end-perform
            else
      *> small allows for counted loops, and needs to remember
                if numbering then
                    move high-value to loop-is-numbered(this-loop)
                    move loop-limit to loop-limits(this-loop)
                end-if
                set loop-offsets(this-loop) to tape-position
      *> Next step will advance, decrement it here to account
                set loop-offsets(this-loop) down by 1
            end-if

            go to next-reset
        .

      *> Output next operator, regardless
       L093.
    >>D     display " BACKSLASH " end-display
            if numbering then
                move last-number to default-value
            else
                move 1 to default-value
            end-if

      *> Special backslash escape mode  with 0\
            if default-value equal zero then
                perform until tape-position equal to tape-length
                    set tape-position up by 1
                    if source-tape(tape-position) = '\' then
```

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```
                    exit perform
                end-if
                display
                   source-tape(tape-position) with no advancing
                end-display
            end-perform
            if tape-position greater than tape-length then
                go to script-end
            end-if
        else
            perform until default-value equal zero
                set tape-position up by 1
                move source-tape(tape-position) to character-value
                if leading-zero then
                    perform rot13-convert
                end-if
                display character-value with no advancing end-display
                set default-value down by 1
            end-perform
       end-if

       go to next-reset
    .

    L094.
>>D     display " CLOSE BRACKET " end-display
        if loop-is-numbered(this-loop) equal high-value then
            set loop-limits(this-loop) down by 1
        end-if

        set tape-position to loop-offsets(this-loop)
        set this-loop down by 1

        go to next-reset
    .

    L124.
>>D     display " BRACE " end-display
        if numbering then
            move last-number to enter-block
        else
            move memory-cell(current-cell) to enter-block
        end-if

  *> If current is not zero, skip to end of the (nested) block
        move 0 to bracket-counter
        if enter-block not equal zero then
            perform until tape-position greater than tape-length
                set tape-position up by 1
                if source-tape(tape-position) = '{' then
                    add 1 to bracket-counter end-add
                end-if
                if source-tape(tape-position) = "}" then
                    if bracket-counter = zero then
                        exit perform
                    end-if
                    subtract 1 from bracket-counter end-subtract
```

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```
                end-if
            end-perform
        end-if

        go to next-reset
    .

    L126.
>>D     display " CLOSE BRACE " end-display

        go to next-reset
    .

  *>
  *> Support routines
  *>

  *> code common to all digits, except 0
   prep-digit.
        if numbering then
            multiply
                last-number by 10 giving last-number
            end-multiply
        else
           set last-number to zero
           set numbering to true
        end-if
    .

  *> secret sam decoder rings
   rot13-convert.
        inspect character-value converting
             "ABCDEFGHIJKLMNOPQRSTUVWXYZabcdefghijklmnopqrstuvwxyz"
                  to
             "NOPQRSTUVWXYZABCDEFGHIJKLMnopqrstuvwxyzabcdefghijklm"
    .

  *> --file support
   read-program-from-file.
        set tape-length to 0
        accept program-filename from argument-value end-accept

        if program-filename equal spaces then
            move 27 to tape-length
            move "small s\.c\.r\.i\.p\.t\.10." to program-source
        else
            open input program-channel
            if source-status-one not equal zero then
                display "Sorry, file " trim(program-filename)
                        " not accessible."
                end-display
                move 1 to return-code
                goback
            end-if

            read program-channel
                at end set no-more-source to true
```

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```
            end-read
            perform until no-more-source
                set tape-length up by length(trim(source-line))
                set tape-length up by 1
      *> add in newline, stripped by LINE SEQUENTIAL
                move concatenate(trim(program-source)
                        trim(source-line) newline)
                to program-source
                read program-channel
                    at end set no-more-source to true
                end-read
            end-perform
            close program-channel
      *> Remove final newline as possibly unwanted output
            if source-tape(tape-length) equal newline then
                set tape-length down by 1
            end-if
        end-if
        set file-loaded to true
    .

    show-version.
        display "small s.c.r.i.p.t. 0.6.2" end-display
        goback
    .

    show-help.

    >>SOURCE FORMAT IS FREE
        display
            "small s.c.r.i.p.t." newline
            "-v0.6.2  Aug 2013-" newline
            "A single character read interpret programming toyol" newline
            "by Brian Tiffin, while horsing around with autoconf and OpenCOBOL"
            newline newline
            "Operators include:" newline
            "  ' allowing CALL of a link library symbol" newline
            '  " for placing strings into memory' newline
            "  : colon definitions of the next character" newline
            "  ; marking the end of a colon definition" newline
            "  > for advancing the memory pointer" newline
            "  < for retreating the memory pointer" newline
            "  + adding to current cell" newline
            "  - subtracting from current cell" newline
            "  [ opening a (nestable) enter when not zero loop" newline
            "  ] closing a loop" newline
            "  { opening a (nestable) enter on zero block" newline
            "  } closing a zero block" newline
            "  . to output ascii" newline
            "  , to accept ascii" newline
            "  # to output number" newline
            "  ? randomize cell or numbered debug" newline
            "  @ fetch numbered cell and treat as literal number to next operator"
            newline
            "  \ to echo next operator, or number thereof" newline
            "  ! set source tape position to value or relative value" newline
            "  0 leading zeros further modify behaviour of next operator" newline
```

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```
                "  1 to 9 for building up numbers, which modify behaviour of"
                " next operator" newline
                "  all other characters are echoed" newline
                "Usage: small [--help] [--version] [--file name] [program-text]"
                newline
            end-display
        >>SOURCE FORMAT IS FIXED

            goback
        .
        end program small.
```

Other examples of small s.c.r.i.p.t.s (the 10. operation means display newline, ASCII 10).

```
prompt$ small
small s.c.r.i.p.t.

prompt$ small '65.10.'
A

prompt$ small '065+.10.'
A

prompt$ small '05+[@#-]10.'
54321

prompt$ small '"Hello, world">0+01'"'"'puts'"'"'#10.'
Hello, world
13
```

That last one calls the C puts function with Hello, world and displays the return value from puts. Avoiding all the shell quoting, the script is actually:

```
"Hello, world">0+01'puts'#

"Hello, world"  lays down a string
>0+             advances the current cell and lays down a null byte
01              puts a "zeroed" 1 in the immediate value register
'puts'          calls puts with one argument (the 1 taken from the register)
#               displays the result code as a numeric string.
```

small s.c.r.i.p.t. makes you think, but some nifty programs can be written, in just a few characters of source. As a bonus, it's an esolang, written in COBOL.

5.92.1 deadfish

Another completely useless esoteric programming language is `deadfish`.

Four operators, single value.

- i increment
- d decrement
- s square
- o output

Most implementations add an `h` operator, for halt. A bug ridden reference implementation now drives the design of most of the other `deadfish` interpreters.

The spec asks for values from 0 to 256, but the reference only reset the value when it was explicitly -1 or 256, so large and negative numbers are actually prevalent. For example:

```
iissso
```

displays 0, but:

```
iissiso
```

displays 289. Here is a GnuCOBOL implementation, bugs and all.

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
      *> Date:      20131017
Dead  *> Purpose:   Deadfish in COBOL
 fish *> License:   Public Domain
      *> Tectonics: cobc -x deadfish.cob
      *> ***************************************************************
       identification division.
       program-id. deadfish.

       data division.
       working-storage section.
       77 n                    usage binary-int unsigned.
       77 fishhead             pic x.

      *> ***************************************************************
       procedure division.

       perform forever
           call "printf" using z">> " end-call
           call "scanf" using z"%c" fishhead end-call
           if (n equal -1) or (n equal 256) then move 0 to n end-if
           evaluate fishhead
               when equal "d"
                   subtract 1 from n giving n end-subtract
               when equal "i"
                   add 1 to n giving n end-add
               when equal "o"
                   call "printf" using x"25641000" by value n end-call
               when equal "s"
                   multiply n by n end-multiply
               when equal "h"
                   exit perform
               when other
                   call "printf" using x"0a00" end-call
           end-evaluate
       end-perform

Fish   goback.
 dead  end program deadfish.
```

And here's another, with a slightly less, but still nasty user interface.

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************************
      *> Date:      20131017
Dead  *> Purpose:   Deadfish in COBOL
 fish *> License:   Public Domain
      *> Tectonics: cobc -x deadfish.cob
      *> ***************************************************************
       identification division.
       program-id. deadfish.

       data division.
       working-storage section.
       77 n                    usage binary-int unsigned.
       77 p                    pic -z(8)9.
       77 fishhead             pic x(8192).
       77 newline              pic x value x"0a".

      *> ***************************************************************
       procedure division.

       perform forever
           display ">> " with no advancing
           accept fishhead
           perform varying tally from 1 by 1
             until tally > function length(function trim(fishhead))
               if (n equal -1) or (n equal 256) then move 0 to n end-if
               evaluate fishhead(tally:1)
                   when equal "d"
                       subtract 1 from n giving n
                   when equal "i"
                       add 1 to n giving n
                   when equal "o"
                       move n to p
                       display function trim(p)
                   when equal "s"
                       multiply n by n
                   when equal "h"
                       goback
                   when other
                       display newline with no advancing
               end-evaluate
           end-perform
       end-perform

Fish   goback.
 dead  end program deadfish.
```

5.93 How do I determine the amount of memory available?

With modern operating systems, this can be a tricky business, fraught with complexities.

For GNU/Linux systems, the `sysinfo` function, and corresponding structures is likely the best way.

```
#!/usr/local/bin/cobc -xj
GCobol >>SOURCE FORMAT IS FREE
```

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```
>>IF docpass NOT DEFINED
      *> ****************************************************************
      *>****J* gnucobol/system-info
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20151209  Modified: 2015-12-10/18:32-0500
      *> LICENSE
      *>   Copyright 2015 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or greater)
      *> PURPOSE
      *>   Display sysinfo structure or free ram
      *> TECTONICS
      *>   cobc -x -g -debug system-info.cob
      *> ****************************************************************
       identification division.
       program-id. system-info.
       author. Brian Tiffin.
       date-written. 2015-12-09/23:38-0500.
       date-modified. 2015-12-10/18:32-0500.
       installation. GnuCOBOL 2.0.

       environment division.
       configuration section.
       source-computer.
       object-computer.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 sysinfo-code    usage binary-long.
       01 sysinfo.
          05 uptime       usage binary-c-long.
          05 loads        usage binary-c-long unsigned occurs 3 times.
          05 totalram     usage binary-c-long unsigned.
          05 freeram      usage binary-c-long unsigned.
          05 sharedram    usage binary-c-long unsigned.
          05 bufferram    usage binary-c-long unsigned.
          05 totalswap    usage binary-c-long unsigned.
          05 freeswap     usage binary-c-long unsigned.
          05 procs        usage unsigned-short.
          05 totalhigh    usage binary-c-long unsigned sync.
          05 freehigh     usage binary-c-long unsigned.
          05 mem-unit     usage binary-long   unsigned.
          05 filler       pic x(20).

       01 sys-show.
          05 uptime       pic zz,zzz,zzz,zzz,zzz,zzz,zz9.
          05 loads        pic zz,zzz,zzz,zzz,zzz,zzz,zz9 occurs 3 times.
          05 totalram     pic zz,zzz,zzz,zzz,zzz,zzz,zz9.
          05 freeram      pic zz,zzz,zzz,zzz,zzz,zzz,zz9.
          05 sharedram    pic zz,zzz,zzz,zzz,zzz,zzz,zz9.
          05 bufferram    pic zz,zzz,zzz,zzz,zzz,zzz,zz9.
          05 totalswap    pic zz,zzz,zzz,zzz,zzz,zzz,zz9.
          05 freeswap     pic zz,zzz,zzz,zzz,zzz,zzz,zz9.
          05 procs        pic bbbbbbbbbbbbbbbbbbbbzz,zz9.
```

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```
           05 totalhigh    pic zz,zzz,zzz,zzz,zzz,zzz,zz9.
           05 freehigh     pic zz,zzz,zzz,zzz,zzz,zzz,zz9.
           05 mem-unit     pic bbbbbbbbbbbbbz,zzz,zzz,zz9.
           05 filler       pic x(20).

       01 enumerate        usage binary-c-long.
       01 show-total       pic zzzzzzzzzzzzzz999.
       01 show-free        pic zzzzzzzzzzzzzz999.

       01 cli              pic x(32).
          88 freeing       values "--free", "--memory", "free".
          88 pretty        values "--pretty", "pretty".

      *> ****************************************************************
       procedure division.
       accept cli from command-line

       call "sysinfo" using sysinfo returning sysinfo-code
           on exception
               display "no sysinfo linkage" upon syserr
               perform hard-exception
       end-call
       if sysinfo-code not equal 0 then
           call "perror" using "sysinfo: "
           perform hard-exception
       end-if

       if freeing then
           compute enumerate = totalram of sysinfo * mem-unit of sysinfo
           move enumerate to show-total
           compute enumerate = freeram of sysinfo * mem-unit of sysinfo
           move enumerate to show-free
           display trim(show-free) " of " trim(show-total)
           goback
       end-if

       if pretty then
           move corresponding sysinfo to sys-show
           perform varying tally from 1 by 1 until tally > 3
               move loads of sysinfo(tally) to loads of sys-show(tally)
           end-perform

           display "uptime   : " uptime of sys-show
           display "loads(1) : " loads of sys-show(1)
           display "loads(2) : " loads of sys-show(2)
           display "loads(3) : " loads of sys-show(3)
           display "totalram : " totalram of sys-show
           display "freeram  : " freeram of sys-show
           display "bufferram: " bufferram of sys-show
           display "totalswap: " totalswap of sys-show
           display "freeswap : " freeswap of sys-show
           display "procs    : " procs of sys-show
           display "totalhigh: " totalhigh of sys-show
           display "freehigh : " freehigh of sys-show
           display "mem-unit : " mem-unit of sys-show
       else
           display "uptime   :" uptime of sysinfo
```

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```
           display "loads(1) : " loads of sysinfo(1)
           display "loads(2) : " loads of sysinfo(2)
           display "loads(3) : " loads of sysinfo(3)
           display "totalram : " totalram of sysinfo
           display "freeram  : " freeram of sysinfo
           display "bufferram: " bufferram of sysinfo
           display "totalswap: " totalswap of sysinfo
           display "freeswap : " freeswap of sysinfo
           display "procs    : " procs of sysinfo
           display "totalhigh: " totalhigh of sysinfo
           display "freehigh : " freehigh of sysinfo
           display "mem-unit : " mem-unit of sysinfo
       end-if
       goback.
      *> ****************************************************************

      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .

       end program system-info.
      *> ****************************************************************
      *>****
>>ELSE
!doc-marker!
========
system-info
========

.. contents::

Introduction
------------

Tectonics
---------

    prompt$  cobc -x -g -debug system-info.cob

Usage
-----
```

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```
    prompt$ chmod +x system-info.cob
    prompt$ ./system-info.cob
    prompt$ ./system-info [free | pretty]

Source
------

.. include::  system-info.cob
   :code: cobolfree
>>END-IF
```

And an example run of:

```
prompt$ ./system-info.cob
uptime   :+0000000000000117744
loads(1) : 0000000000000003264
loads(2) : 0000000000000005920
loads(3) : 0000000000000009536
totalram : 0000000007809716224
freeram  : 0000000003545804800
bufferram: 0000000000850726912
totalswap: 0000000007751069696
freeswap : 0000000007751069696
procs    : 00490
totalhigh: 0000000000000000000
freehigh : 0000000000000000000
mem-unit : 0000000001

prompt$ ./system-info pretty
uptime   :                    117,810
loads(1) :                        608
loads(2) :                      1,408
loads(3) :                      4,352
totalram :              7,809,716,224
freeram  :              3,703,771,136
bufferram:                845,275,136
totalswap:              7,751,069,696
freeswap :              7,751,069,696
procs    :                        483
totalhigh:                          0
freehigh :                          0
mem-unit :                          1

prompt$ ./system-info free
3706732544 of 7809716224
```

5.94 What is CBL_OC_GETOPT?

`CBL_OC_GETOPT` is one of the stock library routines that ships with GnuCOBOL. By Philipp Böhme, one of the contributing compiler authors.

It allows for complex command line option handling akin to POSIX `getopt` and GNU `getopt_long` functions. http://www.gnu.org/software/libc/manual/html_node/Getopt.html

These usage example are modified from the GnuCOBOL `make check` testsuite.

```
*> check combination of long and short options
  IDENTIFICATION DIVISION.
  PROGRAM-ID. getopt-test.
  DATA DIVISION.
  WORKING-STORAGE SECTION.
     01 long-options.
          05 OPTIONRECORD OCCURS 2 TIMES.
              10 option-name  PIC X(25).
              10 HAS-VALUE    PIC 9.
              10 VALPOINT     POINTER     VALUE NULL.
              10 VAL          PIC X(4).

      01 short-options PIC X(256).
      01 LONGIND PIC 99.
      01 LONG-ONLY PIC 9 VALUE 1.
      01 RETURN-CHAR PIC X(4).
      01 OPT-VAL PIC X(10).
      01 RET-DISP PIC S9 VALUE 0.

      01 COUNTER PIC 9 VALUE 0.

  PROCEDURE DIVISION.
      MOVE "jkl"     TO SO.

      MOVE "version" TO ONAME     (1).
      MOVE 0         TO HAS-VALUE (1).
      MOVE "v"       TO VAL       (1).

      MOVE "verbose" TO ONAME     (2).
      MOVE 0         TO HAS-VALUE (2).
      MOVE "V"       TO VAL       (2).

      PERFORM WITH TEST AFTER
              VARYING COUNTER FROM 0 BY 1
              UNTIL RETURN-CODE = -1
         CALL 'CBL_OC_GETOPT' USING
            BY REFERENCE SO LO LONGIND
            BY VALUE     LONG-ONLY
            BY REFERENCE RETURN-CHAR OPT-VAL
         END-CALL

         EVALUATE COUNTER
            WHEN 0
               IF RETURN-CHAR NOT = 'v' THEN
                  DISPLAY '0-ERROR: ' RETURN-CHAR END-DISPLAY
               END-IF
            WHEN 1
               IF RETURN-CHAR NOT = 'V' THEN
                  DISPLAY '1-ERROR: ' RETURN-CHAR END-DISPLAY
               END-IF
            WHEN 2
               IF RETURN-CHAR NOT = 'j' THEN
                  DISPLAY '2-ERROR: ' RETURN-CHAR END-DISPLAY
               END-IF
            WHEN 3
               IF RETURN-CHAR NOT = 'k' THEN
                  DISPLAY '3-ERROR: ' RETURN-CHAR END-DISPLAY
```

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```
               END-IF
            WHEN 4
               IF RETURN-CHAR NOT = 'l' THEN
                  DISPLAY '4-ERROR: ' RETURN-CHAR END-DISPLAY
               END-IF
            WHEN 5
               IF RETURN-CODE NOT = -1 THEN
                  MOVE RETURN-CODE TO RET-DISP
                  DISPLAY 'last RETURN-CODE wrong: ' RET-DISP
                  END-DISPLAY
               END-IF
               EXIT PERFORM
         END-EVALUATE
      END-PERFORM.

      MOVE 0 TO RETURN-CODE.

      IF COUNTER NOT = 5 THEN
         MOVE RETURN-CODE TO RET-DISP
         DISPLAY 'CBL_OC_GETOPT returned -1 too early: ' COUNTER
         END-DISPLAY
      END-IF.

      STOP RUN.
```

As this is from the testsuite, there is a very particular order expected:

```
prompt$ cobc -x getopt-test.cob
prompt$ ./getopt-test --version --verbose -jkl
```

Gives no output, all the tests pass. Other options will trigger error responses:

```
$ ./getopt-test -j -k -l -v -V
0-ERROR: j
1-ERROR: k
2-ERROR: l
./getopt-main: option '-v' is ambiguous; possibilities: '--version' '--verbose'
3-ERROR: ?
./getopt-main: unrecognized option '-V'
4-ERROR: ?
```

As of December 2015, this library routine holds promise, but still needs some work.

5.95 Does GnuCOBOL work with shell scripting?

Yes, very well actually.

There is a wide selection of available POSIX shells. Bash likely being the most common, but not in any way the only shell command processor. Other common shells include `csh`, `zsh`, `ksh`, `dash` to name a few. But shells can also get more exotic such as Zoidberg, a Perl based shell, IPython which is an interactive Python shell, tclsh and wish for Tcl and Tk, among others. This entry will focus on `bash`.

POSIX shells allow for what is technically called an interpreter directive, commonly called a “shbang” or “hashbang” line.

```
#!/bin/bash
```

The octothorpe followed by exclamation mark is a special value that is used by the program loader to decide what program is in charge of current command processing. `cobc` can take part in this scheme.

```
#!/usr/local/bin/cobc -xjF
identification division.
program-id. hello.
procedure division.
display "Hello, shell"
goback.
```

That 'script' will cause POSIX to exec the `cobc` program and treat it as the current interpreter. The lines that follow become the standard input to the interpreter, in this case `cobc`. The current script filename is passed to the new shell processor along with a single argument.

There can normally only be one space delimited argument passed to these shell programs, but with the smart option processor built into cobc, the single character command options can be merged into a single string and each option flag processed as if they were separate options.

So, back to the script. -x to generate an executable, -j to run job at end of compile, and -F to treat the source code as FREE format.

```
prompt$ chmod +x script-sample.cob
prompt$ ./script-sample.cob
Hello, shell
```

The script was marked as executable with `chmod +x` and then evaluated. To see what is going on, the verbose flag can be used.

```
#!/usr/local/bin/cobc -xjFv
identification division.
program-id. hello.
procedure division.
display "Hello, shell"
goback.
```

With another run sample of:

```
prompt$ ./script-sample.cob
Command line:   /usr/local/bin/cobc -xjFv ./script-sample.cob
Preprocessing:  ./script-sample.cob -> /tmp/cob23060_0.cob
Return status:  0
Parsing:        /tmp/cob23060_0.cob (./script-sample.cob)
Return status:  0
Translating:    /tmp/cob23060_0.cob -> /tmp/cob23060_0.c (./script-sample.cob)
Executing:      gcc -c -I/usr/local/include -pipe -Wno-unused -fsigned-char
                -Wno-pointer-sign -o "/tmp/cob23060_0.o" "/tmp/cob23060_0.c"
Return status:  0
Executing:      gcc -Wl,--export-dynamic -o "script-sample"
                "/tmp/cob23060_0.o" -L/usr/local/lib -lcob -lm -lgmp
                -lncursesw -ldb -ldl
Return status:  0
Executing:      ./script-sample
Hello, shell
Return status:  0
```

This sequence opens up a world of GnuCOBOL "scripts". They are actually compiled to binary and executed by `cobc` but still look and feel like scripts.

The `-j` job run option was added to GnuCOBOL in October of 2015. Along with another powerful option, compile from standard input when given `-` as an input filename. These two `cobc` arguments can be used to great effect with COBOL shell scripting.

```
#!/bin/bash
cobc -x -o fromhere - <<"EOCode"

      *> Modified: 2015-12-08/06:46-0500
       identification division.
       program-id. SAMPLE.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.

       01 data-in pic x(64).

       procedure division.
       demonstration section.

       accept data-in
       display trim(data-in)

       goback.
       end program SAMPLE.
EOCode
if [ $? -eq 0 ]; then
    ./fromhere <<EOD
Process $$ running $0 with shell options $-
EOD
    ./fromhere <<"EOD"
Process $$ running $0 with shell options $-
EOD
fi
```

The script calls `cobc` and asks for a compile from standard input. That standard input is actually from a shell `here document` which reads lines up to (but not including the **EOCode** line). Note that this is not the same as the cobc interpreter directive. In this case `bash` is the command processor, and `cobc` is invoked as part of a "normal" shell script. Without the `-o fromhere` option, compiling from standard in will default to using an `a.out` destination name.

During the compile steps, the `-j` command line option runs the program, with another `here document` used as the COBOL program standard input. The *ACCEPT* (page 187) verb reads this standard in data as if it were typed on the `CONSOLE` device. To demonstrate the difference between quoted and unquoted here documents, the program is run twice; with unquoted and with quoted shell provided standard input.

All of that together, gives:

```
$ ./fromhere.cob
Process 23135 running ./fromhere.cob with shell options hB
Process $$ running $0 with shell options $-
```

The first run passes a processed string where `$$` is expanded to current process id, `$0` is expanded to current program name, and `$-` is expanded to the current `bash shell` flag settings. Any and all shell expansion features can be used here, including subshell replacement with `$()`.

The second run passes the quoted here document without shell expansion and is passed literally to the COBOL program.

Not only can GnuCOBOL be scripted, it can be scripted along with sample data. Not only that, but sample data can be literal, or can include shell processing before it is passed on to a COBOL program.

Here is a program that reproduces itself. But it is not a *Quine* (page 1439) as this script accesses external data. That data being the disk copy of the script itself. See the *Quine* (page 1439) note for an actual Quine in GnuCOBOL.

```
#!/bin/bash
cobc -x -o reproduce - <<"END-OF-CODE"
      *> Modified: 2015-12-16/01:36-0500
       identification division.
       program-id. reproduce.
       author. Brian Tiffin.
       remarks. Example, donated to the Public Domain.
       installation. Requires GnuCOBOL 2r631 or greater.

       data division.
       working-storage section.

       01 data-in pic x(64).

       procedure division.
       demonstration section.

       perform until exit
           accept data-in
               on exception exit perform
           end-accept
           display function trim(data-in trailing)
       end-perform

       goback.
       end program reproduce.
END-OF-CODE
if [ $? -eq 0 ]; then
    ./reproduce <<EOD
$(cat reproduce.cob)
EOD
fi
```

Giving:

```
prompt$ chmod +x reproduce.cob
prompt$ ./reproduce.cob
```

```
#!/bin/bash
cobc -x -o reproduce - <<"END-OF-CODE"
      *> Modified: 2015-12-16/01:37-0500
       identification division.
       program-id. reproduce.
       author. Brian Tiffin.
       remarks. Example, donated to the Public Domain.
```

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```
       installation. Requires GnuCOBOL 2r631 or greater.

       data division.
       working-storage section.

       01 data-in pic x(80).

       procedure division.
       demonstration section.

       perform until exit
           accept data-in
               on exception exit perform
           end-accept
           display function trim(data-in trailing)
       end-perform

       goback.
       end program reproduce.
END-OF-CODE
if [ $? -eq 0 ]; then
    ./reproduce <<EOD
$(cat reproduce.cob)
EOD
fi
```

And as a small proof that the reproduction matches the original:

```
prompt$ ./reproduce.cob | diff reproduce.cob -
prompt$
```

5.96 Can GnuCOBOL generate Postscript?

Yes. In two modes. Postscript is just text, a programming language. Simple *DISPLAY* (page 248) or *WRITE* (page 433) statements can generate Postscript lines and files.

```
GCobol >>SOURCE FORMAT IS FREE
      *> ****************************************************************
      *>****J* gnucobol/tops-1
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20151220  Modified: 2015-12-20/07:55-0500
      *> LICENSE
      *>   Copyright 2015 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or greater)
      *> PURPOSE
      *>   Display some Postscript.
      *> TECTONICS
      *>   cobc -x -g -debug tops-1.cob
      *> ****************************************************************
       identification division.
       program-id. tops-1.
       author. Brian Tiffin.
```

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```
       date-written. 2015-12-20/04:30-0500.
       date-modified. 2015-12-20/07:55-0500.
       date-compiled.
       installation. Requires ghostscript.
       remarks. Hello, Postscript.
       security.

      *> ****************************************************************
       procedure division.
       display "%!PS"
       display "/Times-Roman 20 selectfont"
       display "72 396 moveto"
       display "(Hello, postscript) show"
       display "showpage"
       goback.
       end program tops-1.
      *> ****************************************************************
      *>****
```

would output text lines suitable for piping to `gs` or `gv`, or other Postscript interpreter.

`prompt$ cobc -xj tops-1.cob` producing:

```
%!PS
/Times-Roman 20 selectfont
72 396 moveto
(Hello, postscript) show
showpage
```

And with `prompt$ cobc -xj tops-1.cob | gv -`

Showing

Hello, postscript

1 inch (72 pts) in and 5.5 inches (396 pts) down an 8.5 by 11 inch page, in a 20pt Times-Roman font. *It's actually 5 1/2 inches "up" the page, as Postscript places the 0,0 origin at the bottom left corner of the page, just like the first quadrant of most math class graphs, y goes up, x goes across.*

The image above would look much sharper with most modern printers, that copy has gone through some transforms getting into this manual, as an image file.

Adding a little COBOL programming, and this fills a page with "Times-Roman" at font sizes from 5pt to 36pt.

```
GCobol >>SOURCE FORMAT IS FREE
      *> ****************************************************************
      *>****J* gnucobol/tops-2
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20151220  Modified: 2015-12-20/10:10-0500
      *> LICENSE
      *>   Copyright 2015 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or greater)
      *> PURPOSE
      *>   tops-2 program.
      *> TECTONICS
```

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```
      *>   cobc -x -g -debug tops-2.cob
      *> ****************************************************************
       identification division.
       program-id. tops-2.
       author. Brian Tiffin.
       date-written. 2015-12-20/04:30-0500.
       date-modified. 2015-12-20/10:10-0500.
       date-compiled.
       installation. Requires ghostscript.
       remarks. Fill a page with Times-Roman 5pt to 36pt.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 base-y      pic 999 value 792.   *> 11 inches at 72 pt.
       01 page-y      pic 999.

       01 show-point  pic zzzz.
       01 show-x      pic z9.
       01 show-y      pic zzz9.
       01 y-point     pic 9999.

      *> ****************************************************************
       procedure division.
       display "%!PS"
       move 72 to show-x
       move 72 to y-point
       compute page-y = base-y - y-point
       move page-y to show-y
       perform varying tally from 5 by 1 until tally > 36
           move tally to show-point
           display "/Times-Roman " tally " selectfont"
           display show-x " "  show-y " moveto "
                   "(Times-Roman " trim(show-point) ") show "
                   400 show-y " moveto "
                   "(at " trim(show-x) " " trim(show-y) ") show"
           add tally to y-point
           compute page-y = base-y - y-point
           move page-y to show-y
       end-perform
       display "showpage"
       goback.

       end program tops-2.
      *> ****************************************************************
      *>****
```

And `cobc -xj tops-2.cob` producing:

```
%!PS
/Times-Roman 00005 selectfont
72  720 moveto (Times-Roman 5) show 400 720 moveto (at 72 720) show
/Times-Roman 00006 selectfont
```

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```
72  715 moveto (Times-Roman 6) show 400 715 moveto (at 72 715) show
/Times-Roman 00007 selectfont
72  709 moveto (Times-Roman 7) show 400 709 moveto (at 72 709) show
/Times-Roman 00008 selectfont
72  702 moveto (Times-Roman 8) show 400 702 moveto (at 72 702) show
/Times-Roman 00009 selectfont
72  694 moveto (Times-Roman 9) show 400 694 moveto (at 72 694) show
/Times-Roman 00010 selectfont
72  685 moveto (Times-Roman 10) show 400 685 moveto (at 72 685) show
/Times-Roman 00011 selectfont
72  675 moveto (Times-Roman 11) show 400 675 moveto (at 72 675) show
/Times-Roman 00012 selectfont
72  664 moveto (Times-Roman 12) show 400 664 moveto (at 72 664) show
/Times-Roman 00013 selectfont
72  652 moveto (Times-Roman 13) show 400 652 moveto (at 72 652) show
/Times-Roman 00014 selectfont
72  639 moveto (Times-Roman 14) show 400 639 moveto (at 72 639) show
/Times-Roman 00015 selectfont
72  625 moveto (Times-Roman 15) show 400 625 moveto (at 72 625) show
/Times-Roman 00016 selectfont
72  610 moveto (Times-Roman 16) show 400 610 moveto (at 72 610) show
/Times-Roman 00017 selectfont
72  594 moveto (Times-Roman 17) show 400 594 moveto (at 72 594) show
/Times-Roman 00018 selectfont
72  577 moveto (Times-Roman 18) show 400 577 moveto (at 72 577) show
/Times-Roman 00019 selectfont
72  559 moveto (Times-Roman 19) show 400 559 moveto (at 72 559) show
/Times-Roman 00020 selectfont
72  540 moveto (Times-Roman 20) show 400 540 moveto (at 72 540) show
/Times-Roman 00021 selectfont
72  520 moveto (Times-Roman 21) show 400 520 moveto (at 72 520) show
/Times-Roman 00022 selectfont
72  499 moveto (Times-Roman 22) show 400 499 moveto (at 72 499) show
/Times-Roman 00023 selectfont
72  477 moveto (Times-Roman 23) show 400 477 moveto (at 72 477) show
/Times-Roman 00024 selectfont
72  454 moveto (Times-Roman 24) show 400 454 moveto (at 72 454) show
/Times-Roman 00025 selectfont
72  430 moveto (Times-Roman 25) show 400 430 moveto (at 72 430) show
/Times-Roman 00026 selectfont
72  405 moveto (Times-Roman 26) show 400 405 moveto (at 72 405) show
/Times-Roman 00027 selectfont
72  379 moveto (Times-Roman 27) show 400 379 moveto (at 72 379) show
/Times-Roman 00028 selectfont
72  352 moveto (Times-Roman 28) show 400 352 moveto (at 72 352) show
/Times-Roman 00029 selectfont
72  324 moveto (Times-Roman 29) show 400 324 moveto (at 72 324) show
/Times-Roman 00030 selectfont
72  295 moveto (Times-Roman 30) show 400 295 moveto (at 72 295) show
/Times-Roman 00031 selectfont
72  265 moveto (Times-Roman 31) show 400 265 moveto (at 72 265) show
/Times-Roman 00032 selectfont
72  234 moveto (Times-Roman 32) show 400 234 moveto (at 72 234) show
/Times-Roman 00033 selectfont
72  202 moveto (Times-Roman 33) show 400 202 moveto (at 72 202) show
/Times-Roman 00034 selectfont
72  169 moveto (Times-Roman 34) show 400 169 moveto (at 72 169) show
```

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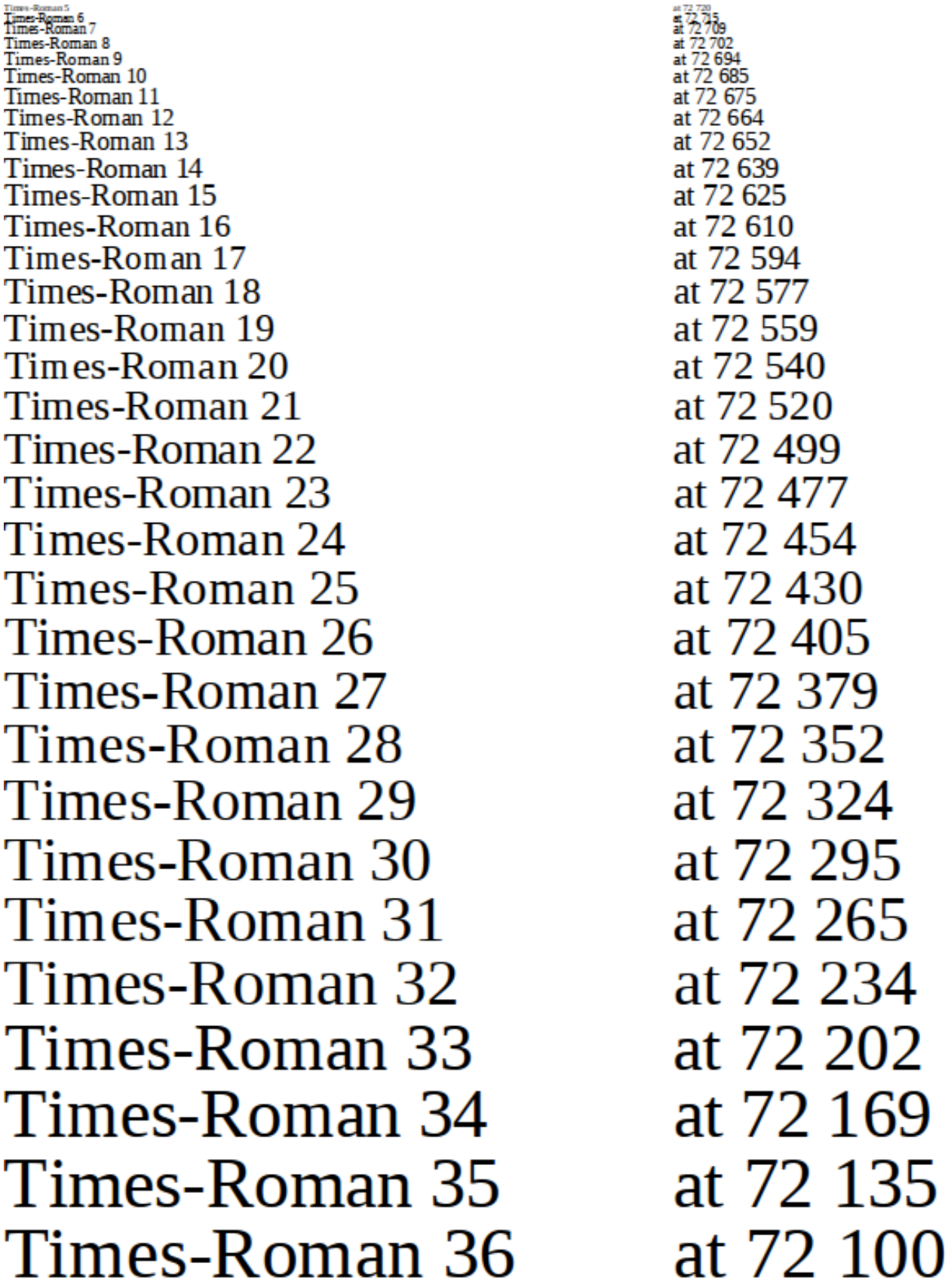
```
/Times-Roman 00035 selectfont
72  135 moveto (Times-Roman 35) show 400 135 moveto (at 72 135) show
/Times-Roman 00036 selectfont
72  100 moveto (Times-Roman 36) show 400 100 moveto (at 72 100) show
showpage
```

And pretty much fills a page to look like:


Times-Roman 5
Times-Roman 6
Times-Roman 7
Times-Roman 8
Times-Roman 9
Times-Roman 10
Times-Roman 11
Times-Roman 12
Times-Roman 13
Times-Roman 14
Times-Roman 15
Times-Roman 16
Times-Roman 17
Times-Roman 18
Times-Roman 19
Times-Roman 20
Times-Roman 21
Times-Roman 22
Times-Roman 23
Times-Roman 24
Times-Roman 25
Times-Roman 26
Times-Roman 27
Times-Roman 28
Times-Roman 29
Times-Roman 30
Times-Roman 31
Times-Roman 32
Times-Roman 33
Times-Roman 34
Times-Roman 35
Times-Roman 36
at 72 720
at 72 715
at 72 709
at 72 702
at 72 694
at 72 685
at 72 675
at 72 664
at 72 652
at 72 639
at 72 625
at 72 610
at 72 594
at 72 577
at 72 559
at 72 540
at 72 520
at 72 499
at 72 477
at 72 454
at 72 430
at 72 405
at 72 379
at 72 352
at 72 324
at 72 295
at 72 265
at 72 234
at 72 202
at 72 169
at 72 135
at 72 100

Same note as before; that is a transformed image, .ps to .eps to .png for inclusion in this document. The real thing looks much sharper.

That's one way GnuCOBOL can generate Postscript, simply as text.

GnuCOBOL can also leverage a Postscript interpreter. Ghostview ships with a shared library, `libgs.so` (or `gs.dll` on Windows) for just this purpose.

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****J* gnucobol/tops
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20151220  Modified: 2015-12-20/09:50-0500
      *> LICENSE
      *>   Copyright 2015 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or greater)
      *> PURPOSE
      *>   tops program.
      *> TECTONICS
      *>   cobc -x -g -debug tops.cob -lgs
      *> ***************************************************************
       identification division.
       program-id. tops.
       author. Brian Tiffin.
       date-written. 2015-12-20/04:30-0500.
       date-modified. 2015-12-20/09:50-0500.
       date-compiled.
       installation. Requires libgs.so
       remarks. Drive a postscript engine.
       security. Embeds a programming language.

       environment division.
       configuration section.
       source-computer. gnulinux.
       object-computer.
           classification is canadian.

       special-names.
           locale canadian is "en_CA.UTF-8".

       repository.
           function all intrinsic.

       data division.
       file section.
       working-storage section.
       01 gs-inst              usage pointer.
       01 gs-status            usage binary-long.
       01 gs-exit-code         usage binary-long.

       01 cob-argc             usage binary-long value 2.
       01 cob-argv.
          05 cob-args          usage pointer occurs 2 times.
       01 cob-argv-1           pic x(8) value z"notused".
       01 cob-argv-2           pic x(18) value z"-sDEVICE=nullpage".
```

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```
       01 GS-ARG-ENCODING-UTF8 constant as 1.
       01 gs-command.
          05 value "currentpagedevice /PageSize get == " &
                   "40 2 add == " &
                   "version == " &
                   "devicenames == " &
                   "flush" & x"0a00".

       01 stdout-callback      usage program-pointer.

      *> ****************************************************************
       procedure division.
       set cob-args(1) to address of cob-argv-1.
       set cob-args(2) to address of cob-argv-2.

       call "gsapi_new_instance" using
           by reference gs-inst
           by reference NULL
           returning gs-status
           on exception
               display "Error: no gsapi_new_instance" upon syserr
               perform hard-exception
       end-call
       if gs-status less than zero then
           display "Error: gsapi_new_instance: " gs-status upon syserr
           perform hard-exception
       end-if

       call "gsapi_set_arg_encoding" using
           by value gs-inst
           by value GS-ARG-ENCODING-UTF8
           returning gs-status
           on exception
               display "Error: no gsapi_set_encoding" upon syserr
               perform hard-exception
       end-call
       if gs-status not equal zero then
           display "Error: gsapi_set_arg_encoding: " gs-status
              upon syserr
           perform hard-exception
       end-if

       call "gsapi_init_with_args" using
           by value gs-inst
           by value cob-argc
           by reference cob-argv
           returning gs-status
           on exception
               display "Error: no gsapi_init_with_args" upon syserr
               perform hard-exception
       end-call
       if gs-status not equal zero then
           display "Error: gsapi_init_with_args: " gs-status
              upon syserr
           perform hard-exception
       end-if
```

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```
       set stdout-callback to entry "stdout-handler"
       if stdout-callback equal NULL then
           display "stdout-handler = " stdout-callback upon syserr
       end-if
       call "gsapi_set_stdio" using
           by value gs-inst
           by reference NULL
           by value stdout-callback
           by reference NULL
           returning gs-status
           on exception
               display "Error: no gsapi_set_stdio" upon syserr
               perform hard-exception
       end-call
       if gs-status not equal zero then
           display "Error: gsapi_set_stdio: " gs-status upon syserr
           perform hard-exception
       end-if

       call "gsapi_run_string" using
           by value gs-inst
           by reference gs-command
           by value 0
           by reference gs-exit-code
           returning gs-status
           on exception
               display "Error: no gsapi_run_string" upon syserr
               perform hard-exception
       end-call
       if gs-status not equal zero then
           display "Error: gsapi_run_string: " gs-status upon syserr
           perform soft-exception
       end-if

       display space
       display "pausing ghostscript rundown" with no advancing
       accept omitted

       call "gsapi_exit" using
           by value gs-inst
           returning gs-status
           on exception
               display "Error: no gsapi_exit" upon syserr
               perform hard-exception
       end-call
       if gs-status not equal zero then
           display "Error: gsapi_exit: " gs-status upon syserr
           perform soft-exception
       end-if

       set return-code to gs-status
       goback.

      *> ****************************************************************

       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
```

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```
      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:

       end program tops.
      *> ****************************************************************
      *> ****************************************************************
       identification division.
       program-id. "stdout-handler".
       data division.
       linkage section.
       01 gs-calling-inst      usage pointer.
       01 stdout-buffer        pic x(65535).
       01 stdout-len           usage binary-long.

       procedure division using
           by reference gs-calling-inst
           by reference stdout-buffer
           by value stdout-len.

       display stdout-buffer(1:stdout-len) with no advancing
       move stdout-len to return-code
       goback.
       .
      *>****
>>ELSE
!doc-marker!
====
tops
====

.. contents::

Introduction
------------

Embed a postscript engine, gs in particular.  Send it some commands.

Tectonics
```

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```
---------

::

    prompt$ cobc -x tops.cob -lgs

Usage
-----

::

    prompt$ ./tops

Source
------

.. include::  tops.cob
   :code: cobolfree
>>END-IF
```

Which doesn't really generate any PS in this sample. Commands are sent to the `gs` interpreter to show the default page dimensions, then add 40 and 2, then display a version number, and finally list supported device names. All that data normally goes to a GS console, but in `tops.cob` the standard out of the engine is captured in a callback and displayed from COBOL. *The sample above even forces the device type to "nullpage" to avoid popping up the normal Ghostscript viewer. Actual deployments would modify or remove that argument.*

The same text that `tops-1.cob` and `tops-2.cob` produced could be used to generate PS pages, but `tops.cob` can take any commands, and interact the engine itself.

```
promtp$ cobc -xj tops.cob -lgs
GPL Ghostscript 9.16 (2015-03-30)
Copyright (C) 2015 Artifex Software, Inc.  All rights reserved.
This software comes with NO WARRANTY: see the file PUBLIC for details.
[612.0 792.0]
42
(3010)
[/md50Eco /hpdj690c /alc1900 /bmpsep1 /lp8700 /fmpr /psdrgb /ijs /ln03
/djet500 /pkmraw /pjxl300 /lbp8 /cdeskjet /mgrgray2 /md50Mono /hpdj850c
/alc2000 /bmpsep8 /lp8800c /fs600 /sgirgb /png16 /lp1800 /djet500c /pksm
/pr1000 /lex2050 /cdj1600 /mgrgray4 /md5k /hpdj855c /alc4000 /ccr /lp8900 /gdi
/spotcmyk /png16m /lp1900 /dl2100 /pksmraw /pr1000_4 /lex3200 /cdj500
/mgrgray8 /mj500c /hpdj870c /alc4100 /cfax /lp9000b /hl1240 /sunhmono /png256
/lp2000 /dnj650c /plan /pr150 /lex5700 /cdj550 /mgrmono /mj6000c /hpdj890c
/alc8500 /cif /lp9000c /hl1250 /tiff12nc /png48 /lp2200 /epl2050 /plan9bm
/pr201 /lex7000 /cdj670 /miff24 /mj700v2c /hpdjplus /alc8600 /devicen /lp9100
/hl7x0 /tiff24nc /pngalpha /lp2400 /epl2050p /planc /pxlcolor /lips2p /cdj850
/pam /mj8000c /hpdjportable /alc9100 /dfaxhigh /lp9200b /hpdj1120c /tiff32nc
/pnggray /lp2500 /epl2120 /plang /pxlmono /lips3 /cdj880 /pamcmyk32 /ml600
/ibmpro /ap3250 /dfaxlow /lp9200c /hpdj310 /tiff48nc /pngmono /lp2563 /epl2500
/plank /r4081 /lips4 /cdj890 /pamcmyk4 /necp6 /imagen /appledmp /eps2write
/lp9300 /hpdj320 /tiff64nc /nullpage /lp3000c /epl2750 /planm /rinkj /lips4v
/cdj970 /pbm /npdl /itk24i /atx23 /faxg3 /lp9400 /hpdj340 /tiffcrle /x11
/lp7500 /epl5800 /plib /rpdl /lj250 /cdjcolor /pbmraw /oce9050 /itk38 /atx24
/faxg32d /lp9500c /hpdj400 /tiffg3 /display /x11alpha /lp7700 /epl5900 /plibc
/samsunggdi /lj3100sw /cdjmono /pcx16 /oki182 /iwhi /atx38 /faxg4 /lp9600
/hpdj500 /tiffg32d /bbox /x11cmyk /lp7900 /epl6100 /plibg /sj48 /lj4dith
```

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```
/cdnj500 /pcx24b /oki4w /iwlo /bj10e /fpng /lp9600s /hpdj500c /tiffg4 /bit
/x11cmyk2 /lp8000 /epl6200 /plibk /st800 /lj4dithp /chp2200 /pcx2up /okiibm
/iwlq /bj10v /inferno /lp9800c /hpdj510 /tiffgray /bitcmyk /x11cmyk4 /lp8000c
/eplcolor /plibm /stcolor /lj5gray /cljet5 /pcx256 /oprp /jetp3852 /bj10vh
/ink_cov /lps4500 /hpdj520 /tifflzw /bitrgb /x11cmyk8 /lp8100 /eplmono /pnm
/t4693d2 /lj5mono /cljet5c /pcxcmyk /opvp /jj100 /bj200 /inkcov /lps6500
/hpdj540 /tiffpack /bitrgbtags /x11gray2 /lp8200c /eps9high /pnmraw /t4693d4
/ljet2p /cljet5pr /pcxgray /paintjet /la50 /bjc600 /jpeg /lq850 /hpdj550c
/tiffscaled /bmp16 /x11gray4 /lp8300c /eps9mid /ppm /t4693d8 /ljet3 /coslw2p
/pcxmono /pcl3 /la70 /bjc800 /jpegcmyk /lxm3200 /hpdj560c /tiffsep /bmp16m
/x11mono /lp8300f /epson /ppmraw /tek4696 /ljet3d /coslwxl /pgm /photoex /la75
/bjc880j /jpeggray /lxm5700m /hpdj600 /tiffsep1 /bmp256 /lp8400f /epsonc
/ps2write /uniprint /ljet4 /cp50 /pgmraw /picty180 /la75plus /bjccmyk /mag16
/m8510 /hpdj660c /txtwrite /bmp32b /lp8500c /escp /pdfwrite /xes /ljet4d
/declj250 /pgnm /pj /laserjet /bjccolor /mag256 /md1xMono /hpdj670c /xcf
/bmpgray /lp8600 /escpage /psdcmyk /cups /ljet4pjl /deskjet /pgnmraw /pjetxl
/lbp310 /bjcgray /mgr4 /md2k /hpdj680c /xpswrite /bmpmono /lp8600f /fmlbp
/psdcmykog /pwgraster /ljetplus /dj505j /pkm /pjxl /lbp320 /bjcmono /mgr8]
```

- line 5 above is the output from PageSize get
- line 6 is the 40 2 add instruction output
- line 7 in the version display
- and the rest is the `devicenames` output

GnuCOBOL can drive Postscript, as external text, or as an embedded engine.

5.97 Can GnuCOBOL interface with Java?

Yes. In a multitude of ways.

First, there is the optional FUNCTION JVM-CREATE and FUNCTION JVM builtin intrinsic functions. These make is very easy to access JVM (Java Virtual Machine) class files from GnuCOBOL.

Second, there is COBJAPI. See *What is COBJAPI?* (page 993) for the full description of this user defined function contribution.

Third, there is SWIG. SWIG is somewhat of a uni-directional tool, Java applications calling GnuCOBOL subprograms. SWIG makes this type of interface very easy on the integrator. See *Does GnuCOBOL work with SWIG?* (page 1046) for an example of Java calling GnuCOBOL.

Next would be directly interfacing with the Java Native Interface, JNI, built by the Java core development teams for just this purpose. Low level details abound, and there is no sample here yet.

5.97.1 FUNCTION JVM

Optionally built into the `cobc` compiler and `libcob` runtime are a set of intrinsic functions that allow embedding of Java Virtual Machine in GnuCOBOL programs. First the engine is created with `FUNCTION JVM-CREATE` and then methods can be dispatched with `FUNCTION JVM` with results delivered to COBOL.

`FUNCTION JVM-CREATE(option[,...])` creates a running JVM given a set of option lines.

```
move jvm-create("-Djava.class.path=."
                "-verbose:class")
  to extranseous
```

Creates and embedded JVM with a class path that includes the current working directory and verbose display of Java Native Interface class calls.

`FUNCTION JVM(class, method, signature, argument[,...])` invokes a static JVM method given the class, method, signature and then parameters matching the signature specification.

Class names are passed as character data and will be searched for in the JVM CLASSPATH.

Method names are the function entry points, passed as character data.

Signatures are defined by the JNI protocol and are passed as character data.

```
Type Signature Java Type
Z boolean
B byte
C char
S short
I int
J long
F float
D double
L fully-qualified-class ;
V void
[ type to specify array of type
( arg-types ) ret-type
```

For example, a Java file that defines class TestJVM with a static function called hello, that takes a String and returns a String.

```
public class TestJVM {
    public static String hello(String entity) {
        System.out.println("Java: Hello, " + entity);
        return "Sent greeting to " + entity;
    }
}
```

That is a JVM prototype of

> "TestJVM" class name "hello" method name "(Ljava/lang/String;)Ljava/lang/String;" take a String, return String "world" argument in

Compile the Java with:

```
prompt$ javac TestJVM.java
```

This GnuCOBOL fragment

```
display "COBOL: " jvm(
    "TestJVM",
    "hello",
    "(Ljava/lang/String;)Ljava/lang/String;",
    "world")
```

will produce:

```
prompt$ cobc -xj testjvm.cob

Java: Hello, world
COBOL: Sent greeting to world
```

And it becomes that easy to leverage the entire Java ecosystem from GnuCOBOL applications. The JVM is also used by Groovy, Scala, Clojure, JRuby, Jython, Frink and a host of other high level programming languages. This author is a fan of Groovy and a huge fan of Frink.

Frink is a very useful calculating tool and programming language that keeps track of the physical units involved in computations (along with including a rich smorgasbord of other features). It can be scripted via FUNCTION JVM with a small class file.

```
// Embed frink, http://frinklang.org
public class EmbedFrink {

    // Initialize Frink
    static frink.parser.Frink interp = new frink.parser.Frink();

    // Unrestricted Frink
    public static String DoFrink(String express) {
        String results;

        try
        {
           results = interp.parseString(express);
        }
        catch (frink.errors.FrinkException fee)
        {
           results = fee.toString();
        }

        return results;
    }

    // Restrictive Frink, once restricted always restricted
    public static String SecureFrink(String express) {
        interp.setRestrictiveSecurity(true);
        return DoFrink(express);
    }
}
```

EmbedFrink.java

```
procedure division.
sample-main.
move jvm-create(
    "-Djava.compiler=NONE"
    "-Djava.class.path=.:" &
        "/home/btiffin/inst/langs/frink/frink.jar"
    "-Djava.library.path=."
    ) to return-code

display "1 barrel + 2 gallons is " jvm(
    "EmbedFrink", "DoFrink",
    "(Ljava/lang/String;)Ljava/lang/String;"
    "1 barrel + 2 gallons -> ""cups""")
```

Shows:

```
1 barrel + 2 gallons is 704 cups
```

https://frinklang.org/

5.97.2 Java Native Access

A slightly higher level abstraction than JNI is JNA, Java Native Access. Gary Cowell posted a quick sample to SourceForge, listed below. JNA builds on JNI to ease integrations.

Code by Gary Cowell, `cobsubtest.cbl`

```
cobsub*
       identification division.
       program-id. cobsubtest.
       data division.
       linkage section.
       01  PassedParameter pic X(72).
       procedure division using
       by reference     PassedParameter.
       A-Main Section.
               display 'Starting cobsubtest.cbl'
               display 'Called With ['  PassedParameter ']'

               move 'We changed it!' to PassedParameter
               move 2 TO return-code.

               goback.
```

A second program `cobsubtest2.cbl`

```
cobsub*
       identification division.
       program-id. cobsubtest2.
       data division.
       linkage section.
       01  PassedParameter pic X(72).
       procedure division using
       by reference     PassedParameter.
       A-Main Section.
               display 'Starting cobsubtest2:'
               display 'Called With [' PassedParameter ']'
               move 8 TO return-code.
               goback.
```

And the Java program `jnacob.java`.

```
import com.sun.jna.*;

/*
 * libcob interface, initialising GnuCOBOL run time
 */
interface libcob extends Library {
        libcob INSTANCE = (libcob) Native.loadLibrary("cob", libcob.class);
        void cob_init(int argc, Pointer argv);
}
```

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```
/*
 * first COBOL program interface, single program
 */
interface subtest extends Library {
        subtest INSTANCE = (subtest) Native.loadLibrary("cobsubtest",
subtest.class);
        int cobsubtest(Pointer aValue);
}

/*
 * second COBOL program interface, single program
 */
interface subtest2 extends Library {
        subtest2 INSTANCE = (subtest2) Native.loadLibrary("cobsubtest2",
subtest2.class);
        int cobsubtest2(Pointer aValue);
}

public class jnacob {
        public static void main(String[] args) {

                /*
                 * try and initialise the GnuCOBOL run time
                 * calling cob_init with no parameters
                 */
                try {
                        libcob.INSTANCE.cob_init(0, null);
                } catch (UnsatisfiedLinkError e) {
                        System.out.println("Libcob Exception" + e);
                }

                /*
                 * call a GnuCOBOL program, passing a PIC X(72)
                 * space filled
                 */
                try {
                        // JAVA string
                        String stringThing = new String("We Did It!");

                        // make a Pointer and space fill
                        Pointer pointer;
                        pointer = new Memory(72);
                        byte space = 32;
                        pointer.setMemory(0,72,space);
                        byte[] data = Native.toByteArray(stringThing);
                        pointer.write(0, data, 0, data.length - 1);

                        int rc;

                        // call the GnuCOBOL program
                        rc=subtest.INSTANCE.cobsubtest(pointer);

                        // display return-code
                        System.out.print("COBOL Return Code ");
                        System.out.println(rc);
```

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```
                        // call the second test
                        rc=subtest2.INSTANCE.cobsubtest2(pointer);
                        System.out.print("COBOL Return Code ");
                        System.out.println(rc);

                } catch (UnsatisfiedLinkError e) {
                        System.out.println("subtest Exception" + e);
                }
        }
}
```

This needs to have jna-4.2.1.jar in current directory (or, elsewhere, modify classpath as appropriate).

And a build sample of:

```
javac -classpath ./jna-4.2.1.jar jnacob.java
cobc -o libcobsubtest.so cobsubtest.cbl
cobc -o libcobsubtest2.so cobsubtest2.cbl
java -classpath ./jna-4.2.1.jar:. jnacob
```

giving:

```
Starting cobsubtest.cbl
Called With [We Did It!                                                ]
COBOL Return Code 2
Starting cobsubtest2:
Called With [We changed it!                                            ]
COBOL Return Code 8
```

And that's pretty much all it takes to fully integrate Java with GnuCOBOL using JNA. https://en.wikipedia.org/wiki/Java_Native_Access

Many thanks to Gary for his posting.

5.98 Can GnuCOBOL interface with Icon?

Yes, by way of *iconc* the Icon compiler. Icon is a programming language designed by the late Ralph Griswold, as a descendant of his earlier work with SNOBOL.

The Icon Project is hosted by the University of Arizona, with sources and reference book materials dedicated to the public domain.

Icon dates back to 1978, with version 9.5.1 released in 2013.

A very high-level language (very high-level) Icon introduced goal directed evaluation, and generators to the world.

Here is a routine that computes a concordance of words read from stdin.

```
############################################################################
#
#   File:     concord.icn
#
#   Subject:  Program to produce concordance
#
#   Author:   Ralph E. Griswold
#
```

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```
#   Date:     October 9, 1994
#
##############################################################################
#
#   This file is in the public domain.
#
##############################################################################
#
#  This program produces a simple concordance from standard input to standard
#  output. Words less than three characters long are ignored.
#
#     There are two options:
#
#   -l n    set maximum line length to n (default 72), starts new line
#   -w n    set maximum width for word to n (default 15), truncates
#
#     There are lots of possibilities for improving this program and adding
#  functionality to it. For example, a list of words to be ignored could be
#  provided.  The formatting could be made more flexible, and so on.
#
##############################################################################
#
#     Note that the program is organized to make it easy (via item()) to
#  handle other kinds of tabulations.
#
##############################################################################
#
#  Links: options
#
##############################################################################

link options

global uses, colmax, namewidth, lineno

procedure main(args)
   local opts, uselist, name, line, pad, i, j, fill

   opts := options(args, "l+w+")        # process options
   colmax := \opts["l"] | 72
   namewidth := \opts["w"] | 15

   pad := repl(" ", namewidth)
   uses := table()
   lineno := 0

   every tabulate(item(), lineno)       # tabulate all the citations

   uselist := sort(uses, 3)         # sort by uses
   while fill := left(get(uselist), namewidth) do {
      line := format(get(uselist))      # line numbers
      while (*line + namewidth) > colmax do {   # handle long lines
         line ?:= {
            i := j := 0
             every i := upto(' ') do {
                if i > (colmax - namewidth) then break
                else j := i
```

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```
                }
             write(fill, tab(j))
             move(1)
             fill := pad
             tab(0)              # new value of line
             }
         }
         if *line > 0 then write(fill, trim(line))
      }

end

#  Add to count of line number to citations for name.
#
procedure tabulate(name, lineno)

   /uses[name] := table(0)
   uses[name][lineno] +:= 1

   return

end

#  Format the line numbers, breaking long lines as necessary.
#
procedure format(linenos)
   local i, line

   linenos := sort(linenos, 3)
   line := ""

   while line ||:= get(linenos) do
      line ||:= ("(" || (1 < get(linenos)) || ") ") | " "

   return line

end

#  Get an item. Different kinds of concordances can be obtained by
#  modifying this procedure.
#
procedure item()
   local i, word, line

   while line := read() do {
      lineno +:= 1
      write(right(lineno, 6), "  ", line)
      line := map(line)              # fold to lowercase
      i := 1
      line ? {
         while tab(upto(&letters)) do {
            word := tab(many(&letters))
            if *word >= 1 then suspend word # skip short words
            }
         }
      }
```

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```
end
```

A concordance is similar to a cross-reference:

concordance an alphabetical list of the words (especially the important ones) present in a text, usually with citations of the passages concerned.

`concord.icn` lists words and the line numbers in the file where they occur. Icon excels at processing words. The version that ships with the Icon Programming Library tests for words greater than or equal to 3 characters long, it was changed here to take any word of 1 character or more, as the plan is to scan computer source code. This isn't a perfect use of concord, as the rules are really meant for text words, not code, but it's still pretty handy.

The `iconc` compiler generates intermediate C sources, much like GnuCOBOL, and compilation can be told to leave the C source files on disk when given the `-c` command option.

So:

```
prompt$ iconc -c concord.icn
```

produces `concord.c` and `concord.h`.

Getting at the C compile details is a little tricky with `iconc` as it does not display the internal toolchain commands when given the verbose option. But it does allow passing extra arguments to the C compiler, and with `gcc` that means `-v` can be used to figure out how Icon is processing the intermediate when building an executable. For Ubuntu and Icon 9.4.3 a suitable Makefile looks like:

```
# Linking Icon into a GnuCOBOL program
.RECIPEPREFIX = >

callicon: callicon.cob concord.c
> cobc -x -g -debug callicon.cob concord.c \
  /usr/lib/iconc/dlrgint.o /usr/lib/iconc/rt.a \
  -lpthread -lX11 -lxcb -lXau -lXdmcp \
  -L/usr/lib/iconc -lIgpx

concord.c: concord.icn
> iconc -c concord.icn
> sed -i 's/int main[(]argc, argv[)]/int imain(argc, argv)/' concord.c
> sed -i 's/c_exit[(]EXIT_SUCCESS[)]/return(EXIT_SUCCESS)/' concord.c
```

The second rule, produces `concord.c` and `concord.h`, then renames the generated `main` function to `imain` so GnuCOBOL can be in charge of the entry point. The recipe then continues and changes an Icon terminating call of `c_exit` to a more GnuCOBOL CALL friendly `return`. Invoking `c_exit` would be the equivalent of `STOP RUN` and would terminate the running program and return to the operating system, not something you normally want in a COBOL sub-program.

The primary rule, `callicon` produces the target executable, using `cobc` to link in all the run-time support files required by Icon along with compiling the COBOL program and the intermediate `concord.c`, generated with `icon -c`

The sample COBOL `callicon.cob`:

```
GCOBOL identification division.
       program-id. callicon.
       author. Brian Tiffin.
       date-written. 2016-02-07/12:10-0500.
       date-modified. 2016-02-07/19:14-0500.
       installation. Requires Icon 9.4.3
```

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```
       remarks. Embed and call an Icon program

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 argc usage binary-long value 1.
       01 argv.
          05 argv-0 usage pointer.
          05 argv-1 usage pointer.
       01 pname.
          05 value z"callicon".

       01 icon-result usage binary-long.

      *> ****************************************************************
       procedure division.
       set argv-0 to address of pname
       call "imain" using by value argc by reference argv
           returning icon-result
           on exception
               display "bad Icon run-time linkage" upon syserr
               perform hard-exception
       end-call
       display "Icon result: " icon-result
       goback.
      *> ****************************************************************

       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:

       end program callicon.
```

And finally a run, using the `callicon.cob` file as input by redirecting standard in for Icon to read.

```
prompt$ make
iconc -c concord.icn
Translating to C:
concord.icn:
/usr/lib/icon-ipl/options.icn:
No errors; no warnings
sed -i 's/int main[(]argc, argv[)]/int imain(argc, argv)/' concord.c
sed -i 's/c_exit[(]EXIT_SUCCESS[)]/return(EXIT_SUCCESS)/' concord.c
cobc -x -g -debug callicon.cob concord.c \
  /usr/lib/iconc/dlrgint.o /usr/lib/iconc/rt.a \
  -lpthread -lX11 -lxcb -lXau -lXdmcp \
  -L/usr/lib/iconc -lIgpx

prompt$ ./callicon <callicon.cob

     1         identification division.
     2         program-id. callicon.
     3         author. Brian Tiffin.
     4         date-written. 2016-02-07/12:10-0500.
     5         date-modified. 2016-02-07/19:14-0500.
     6         installation. Requires Icon 9.4.3
     7         remarks. Embed and call an Icon program
     8
     9         environment division.
    10         configuration section.
    11         repository.
    12             function all intrinsic.
    13
    14         data division.
    15         working-storage section.
    16         01 argc usage binary-long value 1.
    17         01 argv.
    18            05 argv-0 usage pointer.
    19            05 argv-1 usage pointer.
    20         01 pname.
    21            05 value z"callicon".
    22
    23         01 icon-result usage binary-long.
    24
    25        *> ************************************************************
    26         procedure division.
    27         set argv-0 to address of pname
    28         call "imain" using by value argc by reference argv
    29             returning icon-result
    30             on exception
    31                 display "bad Icon run-time linkage" upon syserr
    32                 perform hard-exception
    33         end-call
    34         display "Icon result: " icon-result
    35         goback.
    36        *> ************************************************************
    37
    38         REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
    39         ==
    40        *> informational warnings and abends
    41         soft-exception.
```

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```
    42           display space upon syserr
    43           display "--Exception Report-- " upon syserr
    44           display "Time of exception:   " current-date upon syserr
    45           display "Module:              " module-id upon syserr
    46           display "Module-path:         " module-path upon syserr
    47           display "Module-source:       " module-source upon syserr
    48           display "Exception-file:      " exception-file upon syserr
    49           display "Exception-status:    " exception-status upon syserr
    50           display "Exception-location:  " exception-location upon syserr
    51           display "Exception-statement: " exception-statement upon syserr
    52         .
    53
    54         hard-exception.
    55             perform soft-exception
    56             stop run returning 127
    57         .
    58         ==.
    59
    60         :EXCEPTION-HANDLERS:
    61
    62         end program callicon.
abends         40
address        27
all            12
also           38
an             7
and            7 40
argc           16 28
argv           17 18 19 27 28
author         3
bad            31
binary         16 23
brian          3
by             28(2) 38
call           7 28 33
callicon       2 21 62
configuration  10
current        44
data           14
date           4 5 44
display        31 34 42 43 44 45 46 47 48 49 50 51
division       1 9 14 26
embed          7
end            33 62
environment    9
exception      30 32 38 41 43 44 48(2) 49(2) 50(2) 51(2) 54 55 60
file           48(2)
function       12
goback         35
handlers       38 60
hard           32 54
icon           6 7 23 29 31 34(2)
id             2 45
identification 1
imain          28
informational  40
installation   6
```

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```
intrinsic      12
linkage        31
location       50(2)
long           16 23
modified       5
module         45(2) 46(2) 47(2)
of             27 44
on             30
path           46(2)
perform        32 55
pname          20 27
pointer        18 19
procedure      26
program        2 7 62
reference      28
remarks        7
replace        38
report         43
repository     11
requires       6
result         23 29 34(2)
returning      29 56
run            31 56
section        10 15
set            27
soft           41 55
source         47(2)
space          42
statement      51(2)
status         49(2)
stop           56
storage        15
syserr         31 42 43 44 45 46 47 48 49 50 51
tiffin         3
time           31 44
to             27
upon           31 42 43 44 45 46 47 48 49 50 51
usage          16 18 19 23
using          28
value          16 21 28
warnings       40
working        15
written        4
z              21
Icon result: +0000000000
```

The most common word being “exception” which occurs at lines:

```
30 32 38 41 43 44 48(2) 49(2) 50(2) 51(2) 54 55 60
```

with 2 occurrences on lines 48, 49, 50, and 51.

GnuCOBOL calling Icon, with somewhat complex tectonics, but worth it.

Icon sources are public domain, the main (very well written) reference materials are public domain. Worth a read.

https://www.cs.arizona.edu/icon/

https://www.cs.arizona.edu/icon/books.htm

5.98.1 Unicon

Clint Jeffery and a small team of brilliant programmers out of the University of Idaho, have been extending Icon and creating Unicon. Unicon adds

- classes and packages
- exceptions
- loadable child programs
- monitoring
- dynamic C modules (on some platforms)
- ODBC database access
- dbm files as associative arrays
- a POSIX system interface
- networking
- 3D graphics

Out of great respect for Ralph Griswold, and his decision to freeze Icon features, Unicon is a separate project and is not officially a continuation of the Icon project. Well worth keeping an eye on, release 12 (January 2016) of Unicon is a formidable programming environment. Now with SNOBOL patterns built right in (as part of alpha release 13).

In the spirit of the Icon project, Unicon is free software, and the book, `Programing with Unicon` is free to download and share, licensed under the GNU FDL.

http://unicon.sourceforge.net/ and https://sourceforge.net/projects/unicon/

It is one of the hidden gems of the programming world.

A graphical Hello, world:

```
import gui
$include "guih.icn"

class WindowApp : Dialog ()

  # -- automatically called when the dialog is created
  method component_setup ()
    # add 'hello world' label
    label := Label("label=Hello world","pos=0,0")
    add (label)

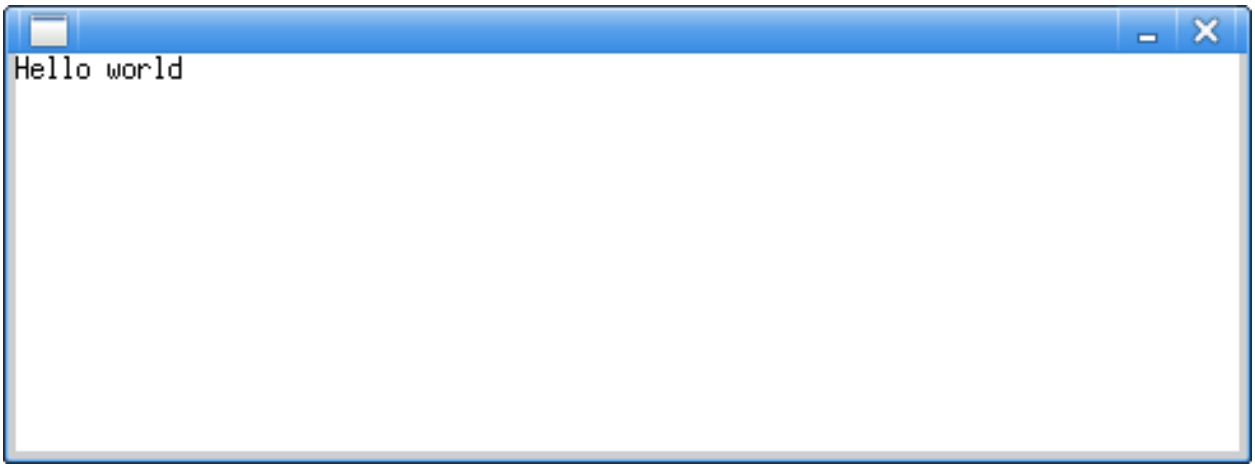
    # make sure we respond to close event
    connect(self, "dispose", CLOSE_BUTTON_EVENT)
  end
end

# create and show the window
procedure main ()
  w := WindowApp ()
  w.show_modal ()
end
```

With:

```
prompt$ unicon hello-unicon.icn -x
Parsing hello-unicon.icn: ......  inherits gui__Dialog from dialog.icn
  inherits gui__Component from component.icn
  inherits lang__Object from object.icn
  inherits util__SetFields from setfields.icn
  inherits util__Connectable from connectable.icn

/home/btiffin/inst/langs/unicon-svn/bin/icont -c   -O hello-unicon.icn
/tmp/uni96130157
Translating:
hello-unicon.icn:
  WindowApp_component_setup
  WindowApp
  WindowAppinitialize
  main
No errors
/home/btiffin/inst/langs/unicon-svn/bin/icont  hello-unicon.u -x
Linking:
Executing:
```



Unicon also supports the simpler Icon v9 version

```
link graphics
procedure main()
   WOpen("size=100,20") | stop("No window")
   WWrites("Hello, world")
   WDone()
end
```

Graphical programs in Icon allow 'q' to quit by default when using `WDone()`.

```
prompt$ unicon hello-icon.icn -x
Parsing hello.icn: ..
/home/btiffin/inst/langs/unicon-svn/bin/icont -c   -O hello.icn
/tmp/uni20774585
Translating:
hello.icn:
  main
No errors
/home/btiffin/inst/langs/unicon-svn/bin/icont  hello.u -x
Linking:
```

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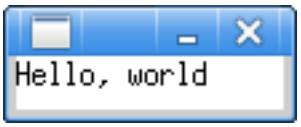
```
Executing:
```



And just a little more Unicon advertising:

```
prompt$ unicon --help
Usage: unicon [-cBCstuEGyZM] [-Dsym=val] [-f s] [-o ofile]
   [--help] [-version] [-features] [-v i] file... [-x args]
options may be one of:
   -B          : bundle VM (iconx) into executable
   -c          : compile only, do not link
   -C          : generate (optimized) C code executable
   -Dsym[=val] : define preprocessor symbol
   -E          : preprocess only, do not compile
   -features   : report Unicon features supported in this build
   -fs         : prevent removal of unreferenced declarations
   -G          : generate graphics (wiconx) executable
   -M          : report error message to the authorities
   -o ofile    : generate executable named ofile
   -O          : optimize (under construction)
   -s          : work silently
   -t          : turn on tracing
   -u          : warn of undeclared variables
   -v i        : set diagnostic verbosity level to i
   -version    : report Unicon version
   -x args     : execute immediately
   -y          : parse (syntax check) only, do not compile
   -Z          : compress icode

prompt$ unicon -features
Unicon Version 12.3.  Feb 29, 2016
UNIX
POSIX
DBM
ASCII
co-expressions
native coswitch
concurrent threads
dynamic loading
environment variables
event monitoring
external functions
keyboard functions
large integers
multiple programs
pattern type
pipes
pseudo terminals
system function
messaging
graphics
3D graphics
X Windows
```

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```
JPEG images
CCompiler gcc 5.2.1
Physical memory: 7809204224 bytes
Revision 4384
Arch x86_64
CPU cores 4
Binaries at /home/btiffin/inst/langs/unicon-svn/bin/
```

5.99 What is JRecord?

JRecord is a Java based utility that slices and dices COBOL data layouts; by Bruce Martin.

Hosted on SourceForge at http://jrecord.sourceforge.net/

Java you say? Why mention this in a COBOL document?

Well, just because it's Java based doesn't mean it doesn't know COBOL formats. It knows them very well, as well as Java forms, which make it a mix and match porters dream tool. Free software, licensed under the same GPL and LGPL that GnuCOBOL enjoys.

- Read and write files of length based records (both fixed length records and Length field based records).
- Read and write CSV files.
- Read and Write Flat Fixed width files (Text and Binary) via either a Xml-Record-Layout or a Cobol Copybook..
- Read and write XML files (via StAX parser).
- Common IO routines across all File Types (XML, CSV, Fixed field Width).
- Support for various Flat file formats (Fixed, Delimited, Length based Files (i.e. Mainframe VB).

One small extract from the very well documented JRecord feature pages:

```
 Cobol

 The package accepts standard Cobol Copybooks, look up the Cobol definition
on the Web for more details. Here is a Sample:
```

```
000600*
000700*   RECORD LENGTH IS 27.
000800*
000900        03  DTAR020-KCODE-STORE-KEY.
001000            05 DTAR020-KEYCODE-NO      PIC X(08).
001100            05 DTAR020-STORE-NO        PIC S9(03)   COMP-3.
001200        03  DTAR020-DATE               PIC S9(07)   COMP-3.
001300        03  DTAR020-DEPT-NO            PIC S9(03)   COMP-3.
001400        03  DTAR020-QTY-SOLD           PIC S9(9)    COMP-3.
001500        03  DTAR020-SALE-PRICE         PIC S9(9)V99 COMP-3.
```

```
RecordEditor XML

Record can be described via XML like the following. The easiest way to
define a RecordEditor-XML file is to use the Layout-Wizard
```

```
<?xml version="1.0" ?>
<RECORD RECORDNAME="DTAR020" COPYBOOK="DTAR020" DELIMITER="&lt;Tab&gt;"
FONTNAME="CP037" FILESTRUCTURE="Default" STYLE="0" RECORDTYPE="RecordLayout"
LIST="Y" QUOTE="" RecSep="default">
  <FIELDS>
    <FIELD NAME="KEYCODE-NO" POSITION="1"  LENGTH="8" TYPE="Char" />
    <FIELD NAME="STORE-NO"   POSITION="9"  LENGTH="2" TYPE="Mainframe Packed Decimal␣
↪(comp-3)" />
    <FIELD NAME="DATE"       POSITION="11" LENGTH="4" TYPE="Mainframe Packed Decimal␣
↪(comp-3)" />
    <FIELD NAME="DEPT-NO"    POSITION="15" LENGTH="2" TYPE="Mainframe Packed Decimal␣
↪(comp-3)" />
    <FIELD NAME="QTY-SOLD"   POSITION="17" LENGTH="5" TYPE="Mainframe Packed Decimal␣
↪(comp-3)" />
    <FIELD NAME="SALE-PRICE" POSITION="22" LENGTH="6" DECIMAL="2" TYPE="Mainframe␣
↪Packed Decimal (comp-3)" />
  </FIELDS>
</RECORD>
```

JRecord can do automated read/write conversion to and from COBOL in all sorts of production ready formats.

Visit the SourceForge project space for all the rich details. The entry here barely scratches the surface on what you will find on the JRecord utility belt.

Actively developed with a long history. JRecord is GnuCOBOL friendly, and GnuCOBOL is JRecord friendly. With an eye to mainframe data crunching.

5.99.1 cb2xml

Along with JRecord, Bruce helps with a project that translates COBOL copybook data layouts to XML and vice versa.

https://sourceforge.net/projects/cb2xml/

Visit the link, as it'll tell you a lot more than what will fit here.

5.99.2 RecordEditor

Bruce and the small team have also put up a RecordEditor project:

https://sourceforge.net/projects/record-editor

This utility with a few simple steps allows one to go from this

```
******************************
* Location Download
******************************

 01 Ams-Vendor.
    03 Brand               Pic x(3).
    03 Location-Number     Pic 9(4).
    03 Location-Type       Pic XX.
    03 Location-Name       Pic X(35).
    03 Address-1           Pic X(40).
    03 Address-2           Pic X(40).
    03 Address-3           Pic X(35).
    03 Postcode            Pic 9(10).
```

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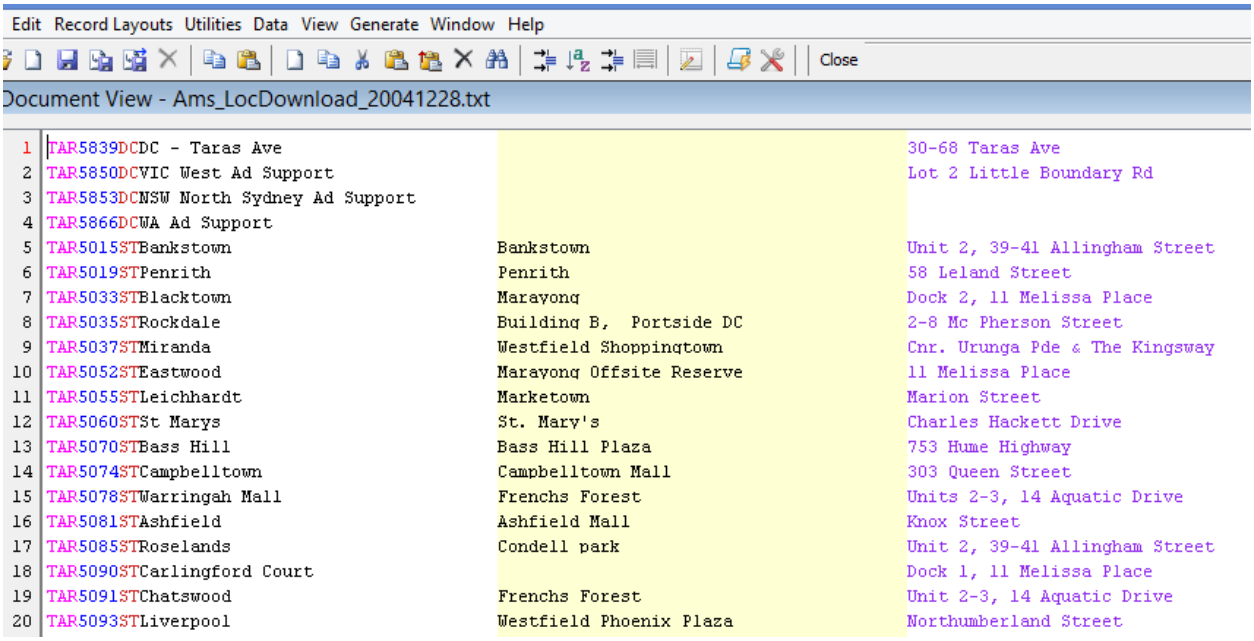
```
    03 State                Pic XXX.
    03 Location-Active      Pic X.
```

to this



from inside the RecordEditor tool. *(Assuming the AmsLocDataFile is populated).*

See the project link above, and the nicely complete documentation and example listings provided with the website, at http://record-editor.sourceforge.net/

This a handy set of integrated tools; JRecord, RecordEditor, and cbxml (along with some other utilities) worthy of addition to any COBOL programmer's toolbelt. And you might just pick up a few Java skills along the way.

There tends to be a friendly rivalry between Java and COBOL programmers, but knowing both puts a developer in a pretty sweet position.

5.100 Can GnuCOBOL interface with Piet?

Yes. As with the Shakespeare Programming Language, the simplest way is to just compile a Piet interepreter into a GnuCOBOL progam.

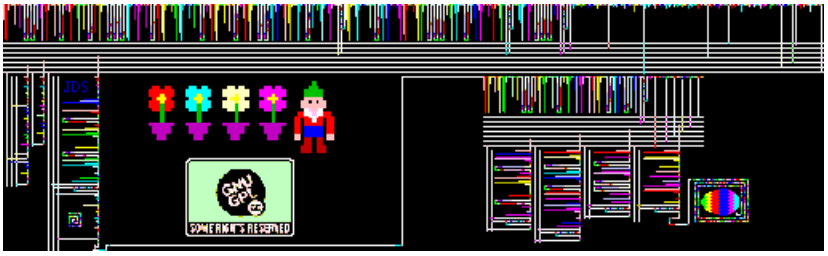
Like Shakespeare, Piet programs are of the esoteric variety. Piet sources are actually images. Pixel colours determine the operation to be performed.

And Piet programs are very likely the most beautiful programs on the planet.

Named after Piet Mondrian a pioneer in geometric abstract art, Piet was designed by David Morgan-Mar.

From Mondrian style art that says Hello, world or tests for numeric primality

to a full on Gnome Sort implementation, by Joshua Schulter, licensed under the GPL.



Please note: the above image is the runnable code used in the sample below.

And that first image is in what Piet calls `codel` format, large blocks of colour that represent each pixel. The actual hello program is 481 bytes of .png.

This GnuCOBOL example uses code from `npiet-1.3d` by Erik Schoenfelder for the embedded interpreter and for example Piet program/images.

```
prompt$ cobc -x callpiet.cob npiet.c -g -debug
prompt$ ./callpiet examples/sortgnu.ppm
Pietsort: a sorting program written in piet
Copyright 2010 Joshua Schulter
How many elements to be sorted?
? 6
elements:
? 1
? 6
? 5
? 2
? 4
? 3
the sorted list:
1
2
3
4
5
6
This work by Joshua Schulter is licensed under
the CC-GNU GPL version 2.0 or later.
```

`callpiet.cob` uses code from the `npiet-1.3d` interpreter, which reads `.ppm` formatted graphics by default. `npiet` can be extended with PNG, and GIF readers, and with GD, can produce graphical trace output. This sample

does not use those features. http://www.bertnase.de/npiet/ GPL 2.0.

```
GCobol >>SOURCE FORMAT IS FREE

REPLACE ==callpiet== BY ==program-name==.
>>IF docpass NOT DEFINED

      *> ***************************************************************
      *>****p* project/callpiet
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   2015-03-26
      *> LICENSE
      *>   GNU General Public License, GPL, 3.0 (or greater)
      *> PURPOSE
      *>   call piet program/picture.
      *> TECTONICS
      *>   cobc -x callpiet.cob npiet.c -g -debug
      *> ***************************************************************
       identification division.
       program-id. callpiet.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 picture-file  pic x(80).
       01 zpicture      pic x(81).
       01 argvs.
          03 argv       usage pointer occurs 2 times.

       procedure division.

      *> fake the argc, argv
       accept picture-file from command-line end-accept
       if picture-file equal spaces then
           move "examples/hi.ppm" to picture-file
       end-if
       set argv(1) to address of picture-file

       move concatenate(trim(picture-file), x"00") to zpicture
       set argv(2) to address of zpicture

       call "piet" using
           by value 2
           by reference argvs
           on exception
               display "error: no piet linkage" upon syserr
       end-call

       goback.
       end program callpiet.
      *> ***************************************************************
>>ELSE
```

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```
==============
callpiet usage
==============

    ./callpiet picture-file

Introduction
------------

Source
------

.. code-include::  callpiet.cob
   :language: cobol
>>END-IF
```

If you are using a POSIX system, this version of `callpiet.cob` is much more flexible.

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ****************************************************************
      *>****p* project/callpiet
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   2016-03-24
      *> LICENSE
      *>   GNU General Public License, GPL, 3.0 (or greater)
      *> PURPOSE
      *>   call piet program/picture.
      *> TECTONICS
      *>   cobc -x callpiet.cob npiet.c -g -debug
      *> ****************************************************************
       identification division.
       program-id. callpiet.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.

       >>IF P64 IS SET
       01 SIZE-MOD             constant as 18.
       >>ELSE
       01 SIZE-MOD             constant as 8.
       >>END-IF

       01 cli                  pic x(1024).
       01 prog                 pic x(9) value "callpiet".

      *> wordexp fields
       01 we-sub               usage binary-short.
       01 expanded-words       usage pointer.
       01 expand-flags         pic 9(SIZE-MOD) comp-5.
```

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```
       01 expanded-structure.
          05 we-wordc          pic 9(SIZE-MOD) comp-5.
          05 we-wordv          usage pointer.
          05 we-offs           pic 9(SIZE-MOD) comp-5 value 0.
       01 wordexp-result       usage binary-long.

       procedure division.

      *> set the argc, argv
       accept cli from command-line
       if cli equal spaces then
           move "nhello.ppm" to cli
       end-if

       call "wordexp" using
           by content   concatenate(prog, space, trim(cli), x"00")
           by reference expanded-structure
           by value     expand-flags
           returning    wordexp-result
           on exception
               display "no wordexp linkage" upon syserr
               goback
       end-call

      *> call piet from the npiet-1.3d distribution
       call "piet" using
           by value we-wordc
           by value we-wordv
           on exception
               display "error: no piet linkage" upon syserr
       end-call

       goback.
       end program callpiet.
      *> ****************************************************************
>>ELSE
!doc-marker!
========
callpiet
========

    ./callpiet [options] picture-file

Introduction
------------
Piet programs use coloured pixels as instruction.  Art as code.

See http://www.dangermouse.net/esoteric/piet/samples.html for the
language designers collection of samples.

See http://www.dangermouse.net/esoteric/piet.html for the language
description.

The embedded Piet interpreter is from npiet-1.3d by Erik Schoenfelder

Usage
-----
```

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```
    ./callpiet [options] [picture-file]

Uses npiet-1.3d, and the same command line options are supported.
picture-file defaults to ``nhello.ppm``, if not given.

Tectonics can include -A and -Q options to extend the features
built into the npiet engine.

-DHAVE_PNG for PNG support, along with GD, GIF library checks

Source
------

.. code-include::  callpiet.cob
   :language: cobol

.. image:: nhello-big.png

.. image:: sortgnu.png
>>END-IF
```

5.101 Can GnuCOBOL be used with D-Bus?

Yes. GnuCOBOL can serve and call D-Bus with any of the C level bindings. `libdbus` is the reference implementation, and is exercised below. `dbus-glib` would also work, and it would likely be a little easier, as the event loop management would then be part of the standard GLib mainloop.

The sample below is only an example. Changes to add application specific logic would be required before this would be anything more than a demo.

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****L* cobweb/dbus [0.2]
      *> Author:
      *>   Brian Tiffin
      *> Colophon:
      *>   Part of the GnuCobol free software project
      *>   Copyright (C) 2016, Brian Tiffin
      *>   Date      20160322
      *>   Modified: 2016-04-14/00:02-0400
      *>   Licensed for use under the
      *>   GNU Library General Public License, LGPL, 3 or superior
      *>   Documentation licensed GNU GPL, version 2.1 or greater
      *>   HTML Documentation thanks to ROBODoc --cobol
      *> Purpose:
      *>   Demonstrate GnuCobol functional bindings to D-Bus
      *>   Main module includes repository output and self test
      *>   ONLY A STARTER KIT. Effective use will require customization.
      *> Synopsis:
      *>   |dotfile cobweb-dbus.dot
      *>   |html <br />
      *>   Functions include
```

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```
      *>   |exec cobcrun cobweb-dbus >cobweb-dbus.repository
      *>   |html <pre>
      *>   |copy cobweb-dbus.repository
      *>   |html </pre>
      *>   |exec rm cobweb-dbus.repository
      *> Tectonics:
      *>   cobc -x -g -debug cobweb-dbus.cob $(pkg-config --libs dbus-1)
      *>   robodoc --cobol --src ./ --doc cobwebdbus --multidoc \
      *>           --rc robocob.rc --css cobodoc.css
      *>   # run rst2html
      *>   > sed ':loop;/!rst.marker!/{d};N;b loop' $^ \
      *>   | sed '$${/^$$/d;}' \
      *>   | sed '$$d' | rst2html >$*.html
      *> Example:
      *>   procedure division.
      *>   move dbus-query(dbus-identity, "a message") to dbus-response
      *>   goback.
      *> Notes:
      *>   D-Bus has a reputation as being finicky, but seems fairly
      *>   stable now.
      *> Screenshot:
      *>   image:cobweb-dbus1.png
      *> Source:
       identification division.
       program-id. cobweb-dbus.
       author. Brian Tiffin.
       date-written. 2016-03-22/17:01-0400.
       date-modified. 2016-04-14/00:02-0400.
       date-compiled.
       installation. Requires libdbus version 1.
       remarks. Main module is test head, it forks servers for testing.
       security. Session D-Bus, no extra security layer in place.

       environment division.
       configuration section.
       source-computer. gnulinux.
       object-computer. gnulinux
           classification is canadian.

       special-names.
           locale canadian is "en_CA.UTF-8".

       repository.
           function dbus-listen
           function dbus-query
           function dbus-signal
           function dbus-catch
           function all intrinsic.

       input-output section.
       file-control.
       i-o-control.

       data division.
       file section.

      *> In lieu of copybooks
```

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```
       REPLACE ==:DBUS-DATA:== BY
       ==
       01 DBUS_BUS_SESSION                      usage binary-long value 0.

       01 DBUS_NAME_FLAG_REPLACE_EXISTING       usage binary-long value 2.
       01 DBUS_REQUEST_NAME_REPLY_PRIMARY_OWNER usage binary-long value 1.
       01 DBUS_REQUEST_NAME_REPLY_ALREADY_OWNER usage binary-long value 4.

       01 DBUS_TYPE_INVALID          usage binary-long value 0.
       01 DBUS_TYPE_BOOLEAN          usage binary-long value 98.
       01 DBUS_TYPE_STRING           usage binary-long value 115.
       01 DBUS_TYPE_UINT32           usage binary-long value 117.
       01 DBUS_TYPE_INT64            usage binary-long value 120.
       01 dbus-type                  usage binary-long.

       01 stderr                     usage pointer.
       01 hosted                     usage binary-long.

       01 dbus-connection            usage pointer.
       01 dbus-message               usage pointer.

       01 dbus-result                usage binary-long.
       01 conn-result                usage binary-long.

       01 dbus-param                 usage pointer.
       01 dbus-pending               usage pointer.

       01 dbus-reply                 usage pointer.
       01 param-length               usage binary-double.

       01 response-field-stat        usage binary-long.
       01 response-field-level       usage binary-long.
       01 response-field-length      usage binary-double.
       01 response-field-serial      usage binary-long.
       01 field-string               usage pointer.
       01 field-workspace            pic x(256).

       01 dbus-timeout               usage binary-long value -1.

       01 dbus-error                 pic x(128).
       01 dbus-error-message         usage pointer.

       01 DBusMessageIter.
          05 dummy1                  usage pointer.
          05 dummy2                  usage pointer.
          05 dummy3                  usage binary-long.
          05 dummy4                  usage binary-long.
          05 dummy5                  usage binary-long.
          05 dummy6                  usage binary-long.
          05 dummy7                  usage binary-long.
          05 dummy8                  usage binary-long.
          05 dummy9                  usage binary-long.
          05 dummy10                 usage binary-long.
          05 dummy11                 usage binary-long.
          05 pad1                    usage binary-long.
          05 pad2                    usage binary-long.
          05 pad3                    usage pointer.
```

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```
       01 dbus-args                  usage pointer.
       01 iter-result                usage binary-long.
       01 dbus-indirect              usage pointer.

       01 len-signal-interface       usage binary-long.

       01 listener-interval          constant as 100000000.
       01 catcher-interval           constant as 100000000.
       01 fork-pause                 constant as 500000000.
       ==.

       REPLACE ALSO ==:DBUS-IDENTITY-LINKAGE:== BY
       ==
       01 dbus-identity.
           05 dbus-server-name       pic x(32).
           05 dbus-client-name       pic x(32).
           05 dbus-source-name       pic x(32).
           05 dbus-catch-name        pic x(32).
           05 dbus-method-path       pic x(32).
           05 dbus-method-interface  pic x(32).
           05 dbus-method-name       pic x(32).
           05 dbus-signal-path       pic x(32).
           05 dbus-signal-interface  pic x(32).
           05 dbus-signal-name       pic x(32).
           05 dbus-name              pic x(32).
           05 dbus-verbose           pic 9.
       ==.

       working-storage section.
       01 cli                        pic x(16).
          88 helping                 value "help", "-h", "--help".
          88 testing                 values "test", "testing", "check".
          88 quieting                value "quiet".
          88 verbosing               value "verbose".

       01 newline                    pic x value x"0a".

       01 result                     usage binary-long.
       01 process-id                 usage binary-long.
       01 process-status             usage binary-long.

       :DBUS-DATA:

       01 dbus-identity.
           05 dbus-server-name       pic x(32) value z"gnucobol.method.server".
           05 dbus-client-name       pic x(32) value z"gnucobol.method.caller".
           05 dbus-source-name       pic x(32) value z"gnucobol.signal.source".
           05 dbus-catch-name        pic x(32) value z"gnucobol.signal.sink".
           05 dbus-method-path       pic x(32) value z"/gnucobol/method/Object".
           05 dbus-method-interface  pic x(32) value z"gnucobol.method.Type".
           05 dbus-method-name       pic x(32) value z"SampleMethod".
           05 dbus-signal-path       pic x(32) value z"/gnucobol/signal/Object".
           05 dbus-signal-interface  pic x(32) value z"gnucobol.signal.Type".
           05 dbus-signal-name       pic x(32) value z"SampleSignal".
           05 dbus-name              pic x(32).
           05 dbus-verbose           pic 9     value 0.
```

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```
       01 dbus-response              usage binary-long.
       01 dbus-final                 usage binary-long.

       local-storage section.
       linkage section.
       report section.
       screen section.

      *> ****************************************************************
       procedure division.
       display "      *> cobweb-dbus UDF repository"           newline
               "       repository."                            newline
               "           function dbus-listen"               newline
               "           function dbus-query"                newline
               "           function dbus-signal"               newline
               "           function dbus-catch"                newline

       accept cli from command-line
       if helping then
           display "cobweb-dbus"
           display "cobcrun cobweb-dbus [help | quiet | test | verbose]"
           display "  verbose runs testing with internal udf displays"
           display "  and quiet only displays failures during testing"
           goback
       end-if

      *> default to showing test head messages but not internals
       move 1 to dbus-verbose

       if quieting then
           move 0 to dbus-verbose
           set testing to true
       end-if
       if verbosing then
           move 2 to dbus-verbose
           display "one   #   is testhead messaging" newline
                   "two   ##  is dbus-listen, dbus-catch server" newline
                   "three ### is dbus-query, dbus-signal test" newline
           set testing to true
       end-if

       if testing then
          *> fork a listener, query a few times, and then shut it down
           if dbus-verbose greater than 0 then
               display "# fork listener #"
           end-if
           call "fork" returning process-id
           if process-id is less than zero then
               call "perror" using z"cobweb-dbus fork process error"
               perform hard-exception
           end-if

           *> child process code, listen server
           if process-id equal zero then
               move dbus-listen(dbus-identity) to dbus-final
               if dbus-verbose greater than 0 then
                   display "# dbus-listen exited with " dbus-final
```

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```
                    " #" newline
            end-if
            goback
        end-if

       *> ********************************************************
       *> test continues, start talking to listener after a pause
        if dbus-verbose greater than 0 then
            display "# listener is " process-id " #"
        end-if
        call "CBL_OC_NANOSLEEP" using fork-pause

        if dbus-verbose greater than 0 then
            display newline "# send query 'Test' #"
        end-if
        move dbus-query(dbus-identity, "Test") to dbus-response
        if dbus-response not equal 4 then
            display "First query test failed, wanted 4: "
                    dbus-response upon syserr
        end-if

        if dbus-verbose greater than 0 then
            display newline "# send query 'Test two' #"
        end-if
        move dbus-query(dbus-identity, "Test two") to dbus-response
        if dbus-response not equal 8 then
            display "Second query test failed, wanted 8: "
                    dbus-response upon syserr
        end-if

        if dbus-verbose greater than 0 then
            display newline "# send query 'Test three' #"
        end-if
        move dbus-query(dbus-identity, "Test three") to dbus-response
        if dbus-response not equal 10 then
            display "Third query test failed, wanted 10: "
                    dbus-response upon syserr
        end-if

        if dbus-verbose greater than 0 then
            display newline "# send query 'Test four' #"
        end-if
        move dbus-query(dbus-identity, "Test four") to dbus-response
        if dbus-response not equal 9 then
            display "Fourth query test failed, wanted 9: "
                    dbus-response upon syserr
        end-if

        if dbus-verbose greater than 0 then
            display newline "# send query to quit #"
        end-if
        move dbus-query(dbus-identity, "quit") to dbus-response
        if dbus-response not equal 4 then
            display "quit query failed, wanted 4: "
                    dbus-response upon syserr
        end-if
```

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```
           *> wait for listener to terminate
            call "waitpid" using
                by value process-id
                by reference process-status
                by value 0
                returning result
            if result not equal process-id then
                display "Unexpected listener wait result: "
                        result ", " process-id
                   upon syserr
            end-if
            if process-status not equal 0 then
                display "Unexpected listener status: " process-status
                   upon syserr
            end-if
           *> ********************************************************

           *> fork a catcher, signal, and then shut it down
            move zero to process-id
            if dbus-verbose greater than 0 then
                display newline newline "# fork catcher #"
            end-if
            call "fork" returning process-id
            if process-id is less than zero then
                call "perror" using z"cobweb-dbus fork process error"
                perform hard-exception
            end-if

            *> child process code, catch server
            if process-id equal zero then
                move dbus-catch(dbus-identity) to dbus-final
                if dbus-verbose greater than 0 then
                    display "# dbus-catch exited with " dbus-final " #"
                    display space
                end-if
                goback
            end-if

           *> ********************************************************
           *> test continues, send signals to catcher after a pause
            if dbus-verbose greater than 0 then
                display "# catcher is " process-id " #"
            end-if
            call "CBL_OC_NANOSLEEP" using fork-pause

            if dbus-verbose greater than 0 then
                display newline "# broadcast signal with 'beep' #"
            end-if

            move dbus-signal(dbus-identity, "beep") to dbus-response
            if dbus-response not equal 4 then
                display "signal test failed, wanted 4: "
                        dbus-response upon syserr
            end-if

           *> sleep to match the sleep interval of catcher loop
            call "CBL_OC_NANOSLEEP" using catcher-interval
```

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```
           if dbus-verbose greater than 0 then
               display newline "# broadcast signal with 'new' #"
           end-if

           move dbus-signal(dbus-identity, "new") to dbus-response
           if dbus-response not equal 3 then
               display "new signal failed, wanted 3: "
                       dbus-response upon syserr
           end-if

           call "CBL_OC_NANOSLEEP" using catcher-interval
           if dbus-verbose greater than 0 then
               display newline "# broadcast signal to quit #"
           end-if

           move dbus-signal(dbus-identity, "quit") to dbus-response
           if dbus-response not equal -1 then
               display "quit signal failed, wanted -1: "
                       dbus-response upon syserr
           end-if

          *> wait for catcher to terminate
           call "waitpid" using
               by value process-id
               by reference process-status
               by value 0
               returning result
           if result not equal process-id then
               display "Unexpected catcher wait result: "
                       result ", " process-id
                  upon syserr
           end-if
           if process-status not equal 0 then
               display "Unexpected catcher status: " process-status
                  upon syserr
           end-if
       end-if

       move 0 to return-code
       goback.
      *> ****************************************************************

      *> add support routines, once again in lieu of copybooks
       REPLACE ALSO ==:DBUS-HANDLERS:== BY
       ==
      *> D-Bus error handling
       dbus-error-init.
       call "dbus_error_init" using
           by reference dbus-error
           returning omitted
           on exception
               display "dbus_error_init exception" upon syserr
               perform soft-exception
       end-call
       .

       dbus-error-test.
```

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```
       call "dbus_error_is_set" using
           by reference dbus-error
           returning dbus-result
           on exception
               display "dbus_error_is_set exception" upon syserr
               perform soft-exception
       end-call
       if dbus-result not equal zero then
           call "CBL_OC_HOSTED" using stderr "stderr" returning hosted
           if hosted equal 1 or stderr equal null then
               display "error fetching stderr" upon syserr
               perform soft-exception
           else
               call "fprintf" using
                   by value stderr
                   by content "D-Bus error: (%s)" & x"0a00"
                   by value dbus-error-message
                   on exception
                       display "fprintf exception" upon syserr
                       perform soft-exception
               end-call
           end-if

           if dbus-result not equal zero then
               call "perror" using z"cobweb-dbus stderr close error"
               perform soft-exception
           end-if

           call "dbus_error_free" using
               by reference dbus-error
               returning omitted
               on exception
                   display "dbus_error_is_set exception" upon syserr
                   perform soft-exception
           end-call
       end-if
       .

      *> D-Bus bus init
       dbus-bus-get.
       call "dbus_bus_get" using
           by value DBUS_BUS_SESSION
           by reference dbus-error
           returning dbus-connection
           on exception
               display "dbus_bus_get exception" upon syserr
               perform soft-exception
       end-call
       perform dbus-error-test

       if dbus-result not equal zero then
           display "D-Bus connection error" upon syserr
           perform hard-exception
       end-if

       if dbus-connection equal null then
           display "D-Bus connection null" upon syserr
```

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```
           perform hard-exception
       end-if
       .

       dbus-bus-request-name.
       call "dbus_bus_request_name" using
           by value dbus-connection
           by content dbus-name
           by value DBUS_NAME_FLAG_REPLACE_EXISTING
           by reference dbus-error
           returning dbus-result
           on exception
               display "dbus_bus_request_name exception" upon syserr
               perform soft-exception
       end-call
       move dbus-result to conn-result
       perform dbus-error-test

       if conn-result not equal DBUS_REQUEST_NAME_REPLY_PRIMARY_OWNER
                            and DBUS_REQUEST_NAME_REPLY_ALREADY_OWNER
           display "Not primary owner: (" conn-result ")" upon syserr
           perform hard-exception
       end-if
       .

      *> D-Bus reading writing
       dbus-connection-read-write.
       call "dbus_connection_read_write" using
           by value dbus-connection
           by value 0                  *> read timeout 0 for non-blocking
           returning dbus-result
           on exception
               display "dbus_connection_read_write exception"
                  upon syserr
               perform soft-exception
       end-call

       call "dbus_connection_pop_message" using
           by value dbus-connection
           returning dbus-message
           on exception
               display "dbus_connection_pop_message exception"
                  upon syserr
               perform soft-exception
       end-call
       .

       dbus-connection-send.
       call "dbus_connection_send" using
           by value dbus-connection
           by value dbus-message
           by reference response-field-serial
           returning dbus-result
           on exception
               display "dbus_message_iter_append_basic exception"
                  upon syserr
               perform soft-exception
```

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```
       end-call
       if dbus-result equal zero then
           display "D-Bus resource exhaustion" upon syserr
           perform hard-exception
       end-if
       .

       dbus-connection-send-with-reply.
       call "dbus_connection_send_with_reply" using
           by value dbus-connection
           by value dbus-message
           by reference dbus-pending
           by value dbus-timeout
           returning dbus-result
           on exception
               display "dbus_connection_send_with_reply exception"
                  upon syserr
               perform soft-exception
       end-call
       if dbus-pending equal null then
           display "D-Bus pending call null" upon syserr
           perform hard-exception
       end-if
       .

       dbus-pending-call-block.
       call "dbus_pending_call_block" using
           by value dbus-pending
           returning omitted
           on exception
               display "dbus_pending_call_block exception" upon syserr
               perform soft-exception
       end-call
       .

       dbus-pending-call-steal-reply.
       call "dbus_pending_call_steal_reply" using
           by value dbus-pending
           returning dbus-message
           on exception
               display "dbus_pending_call_block exception" upon syserr
               perform soft-exception
       end-call
       if dbus-message equal null then
           display "D-Bus reply null" upon syserr
           perform hard-exception
       end-if
       .

       dbus-connection-flush.
       call "dbus_connection_flush" using
           by value dbus-connection
           returning omitted
           on exception
               display "dbus_connection_flush exception" upon syserr
               perform soft-exception
       end-call
```

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```
      .
     *> D-Bus message management
      dbus-message-iter-init.
      initialize DBusMessageIter all to value
      set dbus-args to address of DBusMessageIter
      call "dbus_message_iter_init" using
          by value dbus-message
          by value dbus-args
          returning dbus-result
          on exception
              display "dbus_message_iter_init exception" upon syserr
              perform soft-exception
      end-call
      .

      dbus-message-iter-init-append.
      set dbus-args to address of DBusMessageIter
      call "dbus_message_iter_init_append" using
          by value dbus-message
          by value dbus-args
          returning omitted
          on exception
              display "dbus_message_iter_init_append exception"
                 upon syserr
              perform soft-exception
      end-call
      .

      dbus-message-iter-get-arg-type.
      call "dbus_message_iter_get_arg_type" using
          by value dbus-args
          returning iter-result
          on exception
              display "dbus_message_iter_get_arg_type exception"
                 upon syserr
              perform soft-exception
      end-call
      .

      dbus-message-iter-get-basic.
      call "dbus_message_iter_get_basic" using
          by value dbus-args
          by value dbus-indirect
          returning omitted
          on exception
              display "dbus_message_iter_get_basic" upon syserr
              perform soft-exception
      end-call
      .

      dbus-message-iter-next.
      call "dbus_message_iter_next" using
          by value dbus-args
          returning dbus-result
          on exception
              display "dbus_message_iter_next exception" upon syserr
              perform soft-exception
```

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```
       end-call
       .

       dbus-message-iter-append-basic.
       call "dbus_message_iter_append_basic" using
           by value dbus-args
           by value dbus-type
           by value dbus-indirect
           returning dbus-result
           on exception
               display "dbus_message_iter_append_basic exception"
                  upon syserr
               perform soft-exception
       end-call
       if dbus-result equal zero then
           display "D-Bus resource exhaustion" upon syserr
           perform hard-exception
       end-if
       .

      *> D-Bus method and signal handling
       dbus-message-new-method-call.
       call "dbus_message_new_method_call" using
           by content dbus-server-name
           by content dbus-method-path
           by content dbus-method-interface
           by content dbus-method-name
           returning dbus-message
           on exception
               display "dbus_message_new_method_call exception"
                  upon syserr
               perform soft-exception
       end-call
       if dbus-message equal null then
           display "D-Bus message null" upon syserr
           perform hard-exception
       end-if
       .

       dbus-message-is-method-call.
       call "dbus_message_is_method_call" using
           by value dbus-message
           by content dbus-method-interface
           by content dbus-method-name
           returning dbus-result
           on exception
               display "dbus_message_is_method_call exception"
                  upon syserr
               perform soft-exception
       end-call
       .

       dbus-message-new-signal.
       call "dbus_message_new_signal" using
           by content dbus-signal-path
           by content dbus-signal-interface
           by content dbus-signal-name
```

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```
           returning dbus-message
           on exception
               display "dbus_message_new_signal exception" upon syserr
               perform soft-exception
       end-call
       if dbus-message equal null then
           display "D-Bus message null" upon syserr
           perform hard-exception
       end-if
       .

       dbus-message-is-signal.
       call "dbus_message_is_signal" using
           by value dbus-message
           by content dbus-signal-interface
           by content dbus-signal-name
           returning dbus-result
           on exception
               display "dbus_message_is_signal exception" upon syserr
               perform soft-exception
       end-call
       .

       dbus-bus-add-match.
       compute len-signal-interface =
           length(trim(dbus-signal-interface)) - 1

       call "dbus_bus_add_match" using
           by value dbus-connection
           by content concatenate("type='signal',interface='",
               dbus-signal-interface(1:len-signal-interface)
               z"'")
           by reference dbus-error
           on exception
               display "dbus_bus_add_match exception" upon syserr
               perform soft-exception
       end-call
       .

      *> D-Bus resource unreference
       dbus-message-unref.
       call "dbus_message_unref" using
           by value dbus-message
           returning omitted
           on exception
               display "dbus_message_unref exception" upon syserr
               perform soft-exception
       end-call
       .

       dbus-connection-unref.
       if dbus-connection not equal null then
           perform dbus-connection-flush

           call "dbus_connection_unref" using
               by value dbus-connection
               returning omitted
```

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```
                on exception
                    display "dbus_connection_unref exception" upon syserr
                    perform soft-exception
            end-call
        end-if
        .

        dbus-pending-call-unref.
        call "dbus_pending_call_unref" using
            by value dbus-pending
            returning omitted
            on exception
                display "dbus_pending_call_unref exception" upon syserr
                perform soft-exception
        end-call
        .
        ==.

        REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
        ==
       *> exception warnings and abends
        soft-exception.
          display space upon syserr
          display "--Exception Report-- " upon syserr
          display "Time of exception:   " current-date upon syserr
          display "Module:              " module-id upon syserr
          display "Module-path:         " module-path upon syserr
          display "Module-source:       " module-source upon syserr
          display "Exception-file:      " exception-file upon syserr
          display "Exception-status:    " exception-status upon syserr
          display "Exception-location:  " exception-location upon syserr
          display "Exception-statement: " exception-statement upon syserr
        .

        hard-exception.
            perform soft-exception
            stop run returning 127
        .
        ==.

        :EXCEPTION-HANDLERS:

        end program cobweb-dbus.
       *>****

       *> ****************************************************************
```

```
*>****F* dbus/listen [0.2]
*> Purpose:
*> Start a session D-Bus listener
*> Input:
*>   dbus-identity
*> Output:
*>   dbus-final
*> Source:
 identification division.
```

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```
 function-id. dbus-listen.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 data division.
 working-storage section.
 :DBUS-DATA:

 01 not-method-call            usage binary-long.

 01 reply-status               usage binary-long.
    88 quitting                value -1.

*> limited for testing
 01 bailer                     usage binary-long value 1.
    88 bailing                 value 150.

 linkage section.
 :DBUS-IDENTITY-LINKAGE:

 01 dbus-final                 usage binary-long.

*> ****************************************************************
 procedure division using dbus-identity returning dbus-final.

 if dbus-verbose greater than 1 then
     display "## START LISTENING [" current-date "] ##"
 end-if

 perform dbus-error-init
 perform dbus-bus-get

 move dbus-server-name to dbus-name
 perform dbus-bus-request-name

*> play nice, and sleep during waits with non blocking read
 move 1 to bailer
 perform until exit
     add 1 to bailer
     if bailing then exit perform end-if

     perform dbus-connection-read-write
     if dbus-message equal null then
         call "CBL_OC_NANOSLEEP" using listener-interval
         exit perform cycle
     end-if

     perform dbus-message-is-method-call
     if dbus-result not equal zero then
         if dbus-verbose greater than 1 then
             display "## REPLYING [" current-date "] ##"
         end-if
         call "reply-to-method-call" using
             dbus-message
```

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```
             dbus-connection
             returning reply-status
             on exception
                 display "reply-to-method-call exception"
                    upon syserr
                 set quitting to true
                 perform soft-exception
         end-call
     else
         add 1 to not-method-call
     end-if

     perform dbus-message-unref

     if quitting then exit perform end-if

 end-perform

 perform dbus-connection-unref

 if dbus-verbose greater than 1 then
     display "## STOP LISTENING. Ignored: " not-method-call
             " [" current-date "] ##"
 end-if
 move 0 to dbus-final
 goback
 .

 :DBUS-HANDLERS:

 :EXCEPTION-HANDLERS:
 end function dbus-listen.

*>*****
*> ****************************************************************

*>*****S* dbus/reply-to-method-call [0.2]
*> Purpose:
*>   Handle D-Bus reply
*> Input:
*>   dbus-message pointer
*>   dbus-connection pointer
*> Output:
*>   quit status integer
*> Source:
 identification division.
 program-id. reply-to-method-call.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 data division.
 working-storage section.
 :DBUS-DATA:
 :DBUS-IDENTITY-LINKAGE:
```

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```
 01 quit-flag                  usage binary-long.
 01 quit-length                usage binary-c-long value 4.

 linkage section.
 01 dbus-reply-message          usage pointer.
 01 dbus-reply-connection       usage pointer.

 procedure division using
     dbus-reply-message
     dbus-reply-connection.
     *> returning quit-flag.

 move 1 to response-field-stat
 move 20042 to response-field-level

 if dbus-verbose greater than 1 then
     display "### IN REPLY" with no advancing
 end-if

*> move linkage to names expected by paragraphs
 set dbus-message to dbus-reply-message
 set dbus-connection to dbus-reply-connection

 perform dbus-message-iter-init
 if dbus-result equal zero then
     display "reply-to-method-call expected arguments" upon syserr
 else
     perform dbus-message-iter-get-arg-type
     if iter-result not equal DBUS_TYPE_STRING then
         display "reply-to-method expected string" upon syserr
     else
         set dbus-indirect to address of dbus-param
         perform dbus-message-iter-get-basic
         if dbus-param not equal null then
             if dbus-verbose greater than 1
                 call "printf" using
                     by content z" with (%s) "
                     by value dbus-param
                     on exception
                         display "printf exception" upon syserr
                         perform soft-exception
                 end-call
                 display "[" current-date "] ###"
             end-if
             call "strlen" using
                 by value dbus-param
                 returning param-length
                 on exception
                     display "strlen exception" upon syserr
                     perform soft-exception
             end-call
             call "strncmp" using
                 by value dbus-param
                 by content z"quit"
                 by value quit-length
                 returning quit-flag
```

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```
                on exception
                    display "strncmp exception" upon syserr
                    perform soft-exception
            end-call
        else
            move 0 to param-length
        end-if
    end-if
end-if

*> create the reply from the incoming message
call "dbus_message_new_method_return" using
    by value dbus-message
    returning dbus-reply
    on exception
        display "dbus_message_new_method_return exception"
           upon syserr
        perform soft-exception
end-call

call "dbus_message_iter_init_append" using
    by value dbus-reply
    by value dbus-args
    returning omitted
    on exception
        display "dbus_message_iter_init_append exception"
           upon syserr
        perform soft-exception
end-call

*> turns out DBUS_BOOLEAN is 32 bits
set dbus-indirect to address of response-field-stat
move DBUS_TYPE_BOOLEAN to dbus-type
perform dbus-message-iter-append-basic

set dbus-indirect to address of response-field-level
move DBUS_TYPE_UINT32 to dbus-type
perform dbus-message-iter-append-basic

set dbus-indirect to address of param-length
move DBUS_TYPE_INT64 to dbus-type
perform dbus-message-iter-append-basic

*> send the reply
*> overwriting message field with reply for these paragraphs
set dbus-message to dbus-reply
perform dbus-connection-send
perform dbus-connection-flush

perform dbus-message-unref

if quit-flag equal 0 then
    move -1 to return-code
else
    move 0 to return-code
end-if
goback.
```

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```
 :DBUS-HANDLERS:

 :EXCEPTION-HANDLERS:
 end program reply-to-method-call.
*>****
*> ****************************************************************
```

```
*>****F* dbus/query [0.2]
*> Purpose:
*> Send a query string to a D-Bus listener
*> Input:
*>   dbus-identity
*>   message pic x any
*> Output:
*>   dbus-response
*> Source:
 identification division.
 function-id. dbus-query.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 data division.
 working-storage section.
 :DBUS-DATA:

 01 quit-flag                  usage binary-long.
 01 quit-length                usage binary-c-long value 4.

 linkage section.
 :DBUS-IDENTITY-LINKAGE:

 01 dbus-string                pic x any length.
 01 dbus-final                 usage binary-long.

 procedure division using
     dbus-identity
     dbus-string
   returning dbus-final.

*> the quit message
 if dbus-string = "quit" then move -1 to dbus-final end-if

 move concatenate(trim(dbus-string), x"00")
   to field-workspace

 if dbus-verbose greater than 1 then
     display "### SEND QUERY " dbus-string
             " [" current-date "] ###"
 end-if

 perform dbus-error-init
 perform dbus-bus-get
```

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```
 move dbus-client-name to dbus-name
 perform dbus-bus-request-name

*> create the method call
 perform dbus-message-new-method-call

 perform dbus-message-iter-init-append

*> add the passed in string
 set field-string to address of field-workspace
 set dbus-indirect to address of field-string
 move DBUS_TYPE_STRING to dbus-type
 perform dbus-message-iter-append-basic

*> send message and get the reply handle
 perform dbus-connection-send-with-reply
 perform dbus-connection-flush

 if dbus-verbose greater than 1 then
     display "### Request sent [" current-date "] ###"
 end-if

 perform dbus-message-unref

*> wait for the pending reply
 perform dbus-pending-call-block
 perform dbus-pending-call-steal-reply
 perform dbus-pending-call-unref

*> Read the response values
 perform dbus-message-iter-init
 if dbus-result equal zero then
     display "Message has no arguments" upon syserr
 else
     perform dbus-message-iter-get-arg-type

     perform until iter-result = DBUS_TYPE_INVALID
         evaluate iter-result
             when equal DBUS_TYPE_BOOLEAN
                 set dbus-indirect to address of response-field-stat
                 perform dbus-message-iter-get-basic
                 if dbus-verbose greater than 1 then
                     display "### got stat " response-field-stat
                        with no advancing
                 end-if

             when equal DBUS_TYPE_UINT32
                 set dbus-indirect to address of response-field-level
                 perform dbus-message-iter-get-basic
                 if dbus-verbose greater than 1 then
                     display " level of " response-field-level
                             " [" current-date "] ###"
                 end-if

             when equal DBUS_TYPE_INT64
                 set dbus-indirect to address of response-field-length
```

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```
                perform dbus-message-iter-get-basic
                if dbus-verbose greater than 1 then
                    display "### result of "
                            response-field-length
                            " [" current-date "] ###"
                end-if

                *> use length of input string as function result
                move response-field-length to dbus-final

            when equal DBUS_TYPE_STRING
                if dbus-verbose greater than 1 then
                    display "### got an erroneous string"
                       with no advancing
                end-if
                set dbus-indirect to address of dbus-param
                perform dbus-message-iter-get-basic
                if dbus-verbose greater than 1
                    and dbus-param not equal null then
                    call "printf" using
                        by content z" of (%s) "
                        by value dbus-param
                        on exception
                            display "printf exception"
                               upon syserr
                            perform soft-exception
                    end-call
                    display "[" current-date "] ###"
                end-if

            when other
                if dbus-verbose greater than 1 then
                    display "### got an unexpected " iter-result
                            " [" current-date "] ###"
                end-if
        end-evaluate

        perform dbus-message-iter-next
        perform dbus-message-iter-get-arg-type

    end-perform
 end-if

 perform dbus-message-unref

 goback
 .

 :DBUS-HANDLERS:

 :EXCEPTION-HANDLERS:
 end function dbus-query.
*>****
*> ****************************************************************
```

```
*>****F* dbus/signal [0.2]
```

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```
*> Purpose:
*> Send a query string to a D-Bus listener
*> Input:
*>   dbus-identity
*>   message pic x any
*> Output:
*>   dbus-response
*> Source:
 identification division.
 function-id. dbus-signal.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 data division.
 working-storage section.
 :DBUS-DATA:

 01 quit-flag                  usage binary-long.
 01 quit-length                usage binary-c-long value 4.

 linkage section.
 :DBUS-IDENTITY-LINKAGE:

 01 dbus-string                pic x any length.
 01 dbus-final                 usage binary-long.

 procedure division using
     dbus-identity
     dbus-string
   returning dbus-final.

*> the quit signal
 if dbus-string = "quit" then
     move -1 to dbus-final
 else
     move length(dbus-string) to dbus-final
 end-if

 if dbus-verbose greater than 1 then
     display "### SEND SIGNAL " dbus-string " [" current-date "] ###"
 end-if

 perform dbus-error-init

 perform dbus-bus-get

 move dbus-source-name to dbus-name
 perform dbus-bus-request-name

*> create the signal
 perform dbus-message-new-signal

 perform dbus-message-iter-init-append
```

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```
*> add the passed in string
 move concatenate(trim(dbus-string), x"00")
   to field-workspace

 set field-string to address of field-workspace
 set dbus-indirect to address of field-string
 move DBUS_TYPE_STRING to dbus-type
 perform dbus-message-iter-append-basic

*> send the signal
 perform dbus-connection-send
 perform dbus-connection-flush

 if dbus-verbose greater than 1 then
     display "### Signal sent [" current-date "] ###"
 end-if

 perform dbus-message-unref

 goback
 .

 :DBUS-HANDLERS:

 :EXCEPTION-HANDLERS:
 end function dbus-signal.
*>****
*> ****************************************************************
```

```
      *>****F* dbus/catch [0.2]
      *> Purpose:
      *> Catch signals to the bus
      *> Input:
      *>   dbus-identity
      *>   message pic x any
      *> Output:
      *>   dbus-response
      *> Source:
       identification division.
       function-id. dbus-catch.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       :DBUS-DATA:

       01 quit-flag                 usage binary-long.
       01 quit-length               usage binary-c-long value 4.

       01 not-our-signal            usage binary-long.

      *> limiter for testing
```

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```
       01 bailer                    usage binary-long value 1.
          88 bailing                value 0.

       01 reply-status              usage binary-long.
          88 quitting               value -1.

       linkage section.
       :DBUS-IDENTITY-LINKAGE:

       01 dbus-final                usage binary-long.

      *> ****************************************************************
       procedure division using dbus-identity returning dbus-final.

       if dbus-verbose greater than 1 then
           display "## CATCH SIGNALS [" current-date "] ##"
       end-if

       perform dbus-error-init

       perform dbus-bus-get

       move dbus-catch-name to dbus-name
       perform dbus-bus-request-name

       perform dbus-bus-add-match
       perform dbus-connection-flush
       if dbus-verbose greater than 1 then
           display "## MATCH RULE SENT [" current-date "] ##"
       end-if

      *> play nice, and sleep during waits with non blocking read
       move 1 to bailer
       perform until exit
           add 1 to bailer
           if bailing then exit perform end-if

           perform dbus-connection-read-write

           if dbus-message equal null then
               call "CBL_OC_NANOSLEEP" using catcher-interval
               exit perform cycle
           end-if

           perform dbus-message-is-signal
           if dbus-result not equal zero then
               if dbus-verbose greater than 1 then
                   display "## CATCH" with no advancing
               end-if
               perform dbus-message-iter-init
               if dbus-result equal zero then
                   display "Signal has no arguments" upon syserr
               else
                   perform dbus-message-iter-get-arg-type
                   if iter-result not equal DBUS_TYPE_STRING then
                       display "catcher expected a string" upon syserr
                   else
```

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```
                    set dbus-indirect to address of dbus-param
                    perform dbus-message-iter-get-basic
                    if dbus-param not equal null then
                        if dbus-verbose greater than 1 then
                            call "printf" using
                                by content z" with (%s) "
                                by value dbus-param
                                on exception
                                    display "printf exception"
                                       upon syserr
                                    perform soft-exception
                            end-call
                            display "[" current-date "] ##"
                        end-if
                        call "strlen" using
                            by value dbus-param
                            returning param-length
                            on exception
                                display "strlen exception"
                                   upon syserr
                                perform soft-exception
                        end-call
                        call "strncmp" using
                            by value dbus-param
                            by content z"quit"
                            by value quit-length
                            returning quit-flag
                            on exception
                                display "strncmp exception"
                                   upon syserr
                                perform soft-exception
                        end-call
                        if quit-flag equal 0 then
                            set quitting to true
                        end-if
                    end-if
                end-if
            end-if
        else
            add 1 to not-our-signal
        end-if

        perform dbus-message-unref

        if quitting then
            exit perform
        end-if

    end-perform
    if dbus-verbose greater than 1 then
        display "## STOP CATCHING. Ignored: " not-our-signal
                " [" current-date "] ##"
    end-if
    move 0 to dbus-final
    goback
    .
```

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```
       :DBUS-HANDLERS:

       :EXCEPTION-HANDLERS:
       end function dbus-catch.
      *>****
      *> ****************************************************************
>>ELSE
!doc-marker!
===========
cobweb-dbus
===========

.. contents::

Introduction
------------
D-Bus sample with user defined functions.

Includes an example of

- dbus-listen to loop and listen for method calls until told to quit
- dbus-query  to send a method call and await response

- dbus-catch  to loop and listen for signals until told to quit
- dbus-signal  to broadcase a signal

Tectonics
---------

::

    prompt$ cobc -m -d -frelax cobweb-dbus.cob $(pkg-config --libs dbus-1)

    -frelax is required due to long names

Usage
-----

::

    prompt$ cobcrun cobweb-dbus test
    prompt$ cobcrun cobweb-dbus verbose (for noisy internals testing)
    prompt$ cobcrun cobweb-dbus quiet (only display failures in testing)

Customization
-------------

This is not really a stand alone library.  It requires customization to
add application specific logic.  The sample creates method calls that
send a string and expect three values in return;

- a status true/false
- an integer "application version"
- length of the sent string

from a listener process.  The listener is forked into a child process
for cobcrun testing of the library.
```

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```
There is also a signal routine that attaches a string to the broadcast
and a catch loop (again, forked during main module testing).

Both the listen and catch loops react to a 'quit' message to stop
and exit.

See dbus-identity in the main module for names used for methods and
signals.  These are SESSION bus tests.  SYSTEM bus setups will require
external D-Bus configurations for security setting.

Source
------

.. include::  cobweb-dbus.cob
   :code: cobolfree
>>END-IF
```

A small Makefile:

```
# dbus samples
.RECIPEPREFIX = >

cobweb-dbus.so: cobweb-dbus.cob
> cobc -m -d -v cobweb-dbus.cob -frelax `pkg-config --libs dbus-1`

.PHONY: test verbose quiet cobweb-dbus
cobweb-dbus: cobweb-dbus.so

test: cobweb-dbus
> cobcrun cobweb-dbus test

verbose: cobweb-dbus
> cobcrun cobweb-dbus verbose

quiet: cobweb-dbus
> cobcrun cobweb-dbus quiet
```

And a quick tour:

```
prompt$ make
cobc -m -d -v cobweb-dbus.cob -frelax `pkg-config --libs dbus-1`
Loading standard configuration file 'default.conf'
Command line:   cobc -m -d -v -frelax -ldbus-1 cobweb-dbus.cob
Preprocessing:  cobweb-dbus.cob -> /tmp/cob18777_0.cob
Return status:  0
Parsing:        /tmp/cob18777_0.cob (cobweb-dbus.cob)
cobweb-dbus.cob: 200: Warning: 'REPORT SECTION' not implemented
Return status:  0
Translating:    /tmp/cob18777_0.cob -> /tmp/cob18777_0.c (cobweb-dbus.cob)
Executing:      gcc -I/usr/local/include -pipe -Wno-unused -fsigned-char
                -Wno-pointer-sign -shared -fPIC -DPIC -Wl,--export-dynamic -o
                "cobweb-dbus.so" "/tmp/cob18777_0.c" -Wl,--no-as-needed
                -L/usr/local/lib -lcob -lm -lvbisam -lgmp -lncurses -ldl
                -l"dbus-1"
Return status:  0
```

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```
prompt$ make quiet
cobcrun cobweb-dbus quiet
      *> cobweb-dbus UDF repository
       repository.
           function dbus-listen
           function dbus-query
           function dbus-signal
           function dbus-catch

prompt$ make test
cobcrun cobweb-dbus test
      *> cobweb-dbus UDF repository
       repository.
           function dbus-listen
           function dbus-query
           function dbus-signal
           function dbus-catch

# fork listener #
# listener is +0000018790 #

# send query 'Test' #

# send query 'Test two' #

# send query 'Test three' #

# send query 'Test four' #

# send query to quit #
# dbus-listen exited with +0000000000 #



# fork catcher #
# catcher is +0000018791 #

# broadcast signal with 'beep' #

# broadcast signal with 'new' #

# broadcast signal to quit #
# dbus-catch exited with +0000000000 #

prompt$ make verbose
cobcrun cobweb-dbus verbose
      *> cobweb-dbus UDF repository
       repository.
           function dbus-listen
           function dbus-query
           function dbus-signal
           function dbus-catch

one   #   is testhead messaging
two   ##  is dbus-listen, dbus-catch server
three ### is dbus-query, dbus-signal test
```

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```
# fork listener #
# listener is +0000018794 #
## START LISTENING [20160414001034520400] ##

# send query 'Test' #
### SEND QUERY Test [20160414001035020400] ###
### Request sent [20160414001035030400] ###
## REPLYING [20160414001035130400] ##
### got stat +0000000001 level of +0000020042 [20160414001035130400] ###
### result of +0000000000000000004 [20160414001035130400] ###

# send query 'Test two' #
### SEND QUERY Test two [20160414001035130400] ###
### Request sent [20160414001035130400] ###
## REPLYING [20160414001035230400] ##
### got stat +0000000001 level of +0000020042 [20160414001035230400] ###
### result of +0000000000000000008 [20160414001035230400] ###

# send query 'Test three' #
### SEND QUERY Test three [20160414001035230400] ###
### Request sent [20160414001035230400] ###
## REPLYING [20160414001035330400] ##
### got stat +0000000001 level of +0000020042 [20160414001035330400] ###
### result of +0000000000000000010 [20160414001035330400] ###

# send query 'Test four' #
### SEND QUERY Test four [20160414001035330400] ###
### Request sent [20160414001035330400] ###
## REPLYING [20160414001035430400] ##
### got stat +0000000001 level of +0000020042 [20160414001035430400] ###
### result of +0000000000000000009 [20160414001035430400] ###

# send query to quit #
### SEND QUERY quit [20160414001035430400] ###
### Request sent [20160414001035430400] ###
## REPLYING [20160414001035530400] ##
## STOP LISTENING. Ignored: +0000000002 [20160414001035530400] ##
# dbus-listen exited with +0000000000 #

### got stat +0000000001 level of +0000020042 [20160414001035530400] ###
### result of +0000000000000000004 [20160414001035530400] ###


# fork catcher #
# catcher is +0000018795 #
## CATCH SIGNALS [20160414001035530400] ##
## MATCH RULE SENT [20160414001035530400] ##

# broadcast signal with 'beep' #
### SEND SIGNAL beep [20160414001036030400] ###
### Signal sent [20160414001036030400] ###
## CATCH with (beep) [20160414001036030400] ##

# broadcast signal with 'new' #
### SEND SIGNAL new [20160414001036130400] ###
### Signal sent [20160414001036130400] ###
## CATCH with (new) [20160414001036130400] ##
```

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```
# broadcast signal to quit #
### SEND SIGNAL quit [20160414001036 23-0400] ###
### Signal sent [20160414001036 23-0400] ###
## CATCH with (quit) [20160414001036 33-0400] ##
## STOP CATCHING. Ignored: +0000000003 [20160414001036 33-0400] ##
# dbus-catch exited with +0000000000 #

prompt$
```

Demonstrates a *method* listen loop and *method* call, and then a *signal* catch loop and *signal* broadcast. The loops are forked out to a child process for testing. The main module in the repository accepts `quiet`, `test` and `verbose` command line arguments to run the demos with various verbosity settings.

Most D-Bus supported data types should work, as the basic D-Bus get and set routines are indirect through pointers to working storage. This demo only touches on Boolean, C character string, 32 unsigned and 64 bit signed values.

Customize the dbus-identity block to use different method and signal names for an application. The `reply-to-method-call` subprogram would be where most of the custom logic would be placed, but all four User Defined Functions would require some level of change to be useful in an actual application.

SYSTEM level bus services would require external configuration before most operating environments would permit access. This sample uses SESSION bus mechanisms, single user, and by nature, far less restrictive when it comes to permissions.

D-Bus is dual licensed. The GnuCOBOL project recommends the GPL choice, but AFL (Acedemic Free License) is another choice provided by the developers of the D-Bus reference implementation.

D-Bus: https://dbus.freedesktop.org

5.102 Can GnuCOBOL interface with Red?

Yes. Red is a programming language with design heavily influenced by REBOL.

First, some background, from a short article orginally titled

`Expressiveness in programming, Red`

There is a web page, a few years old now, that attempts to quantify the *expressiveness* of programming languages.

http://redmonk.com/dberkholz/2013/03/25/programming-languages-ranked-by-expressiveness/

Top three. Augeas, Puppet and REBOL. The graph is a box-whisker plot of lines of code per commit per month over a 20 year span. Augeas and Puppet are Domain Specific Languages, so yeah, a small number of lines of code to implement an idea (within the specialized domain) Augeas for configuration edits and Puppet for, hey, configuration management. Not for general purpose programming really.

REBOL marked as third, is a general purpose language, suitable for almost all tasks, including the network and graphics.

COBOL isn't even on the list. I'm assuming the lack of publicly available sources is to blame, *or the plot didn't extend far enough to the right, as I'm sure COBOL can beat fixed form Fortran in lines of code per idea.* :-)

But the reason for the mention, is REBOL. REBOL is grand. Can't be beat in effective programming sans bloat. Well, that's not really the reason. The real reason is Red. Red is based on REBOL, being developed by DocKimbel, but with the goal of being compiled as well as interpreted. Along with Carl Sassenrath (REBOL designer), Doc is one of my heroes, has been since the 2nd millennium.

What Nenad (Doc's real name alias) is developing, is nothing short of extraordinary.

Red isn't ready for public consumption just yet, but that day approaches. Perhaps within the year, Doc will check off the list of main features. Doc is a perfectionist, and brilliant. Red is usable, but only for the diehards at this point in time. I'd suggest REBOL 2.7 or some of the new REBOL/3 builds for most developers.

I got into OpenCOBOL as I was getting ansy waiting for REBOL/3 and bumped into Roger's work by accident. So glad. REBOL/3 still isn't "ready", and that was 2007.

But now, Red. Red is way cool. It should be the future of computing. It likely won't be, as it may be too different for most development shops. But it's already an option for GnuCOBOL, Doc's compiler in version 0.5.3 pumps out object (various forms, ELF being the one of interest here), and DSO libraries, *but only IA32 format is emitted at this point in time*

and CALL away.

For example: Given

```
Red/System [
    Title: "hello red, callable"
]

hello: function [] [
    print "Hello, world"
]

#export [hello]
```

hello-red.red

compiled with:

```
prompt$ red -dlib hello-red.red

-=== Red Compiler 0.5.3 ===-

Compiling /home/btiffin/lang/red/hello-red.red ...

Compiling to native code...
...compilation time : 196 ms
...linking time     : 9 ms
...output file size : 5164 bytes
...output file      : /home/btiffin/lang/red/hello-red.so
```

and some GnuCOBOL

```
GCobol >>SOURCE FORMAT IS FREE
REPLACE ==SAMPLE== BY ==program-name==.
>>IF docpass NOT DEFINED
      *> ************************************
      *>****J* project/SAMPLE
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20150610
      *> LICENSE
      *>   GNU General Public License, GPL, 3.0
      *> PURPOSE
      *>   SAMPLE program.
      *> TECTONICS
      *>   red -dlib hello-red.red
```

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```
      *>   cobc -x callred.cob hello-red.so
      *> ************************************
       identification division.
       program-id. SAMPLE.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       input-output section.
       file-control.

       data division.
       file section.
       working-storage section.
       local-storage section.
       linkage section.
       report section.
       screen section.

      *> ************************************
       procedure division.

       call "hello" end-call

       goback.
       end program SAMPLE.
      *> ************************************
      *>****
>>ELSE
============
SAMPLE usage
============

Introduction
------------

Source
------

.. code-include::  SAMPLE.cob
   :language: cobol
>>END-IF
```

callred.cob

and a compile pass of:

```
prompt$ cobc -x callred.cob hello-red.so
prompt$ ./callred
Hello, world
prompt$
```

Woohoo.

The future of computing. Mix the most expressive general purpose programming language with arguably the least expressive [see footnote 1], for the win.

I firmly believe that most COBOL falls in the least expressive camp, line counts per commit per month, but GnuCOBOL FUNCTION-ID is prepped to set that historical trend on it's head. Take a peek at cobjapi, for instance. Once the REPOSITORY entries are coded up, function libraries make for very concise application level COBOL.

The future of computing. Expressively competitive COBOL. *to infinity, and beyond.*

Check out Red, the programming language at http://www.red-lang.org/

DocKimbel has grand plans. The first full-stack system level and general purpose programming language. I believe him. And GnuCOBOL will (and already can) benefit from the design and the efforts.

[footnote 1] Aside. The Shakespeare programming language is more verbose than COBOL, but I'm not sure it counts for real world programming.

One example listed here in the FAQ; 65 lines and some 2000 characters of Shakespeare source code to output *DERP*.

Oh, and one more aside. While setting up this post I needed to build a 32bit cobc on this 64bit system, as Red only emits IA32, for now, and 64bit applications don't easily link to 32bit shared libraries, so, it was easier to just build a 32bit COBOL environment. All that was needed was:

```
export CFLAGS='-m32'
export LDFLAGS='-m32'
./configure
make
make check
source tests/atconfig
source tests/atlocal
```

And libcob and cobc are 32bit builds that compile and run 32bit applications, on a x86_64 base system.

Works the charm.

5.102.1 COBOLREBOL

Steve White has been writing up some articles that explain the REBOL/Red way of programming, from the point of view of a COBOL programmer. Worth a read.

http://www.cobolrebol.com/

5.103 Can GnuCOBOL catch POSIX signals?

Yes. GnuCOBOL installs default signal handlers as part of the libcob runtime.

Now that GnuCOBOL can produce subprograms with `void` returns, application programs can also be used for signal handling.

The following code was written as a Rosetta Code entry.

```
SIGNAL identification division.
       program-id. signals.
       data division.
       working-storage section.
       01 signal-flag  pic 9 external.
          88 signalled value 1.
       01 half-seconds usage binary-long.
       01 start-time   usage binary-c-long.
       01 end-time     usage binary-c-long.
```

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```
       01 handler      usage program-pointer.
       01 SIGINT       constant as 2.

       procedure division.
       call "gettimeofday" using start-time null
       set handler to entry "handle-sigint"
       call "signal" using by value SIGINT by value handler

       perform until exit
           if signalled then exit perform end-if
           call "CBL_OC_NANOSLEEP" using 500000000
           if signalled then exit perform end-if
           add 1 to half-seconds
           display half-seconds
       end-perform

       call "gettimeofday" using end-time null
       subtract start-time from end-time
       display "Program ran for " end-time " seconds"
       goback.
       end program signals.

      *> SIGINT handler
       identification division.
       program-id. handle-sigint.
       data division.
       working-storage section.
       01 signal-flag  pic 9 external.

       linkage section.
       01 the-signal   usage binary-long.

       procedure division using by value the-signal returning omitted.
       move 1 to signal-flag
       goback.
       end program handle-sigint.
```

It installs a SIGINT (keyboard interrupt) handler and then loops, waiting for `^C` from the keyboard.

Here is another cut that uses `sigaction` instead of `signal`. `signal` has different behaviour on different systems; some may remove the handler during exit, some don't. `sigaction` gets around this by having a stricter definition.

But, alas, this cut is specific to a 64 bit, GNU/Linux build. Other platforms would need to synchronize the `struct sigaction` for correct alignment and field sizes.

```
SIGNAL identification division.
       program-id. sigactions.
       data division.
       working-storage section.
       01 signal-flag      pic 9 external.
          88 signalled     value 1.

       01 start-time       usage binary-c-long.
       01 end-time         usage binary-c-long.
       01 show-time        pic z(8)9.

       01 half-seconds     usage binary-long.
```

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```
       01 display-halves   pic z(8)9.

       01 result           usage binary-long.
       01 SIGINT           constant as 2.

      *> here be dragons, examine <signal.h> for struct sigaction
       01 new-sigaction.
          05 sa-handler    usage program-pointer.
          05 sa-sigaction  usage program-pointer.
          05 sa-mask       pic x(128).
          05 sa-flags      usage binary-c-long.
          05 sa-restorer   usage program-pointer.
       01 old-sigaction.
          05 sa-handler    usage program-pointer.
          05 sa-sigaction  usage program-pointer.
          05 sa-mask       pic x(128).
          05 sa-flags      usage binary-c-long.
          05 sa-restorer   usage program-pointer.

      *> ****************************************************************
       procedure division.
       call "gettimeofday" using start-time null

       display "Install SIGINT handler" at 0101
          with erase screen background-colour 7 foreground-colour 0
       set sa-handler in new-sigaction to entry "handle-sigint"
       call "sigaction" using
           by value SIGINT
           by reference new-sigaction
           by reference old-sigaction
           returning result
           on exception
               display "error calling sigaction" upon syserr
       end-call
       if result < zero then
           display "sigaction error" upon syserr
       end-if

      *> spin wait, with counter
       perform until exit
           if signalled then exit perform end-if
           call "CBL_OC_NANOSLEEP" using 500000000
           if signalled then exit perform end-if

           add 1 to half-seconds
           move half-seconds to display-halves
           display "Spin until Ctrl-C:" at 0201
              with background-colour 7 foreground-colour 0
           display display-halves at 0219
              with background-colour 7 foreground-colour 0
       end-perform

       call "gettimeofday" using end-time null
       subtract start-time from end-time
       move end-time to show-time
       display "Program ran for " at 0601
              with background-colour 7 foreground-colour 0
```

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```
       display show-time at 0617
              with background-colour 7 foreground-colour 0
       display " seconds" at 0626
              with background-colour 7 foreground-colour 0

       display "Restored previous SIGINT behaviour" at 0701
          with background-colour 7 foreground-colour 0
       call "sigaction" using
           by value SIGINT
           by reference old-sigaction
           by reference null
           returning result
           on exception
               display "error calling sigaction" upon syserr
       end-call

       display "Enter to exit: " at 0801
          with background-colour 7 foreground-colour 0
       accept omitted
       goback.
       end program sigactions.

      *> ****************************************************************
       identification division.
       program-id. handle-sigint.
       data division.
       working-storage section.
       01 signal-flag      pic 9 external.
       01 show-signal      pic 99.

       linkage section.
       01 the-signal       usage binary-long.

       procedure division using by value the-signal returning omitted.
       move the-signal to show-signal
       display "Caught SIGINT" at 0401
          with background-colour 3 foreground-colour 0
       display show-signal at 0415
          with background-colour 6 foreground-colour 0
       move 1 to signal-flag
       goback.
       end program handle-sigint.
```

And:

```
prompt$ cobc -x -d sigactions.cob
Install SIGINT handler
Spin until Ctrl-C:       15

Caught SIGINT 02

Program ran for         7 seconds
Restored previous SIGINT behaviour
Enter to exit:
prompt$

prompt$ ./sigactions
```

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```
Install SIGINT handler
Spin until Ctrl-C:        6

Caught SIGINT 02

Program ran for         4 seconds
Restored previous SIGINT behaviour
Enter to exit:

sigactions.cob: 89: Caught Signal (Signal SIGINT)
Abnormal termination - File contents may be incorrect
prompt$
```

Where the first run was terminated with a simple Enter, and the second with Ctrl-C, which was handled by the restored GnuCOBOL runtime setting.

5.104 Can GnuCOBOL interface with X11?

Yes.

The following code was posted to Rosetta Code for demonstration of the Window Creation/X11 task. http://rosettacode.org/wiki/Window_creation/X11#COBOL

Due to the macro heavy nature of X11 programming from C, some of the opaque X11 data structures need to be exposed for use in COBOL programs. *These data structures may need tuning for some variants of X11 implementations*.

More sophisticated X11 programming would likely require even more of these opaque data structures to be recoded as COBOL records. That is *currently* a manual operation, requiring translation from information in Xlib.h.

```
X11    identification division.
       program-id. x11-sup.
       installation. cobc -x x11-sup.cob -lX11
       remarks. Use of private data is likely not cross platform.

       data division.
       working-storage section.
       01 msg.
          05 filler            value z"S'up, Earth?".
       01 msg-len              usage binary-long value 12.

       01 x-display            usage pointer.
       01 x-window             usage binary-c-long.

      *> GnuCOBOL does not evaluate C macros, need to peek at opaque
      *> data from Xlib.h
      *> some padding is added, due to this comment in the Xlib header
      *> "there is more to this structure, but it is private to Xlib"
       01 x-display-private    based.
          05 x-ext-data        usage pointer sync.
          05 private1          usage pointer.
          05 x-fd              usage binary-long.
          05 private2          usage binary-long.
          05 proto-major-version   usage binary-long.
          05 proto-minor-version   usage binary-long.
```

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```
           05 vendor             usage pointer sync.
           05 private3           usage pointer.
           05 private4           usage pointer.
           05 private5           usage pointer.
           05 private6           usage binary-long.
           05 allocator          usage program-pointer sync.
           05 byte-order         usage binary-long.
           05 bitmap-unit        usage binary-long.
           05 bitmap-pad         usage binary-long.
           05 bitmap-bit-order   usage binary-long.
           05 nformats           usage binary-long.
           05 screen-format      usage pointer sync.
           05 private8           usage binary-long.
           05 x-release          usage binary-long.
           05 private9           usage pointer sync.
           05 private10          usage pointer sync.
           05 qlen               usage binary-long.
           05 last-request-read  usage binary-c-long unsigned sync.
           05 request            usage binary-c-long unsigned sync.
           05 private11          usage pointer sync.
           05 private12          usage pointer.
           05 private13          usage pointer.
           05 private14          usage pointer.
           05 max-request-size   usage binary-long unsigned.
           05 x-db               usage pointer sync.
           05 private15          usage program-pointer sync.
           05 display-name       usage pointer.
           05 default-screen     usage binary-long.
           05 nscreens           usage binary-long.
           05 screens            usage pointer sync.
           05 motion-buffer      usage binary-c-long unsigned.
           05 private16          usage binary-c-long unsigned.
           05 min-keycode        usage binary-long.
           05 max-keycode        usage binary-long.
           05 private17          usage pointer sync.
           05 private18          usage pointer.
           05 private19          usage binary-long.
           05 x-defaults         usage pointer sync.
           05 filler             pic x(256).

       01 x-screen-private       based.
           05 scr-ext-data       usage pointer sync.
           05 display-back       usage pointer.
           05 root               usage binary-c-long.
           05 x-width            usage binary-long.
           05 x-height           usage binary-long.
           05 m-width            usage binary-long.
           05 m-height           usage binary-long.
           05 x-ndepths          usage binary-long.
           05 depths             usage pointer sync.
           05 root-depth         usage binary-long.
           05 root-visual        usage pointer sync.
           05 default-gc         usage pointer.
           05 cmap               usage pointer.
           05 white-pixel        usage binary-c-long unsigned sync.
           05 black-pixel        usage binary-c-long unsigned.
           05 max-maps           usage binary-long.
```

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```
           05 min-maps          usage binary-long.
           05 backing-store     usage binary-long.
           05 save_unders       usage binary-char.
           05 root-input-mask   usage binary-c-long sync.
           05 filler            pic x(256).

       01 event.
           05 e-type usage      binary-long.
           05 filler            pic x(188).
           05 filler            pic x(256).
       01 Expose                constant as 12.
       01 KeyPress              constant as 2.

      *> ExposureMask or'ed with KeyPressMask, from X.h
       01 event-mask            usage binary-c-long value 32769.

      *> make the box around the message wide enough for the font
       01 x-char-struct.
           05 lbearing          usage binary-short.
           05 rbearing          usage binary-short.
           05 string-width      usage binary-short.
           05 ascent            usage binary-short.
           05 descent           usage binary-short.
           05 attributes        usage binary-short unsigned.
       01 font-direction        usage binary-long.
       01 font-ascent           usage binary-long.
       01 font-descent          usage binary-long.

       01 XGContext             usage binary-c-long.
       01 box-width             usage binary-long.
       01 box-height            usage binary-long.

      *> ****************************************************************
       procedure division.

       call "XOpenDisplay" using by reference null returning x-display
           on exception
               display function module-id " Error: "
                       "no XOpenDisplay linkage, requires libX11"
                  upon syserr
               stop run returning 1
       end-call
       if x-display equal null then
           display function module-id " Error: "
                   "XOpenDisplay returned null" upon syserr
           stop run returning 1
       end-if
       set address of x-display-private to x-display

       if screens equal null then
           display function module-id " Error: "
                   "XOpenDisplay associated screen null" upon syserr
           stop run returning 1
       end-if
       set address of x-screen-private to screens

       call "XCreateSimpleWindow" using
```

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```
           by value x-display root 10 10 200 50 1
                    black-pixel white-pixel
           returning x-window
       call "XStoreName" using
           by value x-display x-window by reference msg

       call "XSelectInput" using by value x-display x-window event-mask

       call "XMapWindow" using by value x-display x-window

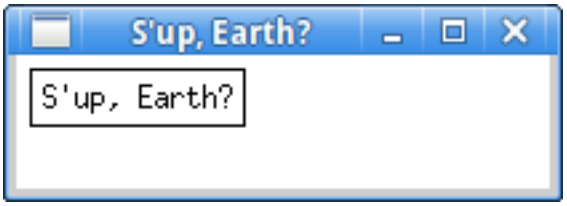
       call "XGContextFromGC" using by value default-gc
           returning XGContext
       call "XQueryTextExtents" using by value x-display XGContext
           by reference msg by value msg-len
           by reference font-direction font-ascent font-descent
           x-char-struct
       compute box-width = string-width + 8
       compute box-height = font-ascent + font-descent + 8

       perform forever
          call "XNextEvent" using by value x-display by reference event
          if e-type equal Expose then
              call "XDrawRectangle" using
                  by value x-display x-window default-gc 5 5
                           box-width box-height
              call "XDrawString" using
                  by value x-display x-window default-gc 10 20
                  by reference msg by value msg-len
          end-if
          if e-type equal KeyPress then exit perform end-if
       end-perform

       call "XCloseDisplay" using by value x-display

       goback.
       end program x11-sup.
```

Giving:



5.105 Can GnuCOBOL interface with PARI/GP?

Yes. The PARI library and the interactive gp linear algebra system works very well when called from GnuCOBOL.

First cut exploration example follows.

Requires:

```
apt-get install pari-gp pari-gp2c libpari-dev`
```

A quick intro:

```
prompt$ gp -q
? 123456! + 0.
2.6040699049291378729513930560926568818 E574964
? quit
prompt$
```

A fairly fat factorial, approaching 575000 digits

The `pari-gp2c` provides `gp2c`, a utility that ships with PARI/GP to allow for complex equations to be imported into `gp` as C code.

```
prompt$ cat fact.gp
123456! + 0.
prompt$ gp2c fact.gp
```

Which outputs

```
/*-*- compile-command: "cc -c -o fact.gp.o -g -O3 -Wall -fomit-frame-pointer
-fno-strict-aliasing -fPIC -I"/usr/include/x86_64-linux-gnu" fact.gp.c && cc
-o fact.gp.so -shared -g -O3 -Wall -fomit-frame-pointer -fno-strict-aliasing
-fPIC -Wl,-shared -Wl,-z,relro fact.gp.o -lc -lm -L/usr/lib/x86_64-linux-gnu
-lpari"; -*-*/
#include <pari/pari.h>
/*
GP;install("init_fact","vp","init_fact","./fact.gp.so");
*/
void init_fact(long prec);
/*End of prototype*/

void
init_fact(long prec)      /* void */
{
  mpadd(mpfact(123456), real_0(prec));
  return;
}
```

Note that the output from `gp2c` does not provide directly callable functions, as it is designed for use with the `gp` import engine, but it does break down the steps required for what library functions to CALL.

That, along with the sample program from the PARI library manual is enough to get started dealing with some algebra in GnuCOBOL.

```
identification division.
program-id. sample.

environment division.
configuration section.
repository.
    function all intrinsic.

data division.
working-storage section.
01 pari-factorial usage pointer.
01 pari-zero usage pointer.
```

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```
01 pari-result usage pointer.

procedure division.
sample-main.

call "pari_init" using by value 8000000 2 returning omitted

call "mpfact" using by value 123456 returning pari-factorial
call "real_0" using by value 31 returning pari-zero
call "mpadd" using by value pari-factorial pari-zero
   returning pari-result

call "pari_printf" using by content "%Ps" & x"0a00"
   by value pari-factorial

call "pari_printf" using by content "%Ps" & x"0a00"
   by value pari-result

call "pari_close" returning omitted
goback.
end program sample.
```

(The capture of the first `pari_printf` of `pari-factorial`, is excluded as it is raw numeric data, 575,0000 digits worth)

```
prompt$ cobc -xj callgp.cob -lpari
...
2.60406990492913787295139305609265688l8 E574964
prompt$
```

Here is the first bit of the factorial `123456!`

```
prompt$ cobc -xj callgp.cob -lpari | head -c 255
260406990492913787295139305609265688l827
327040950301958461018557995205737967683 4
157935607166171279087355200170616660008 5
726127145669858937308652829343172441211 5
286581403020464598557341925130534223113 5
573491050756277735046569337353965973586 9
465710825190620
...
prompt$ cobc -xj callgp.cob -lpari | wc
      2       3  575014
```

2 lines, 3 words, 575014 characters counted.

Fast too.

```
prompt$ time cobc -xj callgp.cob -lpari | tail -1
2.60406990492913787295139305609265688l8 E574964

real    0m0.270s
user    0m0.228s
sys     0m0.024s
```

That's with the compile step, IO streaming time and filtering through tail.

If you ever need to provide some numeric handling for prime numbers, or sophisticated algebra, PARI/GP is worth a

look. PARI/GP is big on prime numbers. The `para_init` call takes an initial value of calculated primes to include in an internal table. Even if you ask for none (this code requested 2 along with an 8meg stack), it guarantees the first 65000 ish primes all prepped and ready for working with the big number library functions. There are a LOT or algrebra functions included. A lot.

The PARI library also supports all kinds of data conversion routines, so getting some of the smaller scale values out of the PARI stack, into COBOL working store won't be hard at all.

https://en.wikipedia.org/wiki/PARI/GP

PARI/GP Development Headquarters http://pari.math.u-bordeaux.fr/

Oh, and `gp` the interactive part of the PARI/GP is just fun.

```
prompt$ gp -q

? plot(X=0,4*Pi,sin(X))

0.9996892 |'''''_""x''''''''''''''''''''''''''''''x""_''''''''''''''''''''|
          |    _    "                            x    x                    |
          |         "                             x      _                  |
          |   "       x                                                     |
          |  _                                   "        x                |
          |            x                        _                          |
          | _                                              "                |
          |             "                       _                          |
          |_                                                 "               |
          |               x                   _                            |
          _                                   :                x           _
          ```````````````x```````````````````:````````````````````````````:
          |                                   "                  x          :|
          |                 _                                                "|
          |                                  "                     _        |
          |                  _                                             " |
          |                                 "                       x       |
          |                   x         _                                 "  |
          |                                                         x      _  |
          |                     "       x                           _        |
          |                       x     x                             _    "  |
-0.999689 |......................"__x.............................x__".....|
          0                                                          12.56637
```

Easy, peasy plot of two circles worth of sine, with X in Radians.

The `gp` calculator is feature rich.

To get a fairly close approximation equation for sin(X), more easy peasy.

```
? sin(x)
%3 = x - 1/6*x^3 + 1/120*x^5 - 1/5040*x^7 + 1/362880*x^9
       - 1/39916800*x^11 + 1/6227020800*x^13
       - 1/1307674368000*x^15 + O(x^17)
```

Fun with math.

The `gp2c` tool makes converting complex linear algebra equations into a sequence of calls that can be made from GnuCOBOL, a very smooth experience.

Things can get orders of magnitude more sophisticated than the sample shown here, so when play time is over, PARI/GP is a very suitable engine for adding complex algebra features to GnuCOBOL programs.
```

5.106 Can GnuCOBOL interface with GRETL?

Yes. The C code that makes up the GNU Regression, Econometrics and Time-series Library, gretl, can be used from GnuCOBOL. Some simple wrappers are required for certain features of libgretl though, as some functions return `struct` data, and GnuCOBOL currently has no way of specifying that in a RETURNING clause.

The quick trial, given a sample listing from the libgretl API reference and one of the sample native gretl data format files (in this case `/usr/share/gretal/data/data10-1.gdt` copied to `sample.gdt`).

```
*> Tectonics: cobc -xj callgretl.cob -lgretl-1.0
 identification division.
 program-id. sample.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 data division.
 working-storage section.
 01 fname.
    05 value z"sample.gdt".
 01 dset usage pointer.
 01 prn  usage pointer.
 01 err  usage binary-long.

 procedure division.
 sample-main.
 call "libgretl_init" returning omitted
 call "gretl_print_new" using by value 1 by reference NULL
     returning prn
 call "datainfo_new" returning dset

 call "gretl_read_native_data" using fname by value dset
     returning err
 if err equal zero then
     call "pprintf" using by value prn
        by content "Data from %s is OK" & x"0a00"
        by reference fname
     call "print_smpl" using by value dset 0 prn
     call "varlist" using by value dset prn
 else
     call "pprintf" using by value prn
        by content "Error %d reading %s" & x"0a00"
        by value err
        by reference fname
 end-if

 call "destroy_dataset" using by value dset returning omitted
 call "gretl_print_destroy" using by value prn returning omitted
 call "libgretl_cleanup" returning omitted

 goback.
 end program sample.

*> #include <gretl/libgretl.h>
*>
```

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```
*> int main (int argc, char **argv)
*> {
*>     char *fname;
*>     DATASET *dset;
*>     PRN *prn;
*>     int err;
*>
*>     if (argc >= 2) {
*>         fname = argv[1];
*>     } else {
*>         exit(EXIT_FAILURE);
*>     }
*>
*>     libgretl_init();
*>     prn = gretl_print_new(GRETL_PRINT_STDOUT, NULL);
*>     dset = datainfo_new();
*>
*>     err = gretl_read_native_data(fname, dset);
*>     if (err) {
*>         pprintf(prn, "Got error %d reading data from %s\n", err, fname);
*>         errmsg(err, prn);
*>     } else {
*>         pprintf(prn, "Read data from %s OK\n", fname);
*>         print_smpl(dset, 0, prn);
*>         varlist(dset, prn);
*>     }
*>
*>     destroy_dataset(dset);
*>     gretl_print_destroy(prn);
*>     libgretl_cleanup();
*>
*>     return 0;
*> }
```

And the trial run:

```
prompt$ cobc -xj callgretl.cob -lgretl-1.0
Data from sample.gdt is OK
Full data range: 1964:1 - 1991:2 (n = 110)

Listing 5 variables:
  0) const     1) period    2) r         3) M         4) D

prompt$
```

The data sample has 110 observations, from this XML source.

```
<?xml version="1.0"?>
<!DOCTYPE gretldata SYSTEM "gretldata.dtd">

<gretldata name="data10-1" frequency="4" startobs="1964.1" endobs="1991.2"
type="time-series">
<description>
DATA10-1:  Quarterly data for the U.S.
    r = INTEREST RATE: U.S.TREASURY BILLS,AUCTION AVG,3-MO(%)
        RANGE 3.514 - 15.904.
    M = MONEY SUPPLY M2 (BILLIONS OF 1987 DOLLARS),
```

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```
        RANGE 1461.733 - 2915.233.
    D = FEDERAL CYCLICALLY ADJ BUDGET: DEFICIT (+) or SURPLUS (-)
        (BILLIONS OF DOLLARS), RANGE 0.6 - 213.
    Source: Citibase, INTRATE AND MONEY SUPPLY ARE AVERAGED FROM
    Monthly data.
</description>
<variables count="4">
<variable name="period"/>
<variable name="r"
 label="interest rate: u.s.treasury bills,auction avg, 3-mo(%)"/>
<variable name="M"
 label="money supply m2 (billions of 1987 dollars)"/>
<variable name="D"
 label="federal cyclically adj budget: deficit (+) or surplus (-) ($
billions)"/>
</variables>
<observations count="110" labels="false">
<obs>1964.1 3.619 1461.733 6.3 </obs>
<obs>1964.2 3.561 1484.567 10.0 </obs>
<obs>1964.3 3.584 1514.300 6.1 </obs>
<obs>1964.4 3.771 1542.267 4.0 </obs>
<obs>1965.1 3.993 1568.867 0.6 </obs>
<obs>1965.2 3.972 1581.200 2.4 </obs>
<obs>1965.3 3.952 1605.967 10.7 </obs>
<obs>1965.4 4.262 1632.567 13.9 </obs>

<!-- snipped out 1966 through 1989 -->

<obs>1990.1 8.023 2891.533 190.5 </obs>
<obs>1990.2 8.033 2889.633 182.0 </obs>
<obs>1990.3 7.743 2872.467 157.6 </obs>
<obs>1990.4 7.247 2840.867 179.1 </obs>
<obs>1991.1 6.237 2838.767 97.8 </obs>
<obs>1991.2 5.763 2853.800 145.6 </obs>
</observations>
</gretldata>
```

A second example needs a little bit of C support code.

MODEL information is returned by `struct` so there needs to be a small piece of middleware to fill in that data for use from COBOL.

```
*> Tectonics: cobc -xjgd callgretl.cob -lgretl-1.0 build-model.c
*>                -A "$(pkg-config --cflags glib-2.0)"
 identification division.
 program-id. sample.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 data division.
 working-storage section.
 01 fname.
    05 value z"sample.gdt".
 01 dset usage pointer.
```

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```
 01 prn  usage pointer.
 01 err  usage binary-long.

 01 list.
    05 list-data usage binary-long occurs 6 times.

 01 model usage pointer.
 01 OLS usage binary-long value 88.
 01 OPT-NONE usage binary-long value 0.
 01 LISTSEP usage binary-long value -100.

 procedure division.
 sample-main.
 call "libgretl_init" returning omitted

 call "gretl_print_new" using by value 1 by reference NULL
     returning prn

 call "datainfo_new" returning dset
 if dset equal null then
     move 10 to err
 else
     call "gretl_read_native_data" using fname by value dset
         returning err
 end-if
 if err equal zero then
     call "pprintf" using by value prn
        by content "Data from %s is OK" & x"0a00"
        by reference fname
     call "print_smpl" using by value dset 0 prn
     call "varlist" using by value dset prn
 else
     call "pprintf" using by value prn
        by content "Error %d reading %s" & x"0a00"
        by value err
        by reference fname
 end-if

*> build the regression model field list
 move 5 to list-data(1)
 move 1 to list-data(2)
 move 0 to list-data(3)
 move 1 to list-data(4)
 move LISTSEP to list-data(5)
 move 1 to list-data(6)

*> the arma model is a struct return, so needs a wrapper
 call "build_model" using list NULL by value dset OPT-NONE prn
     returning model

*> not quite right yet, gretl sets model->errcode as well
 if model equal null then
     call "pprintf" using by value prn
        by content "Error building arma model" & x"0a00"
        by value err
        by reference fname
 else
```

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```
     call "printmodel" using by value model dset OPT-NONE prn
 end-if

 call "gretl_model_free" using by value model
 call "destroy_dataset" using by value dset returning omitted
 call "gretl_print_destroy" using by value prn returning omitted
 call "libgretl_cleanup" returning omitted

 goback.
 end program sample.
```

And some C code to get around the struct return.

```
#include <stdio.h>
#include <gretl/libgretl.h>

MODEL *build_model(int *list, int *pqlags, DATASET *dset, int opts, PRN *prn)
{

    MODEL *model;
    model = gretl_model_new();
    *model = arma(list, pqlags, dset, opts, prn);
    return model;
}
```

which complicates the tectonics a little bit, as cobc needs to pass some glib include path instructions for gretl.

Sample run with an ARMA (AutoRegressive Moving Average) model displayed for some 1975-1990 income data.

```
prompt$ cobc -xjgd callgretl.cob -lgretl-1.0 build-model.c \
             -A "$(pkg-config --cflags glib-2.0)"

Data from sample.gdt is OK
Full data range: 1975:1 - 1990:4 (n = 64)

Listing 12 variables:
  0) const     1) QNC       2) PRICE     3) INCOME    4) PRIME
  5) UNEMP     6) STOCK     7) POP       8) WINTER    9) SPRING
 10) SUMMER   11) FALL


Function evaluations: 39
Evaluations of gradient: 13

Model 1: ARMA, using observations 1975:1-1990:4 (T = 64)
Estimated using Kalman filter (exact ML)
Dependent variable: QNC
Standard errors based on Hessian

             coefficient   std. error      z      p-value
  ---------------------------------------------------------
  const      2438.33       124.004       19.66    4.45e-86 ***
  phi_1         0.867301     0.0857710   10.11    4.90e-24 ***
  theta_1      -0.473176     0.140395    -3.370   0.0008   ***

Mean dependent var   2488.594   S.D. dependent var   332.9220
Mean of innovations  10.96802   S.D. of innovations  262.8761
```

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```
Log-likelihood      -447.6958   Akaike criterion     903.3916
Schwarz criterion    912.0271   Hannan-Quinn         906.7936

                         Real  Imaginary    Modulus  Frequency
  -----------------------------------------------------------
  AR
    Root  1           1.1530     0.0000     1.1530     0.0000
  MA
    Root  1           2.1134     0.0000     2.1134     0.0000
  -----------------------------------------------------------
```

gretl ships with a scripting engine, HANSL; Hansl is A Nice Scripting Language. This pair seems like a very nice match up for GnuCOBOL.

gretl can read from quite a few different data sources besides native .gdt XML (and binary forms). Spreadsheet files, including plain text CSV are also supported, to name a few, so it won't take much to produce datasets from COBOL data. There is a GUI, a command line interface and hansl packages available. gretl also has very well supported import and export of R data, and hansl can even handle interwoven R scripts inside hansl scripts. `gretl` integration will provide a very nice toolset for Econometric modelling, with easy steps to get at GNU R sophisticated statistical analysis.

This is only step one and two in an integration effort, and there is much to leverage with the gretl library and associated utilities. Non-trivial use will require some level of expertise in Econometrics.

http://gretl.sourceforge.net/index.html

```
sudo apt-get install gretl libgretl1-dev
```

5.107 What is CBL_OC_SOCKET?

CBL_OC_SOCKET is an entry in the GnuCOBOL contrib/ tree. Resembling the C$SOCKET system call from other compilers.

Some of the base code is written in C++, so proper use will almost always require `-lstdc++` as part of the `cobc` command when compiling programs that use `CBL_OC_SOCKET`.

Example server:

```
* CBL_OC_SOCKET server sample
 IDENTIFICATION DIVISION.
 PROGRAM-ID. server.

 ENVIRONMENT DIVISION.
 CONFIGURATION SECTION.
 INPUT-OUTPUT SECTION.
 DATA DIVISION.
 FILE SECTION.
 WORKING-STORAGE SECTION.

 01 PORT   PIC X(4) VALUE "1234".
 01 HNDL   PIC X(4).
 01 LISTEN   PIC X(4).
 01 BUFF   PIC X(64000).
 01 BYTES  PIC 9(5).
 01 RECV   PIC 9(5).
```

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```
 01 RESULT PIC 9(3).
 01 OUT    PIC X(25).
 01 dummy pic x.


 PROCEDURE DIVISION.

 MAIN-PARAGRAPH.

        DISPLAY "Opening socket for incoming connections ...".
        CALL "CBL_OC_SOCKET"
             USING "00" PORT LISTEN GIVING RESULT
        END-CALL.
        perform handle-error.

*        CALL "CBL_OC_SOCKET"
*             USING "98" GIVING RESULT.

 ACCEPT-CONN.

        DISPLAY "Listening for incomming connections ...".
        CALL "CBL_OC_SOCKET"
             USING "07" LISTEN HNDL GIVING RESULT
        END-CALL.
        perform handle-error.

        DISPLAY "Getting data from client ...".
        MOVE 14 TO RECV.
        MOVE SPACES TO BUFF.
        CALL "CBL_OC_SOCKET"
               USING "04" HNDL RECV BUFF GIVING RESULT
        END-CALL.
        perform handle-error.

        MOVE SPACES TO OUT.
        MOVE BUFF TO OUT.
        DISPLAY "Client says: " OUT.

        DISPLAY "Sending data and waiting for response ...".
        MOVE "Hello client !" TO BUFF.
        MOVE 14 TO BYTES.
        MOVE 17 TO RECV.

        CALL "CBL_OC_SOCKET"
               USING "05" HNDL BYTES RECV BUFF GIVING RESULT
        END-CALL.
        perform handle-error.

        MOVE SPACES TO OUT.
        MOVE BUFF TO OUT.
        DISPLAY "Client responds: " OUT.

        DISPLAY "Sending data ...".
        MOVE 13 TO BYTES.
        MOVE "Hasta la vista" TO BUFF.

        CALL "CBL_OC_SOCKET"
```

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```
             USING "03" HNDL BYTES BUFF GIVING RESULT
       END-CALL.
       perform handle-error.

       DISPLAY "Closing connection ...".
       CALL "CBL_OC_SOCKET"
              USING "06" HNDL GIVING RESULT
       END-CALL.
       perform handle-error.

       go to accept-conn.

       accept dummy.

       STOP RUN.

 HANDLE-ERROR SECTION.
       DISPLAY "Result is: " RESULT.
       IF RESULT NOT = 0
       THEN
            CALL "CBL_OC_SOCKET" USING "99" GIVING RESULT
            DISPLAY "OS-ERROR: " RESULT
            accept dummy
            STOP RUN
       END-IF
       .
```

And the associated sample client:

```
* CBL_OC_SOCKET client sample
 IDENTIFICATION DIVISION.
 PROGRAM-ID. client.

 ENVIRONMENT DIVISION.
 CONFIGURATION SECTION.
 INPUT-OUTPUT SECTION.
 DATA DIVISION.
 FILE SECTION.
 WORKING-STORAGE SECTION.

 01 IP     PIC X(15) VALUE "127.0.0.1".
 01 PORT   PIC X(4) VALUE "1234".
 01 HNDL   PIC X(4).
 01 BUFF   PIC X(64000).
 01 BYTES  PIC 9(5).
 01 RECV   PIC 9(5).
 01 RESULT PIC 9(3).
 01 OUT    PIC X(25).
 01 dummy pic x.

 PROCEDURE DIVISION.


 start-proc.
* Connect...
       DISPLAY "Connect to server ...".
       CALL "CBL_OC_SOCKET"
```

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```
             USING "02" IP PORT HNDL GIVING RESULT
        END-CALL.
        perform handle-error.

* send data
        DISPLAY "Sending some data ...".
        MOVE "Hello server !" TO BUFF.
        MOVE 14 TO BYTES.
        CALL "CBL_OC_SOCKET"
             USING "03" HNDL BYTES BUFF GIVING RESULT
        END-CALL.
        perform handle-error.

* receive data
        DISPLAY "Reading some data ...".
        MOVE SPACES TO BUFF.
        MOVE 14 TO RECV.
        CALL "CBL_OC_SOCKET"
             USING "04" HNDL RECV BUFF GIVING RESULT
        END-CALL.
        perform handle-error.

        MOVE SPACES TO OUT.
        MOVE BUFF TO OUT.
        DISPLAY "Server says: " OUT.

* send response
        DISPLAY "Sending data ...".
        MOVE 17 TO BYTES.
        MOVE "Good bye server !" TO BUFF.

        CALL "CBL_OC_SOCKET"
             USING "03" HNDL BYTES BUFF GIVING RESULT
        END-CALL.
        perform handle-error.

        DISPLAY "Reading some data ...".
        MOVE SPACES TO BUFF.
        MOVE 13 TO RECV.
        CALL "CBL_OC_SOCKET"
             USING "04" HNDL RECV BUFF GIVING RESULT
        END-CALL.
        perform handle-error.

        MOVE SPACES TO OUT.
        MOVE BUFF TO OUT.
        DISPLAY "Server says: " OUT.

        DISPLAY "Closing socket ...".
        CALL "CBL_OC_SOCKET"
             USING "06" HNDL GIVING RESULT
        END-CALL.
        perform handle-error.

*       accept port.

        call 'C$SLEEP' using '1'.
```

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```
       go to start-proc.

       STOP RUN.

HANDLE-ERROR SECTION.
       DISPLAY "Result is: " RESULT.
       IF RESULT NOT = 0
       THEN
            CALL "CBL_OC_SOCKET" USING "99" GIVING RESULT
            DISPLAY "OS-ERROR: " RESULT
            accept dummy
            STOP RUN
       END-IF.
```

`CBL_OC_SOCKET` is a main callable that uses opcodes for each function.

- "00" Open
- "01" Accept
- "02" Connect
- "03" Write
- "04" Read
- "05" Read and Write
- "06" Close
- "07" Accept
- "08" Read
- "09" Next Read
- "10" Next Read
- "98" Show error
- "99" Show error

5.108 Can GnuCOBOL interface with Haxe/Neko?

Yes. One of the many Haxe output targets is Neko, a Virtual Machine system that is easily embedded in GnuCOBOL.

The Haxe platform/language also targets

- Flash
- ECMAScript
- ActionScript 3
- PHP
- C++
- Java
- C#

- Python
- Lua

Of those targets, only Flash, ActionScript 3 and C# have no working sample for integration with GnuCOBOL. But this entry is all about using the "native" NekoVM target of Haxe programs.

Starting with a small Neko test file

```
// Neko from GnuCOBOL test
// tectonics: nekoc faqtest.neko
//            neko faqtest

$print("The virtual machine is working !\n");
test = $loader.loadprim("std@test",0);
test();
$print("Test successful\n");

// load and call some date primitives
now = $loader.loadprim("std@date_now", 0)();
date = $loader.loadprim("std@date_format", 2)(now, null);
$print(date, "\n");

// Exception handler, clean
try {
    shell = $loader.loadprim("std@sys_command", 1);
    rc = shell("ls faqtest.*");
    $print("Shell returned: ", rc, "\n");
} catch e {
    $print("Raised: ", e, "\n");
}

// Exception handler, purposeful error
try {
    erroneous = $loader.loadprim("std@not_in_std_library", 0);
    rc = erroneous();
    $print("erroneous: ", rc, "\n");
} catch e {
    $print("Raised: ", e, ": ", $typeof(e),
           "\n        from ", $excstack(), " from ", $callstack(), "\n");
}

// Export a value and a function for use from GnuCOBOL
$exports.x = 7;
$exports.f = function(x) {return x * (x - 1);}

// display after exception handler, so we know it keeps running
$print("f(", $exports.x, ") = ", $exports.f($exports.x), "\n");
```

And a quick test of that, first compiled to Neko bytecode, then making sure it works:

```
prompt$ nekoc nekotest.neko
prompt$ neko nekotest
The virtual machine is working !
Calling a function inside std library...
Test successful
2016-07-04 11:26:31
nekotest.n  nekotest.neko
Shell returned: 0
```

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```
Raised: load.c(357) : Primitive not found : std@not_in_std_library(0): 5
        from [[faqtest.neko,26]] from [[faqtest.neko,31]]
f(7) = 42
```

Ok, code seems functional, so now from GnuCOBOL

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****J* gnucobol/cobweb-neko
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20160708  Modified: 2016-07-09/17:49-0400
      *> LICENSE
      *>   Copyright 2016 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or superior)
      *> VERSION
      *>   0.3
      *> PURPOSE
      *>   Embed NekoVM for running compiled HaXe programs.
      *>   (only handles int, string, and function in version 0.3)
      *> TECTONICS
      *>   haxe -neko haxetest.n -main Demonstration
      *>   cobc -debug cobweb-neko.cob -lneko
      *>   cobcrun cobweb-neko [bytecodefile]
      *> ***************************************************************

       identification division.
       program-id. cobweb-neko.
       author. Brian Tiffin.
       date-written. 2016-07-08/04:22-0400.
       date-modified. 2016-07-09/17:49-0400.
       date-compiled.
       installation.
       remarks. cobweb-neko function repository, and test head
       security. embeds NekoVM, and allows bytecode file named from cli

       REPLACE ==:NEKO-RECORD:== BY ==
       01 neko-record.
          05 neko-value        usage pointer.
          05 actual-value      redefines neko-value usage binary-double.
       ==

       ==:NEKO-TAGS:== BY ==
       01 TAG-INT              constant as h"FF".
       01 TAG-NULL             constant as 0.
       01 TAG-FLOAT            constant as 1.
       01 TAG-BOOL             constant as 2.
       01 TAG-STRING           constant as 3.
       01 TAG-OBJECT           constant as 4.
       01 TAG-ARRAY            constant as 5.
       01 TAG-FUNCTION         constant as 6.
       01 TAG-ABSTRACT         constant as 7.
       01 TAG-INT32            constant as 8.
       01 TAG-PRIMITIVE        constant as 22.
       01 TAG-JITFUN           constant as 38.
```

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```
       01 TAG-32-BITS          constant as h"FFFFFFFF".
       ==

       ==:EXCEPTION-HANDLERS:== BY ==
      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       function-exception.
           perform soft-exception
           move 127 to return-code
           goback
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       environment division.
       configuration section.
       source-computer. gnulinux.
       object-computer. gnulinux
           classification is canadian.

       special-names.
           locale canadian is "en_CA.UTF-8".

       repository.
           function neko-load
           function neko-unload
           function neko-type
           function neko-lookup
           function neko-decode
           function neko-call
           function neko-string
           function neko-unstring
           function haxe-unstring
           function all intrinsic.

       input-output section.
       file-control.
       i-o-control.

       data division.
       file section.
```

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```
       working-storage section.
       01 neko-initialized     pic x value low-value external.

       01 cli                  pic x(32) value "haxetest.n".

       01 url.
          05 filler            value "http://example.com".

       01 module-record.
          05 module            usage pointer.
       01 neko-exception       usage pointer.
       01 neko-object          usage pointer.
       01 neko-class           usage pointer.

       :NEKO-RECORD:

       01 v-x                  usage pointer.
       01 v-f                  usage pointer.
       01 v-answer             usage pointer.
       01 x                    usage binary-double.
       01 answer               usage binary-double.

       01 v-url                usage pointer.
       01 v-read               usage pointer.
       01 v-page               usage pointer.

       01 v-len                usage pointer.
       01 coblen               usage binary-long value 1.
       01 MAXLEN               constant as 8388608.
       01 cobbuf.
          05 pic x occurs 0 to MAXLEN times depending on coblen.

       :NEKO-TAGS:

      *> ****************************************************************
       procedure division.
       haxe-neko-main.

      *> start NekoVM given bytecode file on command line or default
       accept cli from command-line
       if cli equal spaces then
           initialize cli all to value
       end-if

       move neko-load(cli) to module-record

      *> Module loaded, now for the application part
       perform neko-application

      *> cleanup NekoVM
       move neko-unload to neko-record
       goback.
      *> ****************************************************************

      *>
      *> application code example
```

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```
      *>
       neko-application.

      *> assume Haxe provides value x, function f and reads string url
      *> from inside class Demonstration

       move neko-lookup(module, "__classes") to neko-record
       set neko-object to neko-value

       move neko-lookup(neko-object, "Demonstration") to neko-record
       set neko-class to neko-value

      *> assume no such class for straight nekotest test
       if neko-class equal null then
           set neko-class to module
       end-if

      *> Look for f(x) example
       move neko-lookup(neko-class, "x") to neko-record
       set v-x to neko-value
       move neko-decode(neko-record) to x

       move neko-lookup(neko-class, "f") to neko-record
       set v-f to neko-value

       if neko-type(v-f) equal TAG-FUNCTION then
           move neko-call(v-f, v-x) to neko-record
           set v-answer to neko-value
           move neko-decode(neko-record) to answer

           display "f(" x ") = " answer
       end-if

      *> see if there is a requestUrl example
       move neko-string(trim(url)) to neko-record
       set v-url to neko-value

       move neko-lookup(neko-class, "requestUrl") to neko-record
       set v-read to neko-value

       if neko-type(v-read) equal TAG-FUNCTION then
           *> call the Haxe function
           display "Read: " trim(url)
           move neko-call(v-read, v-url) to neko-record
           set v-page to neko-value

           *> dereference the haxe String class data
           move MAXLEN to coblen
           move haxe-unstring(v-page, cobbuf, coblen) to neko-record
           display "Haxe returned: " coblen " bytes"
           display cobbuf
       end-if

      *> end sample neko-application
       .

       :EXCEPTION-HANDLERS:
```

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```
       end program cobweb-neko.
      *> ****************************************************************
      *>****

      *>****F* cobweb-neko/neko-lookup
      *> PURPOSE
      *>   lookup a neko field inside given object, by name
       identification division.
       function-id. neko-lookup.

       environment division.
       configuration section.
       repository.
           function neko-type
           function all intrinsic.

       data division.
       working-storage section.
       01 field-id             usage pointer.
       01 field-value          usage pointer.
       :NEKO-TAGS:

       linkage section.
       01 neko-object          usage pointer.
       01 neko-key             pic x any length.
       :NEKO-RECORD:

       procedure division using neko-object neko-key
           returning neko-record.

       neko-field-lookup.
       set neko-value to null

       if (neko-object equal null) or
          (neko-type(neko-object) equal TAG-NULL) then
           goback
       end-if

       call "neko_val_id" using
           by content concatenate(trim(neko-key), x"00")
           returning field-id
       if field-id equal null then
           display "error: neko_val_id " neko-key upon syserr
           perform soft-exception
           goback
       end-if

       call "neko_val_field" using by value neko-object field-id
           returning field-value
       if field-value equal null then
           display "error: neko_val_field " neko-key upon syserr
           perform soft-exception
           goback
       end-if

       set neko-value to field-value
```

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```
       goback
       .

       :EXCEPTION-HANDLERS:

       end function neko-lookup.
      *>****

      *>****F* cobweb-neko/neko-string
      *> PURPOSE
      *>   allocate a neko string value
      *>   if wanted-size not given, copy existing source
      *>   if wanted-size given and source is low-values, allocate empty
      *>   if wanted-size given copy existing to new for wanted-size
       identification division.
       function-id. neko-string.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 field-value          usage pointer.
       01 given-size           usage binary-long.

       linkage section.
       01 source-data          pic x any length.
       01 wanted-size          pic 9 any length.
       :NEKO-RECORD:

       procedure division using source-data optional wanted-size
           returning neko-record.

       neko-allocate-string.
       set neko-value to null

       if wanted-size is omitted then
           call "neko_alloc_string" using
               by content concatenate(source-data, x"00")
               returning field-value

           if field-value equal null then
               display "error: neko_alloc_string " trim(source-data)
                  upon syserr
               perform soft-exception
               goback
           end-if
       else
           move wanted-size to given-size
           if given-size is less than zero then
               display "error: neko-string invalid size" wanted-size
                  upon syserr
               perform soft-exception
               goback
           end-if
```

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```
           if source-data equal low-values then
               call "neko_alloc_empty_string" using
                   by value given-size
                   returning field-value

               if field-value equal null then
                   display "error: neko_alloc_empty_string " wanted-size
                      upon syserr
                   perform soft-exception
                   goback
               end-if
           else
               call "neko_copy_string" using
                   by content concatenate(source-data, x"00")
                   by value given-size
                   returning field-value

               if field-value equal null then
                   display "error: neko_copy_string "
                      trim(source-data) ", " wanted-size
                      upon syserr
                   perform soft-exception
                   goback
               end-if
           end-if
       end-if

       set neko-value to field-value
       goback
       .

       :EXCEPTION-HANDLERS:

       end function neko-string.
      *>*****

      *>*****F* cobweb-neko/neko-unstring
      *> PURPOSE
      *>   Pull the character data out of a neko vstring
      *>   Filling cobol buffer, settting length and
      *>   returning cdata address
       identification division.
       function-id. neko-unstring.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 field-value          usage pointer.
       01 length-value         usage pointer.

       01 string-value         based.
          05 v-type            usage binary-long.
          05 cdata             pic x.
```

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```
       linkage section.
       01 neko-vstring         usage pointer.
       01 cobol-buffer         pic x any length.
       01 neko-length          usage binary-long.
       :NEKO-RECORD:

       procedure division using neko-vstring cobol-buffer neko-length
           returning neko-record.

       dereference-haxe-string.
       set neko-value to null

       if neko-vstring not equal null then
           set address of string-value to neko-vstring
           call "strlen" using cdata returning neko-length
           call "memcpy" using
               cobol-buffer cdata
               by value min(neko-length length(cobol-buffer))
           set neko-value to address of cdata
       end-if

       goback
       .

       :EXCEPTION-HANDLERS:

       end function neko-unstring.
      *>****

      *>****F* cobweb-neko/haxe-unstring
      *> PURPOSE
      *>   pull character data out of a haxe string
      *>   haXe String type is a class object, with members length, __s
       identification division.
       function-id. haxe-unstring.

       environment division.
       configuration section.
       repository.
           function neko-type
           function neko-lookup
           function neko-decode
           function all intrinsic.

       data division.
       working-storage section.
       01 field-value          usage pointer.
       01 length-value         usage pointer.

       01 string-value         based.
          05 v-type            usage binary-long.
          05 v-str             pic x.
       :NEKO-TAGS:

       linkage section.
       01 haxe-value           usage pointer.
```

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```
       01 cobol-buffer         pic x any length.
       01 haxe-length          usage binary-long.
       :NEKO-RECORD:

       procedure division using haxe-value  cobol-buffer haxe-length
           returning neko-record.

       dereference-haxe-string.
       set neko-value to null

      *> Haxe String is a class, data in member __s
       if neko-type(haxe-value) equal TAG-OBJECT then

           move neko-lookup(haxe-value, "length") to neko-record
           if neko-type(neko-record) equal TAG-INT then
               set length-value to neko-value
               move neko-decode(neko-record) to haxe-length
           end-if

           move neko-lookup(haxe-value, "__s") to neko-record
           if neko-type(neko-record) equal TAG-STRING then
               set address of string-value to neko-value
               call "memcpy" using
                   cobol-buffer v-str
                   by value min(haxe-length length(cobol-buffer))
           end-if
           set neko-value to address of v-str
       end-if

       goback
       .

       :EXCEPTION-HANDLERS:

       end function haxe-unstring.
      *>*****

      *>****F* cobweb-neko/neko-call
      *> PURPOSE
      *>   call a neko/haxe function
       identification division.
       function-id. neko-call.

       environment division.
       configuration section.
       repository.
           function neko-type
           function all intrinsic.

       data division.
       working-storage section.
       01 neko-result          usage pointer.
       :NEKO-TAGS:

       linkage section.
       01 neko-function        usage pointer.
       01 neko-arg1            usage pointer.
```

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```
       01 neko-arg2            usage pointer.
       01 neko-arg3            usage pointer.
       :NEKO-RECORD:

       procedure division using neko-function optional neko-arg1
           returning neko-record.

       neko-function-call.
       set neko-value to null

       if neko-type(neko-function) not equal TAG-FUNCTION then
           display "error: not a function " neko-type(neko-function)
              upon syserr
           goback
       end-if

       evaluate number-of-call-parameters
           when 1
               call "neko_val_call0" using
                   by value neko-function
                   returning neko-result
           when 2
               call "neko_val_call1" using
                   by value neko-function neko-arg1
                   returning neko-result
           when 3
               call "neko_val_call2" using
                   by value neko-function neko-arg1 neko-arg2
                   returning neko-result
           when 4
               call "neko_val_call3" using
                   by value neko-function neko-arg1 neko-arg2 neko-arg3
                   returning neko-result
       end-evaluate

       set neko-value to neko-result
       goback
       .

       :EXCEPTION-HANDLERS:

       end function neko-call.
      *>*****

      *>*****F* cobweb-neko/neko-type
      *> PURPOSE
      *>   return type tag give a neko value
       identification division.
       function-id. neko-type.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
```

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```
       01 neko-one             usage binary-double value 1.
       01 neko-result          usage binary-double.
       01 low-byte             usage binary-long value 1.
       01 all-bytes            usage binary-long value 8.
       01 deref-value          usage binary-double based.
       01 neko-fourbits        usage binary-long value 15.

       :NEKO-TAGS:

       linkage section.
       :NEKO-RECORD:
       01 neko-vtype           usage binary-double.

       procedure division using neko-record returning neko-vtype.
       decode-neko-type.

       move neko-one to neko-result
       call "CBL_AND" using actual-value neko-result by value low-byte
       if neko-result equal 1 then
           move TAG-INT to neko-vtype
           goback
       end-if

       set address of deref-value to neko-value
       move neko-fourbits to neko-result
       call "CBL_AND" using deref-value neko-result by value all-bytes

       move neko-result to neko-vtype
       goback
       .

       end function neko-type.
      *>*****

      *>****F* cobweb-neko/neko-decode
      *> PURPOSE
      *>   decode neko integer or leave alone
      *>   neko overlays 31-bit integers with the other value tags
      *>   low bit set is an integer
       identification division.
       function-id. neko-decode.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 neko-one             usage binary-double value 1.
       01 neko-result          usage binary-double.
       01 low-byte             usage binary-long value 1.

       linkage section.
       :NEKO-RECORD:
       01 neko-decoded.
          05 neko-integer      usage binary-double.
```

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```
       procedure division using neko-record returning neko-decoded.
       decode-neko-value.

       move neko-one to neko-result
       call "CBL_AND" using actual-value neko-result by value low-byte
       if neko-result equal 1 then
           divide actual-value by 2 giving neko-integer
       end-if

       goback
       .

       end function neko-decode.
      *>****

      *>****F* cobweb-neko/neko-load
      *> PURPOSE
      *>   load neko bytecode file
      *>   initialize NekoVM on first call
       identification division.
       function-id. neko-load.

       environment division.
       configuration section.
       repository.
           function neko-lookup
           function neko-type
           function all intrinsic.

       data division.
       working-storage section.
       01 neko-initialized     pic x                external.
       01 vm                   usage pointer.
       01 module               usage pointer.
       01 loader               usage pointer.
       01 args.
          05 arg               usage pointer occurs 2 times.
       01 neko-exception       usage pointer.

       01 lookup-record.
          05 function-value    usage pointer.

       :NEKO-TAGS:

       linkage section.
       01 bytecode-file        pic x any length.
       :NEKO-RECORD:

       procedure division using bytecode-file returning neko-record.
       neko-loader.

       set neko-value to null

      *> Initialize NekoVM
       if neko-initialized equal low-value then
           call "neko_global_init" using null returning omitted
```

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```
               on exception
                   display "error initializing NekoVM (-lneko)"
                      upon syserr
                   perform hard-exception
           end-call

           call "neko_vm_alloc" using null returning vm
           if vm equal null then
               display "error: neko_vm_alloc" upon syserr
               goback
           end-if

           call "neko_vm_select" using by value vm returning omitted

           call "neko_default_loader" using
                null by value 0 returning loader
           if loader equal null then
               display "error: neko_default_loader" upon syserr
               perform hard-exception
           end-if

           move high-value to neko-initialized
       end-if

      *> Load bytecode module
       call "neko_alloc_string" using
           by content concatenate(trim(bytecode-file), x"00")
           returning arg(1)

       if arg(1) equal null then
           display "error: neko_alloc_string " trim(bytecode-file)
              upon syserr
           perform hard-exception
       end-if
       set arg(2) to loader

       move neko-lookup(loader, "loadmodule") to lookup-record
       if neko-type(loader) not equal TAG-OBJECT then
           display "error: no Neko loader" upon syserr
           perform hard-exception
       end-if

       call "neko_val_callEx" using
           by value loader function-value
           by reference args
           by value 2
           by reference neko-exception
           returning module
       end-call

       if module equal null then
           display "error: neko_val_callEx loadmodule" upon syserr
           perform hard-exception
       end-if

       if neko-exception not equal null then
           display "error: Neko exception " neko-exception upon syserr
```

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```
           perform hard-exception
       end-if

       set neko-value to module
       goback.

       :EXCEPTION-HANDLERS:

       end function neko-load.
      *>*****

      *>*****F* cobweb-neko/neko-unload
      *> PURPOSE
      *>   neko rundown
       identification division.
       function-id. neko-unload.

       data division.
       linkage section.
       :NEKO-RECORD:

       procedure division returning neko-record.
       neko-unloader.
       set neko-value to null

       call "neko_global_free" returning omitted

       goback.
       .
       end function neko-unload.
      *>*****

>>ELSE
!doc-marker!
```

```
===========
cobweb-neko
===========

.. contents::

Introduction
------------
Haxe/Neko integration with GnuCOBOL.

Haxe is best described as a cross-platform multi-target toolkit
programming language.  One of the Haxe targets, the default, is Neko.
Neko is both a source level programming language and a Virtual Machine,
NekoVM. (There is also a NekoML meta language source compiler).

The cobweb-neko system embeds the NekoVM allowing it to run bytecode
generated from any of Haxe, Neko, NekoML or any future language that
targets this handy little virtual machine.

Haxe programming offers much more, so the pairing of GnuCOBOL and Neko
will offer some interestiong potentials to anyone looking to web enable
```

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```
applications with COBOL in the mix.

Tectonics
---------

::

    prompt$ nekoc nekotest.neko
      or
    prompt$ haxe -neko haxetest.n -main Demonstration
      or
    prompt$ cobc -dg cobweb-neko.cob -lneko
    prompt$ cobcrun cobweb-neko [bytecodefile - defaults to haxetest.n]

    prompt$ cobc -xdgj cobweb-neko.cob -lneko

Usage
-----

Prepare a bytecode file, with either ``nekoc`` or ``haxe -neko``.

Allow cobweb-neko to load the virtual machine, and add GnuCOBOL code to
take advantage of features available with Haxe and Neko.

A note on Strings.  NekoVM supports a ``string`` data-type.  Haxe wraps
this in an actual class.

Passing a Neko string to Haxe is best handled with

.. sourcecode:: haxe

    static function test(str:Dynamic) {
        var haxestr:String = neko.Lib.nekoToHaxe(str)
        ... use the haxestr String
    }

There is also a supporting neko.Lib.haxeToNeko converter.

Receiving a String from Haxe requires a lookup by GnuCOBOL to retrieve a
member element ``__s`` for use.  This data is a NekoVM ``value`` which
requires further treatment to get into COBOL working store.

Use ``haxe-unstring(value)`` or ``neko-unstring(value)`` as appropriate.
Assume any Haxe function will receive neko-string when embedded in
GnuCOBOL, so it will require translation with
``neko.Lib.nekoToHaxe(str)``.

::

    prompt$ ./cobweb-neko nekobytecode.n
    prompt$ cobcrun cobweb-neko nekobytecode.n



Source
------
```

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```
.. include::  cobweb-neko.cob
   :code: cobolfree

.. include:: nekotest.neko
   :code: neko

.. include:: Demonstration.hx
   :code: haxe
```

```
>>END-IF
```

Please note that the code above is some what dual purpose. It can load and run just about any Neko module, but it is also tuned to try and find a few exports from Neko; `var x`, `function f` from Neko, and `function requestUrl` inside a `class Demonstration` from haXe.

Use the above code as a starting point, not as an end.

The Demonstration haXe class

```
using StringTools;

class Demonstration {
    @author("Brian Tiffin")
    @date("July 2016")

    public static var page:String;
    public static var x:Int = 7;
    public static function f(x:Int):Int {return x * (x - 1);}

    public static function requestUrl(u:String):String {
        var url:String = neko.Lib.nekoToHaxe(u);
        page = haxe.Http.requestUrl(url);
        trace("page size: " + page.length);
        return page;
    }

    public static function main():Void {
        var people = [
            "Elizabeth" => "Programming",
            "Joel" => "Design"
        ];
        for (name in people.keys()) {
            var job = people[name];
            trace('$name does $job for a living!');
        }

        #if neko
        trace("neko is defined");
        #end

        #if python
        trace("python is defined");
        #end

        #if sys
        //trace(Sys.environment());
        #end
```

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```
        trace("Codesize: " + neko.vm.Module.local().codeSize());
    }
}
```

And a sample Makefile

```
# Making with some Haxe/Neko
.RECIPEPREFIX = >

cobweb-neko.so: cobweb-neko.cob haxetest.n
> cobc -d cobweb-neko.cob -lneko

cobweb-neko: cobweb-neko.cob haxetest.n
> cobc -xjd cobweb-neko.cob -lneko

haxetest.n: Demonstration.hx
> haxe -neko haxetest.n -main Demonstration

callneko: callneko.cob nekotest.n
> cobc -xd callneko.cob -lneko

nekotest.n: nekotest.neko
> nekoc nekotest.neko

# Translate to neko source
file.neko: Testing.hx
> haxe -neko file.neko -D neko-source -main Testing Testing.hx

file.n: file.neko
> nekoc file.neko

file: file.n
> nekotools boot file.n

# Compile to bytecode
testing.n: Testing.hx
> haxe -neko testing.n -main Testing

# Make some flash, requires flash-test.html
flash.swf: Flash.hx
> haxe -swf flash.swf -main Flash Flash.hx

moving-flash.swf: MovingFlash.hx
> haxe -swf moving-flash.swf -main MovingFlash -swf-version 15 \
       -swf-header 200:200:30:f68712

.PHONY: clean test help
clean:
> -rm cobweb-neko cobweb-neko.so cobweb-neko.c cobweb-neko.c.* cobweb-neko.i
> -rm nekotest.n haxetest.n

test: cobweb-neko.so haxetest.n nekotest.n
> cobcrun cobweb-neko
> cobcrun cobweb-neko nekotest.n

help:
```

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```
> @echo "targets include:"
> @echo "    cobweb-neko.so"
> @echo "    cobweb-neko"
> @echo "    clean"
> @echo "    test"
> @echo "    and this help"
```

And the flying carpet pass:

```
prompt$ make test
haxe -neko haxetest.n -main Demonstration
cobc -d cobweb-neko.cob -lneko
nekoc nekotest.neko
cobcrun cobweb-neko

Demonstration.hx:25: Elizabeth does Programming for a living!
Demonstration.hx:25: Joel does Design for a living!
Demonstration.hx:29: neko is defined
Demonstration.hx:40: Codesize: 29377
f(+0000000000000000007) = +0000000000000000042
Read: http://example.com
Demonstration.hx:14: page size: 1270
Haxe returned: +0000001270 bytes
<!doctype html>
<html>
<head>
    <title>Example Domain</title>

    <meta charset="utf-8" />
    <meta http-equiv="Content-type" content="text/html; charset=utf-8" />
    <meta name="viewport" content="width=device-width, initial-scale=1" />
    <style type="text/css">
    body {
        background-color: #f0f0f2;
        margin: 0;
        padding: 0;
        font-family: "Open Sans", "Helvetica Neue", Helvetica, Arial, sans-serif;

    }
    div {
        width: 600px;
        margin: 5em auto;
        padding: 50px;
        background-color: #fff;
        border-radius: 1em;
    }
    a:link, a:visited {
        color: #38488f;
        text-decoration: none;
    }
    @media (max-width: 700px) {
        body {
            background-color: #fff;
        }
        div {
            width: auto;
            margin: 0 auto;
```

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```
            border-radius: 0;
            padding: 1em;
        }
    }
    </style>
</head>

<body>
<div>
    <h1>Example Domain</h1>
    <p>This domain is established to be used for illustrative examples in documents.
    You may use this domain in examples without prior coordination or asking for
    permission.</p>
    <p><a href="http://www.iana.org/domains/example">More information...</a></p>
</div>
</body>
</html>

cobcrun cobweb-neko nekotest.n

The virtual machine is working !
Calling a function inside std library...
Test successful
2016-07-09 18:14:03
nekotest.n  nekotest.neko
Shell returned: 0
Raised: load.c(357) : Primitive not found : std@not_in_std_library(0): 5
        from [[nekotest.neko,33]] from [[nekotest.neko,38]]
f(7) = 42
f(+00000000000000000007) = +00000000000000000042
```

And the NekoVM is running inside GnuCOBOL, ready to load and run any (well some) Haxe or Neko source that has been compiled down to Neko bytecode. This early version of `cobweb-neko version 0.3` only handles `int`, `string` and `function` Neko data types.

If you want to try the Flash output, here is flash-test.html

```
<html>
<head><title>Haxe Flash</title></head>
<body bgcolor="#dddddd">
<object classid="clsid:d27cdb6e-ae6d-11cf-96b8-444553540000"
        width="400"
    height="300"
    id="haxe"
    align="middle">
<param name="movie" value="flash.swf"/>
<param name="allowScriptAccess" value="always" />
<param name="quality" value="high" />
<param name="scale" value="noscale" />
<param name="salign" value="lt" />
<param name="bgcolor" value="#ffffff"/>
<embed src="flash.swf"
       bgcolor="#ffffff"
       width="400"
       height="300"
       name="haxe"
       quality="high"
```

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```
       align="middle"
       allowScriptAccess="always"
       type="application/x-shockwave-flash"
       pluginspage="http://www.macromedia.com/go/getflashplayer"
/>
</object>
</body>
</html>
```

Note: I have no real idea about the clsid hex code.

Using Haxe to generate a .swf output for Flash.

```
class Flash {
    static function main() {
        var mc:flash.display.MovieClip = flash.Lib.current;
        mc.graphics.beginFill(0xFF0000);
        mc.graphics.moveTo(50,50);
        mc.graphics.lineTo(100,50);
        mc.graphics.lineTo(100,100);
        mc.graphics.lineTo(50,100);
        mc.graphics.endFill();

        trace("Hello, World");
    }
}
```

For some movement in that Flash...

```
import flash.display.MovieClip;
import flash.display.Sprite;
import flash.events.MouseEvent;
import flash.events.Event;

import flash.text.TextFormat;
import flash.text.TextField;

class MovingFlash extends MovieClip {
        var r : Sprite;
        var x_ori:Int;
        var y_ori:Int;
        var theta:Float;
        var cos_theta:Float;
        var sin_theta:Float;

        public function new() {
                super();
                x_ori=50;
                y_ori=50;
                theta =0.01;
                cos_theta = Math.cos(theta);
                sin_theta = Math.sin(theta);
                var background:Sprite = new Sprite ();
                background.graphics.beginFill(0xffaaaa);
                background.graphics.drawRect(0,0,200,200);
                addChild(background);
```

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```
                r = new Sprite();
                r.graphics.beginFill(0xaaaaff);
                r.graphics.drawRect(40,40,20,20);
                addChild(r);
                r.addEventListener("enterFrame",move);
        }

        function move(e:Event) {
                var new_x = cos_theta * (e.target.x-x_ori) - sin_theta *(e.target.y-y_
↪ori);
                var new_y = sin_theta * (e.target.x-x_ori) + cos_theta *(e.target.y-y_
↪ori);
                e.target.x = new_x+x_ori;
                e.target.y = new_y+y_ori;
        }

        static function main() {
                var tf = new TextFormat();
                tf.font = "Times New Roman";
                tf.size = 16;
                tf.color = 0x000000;

                var textblock = new TextField();
                textblock.autoSize = LEFT;
                textblock.text = "Flash animation from HaXe";
                textblock.setTextFormat(tf);

                var m:MovingFlash = new MovingFlash();
                flash.Lib.current.addChild(m);
                flash.Lib.current.addChild(textblock);
        }
}
```

There are make targets listed above for `make flash.swf` and `make moving-flash.swf`.

http://nekovm.org/ for details on Neko and NekoVM. There is a lot to this little engine. Including a development web server built into the main `neko` command, along with XML generators, doc gen tools, and all sorts of handy utilities for C layer integration. There is even a higher level meta language, NekoML.

Even more power comes with Haxe, the cross-platform toolkit. https://haxe.org/

High level Haxe code can generate all kinds of runtime output. Neko is highlighted here, but that is a small (but very useful) part of the Haxe ecosystem. Haxe is aims to start modern, and stay modern. Web applications are a breeze, and output forms are flavoured to suit almost any taste. Python code output, Javascript, PHP, C++ and on and on, all from the same Haxe source file.

The cross language nature of Haxe might seem distracting, but the concept behind it really shines when a Haxe Remoting Python application is directly talking to a Haxe Remoting PHP application (for instance - most targets can talk to most targets so the combination count is pretty high)

From the main Haxe site

```
class Testing {
  static function main() {
    var people = [
      "Elizabeth" => "Programming",
      "Joel" => "Design"
    ];
```

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```
    for (name in people.keys()) {
      var job = people[name];
      trace('$name does $job for a living!');
    }
  }
}
```

With a sample Neko build:

```
prompt$ haxe -neko testing.n -main Testing Testing.hx
prompt$ neko testing
Testing.hx:9: Elizabeth does Programming for a living!
Testing.hx:9: Joel does Design for a living!
```

Or, if Python is more your style:

```
prompt$ haxe -python testing.py -main Testing Testing.hx
```

```
# Generated by Haxe 3.3.0



class Testing:
    __slots__ = ()

    @staticmethod
    def main():
        _g = haxe_ds_StringMap()
        _g.h["Elizabeth"] = "Programming"
        _g.h["Joel"] = "Design"
        tmp = _g.keys()
        while tmp.hasNext():
            name = tmp.next()
            print(str(((("" + ("null" if name is None else name)) + " does ")
            + HxOverrides.stringOrNull(_g.h.get(name,None))) + " for a living!")))


class haxe_IMap:
    __slots__ = ()


class haxe_ds_StringMap:
    __slots__ = ("h",)

    def __init__(self):
        self.h = dict()

    def keys(self):
        return python_HaxeIterator(iter(self.h.keys()))



class python_HaxeIterator:
    __slots__ = ("it", "x", "has", "checked")

    def __init__(self,it):
```

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```
        self.checked = False
        self.has = False
        self.x = None
        self.it = it

    def next(self):
        if (not self.checked):
            self.hasNext()
        self.checked = False
        return self.x

    def hasNext(self):
        if (not self.checked):
            try:
                self.x = self.it.__next__()
                self.has = True
            except Exception as _hx_e:
                _hx_e1 = _hx_e
                if isinstance(_hx_e1, StopIteration):
                    s = _hx_e1
                    self.has = False
                    self.x = None
                else:
                    raise _hx_e
            self.checked = True
        return self.has



class HxOverrides:
    __slots__ = ()

    @staticmethod
    def stringOrNull(s):
        if (s is None):
            return "null"
        else:
            return s
```

Giving:

```
prompt$ python3 testing.py
Elizabeth does Programming for a living!
Joel does Design for a living!
```

And that is just a small taste. There are lots of targets, lots of library features, and an entire game and web development layer in Haxe space. As mentioned before, Neko even ships with a small web development and test server.

The `cobweb-neko` GnuCOBOL sample just needs the neko file passed in as `testing.n` and we get:

```
prompt$ ./cobweb-neko testing.n
Testing.hx:9: Elizabeth does Programming for a living!
Testing.hx:9: Joel does Design for a living!
```

Many thanks to Nicolas Cannasse and the Haxe Foundation. A handy toolkit.

While the Haxe and Neko systems are built along with other software, here is the main Neko license text:

```
Neko Virtual Machine (neko) and Neko Tools (nekotools)
======================================================

Copyright (C)2005-2016 Haxe Foundation

Permission is hereby granted, free of charge, to any person obtaining a
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LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING
FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER
DEALINGS IN THE SOFTWARE.
```

Please see the Haxe and Neko distribution files for the other licensing details.

5.109 Can GnuCOBOL evaluate equations given at runtime?

Yes, with `libmatheval`, a library that is part of the GNU project. There is a user defined function repository, `cobweb-math`.

`cobweb-math` is a GnuCOBOL contribution and can be found at

https://sourceforge.net/p/gnucobol/contrib/HEAD/tree/trunk/tools/cobweb/cobweb-math/

`libmatheval` will parse equations, given as text input and then evaluate the expressions. Equations can include variable names. `x`, `y`, and `z` being common choices. `cobweb-math` currently supports upto 16 variables per equation. Simple calculator style calculations, with no variables, are also supported.

```
environment division.
configuration section.
repository.
    function evaluate-math
    function create-equation
    function evaluate-x
    function destroy-equation
    function all intrinsic.


data division.
working-storage section.
COPY cobweb-math REPLACING ==:tag:== BY ====.

01 x          usage float-long.
01 answer     usage float-long.
01 extraneous usage binary-long.
...
```

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```
procedure division.
*> basic calculator math
display evaluate-math("(1 + 2 * 3 / 4 - 5)^6")

*> equation using x, (with automatically computed derivative)
move create-equation("x^5 + sin(x)^2", "derivative")
  to evaluator-record
perform varying x from 0.0 by 0.1 until x > 1.0
    move evaluate-x(evaluator, x) to answer
    display "f(" x ") = " answer
    move evaluate-x(evaluator-prime, x) to answer
    display "f'(" x ") = " answer
end-perform
move destroy-equation(evaluator-record) to extraneous
```

cobweb-math includes a small calculator demo, and a user defined function repository.

```
*> Repository for cobweb-math
    function create-equation
    function evaluate-equation
    function destroy-equation
    function evaluate-x
    function evaluate-xy
    function evaluate-xyz
    function evaluate-math
```

`create-equation("equation", "options")` accepts two possible options, "derivatives, variables". libmatheval can parse the equation and also build a first order derivative equation. The library can also retrieve a list of named variables in the equation for when you need more than x,y,z.

`evaluate-x(evaluator, x)`, `-xy`, `-xyz` are convenience functions assuming x [, y [, z]] variables are used in the equation, while `evaluate-equation` needs a list of names and table of values in the call.

Use `evaluate-math("math expression")`, another convenience function, for simple math calculations with no variables.

libmatheval uses algebraic order of precedence for arithmetic operators.

Floating point math is used, so this is not meant for calculations requiring financial accuracy or precision.

See https://www.gnu.org/software/libmatheval/

5.110 Can GnuCOBOL interface with Go?

Yes, with a little effort. `Go`, the emergent programming language by Google uses a slightly different *ABI* (page 1350) than C. There is a special wrapper program `cgo` that enables the creation of `Go` packages that call `C` code. `C` calling `Go` is a little trickier, as there needs to be some data marshalling, initialization guarantees and what not.

User *swichblade* on GitHub has created some introductory materials on combining `GnuCOBOL` and `Golang`.

GnuCOBOL Golang on GitHub

This project demonstrates various datatype handling between COBOL definitions and Go native and updates the code to use newer Go lang features.

```
prompt$ cobc -c -static say2.cob
prompt$ cobc -c -static datatype.cob

prompt$ ar q libgbc.a say2.o datatype.o
prompt$ go run testDataTypes.go
```

All the nifty details, and sample code on the GitHub page referenced above.

Go.

Aside: I have one qualm about the Go model. It is a statically linked language by design, for the most part (except when `cgo` is involved and a few other edge cases), which has some very positive pros. But I fear that there will be a reckoning at some point if or when exploits are found in the core libraries. When a security flaw in `libc` is discovered, a single team of brilliant developers puts out a patch, and running programs require no extra steps to benefit from a dynamically linked runtime. If an exploit is discovered in the Go core libraries, *every* Go program will need to be recompiled to benefit from corrective patches. I'm not sure that is in the best interest of long lived application development. Willing to be proven wrong.

Update on the aside:. Golang now supports dynamic builds. That opens up the option to allow developer choice between statically linked programs and dynamic access to an often changing Go run-time system.

5.111 Can GnuCOBOL interface with libcox?

Yep. As with most of the offerings from Symisc Systems, sources are shipped in an SQLite style amalgamation bundle. All that is needed is inclusion of a single `.c` file in a `cobc` compile line for access to all the goodies.

`libcox` is a cross-platform command evaluation engine. Some 145 commands (many are aliases) are provided in the source kit. Things like `ls`, `disk_total_space` and a host of other command line like utilities are callable. This provides one path to a Windows and GNU/Linux cross-platform way of getting directory listings into GnuCOBOL space. *Along with all the other features*. Designed to be embedded, Symisc makes the integration pretty easy.

A seed work example, with two User Defined Function repository entries and a test head follows:

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****J* gnucobol/cobweb-libcox
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20161211  Modified: 2016-12-12/19:00-0500
      *> LICENSE
      *>   Copyright (c) 2016 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or superior)
      *> PURPOSE
      *>   cobweb-libcox demonstration program.
      *>   A seed work, customize to suit local site requirements.
      *> TECTONICS
      *>   cobc -x -g -debug cobweb-libcox.cob libcox.c
      *>   cobc -b cobweb-libcox.cob libcox.c
      *> ***************************************************************
       identification division.
       program-id. cobweb-libcox.
       author. Brian Tiffin.
       date-written. 2016-12-11/20:26-0500.
       date-modified. 2016-12-12/19:00-0500.
```

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```
       date-compiled.
       installation. Needs libcox, from http://libcox.symisc.net.
       remarks.
       security. Complex C library, evaluates user entered commands.

       environment division.
       configuration section.
       source-computer. gnulinux.
       object-computer. gnulinux
           classification is canadian.

       special-names.
           locale canadian is "en_CA.UTF-8".

       repository.
           function libcox-exec
           function libcox-list
           function all intrinsic.

       input-output section.
       file-control.
       i-o-control.

       REPLACE
       ==:LIBCOX-RECORD:== BY
       ==
          05 libcox-handle     usage pointer.
          05 libcox-value      usage pointer.
          05 libcox-elements   usage binary-long.
          05 libcox-type       usage binary-long.
          05 libcox-int        usage binary-long.
          *> BUG: GnuCOBOL CALL is still tripping up on 64 bit returns
          05 libcox-trick      usage pointer.
          05 libcox-int64  redefines libcox-trick usage binary-double.
          05 libcox-bool       usage binary-long.
          05 libcox-double     usage float-long.
          05 libcox-string     usage pointer.
          05 rc                usage binary-long.
       ==
       ==:LIBCOX-TABLE:== BY
       ==
          05 libcox-array      occurs 512 times.
             10 libcox-entry   pic x(64).
       ==
       .

       data division.
       file section.

       working-storage section.
       01 cli                  pic x(8).
          88 quiet-you         values "--quiet", "quiet", "q", "-q".

       01 libcox-record.
          :LIBCOX-RECORD:
       01 extraneous           usage binary-long.
```

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```
      *> for string types
       01 libcox-store         pic x(1048576).

      *> for array types
       01 libcox-table.
          :LIBCOX-TABLE:

      *> for pretty print of disk space info
       01 show64               pic zzz,zzz,zzz,zzz,zzz,999.

      *> ****************************************************************
       procedure division.

       accept cli from command-line
       if quiet-you then goback end-if

      *> show the system type
       display "uname"
       move libcox-exec(libcox-record, "uname", libcox-store)
         to extraneous
       display trim(libcox-store)

      *> fetch the list of known libcox commands
       display space
       display "CMD_LIST"
       move libcox-list(libcox-record, "CMD_LIST", libcox-table)
         to extraneous
       perform varying tally from 1 by 1 until tally > libcox-elements
           display tally ": " trim(libcox-array(tally))
       end-perform

      *> a directory listing, as array
       display space
       display "ls"
       move libcox-list(libcox-record, "ls", libcox-table)
         to extraneous
       perform varying tally from 1 by 1 until tally > libcox-elements
           display tally ": " trim(libcox-array(tally))
       end-perform

      *> a filename listing, as string
       display space
       display "glob *.cob"
       move libcox-exec(libcox-record, "glob *.cob", libcox-store)
         to extraneous
       display libcox-type " " trim(libcox-store)

      *> explode a string by delimiter
       display space
       display 'explode , a,b,c,d'
       move libcox-list(libcox-record,
                        'explode , a,b,c,d,', libcox-table)
         to extraneous
       perform varying tally from 1 by 1 until tally > libcox-elements
           display tally ": " trim(libcox-array(tally))
       end-perform
```

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```
      *> cat files into a string
       display space
       display 'cat libcox-license.txt'
       move libcox-exec(libcox-record,
                        'cat libcox-license.txt', libcox-store)
         to extraneous
       display trim(libcox-store)

       display space
       display "disk_total_space, disk_free_space"
       move libcox-exec(libcox-record, "dt ./", libcox-store)
         to extraneous
       move libcox-int64 to show64
       display trim(show64) " bytes total, " with no advancing
       move libcox-exec(libcox-record, "df ./", libcox-store)
         to extraneous
       move libcox-int64 to show64
       display trim(show64) " bytes free "
       display libcox-type " " trim(libcox-store)

      *> rundown the command evaluation engine
       call static "libcox_release" using by value libcox-handle
       goback.
      *> ****************************************************************

       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:

       end program cobweb-libcox.
      *> ****************************************************************
      *>****

      *> ****************************************************************
      *>****F* cobweb-libcox/libcox-exec
      *> PURPOSE
      *>   evaluate a libcox command string
```

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```
       identification division.
       function-id. libcox-exec.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 inner-rc             usage binary-long.
       01 extraneous-pointer   usage pointer.

       linkage section.
       01 libcox-record.
          :LIBCOX-RECORD:
       01 libcox-command       pic x any length.
       01 libcox-buffer        pic x any length.
       01 extraneous           usage binary-long.

       procedure division using
           libcox-record
           libcox-command
           libcox-buffer
           returning extraneous.

      *> initialize the command processor if needs be
       if libcox-handle equal null then
           call static "libcox_init" using libcox-handle returning rc
               on exception
                   display "no libcox binding" upon syserr end-display
                   goback
           end-call
           if (rc not equal zero) or (libcox-handle equal null) then
               display "libcox init failure" upon syserr
               goback
           end-if
       end-if

      *> evaluate a command
       call static "libcox_exec" using
           by value libcox-handle
           by reference libcox-value
           by content concatenate(libcox-command x"00")
           by value -1
           returning rc
       end-call
       if rc not equal zero then
           display "libcox command evaluation failure" upon syserr
           goback
       end-if

      *> clear any pervious result
       move spaces to libcox-buffer

      *> pass back some usability information
       call static "libcox_value_is_int" using
```

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```
            by value libcox-value returning inner-rc
        end-call
        if inner-rc not equal zero then
            move 1 to libcox-type
            call static "libcox_value_to_int" using
                by value libcox-value
                returning libcox-int
            end-call
           *> BUG: GnuCOBOL CALL is still tripping up on 64 bit returns
            call static "libcox_value_to_int64" using
                by value libcox-value
                returning libcox-trick
            end-call
            go string-it
        end-if

        call static "libcox_value_is_float" using
            by value libcox-value returning inner-rc
        end-call
        if inner-rc not equal zero then
            move 2 to libcox-type
            call static "libcox_value_to_double" using
                by value libcox-value
                returning libcox-double
            end-call
            go string-it
        end-if

        call static "libcox_value_is_bool" using
            by value libcox-value returning inner-rc
        end-call
        if inner-rc not equal zero then
            move 3 to libcox-type
            call static "libcox_value_to_double" using
                by value libcox-value
                returning libcox-bool
            end-call
            go string-it
        end-if

        call static "libcox_value_is_string" using
            by value libcox-value returning inner-rc
        end-call
        if inner-rc not equal zero then
            move 4 to libcox-type
           *> get the result as string
            call static "libcox_value_to_string" using
                by value libcox-value
                by reference libcox-elements
                returning libcox-string
            end-call

           *> truncate move the result string to the given COBOL space
           *> return record gets the libcox character count
            call static "memmove" using
                libcox-buffer
                by value libcox-string
```

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```
               by value min(libcox-elements, length(libcox-buffer))
               returning extraneous-pointer
           end-call
           go out
       end-if


       call static "libcox_value_is_null" using
           by value libcox-value returning inner-rc
       end-call
       if inner-rc not equal zero then
           move 5 to libcox-type
           go out
       end-if

       call static "libcox_value_is_array" using
           by value libcox-value returning inner-rc
       end-call
       if inner-rc not equal zero then
           move 6 to libcox-type
           go string-it
       end-if

      *> Unknown type
       move -1 to libcox-type
       .

       string-it.
      *> get the result as string, just because
       call static "libcox_value_to_string" using
           by value libcox-value
           by reference libcox-elements
           returning libcox-string
       end-call

      *> truncate move the result string to the given COBOL space
      *> return record gets the libcox character count
       call static "memmove" using
           libcox-buffer
           by value libcox-string
           by value min(libcox-elements, length(libcox-buffer))
           returning extraneous-pointer
       end-call
       .

       out.
      *> free the result memory
       call static "libcox_exec_result_destroy" using
           by value libcox-handle libcox-value
           returning extraneous
       end-call

       goback.
       end function libcox-exec.
      *> ************************************************************
      *>*****
```

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```
      *> ****************************************************************
      *>****F* cobweb-libcox/libcox-list
      *> PURPOSE
      *>   evaluate a libcox command string,
      *>   assuming result is array of strings
       identification division.
       function-id. libcox-list.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 libcox-item          usage pointer.
       01 libcox-index         usage binary-long.
       01 extraneous-pointer   usage pointer.

      *> somewhat redundant, but allows table indexing
       01 libcox-table based.
          :LIBCOX-TABLE:

       linkage section.
       01 libcox-record.
          :LIBCOX-RECORD:
       01 libcox-command       pic x any length.
       01 libcox-buffer        pic x any length.  *> passed as table
       01 extraneous           usage binary-long.

       procedure division using
           libcox-record
           libcox-command
           libcox-buffer
           returning extraneous.

      *> allow COBOL table indexing
       set address of libcox-table to address of libcox-buffer

      *> initialize the command processor if needs be
       if libcox-handle equal null then
           call static "libcox_init" using libcox-handle returning rc
               on exception
                   display "no libcox binding" upon syserr end-display
                   goback
           end-call
           if (rc not equal zero) or (libcox-handle equal null) then
               display "libcox init failure" upon syserr
               goback
           end-if
       end-if

      *> evaluate a command
       call static "libcox_exec" using
           by value libcox-handle
           by reference libcox-value
           by content concatenate(libcox-command x"00")
```

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```
           by value -1
           returning rc
       end-call
       if rc not equal zero then
           display "libcox command evaluation failure" upon syserr
           goback
       end-if

      *> ensure we have a array
       call static "libcox_value_is_array" using
           by value libcox-value
           returning rc
       end-call

       move 0 to libcox-index
       if rc not equal zero then
           *> fill the table with space
           move spaces to libcox-table

           *> get first element
           call static "libcox_array_next_elem" using
               by value libcox-value
               returning libcox-item
           end-call

           *> move each array element to a string in the table
           perform until libcox-item equal null
               add 1 to libcox-index
               call static "libcox_value_to_string" using
                   by value libcox-item
                   by reference libcox-elements
                   returning libcox-string
               end-call
               call static "memmove" using
                   libcox-array(libcox-index)
                   by value libcox-string
                   by value min(libcox-elements
                                length(libcox-array(libcox-index)))
                   returning extraneous-pointer
               end-call
               call static "libcox_array_next_elem" using
                   by value libcox-value
                   returning libcox-item
               end-call
           end-perform
       end-if

      *> return record gets the array element count
       move libcox-index to libcox-elements

      *> free the result memory
       call static "libcox_exec_result_destroy" using
           by value libcox-handle libcox-value
           returning extraneous
       end-call
       .
```

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```
       end function libcox-list.
      *> ****************************************************************
      *>****
>>ELSE
```

```
!doc-marker!
=============
cobweb-libcox
=============

.. contents::

Introduction
------------

The libcox system call and standard utility library, embedded in GnuCOBOL.

Tectonics
---------

::

    For a demonstration executable:
    prompt$ cobc -x [-j=quiet] cobweb-libcox.cob libcox.c

    User defined function repository as DSO
    prompt$ cobc -b cobweb-libcox.cob libcox.c
    prompt& cobcrun cobweb-libcox

    Link time usage of the repository
    prompt$ LD_RUN_PATH=. cobc -x program.cob -L. -l:cobweb-libcox

Usage
-----

::

    prompt$ ./cobweb-libcox

    In COBOL programs with
    repository.
        function libcox-exec
        function libcox-list


Source
------

.. include:: cobweb-libcox.cob
   :code: cobolfree

.. include:: libcox-license.txt
>>END-IF
```

A sample run, showing off the `CMD_LIST` and a few of the other built in commands, and all that is needed is adding `libcox.c` to a `cobc` compile.

```
prompt$ cobc -xj cobweb-libcox.cob libcox.c
uname
Linux 4.4.0-53-generic #74-Ubuntu SMP Fri Dec 2 15:59:10 UTC 2016
btiffin-CM1745 x86_64

CMD_LIST
00001: glob
00002: list
00003: ls
00004: mmap
00005: cat
00006: CMD_LIST
00007: time
00008: microtime
00009: getdate
00010: gettimeofday
00011: date
00012: strftime
00013: gmdate
00014: localtime
00015: idate
00016: mktime
00017: base64_decode
00018: base64_encode
00019: urldecode
00020: urlencode
00021: size_format
00022: strrev
00023: strrchr
00024: strripos
00025: strrpos
00026: stripos
00027: strpos
00028: stristr
00029: strstr
00030: bin2hex
00031: strtoupper
00032: strtolower
00033: rtrim
00034: ltrim
00035: trim
00036: explode
00037: implode
00038: strncasecmp
00039: strcasecmp
00040: strncmp
00041: strcmp
00042: strlen
00043: html_decode
00044: html_escape
00045: chunk_split
00046: substr_count
00047: substr_compare
00048: substr
00049: base_convert
00050: baseconvert
00051: octdec
```

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```
00052: bindec
00053: hexdec
00054: decbin
00055: decoct
00056: dechex
00057: round
00058: os
00059: osname
00060: uname
00061: umask
00062: slink
00063: symlink
00064: lnk
00065: link
00066: fnmatch
00067: strglob
00068: pathinfo
00069: basename
00070: dirname
00071: touch
00072: file_type
00073: filetype
00074: dt
00075: disk_total_space
00076: df
00077: disk_free_space
00078: chgrp
00079: chown
00080: chmod
00081: delete
00082: remove
00083: rm
00084: unlink
00085: usleep
00086: sleep
00087: chroot
00088: lstat
00089: stat
00090: tmpdir
00091: temp_dir
00092: tmp_dir
00093: fileexists
00094: file_exists
00095: filemtime
00096: file_mtime
00097: filectime
00098: file_ctime
00099: fileatime
00100: file_atime
00101: filesize
00102: file_size
00103: isexec
00104: is_exec
00105: is_executable
00106: iswr
00107: is_wr
00108: is_writable
```

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```
00109: isrd
00110: is_rd
00111: is_readable
00112: isfile
00113: is_file
00114: islnk
00115: is_lnk
00116: islink
00117: is_link
00118: isdir
00119: is_dir
00120: getgid
00121: getuid
00122: gid
00123: uid
00124: getusername
00125: username
00126: getpid
00127: pid
00128: random
00129: rand
00130: getenv
00131: fullpath
00132: full_path
00133: real_path
00134: realpath
00135: rename
00136: set_env
00137: setenv
00138: putenv
00139: env
00140: echo
00141: mkdir
00142: rmdir
00143: getcwd
00144: cwd
00145: pwd
00146: chdir
00147: cd

ls
00001: ph7.c
00002: libcox.c
00003: call-vedis.cob
00004: unqlite.c
00005: call-libcox.cob
00006: tt.v
00007: ph7.h

glob *.cob
+0000000006
["call-vedis.cob","call-libcox.cob"]

explode , a,b,c,d
00001: a
00002: b
00003: c
```

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```
00004: d

cat libcox-license.txt
/*
 * Symisc libcox: Cross Platform Utilities & System Calls.
 * Copyright (C) 2014, 2015 Symisc Systems http://libcox.net/
 * Version 1.7
 * For additional information on licensing, redistribution of this file, and
for a DISCLAIMER OF ALL WARRANTIES
 * please contact Symisc Systems via:
 *       licensing@symisc.net
 *       contact@symisc.net
 * or visit:
 *      http://libcox.net/
 */
/*
 * Copyright (C) 2014, 2015 Symisc Systems, S.U.A.R.L [M.I.A.G Mrad Chems
Eddine <chm@symisc.net>].
 * All rights reserved.
 *
 * Redistribution and use in source and binary forms, with or without
 * modification, are permitted provided that the following conditions
 * are met:
 * 1. Redistributions of source code must retain the above copyright
 *    notice, this list of conditions and the following disclaimer.
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 * NON-INFRINGEMENT, ARE DISCLAIMED.  IN NO EVENT SHALL SYMISC SYSTEMS
 * BE LIABLE FOR ANY DIRECT, INDIRECT, INCIDENTAL, SPECIAL, EXEMPLARY, OR
 * CONSEQUENTIAL DAMAGES (INCLUDING, BUT NOT LIMITED TO, PROCUREMENT OF
 * SUBSTITUTE GOODS OR SERVICES; LOSS OF USE, DATA, OR PROFITS; OR
 * BUSINESS INTERRUPTION) HOWEVER CAUSED AND ON ANY THEORY OF LIABILITY,
 * WHETHER IN CONTRACT, STRICT LIABILITY, OR TORT (INCLUDING NEGLIGENCE
 * OR OTHERWISE) ARISING IN ANY WAY OUT OF THE USE OF THIS SOFTWARE, EVEN
 * IF ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.
 */

disk_total_space, disk_free_space
976,481,013,760 bytes total, 865,996,541,952 bytes free
+0000000001 865996541952
```

Those `libcox` command strings will work just as well under Windows as they do under GNU/Linux. A handy little library, many thanks to Symisc Systems.

https://www.symisc.net

Symisc also provides similar source bundle style implementations of a Redis style document store, a PHP compatible scripting engine, a JSON based document store and scriptable database, and a few other well designed, easy to embed libraries.

5.112 Can GnuCOBOL interface with UnQLite?

Yep. Another easily embedded offering from Symisc Systems.

UnQLite is an in-process software library which implements a self-contained, serverless, zero-configuration, transactional NoSQL database engine. A mix between a document store like MongoDB and Redis, and a standard Key/Value store ala BerkeleyDB and GDBM. UnQLite includes a subset of the Symisc Jx9 JSON based scripting engine.

A note on licensing. Symisc advertises the UnQLite system as being under a two-clause BSD style license, but the amalgamation bundle that includes the Jx9 subset includes a copy of a Jx9 header file that stipulates a Sleepy Cat style third clause. Symisc has publicly posted that UnQLite is two-clause, and only a standalone version of Jx9 is three clause, but you may want to consult with Symisc and/or legal counsel before shipping closed systems that embed UnQLite, *or better, ship source with your COBOL applications.*

Works cross platform; Windows, GNU/Linux, FreeBSD, Solaris and OS/X are all tested by the developers.

A small sample to create JSON document, and evaluate a query

```
/*
  jx9 scripting sample with UnQLite
*/

// Create the collection 'users'
if( !db_exists('users') ){
    /* Try to create it */
   $rc = db_create('users');
   if ( !$rc ){
     //Handle error
      print db_errlog();
   return;
   }
}

// JSON objects to be stored in the 'users' collection
$zRec = [
{
   name : 'james',
   age  : 27,
   mail : 'dude@example.com'
},
{
   name : 'robert',
   age  : 35,
   mail : 'rob@example.com'
},
{
   name : 'monji',
   age  : 47,
   mail : 'monji@example.com'
},
{
  name : 'barzini',
  age  : 52,
  mail : 'barz@mobster.com'
}
];

// Store the records
```

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```
$rc = db_store('users',$zRec);

// Handle error
if (!$rc) {
    print db_errlog();
    return;
}

// Add One more record
$rc = db_store('users', {name : 'alex', age : 19, mail : 'alex@example.com'});
if (!$rc) {
    print db_errlog();
    return;
}

// The print commands will be redirected by the VM to a GnuCOBOL callback
print "Total number of stored records: ", db_total_records('users'), JX9_EOL;

// Sample query, age test
print "Query; people over 40", JX9_EOL;
$query = function($rec) {
    // People over 40
    if ($rec.age > 40) {
        return TRUE;
    }
    return FALSE;
};

// Fetch data using db_fetch_all() filter
$data = db_fetch_all('users', $query);

// Display each record
foreach ($data as $rec) {
    print $rec, JX9_EOL;
}
```

A COBOL test that directs UnQLite to send it's IO through to a callback.

```
GCobol >>SOURCE FORMAT IS FREE
      *> ************************************************************
      *>****J* gnucobol/callback-unqlite
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20161213  Modified: 2017-01-20/17:37-0500
      *> LICENSE
      *>   Copyright 2016 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or superior)
      *> PURPOSE
      *>   callback-unqlite program.
      *> TECTONICS
      *>   cobc -x -g -debug callback-unqlite.cob unqlite.c
      *> ************************************************************
       identification division.
       program-id. callback-unqlite.
       author. Brian Tiffin.
       date-written. 2016-12-13/07:50-0500.
```

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```
       date-modified. 2017-01-20/17:37-0500.
       installation. Just include unqlite.c in the build.
       security. Evaluates an external Jx9 script.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 unqlite-db               usage pointer.
       01 unqlite-vm               usage pointer.
       01 rc                       usage binary-long.

       01 jx9-script.
          05 value z"unqlite-sample.jx9".

       01 UNQLITE_OPEN_CREATE      usage binary-long value 4.
       01 UNQLITE_VM_CONFIG_OUTPUT usage binary-long value 1.
       01 callback                 usage program-pointer.
       01 invocations              usage binary-long value 0 external.

      *> ****************************************************************
       procedure division.

      *> Create an in memory document store
       call static "unqlite_open" using
           by reference unqlite-db
           by content z":mem:"
           by value UNQLITE_OPEN_CREATE
           returning rc
           on exception
               display "no unqlite" upon syserr end-display
               perform hard-exception
       end-call
       if (rc not equal zero) or (unqlite-db equal null) then
           display "unqlite open failure" upon syserr
           perform hard-exception
       end-if

       call static "unqlite_compile_file" using
           by value unqlite-db
           by content jx9-script
           by reference unqlite-vm
           returning rc
       end-call
       if (rc not equal zero) or (unqlite-vm equal null) then
           display "jx9 compile of " jx9-script " failed" upon syserr
           perform hard-exception
       end-if

      *> the UnQLite VM will call the vmoutput callback with data
       set callback to entry "vmoutput"
       call static "unqlite_vm_config" using
           by value unqlite-vm
           by value UNQLITE_VM_CONFIG_OUTPUT
```

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```
           by value callback
           by reference NULL
       end-call

      *> the script populates, and then queries the document store
       call static "unqlite_vm_exec" using by value unqlite-vm

       call static "unqlite_vm_release" using by value unqlite-vm
       call static "unqlite_close" using by value unqlite-db

      *> each piece of output will cause a callback invocation
       display "Callback invoked " invocations " times"
       goback.
      *> ****************************************************************

       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:

       end program callback-unqlite.
      *> ****************************************************************
      *>*****

      *> ****************************************************************
       identification division.
       program-id. vmoutput.

       data division.
       working-storage section.
       01 invocations          usage binary-long  external.
       01 cobol-buffer         pic x(256) based.

       01 UNQLITE-OK           constant as 0.
       01 UNQLITE-ABORT        constant as 1.

       linkage section.
       01 vm-data              usage pointer.
```

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```
       01 vm-len               usage binary-long.
       01 vm-user              usage pointer.

      *> Called by the UnQLite virtual machine
       procedure division extern using by value vm-data vm-len vm-user.

       add 1 to invocations
       if vm-data not equal null then
           set address of cobol-buffer to vm-data
           display cobol-buffer(1:vm-len) with no advancing
           move UNQLITE-OK to return-code
       else
           move UNQLITE-ABORT to return-code
       end-if

       goback.
       end program vmoutput.
```

Sample run:

```
prompt$ cobc -xj -debug callback-unqlite.cob unqlite.c -w
Total number of stored records: 5
Query; people over 40
{"name":"monji","age":47,"mail":"monji@example.com","__id":2}
{"name":"barzini","age":52,"mail":"barz@mobster.com","__id":3}
Callback invoked +0000000009 times
```

At time of writing the `extern` procedure division mnemonic is in active development and may not be part of your GnuCOBOL install. The `EXTERN` qualifier allows the code to assume that no `COBOL` call parameter management takes place before calling.

Shortly after adding the *EXTERN* (page 259) entry convention, Edward Hart took on the task of formalizing the compiler. The *OPTIONS* (page 335) paragraph in the *IDENTIFICATION* (page 296) DIVISION is now supported.

5.113 Can GnuCOBOL interface with Duktape?

Yep. Another really easy integration, as Duktape ships as a single C source file (with associated header file) that can be included in a GnuCOBOL compile.

Duktape is an ECMAScript interpreter, supporting the ES5.1 standard, with a few features of ES2015 and ES2016 included. There are frequent updates to the engine, 2.0 released in early January of 2017.

The code below includes a magic number. The magic binary number is derived from a macro in `duktape.h` for `duk_eval_string`, which is

```
#define duk_eval_string(ctx,src)  \
        ((void) duk_eval_raw((ctx), (src), 0, 1 /*args*/ | DUK_COMPILE_EVAL |
        DUK_COMPILE_NOSOURCE | DUK_COMPILE_STRLEN | DUK_COMPILE_NOFILENAME))
```

Which gcc -E translated to:

```
((void) duk_eval_raw((ctx), ("print('Hello world!');"), 0, 1 |
(1 << 3) | (1 << 8) | (1 << 9) | (1 << 10)));
```

Which seemed perfect for a bit field, and no by hand math. Bits 0, 3, 8, 9, 10. `b"11100001001"`.

```
GCobol >>SOURCE FORMAT IS FREE
      *> ************************************************************
      *>****J* gnucobol/cobduk
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20161122  Modified: 2016-11-22/01:44-0500
      *> LICENSE
      *>   Copyright 2016 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or superior)
      *> PURPOSE
      *>   Integrate Duktape
      *> TECTONICS
      *>   cobc -x -g -debug cobduk.cob duktape.c
      *> ************************************************************
       identification division.
       program-id. cobduk.
       author. Brian Tiffin.
       date-written. 2016-11-22/00:18-0500.
       date-modified. 2016-11-22/01:44-0500.
       installation. Needs Duktape 1.5.1
       remarks. Just add duktape.c
       security. Probably worth keeping an eye on the ECMAScripting.

       environment division.
       configuration section.
       source-computer. gnulinux.
       object-computer. gnulinux
           classification is canadian.

       special-names.
           locale canadian is "en_CA.UTF-8".

       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 duk-ctx usage pointer.
       01 duk-str usage pointer.
       01 based-str pic x(80) based.
       01 fixed-str pic x(80).

      *> ************************************************************
       procedure division.
      *> Init Duktape
       call "duk_create_heap" using null null null null null
           returning duk-ctx
           on exception
               display "error: no duktape" upon syserr
               perform soft-exception
               goback
       end-call
       if duk-ctx equal null then
           display "duktape init failed" upon syserr
           goback
       end-if
```

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```
      *> Evaluate a test hello
       call "duk_eval_raw" using
           by value duk-ctx
           by content z"print('Hello, world');"
           by value 0 b"11100001001"
           returning omitted
       end-call

      *> Evaluate a custom Duktape JSON encode, no replace, 4 spaces
       call "duk_eval_raw" using
           by value duk-ctx
           by content z"print(Duktape.enc('jx', {foo: 123}, null, 4));"
           by value 0 b"11100001001"
           returning omitted
       end-call

      *> Evaluate a more JSON Duktape JSON encode, no replace, 4 spaces
       call "duk_eval_raw" using
           by value duk-ctx
           by content z"print(Duktape.enc('jc', {foo: 123}, null, 4));"
           by value 0 b"11100001001"
           returning omitted
       end-call

      *> decode some JSON, and print out a field
       call "duk_eval_raw" using
           by value duk-ctx
           by content "print(Duktape.dec('jx', " & z'"{foo:123}").foo);'
           by value 0 b"11100001001"
           returning omitted
       end-call

      *> stringy some JSON, leave data on the Duktape stack
       call "duk_eval_raw" using
           by value duk-ctx
           by content
               z"var res = JSON.stringify({foo: 123}, null, 4); res;"
           by value 0 b"11100001001"
           returning omitted
       end-call

      *> get the character data into COBOL, -1 is top of stack
       call "duk_get_string" using
           by value duk-ctx
           by value -1
           returning duk-str
       end-call
       if duk-str not equal null then
           set address of based-str to duk-str
           string based-str delimited by low-value into fixed-str
           display "COBOL view of JSON: " fixed-str
       else
           display "JSON conversion failed" upon syserr
       end-if

       goback.
```

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```
      *> ****************************************************************

       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:

       end program cobduk.
      *> ****************************************************************
```

And a sample run:

```
prompt$ cobc -xj cobduk.cob duktape.c
Hello, world
{
    foo: 123
}
{
    "foo": 123
}
123
COBOL view of JSON: {
    "foo": 123
}
```

Duktape is a Javascript (more technically an ECMAScript) interpreter, so JSON structures are a “native” datatype in Duktape. It’s not the fastest ECMAScript interpreter, but Duktape is easy to use, and well supported.

http://duktape.org/

5.114 Can GnuCOBOL process JSON?

Yes, kinda. JSON usually requires using third party tools. There are actually quite a few ways to add JSON processing to a GnuCOBOL program.

- UnQLite (a full document storage engine with Jx9 scripting)

- Duktape (an embedded ECMAScript 5.1 interpreter)
- cJSON (described below)
- so many more...

The first two options in the list above are complete scripting engines that can be compiled into GnuCOBOL programs using a single C source on the `cobc` command line. See the entries above for details on these powerful tools.

cJSON is a lightweight JSON parser and construction kit.

On SourceForge at: https://sourceforge.net/projects/cjson/

Current project activity is at: https://github.com/DaveGamble/cJSON

A small example, parsing and creation:

```
GCobol >>SOURCE FORMAT IS FREE
      *> ************************************************************
      *>****J* gnucobol/cobweb-cjson
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20170122  Modified: 2017-01-22/17:50-0500
      *> LICENSE
      *>   Copyright 2017 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or superior)
      *> PURPOSE
      *>   JSON parser example.
      *> TECTONICS
      *>   cobc -x -g -debug cobweb-cjson.cob cJSON.c
      *> ************************************************************
       identification division.
      program-id. cobweb-cjson.
       author. Brian Tiffin.
       date-written. 2017-01-22/15:30-0500.
       date-modified. 2017-01-22/17:50-0500.
       installation. Requires cJSON.c and cJSON.h.
       remarks. Low level JSON parsing and construction.
       security. Should be no issues, even for external resources.

       data division.
       working-storage section.

       REPLACE ==:NEWLINE== BY ==& x"0a" &==.

       01 json-root            usage pointer.
       01 json-object          usage pointer.
       01 json-field           usage pointer.
       01 json-out             usage pointer.

       01 json             based.
          05 json-next         usage pointer.
          05 json-prev         usage pointer.
          05 json-child        usage pointer.
          05 json-type         usage binary-long sync.
          05 valuestring       usage pointer     sync.
          05 valueint          usage binary-long sync.
          05 valuedouble       usage float-long  sync.
          05 json-name         usage pointer     sync.
```

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```
       01 json-data.
          05 value
             '{' :NEWLINE
             '    "name": "Jack (\"Bee\") Nimble",' :NEWLINE
             '    "format": {' :NEWLINE
             '        "type":       "rect",' :NEWLINE
             '        "width":      1920,' :NEWLINE
             '        "height":     1080,' :NEWLINE
             '        "interlace":  false,' :NEWLINE
             '        "frame rate": 24,' :NEWLINE
             '        "price":      123.34' :NEWLINE
             '    }' :NEWLINE
           z'}'.

       01 json-double          usage float-long.

      *> ***************************************************************
       procedure division.
      *> Parse some JSON
       display "GnuCOBOL: Parse JSON from a fixed COBOL field"
       call static "cJSON_Parse" using json-data returning json-root.

      *> if the parse works, do a pretty print
       if json-root not equal null then
           call static "cJSON_Print" using
               by value json-root
               returning json-out
           end-call
           if json-out not equal null then
               call "printf" using
                   by content "%s" & x"0a00"
                   by value json-out
               end-call
               call "free" using by value json-out
           else
               display "JSON print problem" upon syserr
           end-if
       else
           display "JSON parse problem" upon syserr
           goback
       end-if

      *> retrieve the frame rate
       call static "cJSON_GetObjectItem" using
           by value json-root
           by reference z"format"
           returning json-object
       end-call

       call static "cJSON_GetObjectItem" using
           by value json-object
           by reference z"frame rate"
           returning json-field
       end-call
       if json-field not equal null then
           set address of json to json-field
```

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```
            display "frame rate: " valueint
        else
            display "JSON lookup problem" upon syserr
        end-if

       *> retrieve the price
        call static "cJSON_GetObjectItem" using
            by value json-object
            by reference z"price"
            returning json-field
        end-call
        if json-field not equal null then
            set address of json to json-field
            display "price     : " valuedouble
        else
            display "JSON lookup problem" upon syserr
        end-if

       *> free the entire structure
        call static "cJSON_Delete" using
            by value json-root
            returning omitted
        end-call

       *> Create some JSON
        display "GnuCOBOL: Build some JSON from scratch"
        call static "cJSON_CreateObject" returning json-root
        if json-root equal null then
            display "Problem creating JSON object" upon syserr
            goback
        end-if

       *> build a JSON string object
        call static "cJSON_CreateString" using
            z'JSON from GnuCOBOL'
            returning json-field
        end-call
        call static "cJSON_AddItemToObject" using
            by value json-root
            by reference z"title"
            by value json-field
        end-call

        call static "cJSON_CreateObject" returning json-object

        call static "cJSON_AddItemToObject" using
            by value json-root
            by reference z"fields"
            by value json-object
        end-call

        call static "cJSON_CreateString" using
            z'"quoted value"'
            returning json-field
        end-call
        call static "cJSON_AddItemToObject" using
            by value json-object
```

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```
           by reference z"key"
           by value json-field
       end-call

       move 42 to json-double
       call static "cJSON_CreateNumber" using
           by value json-double
           returning json-field
       end-call
       call static "cJSON_AddItemToObject" using
           by value json-object
           by reference z"integer"
           by value json-field
       end-call

       move 21.42 to json-double
       call static "cJSON_CreateNumber" using
           by value json-double
           returning json-field
       end-call
       call static "cJSON_AddItemToObject" using
           by value json-object
           by reference z"double"
           by value json-field
       end-call

      *> print the constructed JSON
       call static "cJSON_Print" using
           by value json-root
           returning json-out
       end-call
       if json-out not equal null then
           call "printf" using
               by content "%s" & x"0a00"
               by value json-out
           end-call
           call "free" using by value json-out
       else
           display "JSON print problem" upon syserr
       end-if

      *> free the entire structure
       call static "cJSON_Delete" using
           by value json-root
           returning omitted
       end-call

       goback.
       end program cobweb-cjson.
      *> ****************************************************************
      *>****
```

The entire parser is just included in a compile by adding `cJSON.c` to a `cobc` command line.

And a sample run:

```
prompt$ cobc -xj cobweb-cjson.cob cJSON.c
GnuCOBOL: Parse JSON from a fixed COBOL field
{
        "name": "Jack (\"Bee\") Nimble",
        "format":       {
                "type": "rect",
                "width":     1920,
                "height":    1080,
                "interlace": false,
                "frame rate":   24,
                "price":     123.340000
        }
}
frame rate: +0000000024
price     : 123.34
GnuCOBOL: Build some JSON from scratch
{
        "title":        "JSON from GnuCOBOL",
        "fields":       {
                "key":  "\"quoted value\"",
                "integer":   42,
                "double":    21.420000
        }
}
```

Depending on needs, a GnuCOBOL programmer can choose a full native Javascript interpreter (Duktape or other engine), a powerful JSON based query and document storage system (Jx9 in UnQLite), or a lightweight parser (cJSON). All three methods easily embedded in a COBOL program.

Bruce Martin (the JRecord author) also dropped hints about a COBOL to JSON converter, CobolToJson. Takes a COBOL data file, with the data hierarchy defined in a copybook and writes out a JSON object:

https://sourceforge.net/projects/jrecord/files/jrecord/Version_0.81.4/

5.115 Can GnuCOBOL interface with Pascal?

Yep. This sample uses the Free Pascal compiler, available on SourceForge at

https://sourceforge.net/projects/freepascal/

Binary installers exist for many platforms and most GNU/Linux distributions will have an `fpc` package. The version captured here, fpc 3.0, has a linker warning bug that is fixed in fpc version 3.1 and later.

An introductory module, a Pascal function put into a shared library:

```
(* HelloFpc, module called from GnuCOBOL *)
(* Tectonics: fpc -CD hellofpc.pp *)
library hellofpc;

function HelloFpc(DataIn: Integer): Integer; cdecl;

    begin
        WriteLn('Hello, world');
        WriteLn('DataIn: ', DataIn);
        HelloFpc := DataIn * 2;
    end;
```

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```
    exports
        HelloFpc;
end.
```

The COBOL caller:

```
      *>
      *> callpascal.cob, Pascal integration with GnuCOBOL
      *>
      *> Tectonics:
      *>   fpc -CD hellofpc.pp
      *>   LD_RUN_PATH=. cobc -xj callpascal.cob -L. -l:libhellofpc.so
      *>
       identification division.
       program-id. callpascal.

       procedure division.
       callfpc-main.

       call "HelloFpc" using by value 42 end-call
       display "fpc returned: " return-code
       move zero to return-code

       goback.
       end program callpascal.
```

Sample run:

```
prompt$ fpc -CD hellofpc.pp
Free Pascal Compiler version 3.0.0+dfsg-2 [2016/01/28] for x86_64
Copyright (c) 1993-2015 by Florian Klaempfl and others
Target OS: Linux for x86-64
Compiling hellofpc.pp
Linking libhellofpc.so
/usr/bin/ld.bfd: warning: link.res contains output sections; did you forget -T?
20 lines compiled, 0.1 sec

prompt$ LD_RUN_PATH=. cobc -x callpascal.cob -L. -l:libhellofpc.so
Hello, world
DataIn: 42
+000000084
```

5.116 Can GnuCOBOL interface with Scala?

Yes. There are a few ways, but *JNA* (page 1466) makes it pretty easy. FUNCTION JVM makes it even easier.

This example has Scala calling GnuCOBOL.

First some Scala:

```
import com.sun.jna.{Library, Native, Platform}

trait CobLibrary extends Library {
    def cob_init(argc: Int, argv: Array[String]): Void
    def cob_tidy(): Int
```

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```
    def cobjna(s: String): Int
    def puts(s: String): Int
}

object CobLibrary {
    def Instance = Native.loadLibrary("cobjna",
        classOf[CobLibrary]).asInstanceOf[CobLibrary]
}

object JnaCob {
    def main(args: Array[String]) {

        /* Initialize libcob */
        /* Could pass the current args array, but this makes one up */
        CobLibrary.Instance.cob_init(4,
            Array("JnaCob", "argv", "from", "Scala"))

        /* Call GnuCOBOL subprogram with a string */

        var rc: Int = CobLibrary.Instance.cobjna("Scala calling GnuCOBOL")
        println("RETURN-CODE from GnuCOBOL = " + rc)

        /* rundown libcob */
        CobLibrary.Instance.cob_tidy()

        /* Display arguments passed to scala using C puts */
        for ((arg, i) <- args.zipWithIndex) {
            CobLibrary.Instance.puts(
                "Argument %d: %s".format(i.asInstanceOf[AnyRef], arg))
        }

        println()
        /* Call GnuCOBOL again, with reinit because of previous cob_tidy */
        CobLibrary.Instance.cob_init(5,
            Array("JnaCob", "argv", "from", "Scala", "a second time"))

        /* Call GnuCOBOL subprogram with a string */

        rc = CobLibrary.Instance.cobjna("Call GnuCOBOL again")
        println("RETURN-CODE from GnuCOBOL = " + rc)

        /* rundown libcob */
        CobLibrary.Instance.cob_tidy()
    }
}
```

This will require an install of `scala` and `libjna-java` and `libjna-platform-java` along with a copy of OpenJDK.

Then a COBOL subprogram to test against.

```
      *>
      *> Called from Scala via JNA as
      *>   var rc: Int = CobLibrary.Instance.cobjna("data")
      *>
       identification division.
       program-id. cobjna.
```

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```
       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 cli pic x(80).

       linkage section.
       01 args pic x(80).

       procedure division using args.
       cobjna-main.

       display "Hello, from GnuCOBOL at " CURRENT-DATE

      *> Seems JNA does not pass through the command line
       accept cli from command-line
       display "COMMAND-LINE: " trim(cli)

      *> Display the string parameter passed from Scala
       move spaces to cli
       string args delimited by low-value into cli
       display "passed: " trim(cli)

      *> Return the length of the item to Scala
       move length(trim(cli)) to return-code

       goback.
       end program cobjna.
```

You will also need to have a `CLASSPATH` that includes `jna.jar` and `jna-platform.jar` along with the other directories for OpenJDK and Scala.

A small `Makefile`:

```
# Scala to GnuCOBOL via JNA
.RECIPEPREFIX=>

JnaCob: JnaCob.scala libcobjna.cob
> @echo 'Requires "source setcp.sh" for CLASSPATH setting'
> scalac JnaCob.scala
> cobc -debug -m libcobjna.cob
> @echo
> LD_LIBRARY_PATH=. scala JnaCob Testing 1 2 3
```

With a sample run of:

```
prompt$ make
Requires "source setcp.sh" for CLASSPATH setting
scalac JnaCob.scala
cobc -debug -m libcobjna.cob

LD_LIBRARY_PATH=. scala JnaCob Testing 1 2 3
Hello, from GnuCOBOL at 2017022404262716-0500
```

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```
COMMAND-LINE: argv from Scala
passed: Scala calling GnuCOBOL
RETURN-CODE from GnuCOBOL = 22
Argument 0: Testing
Argument 1: 1
Argument 2: 2
Argument 3: 3

Hello, from GnuCOBOL at 2017022404262718-0500
COMMAND-LINE: argv from Scala a second time
passed: Call GnuCOBOL again
RETURN-CODE from GnuCOBOL = 19
```

Scala calling GnuCOBOL.

This example initializes and tears down the entire *libcob* runtime engine twice. You could of course invoke `cob_init()` once, and then call many subprograms, and COBOL state would be maintained.

Also note that the COMMAND-LINE received by COBOL is separate from the arguments received by Scala. It would be a trivial change to pass the *args* Array received by Scala along to GnuCOBOL instead of the explicit string values passed to `cob_init()` (as long as an extra string representing *argv[0]*, normally the program name, was inserted at the front of the Scala *args* Array).

5.117 Can GnuCOBOL interface with MUMPS?

Yes. GT.M includes a facility for integration with C, so GnuCOBOL has direct access to MUMPS programming features, including the implicit database technology.

MUMPS Massachusetts General Hospital Utility Multi-Programming System

MUMPS is also know as *M*, although there is some controversy about this naming split. https://en.wikipedia.org/wiki/MUMPS

One of the principal developers behind GT.M published a small example of the C access, and it was used as a starting point for this code sample.

```
      *>
      *> callmumps.cob, integrate FIS-GT.M MUMPS
      *> Tectonics:
      *>     requires GT.M demo setup and gtm_access.ci
      *>     cobc -xj callmumps.cob
      *>
       >>SOURCE FORMAT IS FREE
       identification division.
       program-id. callmumps.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 gtm-message-len constant as 2048.
       01 gtm-status usage binary-long.
       01 gtm-message pic x(gtm-message-len).
```

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```
       01 gtm-error pic x(2048).
       01 err-key pic x(10).

       01 env pic x(2048).
       01 home pic x(2048).
       01 pwd pic x(2048).

       01 data-key occurs 3 times.
          05 filler pic x(32).
       01 data-value occurs 3 times.
          05 data-length usage binary-c-long.
          05 data-address usage pointer.
          05 data-cobol pic x(16).

       01 mumps-key pic x(32).
       01 mumps-value.
          05 mumps-length usage binary-c-long.
          05 mumps-address usage pointer.
          05 mumps-buffer pic x(16).

       01 gtm-zversion.
          05 value 'write $zversion,!'.
       01 gtm-zsystem.
          05 value 'zsystem "'.
       01 gtm-lke.
          05 value 'lke show"'.
       01 gtm-command pic x(256).

       procedure division.
       callmumps-main.

      *> Set up GT.M environment variables
       move all spaces to env
       accept env from environment "gtm_dist"
       if env equals spaces then
           set environment "gtm_dist" to
           "/usr/lib/x86_64-linux-gnu/fis-gtm/V6.2-002A-2build1_x86_64"
       end-if

       move all spaces to env
       accept env from environment "gtmgbldir"
       if env equals spaces then
           accept home from environment "HOME"
           set environment "gtmgbldir" to concatenate(
               trim(home) "/.fis-gtm/V6.2-002A_x86_64/g/gtm.gld")
       end-if

       move all spaces to env
       accept env from environment "gtmroutines"
       if env equals spaces then
           accept home from environment "HOME"
           move module-path to pwd
           move rexx("return filespec('PATH', arg(1))", pwd) to pwd
           accept env from environment "gtm_dist"
           set environment "gtmroutines" to concatenate(
               trim(pwd)
```

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```
               space trim(home) "/.fis-gtm/V6.2-002A_x86_64/r"
               space trim(env) "/libgtmutil.so"
               space trim(env))
       end-if

       move all spaces to env
       accept env from environment "GTMCI"
       if env equals spaces then
           move module-path to pwd
           move rexx("return filespec('PATH', arg(1))", pwd) to pwd
           set environment "GTMCI" to concatenate(
               trim(pwd) "/gtm_access.ci")
       end-if

       move all spaces to env
       accept env from environment "gtmdir"
       if env equals spaces then
           accept home from environment "HOME"
           set environment "gtmdir" to concatenate(
               trim(home) "/.fis-gtm")
       end-if

       move all spaces to env
       accept env from environment "gtmver"
       if env equals spaces then
           set environment "gtmver" to "V6.2-002A_x86_64"
       end-if

      *> Initialize the GT.M runtime
       call "gtm_init" returning gtm-status
           on exception display "no gtm_init" upon syserr end-display
       end-call
       move "gtm_init:" to err-key
       perform gtm-error-test

      *> Enable the access routines, via the gtm_access.ci file
       call "gtm_ci" using "gtminit" gtm-error returning gtm-status
           on exception display "no gtm_ci" upon syserr end-display
       end-call
       move "gtminit:" to err-key
       perform gtm-error-test

      *> prep some data
       move z'^Capital("Canada")' to data-key(1)
       move z"Ottawa" to data-cobol(1)
       set data-address(1) to address of data-cobol(1)
       move length(trim(data-cobol(1))) to data-length(1)

       move z'^Capital("United States")' to data-key(2)
       move z"Washington" to data-cobol(2)
       set data-address(2) to address of data-cobol(2)
       move length(trim(data-cobol(2))) to data-length(2)

       move z'^Capital("Mexico")' to data-key(3)
       move z"Mexico City" to data-cobol(3)
       set data-address(3) to address of data-cobol(3)
       move length(trim(data-cobol(3))) to data-length(3)
```

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```
      *> Set some values
       move "gtmset:" to err-key
       perform varying tally from 1 by 1 until tally > 3
           call "gtm_ci" using "gtmset"
               data-key(tally) data-value(tally) gtm-error
               returning gtm-status
           end-call
           perform gtm-error-test
       end-perform

      *> Get a value
       display space
       display "Retrieve a capital city"
       move z'^Capital("United States")' to mumps-key
       set mumps-address to address of mumps-buffer
       move length(mumps-buffer) to mumps-length

       call "gtm_ci" using "gtmget" mumps-key mumps-value gtm-error
           returning gtm-status
       end-call
       move "gtmget:" to err-key
       perform gtm-error-test

       display mumps-length ", "
               trim(substitute(mumps-buffer x"00" space))
       call "printf" using ":%.*s:" & x"0a00"
           by value mumps-length mumps-address

      *> grab a lock
       call "gtm_ci" using "gtmlock" "+^CIDemo($Job)" gtm-error
           returning gtm-status
       end-call
       move "gtmlock:" to err-key
       perform gtm-error-test

      *> interpret some MUMPS
       display space
       accept env from environment "gtm_dist"
       move concatenate(gtm-zversion space
                        gtm-zsystem trim(env) "/" gtm-lke x"00")
         to gtm-command
       display "Execute: " trim(substitute(gtm-command x"00" space))
       call "gtm_ci" using "gtmxecute" trim(gtm-command) gtm-error
           returning gtm-status
       end-call
       move "gtmxecute:" to err-key
       perform gtm-error-test

      *> clean up the demo storage
       display space
       display "Remove Capital data, then demonstrate error"

       call "gtm_ci" using "gtmkill" z"^Capital" gtm-error
           returning gtm-status
       end-call
       move "gtmkill:" to err-key
```

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```
       perform gtm-error-test

      *> Get a value, which will fail as ^Capital is gone
       move z'^Capital("Canada")' to mumps-key
       move spaces to mumps-buffer
       move length(mumps-buffer) to mumps-length

       call "gtm_ci" using "gtmget" mumps-key mumps-value gtm-error
           returning gtm-status
       end-call
       move "gtmget:" to err-key
       perform gtm-error-test

      *> show an actual error message
       perform gtm-error-display

      *> run down GT.M
       call "gtm_exit" returning gtm-status
           on exception display "no gtm_exit" upon syserr
       end-call
       move "gtm_exit:" to err-key
       perform gtm-error-test

      *> put up warning about tty settings
       display space
       display "GT.M engine will leave terminal in a custom state:"
       display "  ** use 'stty sane' or 'reset' to normalize **"
       goback.

      *> ****************
       gtm-error-test.
       if gtm-status not equal zero then
           display err-key space gtm-status trim(gtm-error) upon syserr
           call "gtm_zstatus" using gtm-message by value gtm-message-len
           display trim(substitute(gtm-message x"00" space)) upon syserr
       end-if
       .

       gtm-error-display.
       display err-key space gtm-status trim(gtm-error) upon syserr
       call "gtm_zstatus" using gtm-message by value gtm-message-len
       display trim(substitute(gtm-message x"00" space)) upon syserr
       .

       end program callmumps.
```

A small interface definition file, to setup the CallIn prototypes:

```
gtmget    : void get^%gtmaccess( I:gtm_char_t*, O:gtm_string_t*, O:gtm_char_t* )
gtminit          : void init^%gtmaccess( O:gtm_char_t* )
gtmkill          : void kill^%gtmaccess( I:gtm_char_t*, O:gtm_char_t* )
gtmlock          : void lock^%gtmaccess( I:gtm_char_t*, O:gtm_char_t* )
gtmorder  : void order^%gtmaccess( I:gtm_char_t*, O:gtm_string_t*, O:gtm_char_t* )
gtmquery  : void query^%gtmaccess( I:gtm_char_t*, O:gtm_string_t*, O:gtm_char_t* )
gtmset    : void set^%gtmaccess( I:gtm_char_t*, I:gtm_string_t*, O:gtm_char_t*)
gtmxecute : void xecute^%gtmaccess( I:gtm_char_t*, O:gtm_char_t* )
```

And a Makefile in support of the simple, yet detailed tectonics.

```
# GnuCOBOL MUMPS integration with fis-gtm
.RECIPEPREFIX=>

export gtm_dist ?= /usr/lib/x86_64-linux-gnu/fis-gtm/V6.2-002A-2build1_x86_64
callmumps: callmumps.cob gtm_access.ci
> LD_RUN_PATH=$(gtm_dist) cobc -x callmumps.cob -L$(gtm_dist) -lgtmshr
> -./callmumps
> stty sane
```

With a sample run:

```
prompt$ make -B
LD_RUN_PATH=/usr/lib/x86_64-linux-gnu/fis-gtm/V6.2-002A-2build1_x86_64 \
cobc -x callmumps.cob \
-L/usr/lib/x86_64-linux-gnu/fis-gtm/V6.2-002A-2build1_x86_64 -lgtmshr \
./callmumps

Retrieve a capital city
+00000000000000000011, Washington
:Washington:

Execute: write $zversion,! zsystem
"/usr/lib/x86_64-linux-gnu/fis-gtm/V6.2-002A-2build1_x86_64/lke show"
GT.M V6.2-002A Linux x86_64

DEFAULT
^CIDemo(5680) Owned by PID= 5680 which is an existing process
%GTM-I-LOCKSPACEUSE, Estimated free lock space: 98% of 40 pages

Remove Capital data, then demonstrate error
gtmget:    +0000000000,M7,Z150372994,
150372994,get+1^%gtmaccess,%GTM-E-GVUNDEF, Global variable undefined:
^Capital("Canada")

GT.M engine will leave terminal in a custom state:
  ** use 'stty sane' or 'reset' to normalize **
stty sane
```

Requires an install of fis-gtm, an initial Demo database setup, and some customizations regarding the environment variables.

```
prompt$ $(gtm_dist)/gtm -direct
```

That command will generate a $HOME local database for experimenting with the *callmumps* code example. gtm_dist and other environment variables will need to be set to match your local site installation. If there are already local settings the *callmumps* code will use what is given.

The *callmumps* example barely touches on the hierarchical database features of the GT.M engine.

https://sourceforge.net/projects/fis-gtm/

The M programming language is very well documented, as is the GT.M implementation.

Oh, and do yourself a favour. Except for interactive console work, resist the temptation to abbreviate MUMPS commands when programming.

```
s a = 4 s b = 2 w a w b k a k b
```

That does not read as well (to non M programmers) as

```
set a = 4
set b = 2
write a
write b
kill a
kill b
```

The full listing has a much higher value in my opinion. Displays '42' by the way, and then cleans up the variables.

M is quite powerful, and with that power comes some responsibility. And hair raising.

Add old COBOL code to old MUMPS code and usher in a new era.

5.118 Can GnuCOBOL interface with Erlang?

Yes, but a current sample uses Elixir on the way to the BEAM virtual machine.

See *Can GnuCOBOL interface with Elixir?* (page 1235)

5.119 Can GnuCOBOL interface with Elixir?

Yes. There a different ways to integrate with Elixir, from directly embedding object code in the BEAM instance (NIF, native implemented function) to external ports and nodes. The example shown here exercises the port style of integration. This keeps the GnuCOBOL process separate from the high availability BEAM engine, avoiding the scenario where a fault in the extension can crash the VM.

This port example just uses stdin/stdout with results collected by Elixir. An alpha trial.

```
      *>
      *> ported.cob, for use with Elixir and iex
      *>
      *> tectonics:
      *>   cobc -x ported.cob
      *>   iex> port = Port.open({:spawn, "./ported"}, [:binary])
      *>   iex> Port.command(port, "info 123\n")
      *>
       identification division.
       program-id. ported.
       author. Brian Tiffin.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 incoming pic x(32).
       01 data-flag    pic x.
          88 nodata    value low-values when set to false high-values.
       01 newline      pic xx value x"0d0a".

       01 command      pic x(32).
```

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```
          88 exiting   value "exit".
          88 crashing  value "crash".
          88 infoing   value "info".
          88 statusing value "status".

       01 arg          pic x(32).
       01 dl           pic x occurs 2 times.

       01 void         pic x(4) value "void" based.
       01 attempts     usage binary-long.
       01 unknowns     usage binary-long.

       procedure division.
       start-ported.
      *> display "COBOL: In ported" newline upon syserr
       set nodata to false
       accept incoming on exception set nodata to true end-accept

       perform until nodata
           move substitute(incoming x"00" space x"0a" space) to incoming
      *>   display "COBOL: accepted " trim(incoming) newline upon syserr
           move spaces to command arg
           unstring incoming
               delimited by all space or all "," or x"0a"
               into command delimiter in dl(1)
                    arg     delimiter in dl(2)

           add 1 to attempts
           evaluate true
               when exiting
                   exit perform
               when crashing
                   set address of void to null
                   display void
               when statusing
                   display "Attempts: " attempts ", Errors: ", unknowns
               when infoing
                   if arg equals space then
                       display "Customer list..."
                   else
                       display "Customer " trim(arg) ": info"
                   end-if
               when other
                   add 1 to unknowns
           end-evaluate

           set nodata to false
           accept incoming on exception set nodata to true end-accept
       end-perform
      *> display "COBOL: Out ported" newline upon syserr

       goback.
       end program ported.
```

And the Elixir management layer for a test

```
#
# GnuCOBOL as a port demo
#
defmodule Ported do
    @moduledoc """
    A small demonstration of a GnuCOBOL program in an Elixir port
    """

    @spec start(String.t) :: none
    @doc """
    Start the external port, given a command string

    Parameters

      - cmd: Command string, defaulting to ./ported

    Examples

        iex> Ported.start
    """
    def start(cmd \\ "./ported") do
        port = Port.open({:spawn, cmd}, [:binary])
        Agent.start(fn -> [p: port] end, name: :p)
    end

    @spec get_port :: port
    @doc """
    The open port is stashed away in an Agent
    """
    def get_port() do
        elem(hd(Agent.get(:p, &(&1))), 1)
    end

    @spec say(String.t) :: none
    @doc """
    Send a command to GnuCOBOL and display response.
    Relies on proper line terminators to avoid a read hang
    """
    def say(str) do
        port = get_port
        Port.command(port, str <> "\n")
        receive do
            {^port, {:data, result}} ->
                IO.puts("Got: #{inspect result}")
            after 50 ->
                IO.puts("Timeout: #{inspect port}")
        end
    end
end
```

A sample run:

```
prompt$ cobc -x ported.cob
prompt$ elixirc ported.ex

prompt$ iex
Erlang/OTP 18 [erts-7.3] [source] [64-bit] [smp:4:4] [async-threads:10]
```

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```
[kernel-poll:false]

Interactive Elixir (1.1.0-dev) - press Ctrl+C to exit (type h() ENTER for
help)
iex(1)> s(Ported)
@spec say(String.t()) :: none()
@spec get_port() :: port()
@spec start(String.t()) :: none()
iex(2)> h(Ported)
* Ported

A small demonstration of a GnuCOBOL program in an Elixir port

iex(3)> Ported.start
{:ok, #PID<0.61.0>}
iex(4)> Ported.say("info 12345")
Got: "Customer 12345: info\n"
:ok
iex(5)> Ported.say("info 54321")
Got: "Customer 54321: info\n"
:ok
iex(6)> Ported.say("status")
Got: "Attempts: +0000000003, Errors: +0000000000\n"
:ok
iex(7)> Ported.say("invalid")
Timeout: #Port<0.1416>
:ok
iex(8)> Ported.say "status"
Got: "Attempts: +0000000005, Errors: +0000000001\n"
:ok
iex(9)> Ported.say "exit"
Timeout: #Port<0.1416>
:ok
iex(10)> Ported.say "status"
** (ArgumentError) argument error
    :erlang.port_command(#Port<0.1416>, "status\n")
    ported.ex:48: Ported.say/1
iex(10)>
BREAK: (a)bort (c)ontinue (p)roc info (i)nfo (l)oaded
       (v)ersion (k)ill (D)b-tables (d)istribution
a
prompt$
```

A first step in what could be a very robust process pairing. The Erlang/OTP roots in Elixir and BEAM can be used to build up fault tolerant high availability applications. The design principle is that things can fail, and to build in recovery which is managed by OTP, the Open Telecom Platform.

5.120 Can GnuCOBOL interface with Rust?

Yes. Rust is designed to cleanly interface with C. So GnuCOBOL integration is fairly simple. Calling a Rust module just means informing Rust to produce a library with external symbols that are not name mangled.

Tectonics are straight forward:

```
# GnuCOBOL and Rust
.RECIPEPREFIX = >

caller: caller.cob libcalled.so
> LD_RUN_PATH=. cobc -xj caller.cob -L. -lcalled

libcalled.so: called.rs
> rustc --crate-type=dylib called.rs
```

The COBOL is straight forward:

```
COBOL *>-<*
      *> Author: Brian Tiffin
      *> Dedicated to the public domain
      *>
      *> Date started: April 2017
      *> Modified: 2017-04-27/00:24-0400 btiffin
      *>+<*
      *>
      *> caller.cob
      *> Tectonics: cobc -xj caller.cob -lcalled -L.
      *>
       identification division.
       program-id. sample.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 rptr usage pointer.
       01 rust-buffer pic x(80) based.
       01 rust-data pic x(80).

       procedure division.
       sample-main.
       call "hello_rust" returning rptr
       if rptr not equal null then
           set address of rust-buffer to rptr
           string rust-buffer delimited by low-value into rust-data
       end-if
       display ":" trim(rust-data) ":"
       goback.
       end program sample.
```

And the Rust simply requires a compile directive:

```
#[no_mangle]
pub extern fn hello_rust() -> *const u8 {
    "Hello, world\0".as_ptr()
}
```

A quick test:

```
prompt$ make -B
```

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```
rustc --crate-type=dylib called.rs
LD_RUN_PATH=. cobc -xj caller.cob -L. -lcalled
:Hello, world:
```

Using `cargo` is just a easy:

```
# GnuCOBOL, Rust and Cargo
.RECIPEPREFIX = >

callnamed: callnamed.cob target/release/libnamed.so
> LD_RUN_PATH=target/release cobc -xj callnamed.cob -lnamed -Ltarget/release

target/release/libnamed.so: named.rs
> cargo build --lib --release
```

The Cargo manifest:

```
[package]

name = "named"
version = "0.0.1"
authors = ["Brian Tiffin <btiffin@gnu.org>"]

[lib]
name = "named"
path = "named.rs"
crate-type = ["dylib"]

[[bin]]
name = "named"
path = "named.rs"
```

A small program to prompt for a name and display it back:

```
use std::io;

#[no_mangle]
pub extern fn named() {
    println!("Enter your name:");
    let mut name = String::new();
    io::stdin().read_line(&mut name).expect("Failed To read Input");
    println!("Hello '{}'!", name.trim());
}

fn main() {
    named();
}
```

The COBOL test head is trivial:

```
identification division.
program-id. sample.

data division.
working-storage section.
```

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```
procedure division.
display "GnuCOBOL start"
call "named"
display "GnuCOBOL end"
goback.

end program sample.
```

And another sample run (some warnings, as the source allows executable and library builds for this trial, using a single filename):

```
prompt$ make -B
cargo build --lib --release
warning: file found to be present in multiple build targets:
/home/btiffin/lang/rust/samples/named.rs
    Finished release [optimized] target(s) in 0.0 secs
LD_RUN_PATH=target/release cobc -xj callnamed.cob -lnamed -Ltarget/release
GnuCOBOL start
Enter your name:
Blue
Hello 'Blue'!
GnuCOBOL end
```

Calling a GnuCOBOL function requires one extra feature of the Cargo.toml file. It needs to be told about links for external libraries, and those links need a extra build step, *with just a little bit of tectonic voodoo*.

```
[package]
name="punt"
version = "0.6.0"
authors = ["Bluey <btiffin@gnu.org>"]
links = "punt"
build = "build.rs"

[dependencies]
libc = "0.2.0"

[[bin]]
name = "punting"
path = "calling.rs"
```

We are going to build `libpunt.so` from a Rust build program.

```
// build.rs

use std::process::Command;
//use std::env;
//use std::path::Path;

fn main() {
    //let out_dir = env::var("OUT_DIR").unwrap();

    // note that there are a number of downsides to this approach, the comments
    // below detail how to improve the portability of these commands.

    //Command::new("gcc").args(&["src/hello.c", "-c", "-fPIC", "-o"])
    //                   .arg(&format!("{}/hello.o", out_dir))
```

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```
    //                    .status().unwrap();
    //Command::new("ar").args(&["crus", "libhello.a", "hello.o"])
    //                   .current_dir(&Path::new(&out_dir))
    //                   .status().unwrap();

    //println!("cargo:rustc-link-search=native={}", out_dir);

    //Command::new("cobc").args(&["libpunt.cob", "-m", "-w", "-fimplicit-init"])
    //                     .status().unwrap();

    Command::new("make").arg("libpunt.so").status().unwrap();
    println!("cargo:rustc-link-search={}", ".");
    println!("cargo:rustc-link-lib=punt");
}
```

build.rs, a lot commented out as reminders for later. Note there are trigger words displayed by *build.rs* that are captured and parsed by `cargo build`. "cargo:" triggers a key=value setting, to inform `rustc` about the names and locations of any libraries, along with some other options:

Specially recognized by Cargo

- cargo:rustc-link-lib=dylib=foo
- cargo:rustc-link-search=native=/path/to/foo
- cargo:rustc-cfg=foo

Arbitrary user-defined metadata

- cargo:root=/path/to/foo
- cargo:libdir=/path/to/foo/lib
- cargo:include=/path/to/foo/include

And a sample run:

```
prompt$ LD_RUN_PATH=. cargo run
   Compiling punt v0.6.0 (file:///home/btiffin/lang/rust)
    Finished dev [unoptimized + debuginfo] target(s) in 0.63 secs
     Running `target/debug/punting`
sent 42, got: 84
```

Punting an integer football, then returning up field.

Rust and GnuCOBOL will play very well together. Rust is being designed and implemented assuming *programming in the large*, and COBOL is quite at home with that level of discipline.

https://www.rust-lang.org

5.121 Can GnuCOBOL executables include resources?

Yes. Either compiled directly into the object code, or externally via an archiving tool such as `libarchive`.

5.121.1 .incbin

Raw data can be directly included in object code by using some assembler, in particular the `.incbin` directive.

This example includes a REXX script, and assigns it to the name `resource`.

```
# Include a resource for compilation as object code
# Defines two global symbols, resource and resource_size
# Tectonics:
#   Modify the filename for the .inbin directive and the symbol names
#   cobc -xj cobol.cob incbin.s

    .section .rodata

    .global resource
    .type   resource, @object
    .align  4
resource:
    .incbin "rexxlib.rexx"
resource_end:

    .global resource_size
    .type   resource_size, @object
    .align  4
resource_size:
    .int    resource_end - resource
```

The assembly would need to be customized for each resource. The global name `resource` and `resource_size` can be changed to suit, and the filename used by the `.incbin` directive needs to be something useful for the task at hand.

The REXX script example used in the demo:

```
/* REXX source code loaded by incbin.s*/
say "Hello, world"
return 0
```

A COBOL hosting program:

```
*>-<*
*> Author: Brian Tiffin
*> Dedicated to the public domain
*>
*> Date started: April 2017
*> Modified: 2017-04-01/23:24-0400 btiffin
*>+<*
*>
*> resinc.cob, include resources from object file
*> Tectonics: cobc -xj resinc.cob incbin.s
*>
 >>SOURCE FORMAT IS FREE
 identification division.
 program-id. resource-include.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 data division.
 working-storage section.
 01 symbol-pointer              usage program-pointer.
```

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```
 01 resource-pointer             usage pointer.
 01 data-size-pointer            usage pointer.
 01 text-data                    pic x(256) based.
 01 show-data                    pic x(256).
 01 data-size                    usage binary-long based.
 01 default-value                usage binary-long value 0.
 01 extraneous                   pic 9.

 procedure division.
 resource-main.

*> lookup the resource address
 set symbol-pointer to entry "resource"
 if symbol-pointer = NULL then
     display "no ""resource"" symbol found" upon syserr
 else
     set resource-pointer to symbol-pointer
     set address of text-data to resource-pointer

     *> example of retrieving the associated resource size
     set symbol-pointer to entry "resource_size"
     if symbol-pointer = NULL then
         set address of data-size to address of default-value
         display "default-size: " data-size
     else
         set data-size-pointer to symbol-pointer
         set address of data-size to data-size-pointer
         display "data-size: " data-size
     end-if

     *> in this case, just look for a null byte
     string text-data delimited by low-value into show-data

     *> evaluate the resource as REXX text
     display "Evaluate: " length(trim(show-data))
     display trim(show-data)
     move rexx(trim(show-data)) to extraneous
 end-if

 goback.
 end program resource-include.
```

And then a sample build and run. This uses the feature of `cobc` that knows that `.s` filenames are included in a compile as assembler source:

```
prompt$ make resinc
cobc -xj resinc.cob incbin.s

data-size: +0000000069
Evaluate: 000000069
/* REXX source code loaded by incbin.s*/
say "Hello, world"
return 0

Hello, world
```

Just use `cobc -x program.cob incbin.s`, and the data will be embedded as `resource` included in the

object code and final executable.

Obfuscation methods could very easily be added for those times when the embedded resource needs a little protection from prying eyes that may like to dump out object code.

5.121.2 libarchive

`libarchive` is a powerful support library that is able to read many native archive formats. Although these resources will be external to the executable, they can look and feel like they are built in.

Formats:

- ar
- CAB
- cpio
- ISO9660
- lha
- lzh
- mtree
- pax
- rar
- raw
- shar
- tar
- xar
- zip
- 7-Zip

Various compression filters are also supported:

- bzip2
- compress
- custom
- gzip
- lzip
- lzma
- uudecode
- xz

The following example just uses `ar` format to build up an archive of text resources that can then be read into GnuCOBOL. The goal here is to create a small bundle of files that can be shipped around as a single entity. The `ar` format specification is nice in that it includes a feature that if all the input data is ASCII, then the complete archive itself is also ASCII.

Other alternatives include complete password protected Zip archives, but this sample focuses on text data.

First the demo COBOL program, *tryarc.cob*, which assumes a *testing.a* `ar` archive with text members.

```
*>-<*
*> Author: Brian Tiffin
*> Dedicated to the public domain
*>
*> Date started: April 2017
*> Modified: 2017-04-02/23:01-0400 btiffin
*>+<*
*>
*> tryarc.cob, testing libarchive
*> Tectonics:
*>   ar cr testing.a some files
*>   cobc -xj tryarc.cob -larchive
*>
 >>SOURCE FORMAT IS FREE
 identification division.
 program-id. tryarc.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 data division.
 working-storage section.
 01 arc                          usage pointer.
 01 arc-entry                    usage pointer.
 01 arc-format                   usage binary-long.

 01 rc                           usage binary-long.
 01 msg                          usage pointer.
 01 errmsg                       usage pointer.

 01 entry-buffer                 usage pointer.
 01 entry-size                   usage binary-c-long.
 01 entry-offset                 usage binary-double.

 procedure division.
 sample-main.

 call "archive_read_new" returning arc
     on exception display "error: no libarchive" upon syserr
 end-call
 if arc equal null then
     display "error: archive_read_new failed" upon syserr
     goback
 end-if
 call "archive_read_support_filter_all" using by value arc
 call "archive_read_support_format_all" using by value arc

 call "archive_read_open_filename" using
     by value arc
     by reference "testing.a"
     by value 10240
     returning rc
 end-call
 perform error-check
```

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```
call "archive_file_count" using by value arc returning arc-format
display "arc count: " arc-format

call "archive_read_next_header" using
    by value arc
    by reference arc-entry
    returning rc
end-call
perform error-check

perform until rc not equal zero
    call "archive_format" using by value arc returning arc-format

    call "archive_entry_pathname" using
        by value arc-entry
        returning msg
    end-call
    perform error-check
    call "printf" using "Type: %d Name :%s: " & x'0a00'
        by value arc-format msg

    call "archive_read_data_block" using
        by value arc
        by reference entry-buffer entry-size entry-offset
        returning rc
    end-call
    perform error-check
    if entry-buffer not equal null then
        call "printf" using "%.*s"
            by value entry-size entry-buffer
    end-if
    perform until rc not equal zero
        call "archive_read_data_block" using
            by value arc
            by reference entry-buffer entry-size entry-offset
            returning rc
        end-call
        perform error-check
        if entry-buffer not equal null then
            call "printf" using "%.*s"
                by value entry-size entry-buffer
        end-if
    end-perform

    call "archive_read_next_header" using
        by value arc
        by reference arc-entry
        returning rc
    end-call
    perform error-check
end-perform
call "archive_file_count" using by value arc returning arc-format
display "arc count: " arc-format

call "archive_read_close" using by value arc
call "archive_read_free" using by value arc
```

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```
 goback.

*> ********************
 error-check.
 if rc less than zero then
     call "archive_error_string" using
         by value arc
         returning errmsg
     end-call
     if errmsg not equal null then
         call "printf" using "%s" & x'0a00' by value errmsg
     end-if
 end-if
 .
 end program tryarc.
```

And a small Makefile to set up a test run:

```
# Archiving and resource embedding utilities
.RECIPEPREFIX = >

resinc: resinc.cob incbin.s rexxlib.rexx
> cobc -xj resinc.cob incbin.s

testing.a:
> ar cr testing.a resinc.cob incbin.s rexxlib.rexx tryarc.cob

tryarc: tryarc.cob
> cobc -xj tryarc.cob -larchive
```

The rule for *testing.a* creates the archive (using the system `ar` command) and adds some source files, `tryarc` will scan through the archive and display the members.

```
prompt$ make testing.a
ar cr testing.a resinc.cob incbin.s rexxlib.rexx tryarc.cob

prompt$ make -B tryarc
cobc -xj tryarc.cob -larchive

arc count: +0000000000
Type: 458753 Name :resinc.cob:
      *>-<*
      *> Author: Brian Tiffin
      *> Dedicated to the public domain
      ...
       end-if

       goback.
       end program resource-include.
Type: 458753 Name :incbin.s:
/*
  Include a resource for compilation as object code
  Defines two global symbols, resource and resource_size
  Tectonics:
      Modify the filename for the .incbin directive and the symbol names
      cobc -xj cobol.cob incbin.s
```

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```
  Started: April 2017
  Modified: 2017-04-02/15:17-0400 btiffin
*/
    .section .rodata

    .global resource
    .type   resource, @object
    .align  4
resource:
    .incbin "rexxlib.rexx"
resource_end:

    .global resource_size
    .type   resource_size, @object
    .align  4
resource_size:
    .int    resource_end - resource
Type: 458753 Name :rexxlib.rexx:
/* REXX source code loaded by incbin.s*/
say "Hello, world"
return 0
Type: 458753 Name :tryarc.cob:
      *>-<*
      *> Author: Brian Tiffin
      *> Dedicated to the public domain
      ...
       end-if
   .
   end program sample.
arc count: +0000000004
```

Some filler listings truncated for this capture.

The key lines of the demo output are:

```
arc count: +0000000000
Type: 458753 Name :resinc.cob:
Type: 458753 Name :incbin.s:
Type: 458753 Name :rexxlib.rexx:
Type: 458753 Name :tryarc.cob:
arc count: +0000000004
```

The Type field is an enumerated value in `archive.h`, the 0x"070001" (458753) just happens to mean `ar` format, GNU variety. `arc count` is the member element count. There is no index in this `ar testing.a` sample, so the count is not known at time of open, only after a complete read pass. (See *`ranlib`* for details on indexing `ar` files, and read through libarchive, it is comprehensive.)

GnuCOBOL can easily scan through archives, and extract required members by name or other scheme.

With `libarchive`, pretty much any common archiving format can be used to bundle GnuCOBOL projects, code, sources, resources, and data. This includes password protected and compressed Zip files. (Please note: opening password protected .zip files may prompt the user for the password at runtime. Your application will need to take this out-of-band prompting into account).

This example turns on `libarchive` support for all formats, all filters.

```
call "archive_read_support_filter_all" using by value arc
call "archive_read_support_format_all" using by value arc
```

Use code to taste, `libarchive` can turn support for individual options on and off at will.[1]

The member elements do not need to be plain text, that was just for the small demonstration above. GnuCOBOL code to manage the extract is a few read paragraphs calling libarchive and pulling data into working-store, while counting.

http://www.libarchive.org/

5.122 Can GnuCOBOL interface with Vedis?

Yes. Another amalgam from Symisc, Vedis is a Redis clone, a key value storage engine modelled on a small Domain Specific Language controlling a NoSQL database. Including a single C file when compiling a COBOL program will embed the entire engine.

There are some 70 commands that can be used with the Vedis system, from simple SET/GET, to hash, set and list management, to transaction processing and data manipulation.

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ****************************************************************
      *>****J* gnucobol/call-vedis
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   20161202  Modified: 2017-04-28/15:53-0400 btiffin
      *> LICENSE
      *>   Copyright 2016 Brian Tiffin
      *>   GNU Lesser General Public License, LGPL, 3.0 (or superior)
      *> PURPOSE
      *>   Embed vedis in GnuCOBOL demo.
      *> TECTONICS
      *>   cobc -x -g -debug call-vedis.cob vedis.c
      *> ****************************************************************
       identification division.
       program-id. call-vedis.
       author. Brian Tiffin.
       date-written. 2016-12-02/00:15-0500.
       date-modified. 2017-04-28/15:53-0400.
       date-compiled.
       installation. Single source file amalgam.
       remarks. Memory store available with ":mem:" filename.
       security. Command driven database engine.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 vedis usage pointer.
       01 rc usage binary-long.
       01 result-address usage pointer.
       01 result-length usage binary-long.
       01 based-address usage pointer.
       01 based-result pic x(4096) based.
```

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[1] *(Takes some work and some source code calling the API to make it look and feel like libarchive has anthropomorphic traits such as will).*

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```
       01 result pic x(4096).

       01 keystr pic x(8).
       01 valstr pic x(32).
       01 chr pic 999.
       01 seed usage float-long.

       01 counter pic 9(6).

      *> **************************************************************
       procedure division.

       move random() to seed
       move random(seed) to seed
       move seed to chr
       move random(chr) to seed

      *> Create a demo "tt.v" file
       call "vedis_open" using vedis by content z"tt.v" returning rc
           on exception display "no vedis linkage" upon syserr
       end-call
       if rc not equal zero then display "vedit_open: " rc end-if
       if vedis equal null then
           display "no vedis init" upon syserr
           goback
       end-if

      *> commands are evaluated as text command lines
      *> Get a command list
       call "vedis_exec" using
           by value vedis
           by content z"CMD_LIST"
           by value -1
           returning rc
       end-call

      *> result pulled by type; this is a list but also a string form
       if rc equal zero then
           call "vedis_exec_result" using
               by value vedis
               by reference result-address
               returning rc
           end-call
           if result-address not equal null then
               call "vedis_value_to_string" using
                   by value result-address
                   by reference result-length
                   returning based-address
               end-call
               if based-address not equal null then
                   set address of based-result to based-address
                   string based-result delimited by x"00" into result
                   display trim(result)
               end-if
           end-if
       else
           display "cmd_list fail " rc upon syserr
```

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```
       end-if

      *> Vedis can be tuned with various configuration settings
      *>   the enum value 2 sets a MAX_PAGE_CACHE hint
      *> call "vedis_config" using by value vedis 2 1000000 returning rc
      *> display "config rc " rc

      *> A set and get
       call "vedis_exec" using
           by value vedis
           by content z"SET test 'Hello, world'"
           by value -1
           returning rc
       end-call

       call "vedis_exec" using
           by value vedis
           by content z"GET test"
           by value -1
           returning rc
       end-call
       if rc equal 0 then
           call "vedis_exec_result" using
               by value vedis
               by reference result-address
               returning rc
           end-call

           if result-address not equal null then
               call "vedis_value_to_string" using
                   by value result-address
                   by reference result-length
                   returning based-address
               end-call
               if based-address not equal null then
                   set address of based-result to based-address
                   move all spaces to result
                   string based-result delimited by x"00" into result
                   display trim(result)
               end-if
           end-if
       else
           display "GET failed" upon syserr
       end-if

      *> a small benchmark pass
       display "10,000 random key inserts using SET"
       display current-date
       perform varying counter from 1 by 1 until counter > 10000
           perform varying tally from 1 by 1 until tally > 8
                compute chr = random() * 26.0 + 65 + 1
                move char(chr) to keystr(tally:1)
           end-perform
           perform varying tally from 1 by 1 until tally > 32
                compute chr = random() * 26.0 + 97 + 1
                move char(chr) to valstr(tally:1)
           end-perform
```

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```
           if mod(counter, 1000) equal 0 then
               display counter ": ", keystr ", " valstr
           end-if

           call "vedis_exec" using
               by value vedis
               by content concatenate("SET " keystr " '" valstr z"'")
               by value -1
               returning rc
           end-call
           if rc not equal 0 then display "vedis SET: " rc end-if

           *> timing will be noticeably slower with commit
           *> call "vedis_commit" using by value vedis returning rc
       end-perform

       call "vedis_close" using by value vedis returning rc
       if rc not equal 0 then display "close rc: " rc end-if
       display current-date
       goback.


      *> ****************************************************************

       REPLACE ALSO ==:EXCEPTION-HANDLERS:== BY
       ==
      *> informational warnings and abends
       soft-exception.
         display space upon syserr
         display "--Exception Report-- " upon syserr
         display "Time of exception:   " current-date upon syserr
         display "Module:              " module-id upon syserr
         display "Module-path:         " module-path upon syserr
         display "Module-source:       " module-source upon syserr
         display "Exception-file:      " exception-file upon syserr
         display "Exception-status:    " exception-status upon syserr
         display "Exception-location:  " exception-location upon syserr
         display "Exception-statement: " exception-statement upon syserr
       .

       hard-exception.
           perform soft-exception
           stop run returning 127
       .
       ==.

       :EXCEPTION-HANDLERS:

       end program call-vedis.
      *> ****************************************************************
      *>****
>>ELSE
!doc-marker!
========
call-vedis
========
```

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```
.. contents::

Introduction
------------
Vedis is a key-value storage engine with a rich set of commands.

Tectonics
---------

::

    prompt$ cobc -x call-vedis.cob vedis.c

Usage
-----

::

    prompt$ ./call-vedis

Source
------

.. include::  call-vedis.cob
   :code: cobolfree
>>END-IF
```

And a sample run:

```
prompt$ cobc -xj call-vedis.cob vedis.c
["BEGIN","ROLLBACK","COMMIT","VEDIS","TABLE_LIST","CMD_LIST","ABORT","PR
INT","ECHO","OS","DATE","TIME","STR_SPLIT","STRIP_TAG","GETCSV","SIZE_FM
T","SOUNDEX","BASE64_DEC","BASE64","RANDSTR","GETRANDMAX","RAND","LPUSH"
,"LPOP","LLEN","LINDEX","SLEN","SINTER","SDIFF","SMEMBERS","SREM","STOP"
,"SPEEK","SPOP","SISMEMBER","SCARD","SADD","HSETNX","HMSET","HSET","HGET
ALL","HVALS","HKEYS","HMGET","HLEN","HDEL","HEXISTS","HGET","DECRBY","IN
CRBY","DECR","INCR","GETSET","MSETNX","MSET","SETNX","SET","MGET","MOVE"
,"COPY","GET","STRLEN","APPEND","EXISTS","REMOVE","DEL"]
Hello, world
10,000 random key inserts using SET
2017042815551871-0400
001000: RHSMAOFB, affctvbimnxzpkvykcttegrvnjioxoqy
002000: JFGLYZYU, sznvifxqjosrkajaaeiadkunqayozxjs
003000: RDEOWWUO, ounywhlblrmwrdodydndisiavmprikgx
004000: NTUGZLAS, ejacjomkrlpvdunygvtcwicjbxpajqtn
005000: JCWFYBQS, jxazalotcabocgcdbycnakrjnopmpgez
006000: JEWJREWA, wbepdpamutavniuidvlhiuarzxbqbyry
007000: TOUIHPYR, dizqeuofcmgscbfyggoffgmzughcwfta
008000: AQBDZMPE, hdnyayywjfkuhospnplcfdkguljuxzyf
009000: LFNJPGHH, yzxwxiqwmylfryopzbomxcejhssxzzex
010000: BQCBWOKG, bbsdaxrieirltpqfrzdpakdbbgdxvnex
2017042815551975-0400
```

Vedis is licensed with a 3-clause Symisc license, sources must be delivered when using Vedis, or call them for alternate licensing arrangements.

http://vedis.symisc.net/

5.123 Can GnuCOBOL embed PH7 PHP?

Yes. Another amalgam from Symisc, PH7 is an embeddable implementation of PHP.

```
*>-<*
*> Author: Brian Tiffin
*> Dedicated to the public domain
*>
*> Date started: April 2017
*> Modified: 2017-04-28/17:31-0400 btiffin
*>+<*
*>
*> call-ph7.cob, integration with Symisc PH7 PHP
*> Tectonics: cobc -xj call-ph7.cob ph7.c
*>
 >>SOURCE FORMAT IS FREE
 identification division.
 program-id. call-ph7.

 REPLACE ==newline== BY ==& x'0a' &==.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 data division.
 working-storage section.
 01 ph7-engine usage pointer.
 01 rc usage binary-long.
 01 ph7-vm usage pointer.
 01 ph7-exitstatus usage binary-long.
 01 ph7-consumer usage program-pointer.

*> The PH7 script text
 01 ph7-script. 05 value
     "<?php echo 'Welcome guest'.PHP_EOL;" newline
     "echo 'System time: ' . date('Y-m-d H:i:s').PHP_EOL;" newline
     "echo 'System: ' . substr(php_uname(),0,16).PHP_EOL;" newline
     z"?>".

 procedure division.
 call-ph7-main.
 call static "ph7_init" using ph7-engine returning rc
     on exception
         display "no ph7_init linked: " rc upon syserr end-display
 end-call
 if (ph7-engine equal null) or (rc not equal zero) then
*> bail
     display "ph7_init fail: " rc upon syserr
     goback
 end-if

 call static "ph7_compile_v2" using
      by value ph7-engine
      by reference ph7-script
      by value -1                *> compute length internally
```

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```
      by reference ph7-vm
      by value 0                 *> Compile-flags
      returning rc
 end-call
 if (ph7-vm equal null) or (rc not equal zero) then
     display "ph7_compile_v2 fail: " rc upon syserr
     goback
 end-if

 set ph7-consumer to entry "ph7consumer"
 if ph7-consumer equal null then
     display "no ph7consumer: " upon syserr
     goback
 end-if

 call static "ph7_vm_config" using
     by value ph7-vm
     by value 1                 *> PH7_VM_CONFIG_OUTPUT (ph7.h)
     by value ph7-consumer
     by value 0                 *> unused private data
     returning rc
 if rc not equal zero then
     display "ph7_compile_v2 fail: " rc upon syserr
     goback
 end-if

 call static "ph7_vm_exec" using
     by value ph7-vm
     by reference ph7-exitstatus
     returning rc
 end-call
 if rc not equal zero then
     display "script fail: " rc ", " ph7-exitstatus upon syserr
 end-if

 call static "ph7_vm_release" using by value ph7-vm
 call static "ph7_release" using by value ph7-engine

 goback.
 end program call-ph7.

*>
*> Capture PH7 output requests, and just print them
*>
 identification division.
 program-id. ph7consumer.

 data division.
 linkage section.
 01 ph7-output usage pointer.
 01 ph7-outlen usage binary-long.
 01 ph7-userdata usage pointer.

 procedure division using
     by value ph7-output ph7-outlen ph7-userdata.

 if ph7-output not equal null then
```

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```
     call "printf" using "%.*s"
         by value ph7-outlen ph7-output
     end-call
     move 0 to return-code
 else
     move 1 to return-code
 end-if

 goback.
 end program ph7consumer.
```

A demo, with PH7 output echoed to stdout. The *ph7consumer* subprogram can be used to capture PH7 displays by shuffling the ph7-output to working storage.

```
prompt$ cobc -Wno-unfinished -xj call-ph7.cob ph7.c
Welcome guest
System time: 2017-04-28 17:32:32
System: Linux 4.4.0-75-g
```

If you are comfortable with PHP, then PH7 may offer a comfortable scripting environment for your GnuCOBOL applications.

Note that PH7 uses a 3-clause Symisc license. Sources that use `ph7.c` must be provided with any distribution of code, or seek out an alternate license arrangement with Symisc.

http://ph7.symisc.net/

5.124 Can GnuCOBOL manage WebSockets?

Yes. One way is with *libwebsockets* a WebSocket library.

https://libwebsockets.org/

```
GCobol >>SOURCE FORMAT IS FREE
>>IF docpass NOT DEFINED
      *> ***************************************************************
      *>****p* project/lws
      *> AUTHOR
      *>   Brian Tiffin
      *> DATE
      *>   2015-06-10
      *>   Modified: 2017-06-10/00:41-0400
      *> LICENSE
      *>   GNU Lesser General Public License, LGPL, 3.0 (or greater)
      *> PURPOSE
      *>   Demonstrate a simple libwebsocket protocol handler
      *>
      *> TECTONICS
      *>   cobc -x lws.cob -g -debug
      *>   browse http://localhost:9000 (enter quit to halt server)
      *> ***************************************************************
       identification division.
       program-id. lws.
       author. Brian Tiffin.
       date-compiled.
```

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```
       date-written. 2017-06-09/17:02-0400.
       installation. Requires libwebsocket 2.1 or greater.
       remarks.
       security. Exposes network port.

       environment division.
       configuration section.
       special-names.
       repository.
           function all intrinsic.

       data division.

       working-storage section.
       01 quit-flag pic x value low-value external.
          88 quitting value high-value.

       01 protocols.
          05 filler occurs 3 times.
             10 protocol-name usage pointer sync.
             10 protocol-handler usage program-pointer sync.
             10 protocol-session-size usage binary-double sync.
             10 protocol-rx-buffer-size usage binary-double sync.
             10 protocol-id usage binary-long sync.
             10 protocol-user usage pointer sync.
             10 protocol-tx-buffer-size usage binary-double sync.

       01 http-name.
          05 filler value z"http-only".
       01 simple-name.
          05 filler value z"simple-protocol".

       01 context-info.
          05 ci-port usage binary-long sync.
          05 iface usage pointer sync.
          05 ci-protocols usage pointer sync.
          05 extensions usage pointer sync.
          05 token-limits usage pointer sync.
          05 ssl-private-key-password usage pointer sync.
          05 ssl-cert-filepath usage pointer sync.
          05 ssl-private-key-filepath usage pointer sync.
          05 ssl-ca-filepath usage pointer sync.
          05 ssl-cipher-list usage pointer sync.
          05 http-proxy-address usage pointer sync.
          05 http-proxy-port usage binary-long sync.
          05 gid usage binary-long value -1 sync.
          05 uid usage binary-long value -1 sync.
          05 ci-options usage binary-long sync.
          05 ci-user usage pointer sync.
          05 ka-time usage binary-long sync.
          05 ka-probe usage binary-long sync.
          05 ka-interval usage binary-long sync.
          05 provided_client_ssl_ctx usage pointer sync.
          05 max-http-header-data usage binary-short sync.
          05 max-http-header-pool usage binary-short sync.
          05 count-threads usage binary-long sync.
          05 fd-limit-per-threads usage binary-long sync.
```

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```
           05 timeout-secs usage binary-long sync.
           05 ecdh-curve usage pointer sync.
           05 vhost-name usage pointer sync.
           05 plugin-dirs usage pointer sync.
           05 pvo usage pointer sync.
           05 keepalive_timeout usage binary-long sync.
           05 log-filepath usage pointer sync.
           05 mounts usage pointer sync.
           05 server-string usage pointer sync.
           05 pt-serv-buf-size usage binary-long sync.
           05 max-http-header-data2 usage binary-long sync.
           05 ssl-options-set usage binary-c-long sync.
           05 ssl-option-clear usage binary-c-long sync.
           05 ws-ping-pong-interval usage binary-short sync.
           05 headers usage pointer sync.
           05 reject-service-keywords usage pointer sync.
           05 external-baggage-free-ondestroy usage pointer sync.
           05 client-ssl-private-key-password usage pointer sync.
           05 client-ssl-cert-filepath usage pointer sync.
           05 client-ssl-private-key-filepath usage pointer sync.
           05 client-ssl-ca-filepath usage pointer sync.
           05 client-ssl-cipher-list usage pointer sync.
           05 fops usage pointer sync.
           05 simultaneous-ssl-restriction usage binary-long sync.
           05 socks-proxy-address usage pointer sync.
           05 socks-proxy-port usage binary-long sync.
           05 filler usage pointer occurs 8 times sync.

       01 context usage pointer.

      *> ****************************************************************
       procedure division.

      *> First protocol is always http-only
       set protocol-name(1) to address of http-name
       set protocol-handler(1) to entry "callback_http"
       if protocol-handler(1) equal null then
           display "no callback_http entry error" upon syserr
           move 1 to return-code
           goback
       end-if
       move 0 to protocol-session-size(1)
       move 0 to protocol-rx-buffer-size(1)

      *> Second is our simple testing protocol
       set protocol-name(2) to address of simple-name
       set protocol-handler(2) to entry "callback_simple"
       if protocol-handler(2) equal null then
           display "no callback_simple entry error" upon syserr
           move 1 to return-code
           goback
       end-if
       move 0 to protocol-session-size(2)
       move 0 to protocol-rx-buffer-size(2)

      *> end of protocol support list
       set protocol-name(3) to NULL
```

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```
       set protocol-handler(3) to NULL
       move 0 to protocol-session-size(3)
       move 0 to protocol-rx-buffer-size(3)

      *> zero out the context space
       move all low-values to context-info

      *> port 9000, gid/uid reset of server, link the simple protocol
       move 9000 to ci-port
       move -1 to gid uid
       set ci-protocols to address of protocols

      *> create the websocket context
       call "lws_create_context" using context-info returning context.
       if context equal null then
           display "lws_create_context error" upon syserr
           move 1 to return-code
           goback
       end-if

       display "Starting server..." upon syserr
       perform until quitting
           call "lws_service" using by value context 50 *> milliseconds
           add 1 to tally
       end-perform
       display "Leaving server... tally at " tally upon syserr

       call "lws_context_destroy" using by value context

       move 0 to return-code
       goback.
       end program lws.
      *> ****************************************************************

      *> ****************************************************************
       identification division.
       program-id. callback_http.

       environment division.
       configuration section.
       special-names.
           call-convention 0 is extern.
       repository.
           function all intrinsic.

       data division.
       linkage section.
       01 wsi usage pointer.
       01 reason usage binary-long.
       01 user usage pointer.
       01 inp usage pointer.
       01 len usage binary-double.

       procedure division extern using
           by value wsi
           by value reason
           by value user
```

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```
           by value inp
           by value len.

      *> HTTP not implemented for this example
       move 0 to return-code
       goback.

       end program callback_http.
      *> ************************************************************

      *> ************************************************************
       identification division.
       program-id. callback_simple.

       environment division.
       configuration section.
       special-names.
           call-convention 0 is extern.
       repository.
           function all intrinsic.

       data division.
       working-storage section.
       01 LWS-WRITE-TEXT constant as 0.

       01 LWS-CALLBACK-ESTABLISHED constant as 0.
       01 LWS-CALLBACK-CLOSED constant as 4.
       01 LWS-CALLBACK-RECEIVE constant as 6.

       01 copy-buffer pic x(8192) based.

       01 work-buffer pic x(8192).
          88 quitting values "QUIT".
       01 quit-flag pic x external.

       linkage section.
       01 wsi usage pointer.
       01 reason usage binary-long.
       01 user usage pointer.
       01 inp usage pointer.
       01 len usage binary-long.

       procedure division extern using
           by value wsi
           by value reason
           by value user
           by value inp
           by value len.

       >>IF DEBUG DEFINED
           display "callback_simple"
           display "wsi: " wsi
           display "reason: " reason
           display "user: " user
           display "inp: " inp
           display "len: " len
       >>END-IF
```

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```
       evaluate reason
           when = LWS-CALLBACK-ESTABLISHED
               display "Connection established" upon syserr

           when = LWS-CALLBACK-CLOSED
               display "Connection closed" upon syserr

           when = LWS-CALLBACK-RECEIVE
       >>IF DEBUG DEFINED
               display "got data: " inp ", " len
               call "printf" using "printf: %.*s" & x"0a00"
                   by value len by value inp
       >>END-IF

               *> Shuffle into nice safe working store, with transform
               set address of copy-buffer to inp
               move upper-case(copy-buffer(1:len)) to work-buffer
               set address of copy-buffer to NULL

               *> Normal servers would have a more sophisticated exit
               if quitting then
                   move high-value to quit-flag
                   goback
               end-if

               *> Send the work-buffer back to the client
               call "lws_write" using
                   by value wsi
                   by reference work-buffer
                   by value len
                   by value LWS-WRITE-TEXT

           when other
               display "websocket reason: " reason upon syserr
       end-evaluate

       move 0 to return-code
       goback.

       end program callback_simple.
>>ELSE
```

```
!doc-marker!
==========
lws sample
==========

Introduction
------------

Tectonics
---------

.. sourcecode:: make
```

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```
lws: lws.cob
        cobc -x lws.cob

docs:
        sed ':loop;/!doc-marker!/{d};N;b loop' lws.cob \
        | sed '$$d' | rst2html >lws.html

clean:
        -rm lws lws.c.* lws.c lws.i

Source
------

.. include::  lws.cob
   :code: cobolfree
>>END-IF
```

That code sets up a simple protocol server, that accepts text and returns text.

Here is a sample HTML file, with some Javascript, to act as the WebSocket client.

```
<!DOCTYPE html>
<html>
    <!-- GnuCOBOL libwebsocket demo -->
    <!-- Dedicated to the public domain -->
    <head>
        <meta charset="utf-8">
        <script src="https://ajax.googleapis.com/ajax/libs/jquery/3.2.1/jquery.min.js
↪"></script>
        <script type="text/javascript">
            $(function () {
                window.WebSocket = window.WebSocket || window.MozWebSocket;

                var websocket = new WebSocket('ws://127.0.0.1:9000',
                                              'simple-protocol');

                websocket.onopen = function () {
                    $('h2').css('color', 'green');
                };

                websocket.onclose = function () {
                    $('h2').css('color', 'gold');
                };
                websocket.onerror = function () {
                    $('h2').css('color', 'red');
                };

                websocket.onmessage = function (message) {
                    console.log(message.data);
                    $('#replacement').append($('<p>', { text: message.data }));
                };

                $('button').click(function (e) {
                    e.preventDefault();
                    websocket.send($('input').val());
                });
            });
```

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```
        </script>
    </head>
    <body>
        <h2>GnuCOBOL libwebsockets test</h2>
        <form>
            <input type="text" />
            <button>Send</button>
        </form>
        <p>Responses:</p>
        <div id="replacement"
             style="overflow:scroll; height:320px; width:180px;
                    border:2px dotted lightgray;">
        </div>
    </body>
</html>
```

Based on code by Martin Sikora

https://medium.com/@martin.sikora/libwebsockets-simple-websocket-server-68195343d64b

That routine sets the title Green on successful connect, Red on error, or to Amber on socket close.

It sends the text from the form, the GnuCOBOL server transforms the data to upper-case and then Javascript adds the response to a scrollable div.

The server is setup to terminate on receiving a "Quit" message.

Sample run:

```
prompt$ cobc -xj -g -w lws.cob -lwebsockets &
[1] 15978

prompt$
[2017/06/10 00:45:32:5409] NOTICE: Initial logging level 7
[2017/06/10 00:45:32:5413] NOTICE: Libwebsockets version: 2.2.0
btiffin@localhost.localdomain-v2.0.0-397-g3ec32b1
[2017/06/10 00:45:32:5415] NOTICE: IPV6 not compiled in
[2017/06/10 00:45:32:5416] NOTICE: libev support not compiled in
[2017/06/10 00:45:32:5418] NOTICE: libuv support not compiled in
[2017/06/10 00:45:32:5420] NOTICE:  Threads: 1 each 1024 fds
[2017/06/10 00:45:32:5422] NOTICE:  mem: platform fd map:  8192 bytes
[2017/06/10 00:45:32:5424] NOTICE:  Compiled with OpenSSL support
[2017/06/10 00:45:32:5426] NOTICE:  SSL disabled: no
LWS_SERVER_OPTION_DO_SSL_GLOBAL_INIT
[2017/06/10 00:45:32:5428] NOTICE: Creating Vhost 'default' port 9000, 2
protocols, IPv6 off
[2017/06/10 00:45:32:5431] NOTICE:  Listening on port 9000
[2017/06/10 00:45:32:5433] NOTICE:  mem: per-conn:          568 bytes +
protocol rx buf
[2017/06/10 00:45:32:5435] NOTICE:  canonical_hostname = localhost.localdomain
Starting server...
websocket reason: +0000000027

prompt$ seamonkey index.html

websocket reason: +0000000020
Connection established
Leaving server... tally at 00602
```

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```
[2017/06/10 00:46:02:5814] NOTICE: lws_context_destroy: ctx 0xe24e00
Connection closed
websocket reason: +0000000028
[2017/06/10 00:46:02:5816] NOTICE: lws_context_destroy2: ctx 0xe24e00

prompt$
[1]+  Done                    cobc -xj -g -w lws.cob -lwebsockets
```

5.125 Can GnuCOBOL interface with XForms?

Yes (assuming the target platform supports X11), quite handily.

The XForms Toolkit is a lightweight library for building graphical user interfaces.

XForms includes basic graphical objects like buttons and text fields to higher level objects that handle things like on screen clocks and visual data plots.

Started in 1995, XForms is still in active development. At time of writing version 1.2.4 is the latest production release, with version 1.2.5 in the wings.

Currently, GnuCOBOL integration with XForms is straight up CALL to the various functions in the libforms library.

A simple bar chart:

```
      *>
      *> xforms-chart.cob, demonstrate a bar chart
      *> Tectonics: cobc -xj xforms-chart.cob -lforms
      *>
       >>SOURCE FORMAT IS FREE
       identification division.
       program-id. sample.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.

       COPY xforms.

       01 argc                         usage binary-long.
       01 argv                         usage pointer.

       01 base-colour                  pic 999.

       01 form                         usage pointer.
       01 form-box                     usage pointer.

       01 chart-objects.
          05 chart-object              usage pointer occurs 4 times.

       01 items                        constant as 12.
       01 chart-items.
          05 chart-item                occurs items times.
```

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```
           10 chart-name             pic x(16).
           10 chart-value            usage float-long.
           10 chart-colour           usage binary-long.

       01 exit-button                usage pointer.
       01 form-button                usage pointer.

       01 xforms-window              usage binary-long.
       01 xforms-display             usage pointer.

       01 close-callback             usage program-pointer.
       01 close-install-status       usage binary-long.

       procedure division.
       sample-main.

       call "CBL_GC_HOSTED" using argc "argc"
       call "CBL_GC_HOSTED" using argv "argv"

       call "fl_initialize" using argc argv z"XForms" NULL by value 0
           returning xforms-display
           on exception
               display
                   "Error: no XForms (-lforms)" upon syserr
               end-display
               goback
       end-call

      *> fill in some chart data
       move "Jan" to chart-name(1)
       move 23.23 to chart-value(1)

       move "Feb" to chart-name(2)
       move 42.42 to chart-value(2)

       move "Mar" to chart-name(3)
       move 64.64 to chart-value(3)

       move "Apr" to chart-name(4)
       move 13.13 to chart-value(4)

       move "May" to chart-name(5)
       move 84.84 to chart-value(5)

       move "Jun" to chart-name(6)
       move 66.66 to chart-value(6)

       move "Jul" to chart-name(7)
       move 77.77 to chart-value(7)

       move "Aug" to chart-name(8)
       move 12.12 to chart-value(8)

       move "Sep" to chart-name(9)
       move 55.55 to chart-value(9)

       move "Oct" to chart-name(10)
```

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```
       move 99.99 to chart-value(10)

       move "Nov" to chart-name(11)
       move 42.42 to chart-value(11)

       move "Dec" to chart-name(12)
       move 66.66 to chart-value(12)

      *> let GnuCOBOL control image shutdown from system menu
       set close-callback to entry "xforms-close"
       if close-callback not equal null then
           call "fl_set_atclose" using
               by value close-callback
               by reference NULL
               returning close-install-status
       else
           display "XForms close will terminate program" upon syserr
       end-if

      *> Build a new form to demontrate the chart object
       call "fl_bgn_form" using by value FL-UP-BOX 320 270
           returning form

       call "fl_add_box" using
           by value FL-UP-BOX 0 0 320 270
           by reference NULL
           returning form-box

      *> Can be BAR, HORBAR, LINE, FILL, SPIKE, PIE or SPECIALPIE
       call "fl_add_chart" using
           by value FL-BAR-CHART 5 5 310 200
           by reference "Bar chart"
           returning chart-object(1)
      *> call "fl_set_object_color" using
      *>     by value chart-object(1) FL-BLACK 0
      *> call "fl_set_chart_lcolor" using
      *>     by value chart-object(1) FL-WHITE

      *> stay safe with the incrementing colour range
       compute base-colour = random(form) * random() * 100
       if base-colour > 255 - items then
           compute base-colour = 255 - items
       end-if
       perform varying tally from 1 by 1 until tally > items
           compute chart-colour(tally) = tally + base-colour
           if chart-colour(tally) = FL-BLACK then
               move FL-WHITE to chart-colour(tally)
           end-if
           call "fl_add_chart_value" using
               by value chart-object(1)
               by value chart-value(tally)
               by reference
                   concatenate(trim(chart-name(tally) trailing), x"00")
               by value chart-colour(tally)
       end-perform

       call "fl_add_button" using
```

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```
           by value FL-NORMAL-BUTTON 110 230 80 30
           by reference z"Exit"
           returning exit-button

       call "fl_end_form" returning omitted

       call "fl_show_form" using
           by value form FL-PLACE-CENTER FL-TRANSIENT
           by reference "Charts"
           returning xforms-window

       call "fl_do_forms" returning form-button

       call "fl_finish" returning omitted
       goback.

       end program sample.
      *> ***************************************************************

      *> Give process rundown control to GnuCOBOL
       identification division.
       program-id. xforms-close.

       environment division.
       configuration section.
       special-names.
           call-convention 0 is extern.

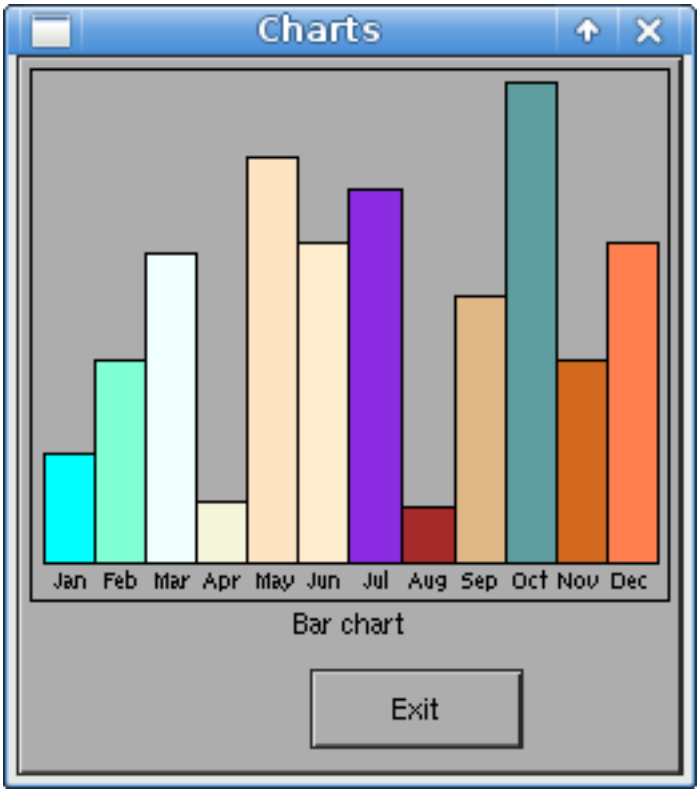
       data division.
       working-storage section.
       01 FL-IGNORE constant as -1.

       linkage section.
       01 xform usage pointer.
       01 close-data usage pointer.

       procedure division extern using
           by value xform close-data.

      *> IGNORE close or just stop run, otherwise XForms calls exit()
       move FL-IGNORE to return-code
       stop run.

       end program xforms-close.
     *> ***************************************************************
```



Some clocks:

```
      *>
      *> xforms-clock.cob, demonstrate some clock objects
      *> Tectonics: cobc -xj xforms-clock.cob -lforms
      *>
       >>SOURCE FORMAT IS FREE
       identification division.
       program-id. sample.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       data division.
       working-storage section.

       COPY xforms.

       01 argc                         usage binary-long.
       01 argv                         usage pointer.

       01 form                         usage pointer.
       01 form-box                     usage pointer.
       01 clock-forms.
          05 clock-form                usage pointer occurs 4 times.
       01 exit-button                  usage pointer.
       01 form-button                  usage pointer.
```

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```
       01 xforms-window                usage binary-long.
       01 xforms-display                usage pointer.

       01 close-callback                usage program-pointer.
       01 close-install-status          usage binary-long.

       01 hour                          usage binary-long.
       01 minute                        usage binary-long.
       01 second                        usage binary-long.
       01 show-hour                     pic 99.
       01 show-minute                   pic 99.
       01 show-second                   pic 99.

       procedure division.
       sample-main.
       call "CBL_GC_HOSTED" using argc "argc"
       call "CBL_GC_HOSTED" using argv "argv"

       call "fl_initialize" using argc argv z"XForms" NULL by value 0
           returning xforms-display
           on exception
               display
                   "Error: no XForms (-lforms)" upon syserr
               end-display
               goback
       end-call

      *> let GnuCOBOL control image shutdown from system menu
       set close-callback to entry "xforms-close"
       if close-callback not equal null then
           call "fl_set_atclose" using
               by value close-callback
               by reference NULL
               returning close-install-status
       else
           display "XForms close will terminate program" upon syserr
       end-if

       call "fl_bgn_form" using by value FL-UP-BOX 460 350
           returning form

       call "fl_add_box" using
           by value FL-UP-BOX 0 0 460 350
           by reference NULL
           returning form-box

       call "fl_add_clock" using
           by value FL-ANALOG-CLOCK 5 5 220 200
           by reference "Analog with seconds"
           returning clock-form(1)

       call "fl_add_clock" using
           by value FL-ANALOG-CLOCK 280 55 110 100
           by reference "Analog without seconds"
           returning clock-form(2)

      *> local patch
```

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```
       call "fl_set_clock_hide_seconds" using
           by value clock-form(2) 1
           on exception continue
       end-call

       call "fl_add_clock" using
           by value FL-DIGITAL-CLOCK 65 240 100 35
           by reference "Digital with seconds"
           returning clock-form(3)
       call "fl_set_object_color" using
           by value clock-form(3) FL-COL1 FL-BLACK

       call "fl_add_clock" using
           by value FL-DIGITAL-CLOCK 290 240 100 35
           by reference "Digital am/pm"
           returning clock-form(4)
       call "fl_set_clock_hide_seconds" using
           by value clock-form(4) 1
           on exception continue
       end-call

       call "fl_set_clock_ampm" using
           by value clock-form(4) 1
       call "fl_set_object_color" using
           by value clock-form(4) FL-COL1 FL-BLACK
       call "fl_set_object_lsize" using
           by value clock-form(4) FL-MEDIUM-SIZE
       call "fl_set_object_lstyle" using
           by value clock-form(4) FL-BOLD-STYLE

       call "fl_add_button" using
           by value FL-NORMAL-BUTTON 190 300 80 30
           by reference z"Exit"
           returning exit-button

       call "fl_end_form" returning omitted

       call "fl_show_form" using
           by value form FL-PLACE-MOUSE FL-TRANSIENT
           by reference "Clocks"
           returning xforms-window
       call "fl_do_forms" returning form-button

       call "fl_get_clock" using
           by value clock-form(1)
           by reference hour minute second
       move hour to show-hour
       move minute to show-minute
       move second to show-second
       display "Exited at: " show-hour ":" show-minute ":" show-second

       call "fl_finish" returning omitted
       goback.

       end program sample.
      *> ***************************************************************
```

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```
      *> Give process rundown control to GnuCOBOL
       identification division.
       program-id. xforms-close.

       environment division.
       configuration section.
       special-names.
           call-convention 0 is extern.

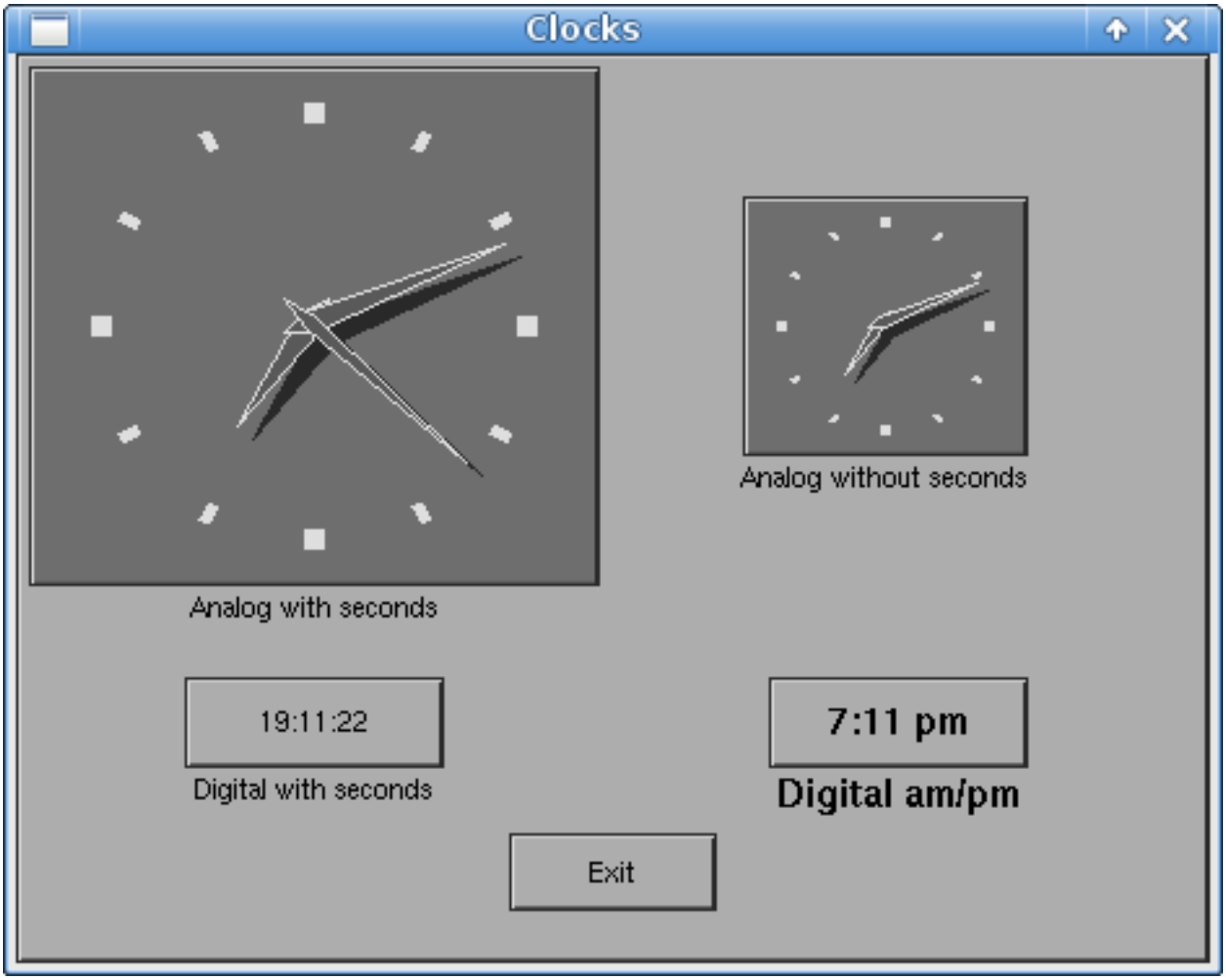
       data division.
       working-storage section.
       01 FL-IGNORE constant as -1.

       linkage section.
       01 xform usage pointer.
       01 close-data usage pointer.

       procedure division extern using
           by value xform close-data.

      *> IGNORE close or just stop run, otherwise XForms calls exit()
       move FL-IGNORE to return-code
       stop run.

       end program xforms-close.
     *> ************************************************************
```



The XForms Toolkit is available in most GNU/Linux distributions or from

http://xforms-toolkit.org/

5.126 Can GnuCOBOL interface with Agar?

Yes, quite well and this toolkit will be getting some attention with a user defined function wrapper for GnuCOBOL.

A fairly detailed work in progress discussion, with early code and screenshots can be found in the GnuCOBOL SourceForge project space at:

https://sourceforge.net/p/gnucobol/discussion/cobol/thread/c2ac66c1/

The pre-release 0.6 cut includes the following repository functions:

```
repository.
       function agar-window
       function agar-windowshow
       function agar-zoom
       function agar-setevent
       function agar-eventname
       function agar-setevent-with-field
```

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```
       function agar-eventloop
       function agar-box
       function agar-label
       function agar-button
       function agar-checkbox
       function agar-textbox
       function agar-combo
       function agar-close-datasource
       function agar-console
       function agar-consolemsg
       function agar-dirdlg
       function agar-editable
       function agar-execute
       function agar-filedlg
       function agar-fixed
       function agar-fixed-put
       function agar-fixed-del
       function agar-fixed-size
       function agar-fixed-move
       function agar-fixedplotter
       function agar-fixedplottercurve
       function agar-fixedplotterdatum
       function agar-fontselector
       function agar-bindvariable
       function agar-get-error
       function agar-get-error-pic
       function agar-graph
       function agar-graphvertex
       function agar-graphvertex-label
       function agar-graphvertex-position
       function agar-graphedge
       function agar-graphedge-label
       function agar-hsvpal
       function agar-kill-process
       function agar-menu
       function agar-menunode
       function agar-menuaction
       function agar-mpane
       function agar-netsocket
       function agar-netsocketfree
       function agar-netsocketset
       function agar-netsocketset-add
       function agar-netsocketset-first
       function agar-netsocketset-next
       function agar-netpoll
       function agar-netresolve
       function agar-netconnect
       function agar-netbind
       function agar-netaccept
       function agar-netclose
       function agar-netread
       function agar-netread-pic
       function agar-netwrite
       function agar-netwrite-pic
       function agar-notebook
       function agar-notebook-add
       function agar-numerical
```

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```
      function agar-open-core
      function agar-open-core-pic
      function agar-open-file
      function agar-open-filehandle
      function agar-open-netsocket
      function agar-pane
      function agar-pixmap
      function agar-pixmap-file
      function agar-pixmap-surface
      function agar-pixmap-surface-scaled
      function agar-progressbar
      function agar-radio
      function agar-scrollview
      function agar-separator
      function agar-set-style
      function agar-slider
      function agar-socket
      function agar-static-icon
      function agar-table
      function agar-timer
      function agar-tlist-add
      function agar-treetbl
      function agar-read
      function agar-read-pic
      function agar-read-at
      function agar-read-at-pic
      function agar-wait-on-process
      function agar-widget-focus
      function agar-widget-unfocus
      function agar-write
      function agar-write-pic
      function agar-write-at
      function agar-write-at-pic
```

A GUI with a nice set of widgets, networking, stream files, system services, more. All cross-platform.

5.126.1 gcv

Get C Value.

Due to some of the constraints faced when interfacing GnuCOBOL to C in a truly cross-platform manner, there is need to know, usually by hand, data sizes and constant values. These values are C preprocessor values, usually out of reach of COBOL.

So, gcv, a small program that writes single expression C programs that outputs the expression value.

```
/*
  Author: Brian Tiffin
  Dedicated to the public domain

  Date started: August 2018
  Modified: 2018-08-09/17:42-0400 btiffin

  Tectonics:
    gcc [-D AGAR] -o gcv gcv.c
    export CFLAGS
```

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```
    ./gcv expression includefiles spec

*/

/* gcv, Get C Value, given an expression, include files and spec */
#include <stdio.h>
#include <string.h>
#include <stdlib.h>
#include <unistd.h>

int
main(int argc, char** argv)
{

    int rc;
    int i;
    FILE *tmpfile;
    char leader;
    char opt;
    char *datatype;  /* the printf spec (without percent) for output handling */

    if (argc > 1 && (!strcmp(argv[1], "-h") || !strcmp(argv[1], "--help"))) {
        printf("Usage: gcv 'expression' [includes...] [-V|-C|-E|-'spec']\n");
        printf("  compile a C fragment and print the value given a printf spec\n");
        printf("  include as many headers as it takes to resolves symbols\n");
        printf("  last argument can be -V, -C, -E, or -spec or %%c-of-spec\n");
        printf("\n");
        printf("  -v, --version and -h, --help also supported\n");
        printf("\n");
        printf("  Relies on exported CFLAGS to manage include file search path\n");
        return 0;
    }
    if (argc > 1 && (!strcmp(argv[1], "-v") || !strcmp(argv[1], "--version"))) {
        printf("gcv version 0.3 Aug 2018\n");
        return 0;
    }
    /* Remain silent on no args as this is paired with commands.sed for substitution␣
↪*/
    if (argc < 2) return 0;

    /* if not help, then treat last option as the style or printf spec, default %d */
    leader = argv[argc-1][0];
    opt = argv[argc-1][1];
    datatype = "%d";
    if (leader == '-'&& (opt != 'V' && opt != 'C' && opt != 'E')) { datatype = &
↪argv[argc-1][1]; }
    if (leader == '%') { datatype = &argv[argc-1][0]; }

    /* create a small C program */
    tmpfile = fopen("gcv.tmp.c", "w");
    if (tmpfile) {

        /* transform underscores in names to dashes */
        char *underdash = strdup(argv[1]);
        for (char* current_pos = underdash; (current_pos = strchr(underdash, '_')) !=␣
↪NULL; *current_pos = '-');
```

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```
        /* extra arguments are include files to load to get at symbols */
        for (i = 2; i < argc; i++) {
            if (argv[i] && strcmp(argv[i], "stdio.h") &&
                strcmp(argv[i], "stddef.h") &&
#ifdef AGAR
                strcmp(argv[i], "agar/core.h") &&
                strcmp(argv[i], "agar/gui.h") &&
#endif
                argv[i][0] != '-' && argv[i][0] != '%') {
                fprintf(tmpfile, "%s%s%s", "#include \"", argv[i], "\"\n");
            }
        }
        fprintf(tmpfile, "%s", "#include <stdio.h>\n");
        fprintf(tmpfile, "%s", "#include <stddef.h>\n");
#ifdef AGAR
        fprintf(tmpfile, "%s", "#include \"agar/core.h\"\n");
        fprintf(tmpfile, "%s", "#include \"agar/gui.h\"\n\n");
#endif
        fprintf(tmpfile, "%s", "int main(int argc, char** argv) {\n");

        if (leader == '-' && opt == 'C') {
            fprintf(tmpfile, "    %s%s%s%s%s", "printf(\"01 %s%d%s\", \"", underdash,
↪" constant as \", (int)(", argv[1], "), \".\\n\");\n");
        } else if (leader == '-' && opt == 'V') {
            fprintf(tmpfile, "    %s%s%s%s%s", "printf(\"   05 %s%d%s\", \"",␣
↪underdash, " usage binary-long value \", (int)(", argv[1], "), \".\\n\");\n");
        } else {
            fprintf(tmpfile, "    %s%s%s%s%s", "printf(\"", datatype, "\", ", argv[1],
↪ ");\n");
        }
        fprintf(tmpfile, "%s", "}\n");

        free(underdash);
    }

    rc = fclose(tmpfile);
    if (!rc) {
        if (leader == '-' && opt == 'E') {
            rc = system("cat gcv.tmp.c");
            rc = system("echo gcc \"$CFLAGS\" -o gcv.tmp gcv.tmp.c");
            rc = system("gcc $CFLAGS -o gcv.tmp gcv.tmp.c");
        } else {
            rc = system("gcc -w $CFLAGS -o gcv.tmp gcv.tmp.c");
        }
        if (!rc) {
            rc = system("./gcv.tmp");
        }
    }

    /* only leave generated sources around with -E echo */
    if (leader != '-' || opt != 'E') {
        rc = unlink("./gcv.tmp.c");
    }
    rc = unlink("./gcv.tmp");
    return rc;
}
```

gcv usage

gcv needs to know any non default C compiler include file search paths, passed in CFLAGS.

```
prompt$ export CFLAGS='-I/usr/local/include -I/usr/local/include/agar'
prompt$ ./gcv AG_WINDOW_FADEIN agar/core.h agar/gui.h
134217728prompt$
```

Just for fun, lets give that a more human friendly spec.

```
prompt$ ./gcv AG_WINDOW_FADEIN agar/core.h agar/gui.h -C
01 AG-WINDOW-FADEIN constant as 134217728.
```

A COBOL programmer friendly data division statement.

Or, when other formats might be of use:

```
prompt$ ./gcv AG_WINDOW_FADEIN agar/core.h agar/gui.h -'0x%08X'
0x08000000
```

gcv is entirely easy to break. It uses the command line argument as a C expression that is an argument to a printf function call. Any expression that would break a C compile in that context will break gcv. The spec at the end of the command line can include %s, that will likely bork when the temporary program is run, unless the expression resolves to a valid pointer. Etc. The spec must include one and only one printf replacement (unless you game the engine and write a comma'ed expression). Etc, etc, breaks, real easy.

That is only the first part of tackling this particular COBOL/C problem; getting at local platform C values before compiling a GnuCOBOL program.

Enter commands.sed, a source text substitution program that allows source code substitution of markup text with gcv values.

GNU sed accepts an e flag for the substitute command. e captures a pattern match, and uses the match to invoke a system command. The command output is buffered and used as the replacement text. Awesome, simple, preprocessing.

```
prompt$ sed -re 's/(ls)/\1/e'
This is not replaced
ls
that was.
```

sed will replace the ls input line with the output of an ls command.

> prompt$ sed -re 's/(FILE-DIRECTORY)([ ]?)(.*)/ls 3/e' This is not replaced FILE-DIRECTORY ../data
> that was.

sed will replace FILE-DIRECTORY path with a listing.

A power tool.

5.126.2 commands.sed

```
# Date started: August 2018
# Modified: 2018-08-14/18:23-0400 btiffin
#
# commands.sed, markup command substitution
# Dedicated to the public domain
#
# Tectonics:
```

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```
#    Needs local copy of gcv.c compiled and ready in current working dir
#    sed -rf commands.sed [inputfiles]

# Replace #indent prog params# with the captured output indented 4 spaces
s%#indent ([^ ]*)[ ]?([^ ]*)[ ]?([^ ]*)[ ]?([^ ]*)[ ]?(.*)#%\1 \2 \3 \4 \5 | sed 's/^/
↪    /'%e

# Replace #command prog params# with the captured output
s%#command ([^ ]*)[ ]?([^ ]*)[ ]?([^ ]*)[ ]?([^ ]*)[ ]?(.*)#%\1 \2 \3 \4 \5%e

# Replace include file constants, enums, and C expressions
s#(.*)\[\[symbol[ ]?(.*)[ ]?(.*)\]\](.*)#printf "%s%s%s" "\1" "$(./gcv \2 \3)" "\4"#e

# Replace include file constants, enums, and C expressions wrapped in single quotes
s#(.*)\[\[eval[ ]?'(.*)'[ ]?(.*)\]\](.*)#printf "%s%s%s" "\1" "$(./gcv "\2" \3)" "\4"
↪#e

# Output suitable for replacement in COBOL source
s#(.*)\[\[constant[ ]?(.*)[ ]?(.*)\]\](.*)#printf "%s%s%s" "\1" "$(./gcv \2 \3 -C)"
↪"\4"#e
s#(.*)\[\[value[ ]?(.*)[ ]?(.*)\]\](.*)#printf "%s%s%s" "\1" "$(./gcv \2 \3 -V)" "\4"
↪#e

# Non gcv shell replacement
s#(.*)\[\[shell[ ]?([^ ]*)[ ]?'(.*)'[ ]?\]\](.*)#printf "%s%s%s" "\1" "$("\2" "\3")"
↪"\4"#e
```

That replaces text markup for

- [[symbol expression include-dirs… spec]]
- [[eval 'expression' include-dirs… spec]]
- [[constant symbol includes…]]
- [[value symbol include…]]

and a few others for non gcv shell command capture. The eval keyword expression has mandatory single quotes in the pattern match, to allow spaces in the command portion.

Now, C library bindings can include COBOL sources like

```
01 C-SIZEOF-FILE constant as [[eval 'sizeof(FILE)']].
01 FILE-STRUCTURE PIC X(C-SIZEOF-FILE) BASED.
```

That source is processed by

```
prompt$ sed -rf commands.sed program.gcv
```

Giving:

```
01 C-SIZEOF-FILE constant as 216.
01 FILE-STRUCTURE PIC X(C-SIZEOF-FILE) BASED.
```

So,

```
prompt$ sed -rf commands.sed program.gcv >program.cob
prompt$ cobc -xj program.cob
```

And *program* will have the correct size of a C FILE structure. 216 bytes on this machine. It'll be different on other platforms (depending on pointer size and features, etc).

The above is just a simple example. gcv was written to assist in creating cobweb-agar.cob, (in particular, a libagar.cpy copybook). gcv retrieves actual C values to ensure proper data sizing and alignments, along with enum and preprocessor constants, on each platform, when binding to libagar.

5.126.3 cobweb-agar samples

libagar was put to use to develop a Rosetta Code task entry, the Simple windowed application.

```
      *>
      *> Simple windowed application
      *> Tectonics:
      *>   cobc -xj swapp.cob cobweb-agar.cob `agar-config --libs`
      *>
       >>SOURCE FORMAT IS FIXED
       identification division.
       program-id. swapp.

       environment division.
       configuration section.
       repository.
           function agar-window
           function agar-box
           function agar-label
           function agar-button
           function agar-windowshow
           function agar-eventloop
           function all intrinsic.

       data division.
       working-storage section.
       01 window-positions.
          05 AG-WINDOW-CENTER          usage binary-long value 5.

       01 AG-NOFLAGS                   usage binary-long value 0.
       01 AG-WINDOW-SHOW               usage binary-long value 1.

       01 AG-BOX-HORIZ                 usage binary-long value 0.
       01 AG-BOX-EXPAND                usage binary-long value 6.

       01 AG-LABEL-EXPAND              usage binary-long value 3.

       01 agar-window-record.
          05 agar-win usage pointer.

       01 agar-box-record.
          05 agar-box-widget usage pointer.

       01 agar-label-record.
          05 agar-label-widget usage pointer.

       01 agar-button-record.
          05 agar-button-widget usage pointer.

       01 rc usage binary-long.
```

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```
       01 total-clicks-plural.
          05 total-click-display.
             10 value "There have been ".
             10 total-clicks pic 9(6).
             10 value " click".
          05 value "s ".

       linkage section.
       01 event usage pointer.

       procedure division.
       simple-main.

       move agar-window(AG-WINDOW-CENTER, numval(280), numval(32),
                        "Click counter") to agar-window-record

       move agar-box(agar-win, AG-BOX-HORIZ, AG-BOX-EXPAND)
         to agar-box-record

       move agar-label(agar-box-widget, AG-LABEL-EXPAND,
            "There have been no clicks yet") to agar-label-record

       move agar-button(agar-box-widget, AG-NOFLAGS, "click me",
                        "upclick", "buttonname", numval(1))
         to agar-button-record

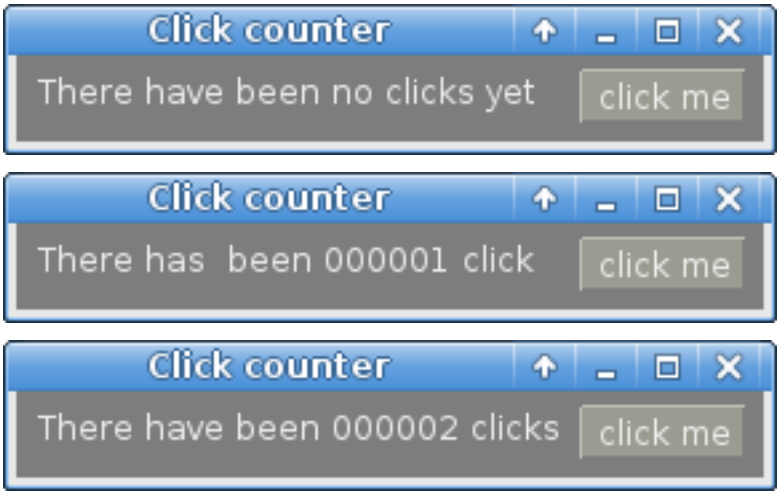
       move agar-windowshow(agar-win, AG-WINDOW-SHOW) to rc
       move agar-eventloop to rc

       goback.

      *> internal entry point for event callback
       entry "upclick" using by value event.
           add 1 to total-clicks
           if total-clicks equal 1
               *> tweaking a literal for sake of grammar and spelling
               inspect total-click-display
                   replacing all "have" by "has "
               call "AG_LabelTextS" using
                   by value agar-label-widget
                   by content concatenate(total-click-display, x"00")
                   returning omitted
               end-call
               inspect total-click-display
                   replacing all "has " by "have"
           else
               call "AG_LabelTextS" using
                   by value agar-label-widget
                   by content concatenate(total-clicks-plural, x"00")
                   returning omitted
               end-call
           end-if

       goback.
       end program swapp.
```

Producing a window that accepts clicks and changes a message to show the click count:



5.127 How do I enable mouse support in GnuCOBOL programs?

Thanks to user *cdg* on the GnuCOBOL forums on SourceForge. *Edited slightly for the FAQ.*

1) In order for a GnuCOBOL program to detect mouse activity, it is first necessary to set `COB_MOUSE_FLAGS` (either externally via terminal command, or internally via "set environment" to the applicable "mouse mask" (specifying which activities you wish the program to detect). The options are shown in screenio.cpy under "COB-MOUSE-MASK". Here is an example of setting the mask from a COBOL program:

```
COPY screenio.

01  mouse-flags PIC 9(4).

...

    COMPUTE mouse-flags = COB-AUTO-MOUSE-HANDLING
                        + COB-ALLOW-LEFT-DOWN
                        + COB-ALLOW-MIDDLE-DOWN
                        + COB-ALLOW-RIGHT-DOWN

    SET ENVIRONMENT "COB_MOUSE_FLAGS" TO mouse-flags.
```

   a) The following appears in the GC3.1-DEV manual, but NOT in the 3.2 programmer's guide. I assume it is correct:

```
Environment name: COB_MOUSE_FLAGS
Parameter name: mouse_flags
Purpose: specify which mouse events will be sent as function key
to the application during ACCEPT and how they will be handled
Type: int (by bits)
Default: 1
Note: 0 disables the mouse cursor, any other value enables it,
any value containing 1 will enable internal handling (click
to position, double-click to enter).
See copy/screenio.cpy for list of events and their values.
Alias: MOUSE_FLAGS
```

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```
Example: 11 (enable internal handling => 1, left press => 2,
double-click => 8; 1+2+8=11)

Environment name: COB_MOUSE_INTERVAL
Parameter name: mouse_interval
Purpose: specifies the maximum time (in thousands of a second)
that can elapse between press and release events for them to be
recognized as a click.
Type: int (0 - 166)
Default: 100
Note: 0 disables the click resolution (instead press + release
are recognized), also disables positioning by mouse click
```

2) Once that has been done, every (extended) *ACCEPT* (page 187), and `CBL_READ_KBD_CHAR`, will return a value in `COB_CRT_STATUS` reflecting mouse activity, when such activity occurs. The applicable values are shown in screenio.cpy under "Exception keys for mouse handling".

3) If you define a variable in SPECIAL NAMES as follows:

```
SPECIAL-NAMES.
   CURSOR IS data-name.   *> where data-name is PIC 9(4) or 9(6).
```

   the cursor or mouse position will be returned as well. The position is expressed as row and column (rrcc or rrrccc), and row is numbered from 1, whereas (for some reason) column is numbered from 0.

4) If you need to use "getch" instead of *ACCEPT* (page 187) or `CBL_READ_KB_CHAR` (because of the limitations of those routines, as discussed elsewhere), I have written and tested a "C" subroutine that invokes the pdcurses "getch" macro, and returns the keyboard entry or mouse activity, including the cursor position, which I will be happy to share with you. *Note: this was a forum post, to take advantage of cdg's offer, check the GnuCOBOL discussion groups on SourceForge.*

5) MOUSE functions are only supported from the Windows Command Prompt if "Quick Edit Mode" is turned off, but pdcurses appears to turn it off when it opens a new window, so this isn't an issue.

CHAPTER

SIX

GNUCOBOL IN PRODUCTION

GnuCOBOL in production

6.1 Is GnuCOBOL ready for production use?

Yes. For your particular application? Probably. GnuCOBOL has proven to be a very viable alternative to commercial COBOL offerings. GnuCOBOL supports most features of COBOL-85, almost all of the COBOL-89 Intrinsics, many features from COBOL-2002 and some from COBOL-2014. Bugs are fixed as they are found, the support community gets pretty good reviews, and is actively helpful. Very smart people are continually enhancing the product, both in terms of core support, and in support of extensions in use by other compilers. Freedom does that to people, they want more.

As listed in *Does GnuCOBOL pass the NIST Test Suite?* (page 14), the 2.0 reportwriter version of GnuCOBOL passes well over 9,700 tests, across 420 different modules. If you have never read the NIST COBOL-85 test validation suite, it was designed to torture test COBOL compilers. GnuCOBOL does a very admirable job. Although NIST no longer updates the test collection, when they did, it was treated very seriously. Validation test results were (and are) used by decision makers, in the highest levels of government, corporate enterprise, and educational sectors from around the world.

This question is also touched on in *Can GnuCOBOL be used for production applications?* (page 30), but this answer will try and go deeper, now that GnuCOBOL has matured as a product and there are more and more success (and some failure) stories.

Use of certain vendor extensions may mean there is more effort to port to GnuCOBOL, some may even put pause on a decision to port to GnuCOBOL at all. PowerCOBOL windowing support is one area that does not have good coverage in GnuCOBOL, *yet*.

6.2 What issues will I face when porting from a mainframe?

Depends on the work load. A small to midsize application, probably not that many issues to tackle, in terms of source code, but there will always be ENVIRONMENT DIVSION issues to work out. Along with the COBOL

ENVIRONMENT there is the operating system enviroments to contend with. Are you porting COBOL to GnuCOBOL on Windows(tm) or GNU/Linux, or perhaps you are aiming for HP3000 or AIX? All of these platform changes will come with highly specific program build and maintainence issues.

GNU/Linux is likely the easiest to move to. As a GNU project, GnuCOBOL is built with GNU tools and targets POSIX standards. (Not claiming compliance, but built with POSIX features in mind.) The compiler is built around C and the C application binary interface, an environment best supported by POSIX biased operating systems. Unix(tm) and Linux, with the GNU userland is the reference implementation of GnuCOBOL.

Windows(tm), Apple OS/X, HP3000, AS/400, R/S600, are all options though, binaries exist for these, and other systems, including MVS.

GnuCOBOL supports a rich and detailed set of configuration options to help manage cross platform issues, and this is likely where the first hurdles will be faced when moving from the mainframe. As binary fields are "implementation defined", there are several data typing issues to manage. Starting with *big-endian* (page 1318) and byte order, to position of numeric sign, to width of fields, there are options available in GnuCOBOL `.conf` files.

- binary-size: (can be 1 thru 8 as needed for packing, limited to 1-2-4-8 or even 2-4-8)

6.2.1 Enterprise

Do you have a large enterprise scale system with 40 years of production tweaking and millions of expensive hours spent on its design, implementation and maintenance? You are looking at work, issues, and problems to overcome when porting to GnuCOBOL. Probably many. The same range of issues as you would have with any large system port, regardless of source and target COBOL compiler, or non COBOL environment.

GnuCOBOL offers the freedom to explore the system, from the inside, and to ponder on potential customizations that would strengthen trust, and usabilty.

It also offers another option to consider if pondering to leave COBOL due to dues and annual fees. Instead of porting from COBOL to less expensive non-COBOL, port *from COBOL to less expensive COBOL.*

The C *ABI* (page 1350) offers untold potential for system integrations, from the highest to lowest levels. Integrate R analysis, Java, add sensor monitors, web services, cloud, all mixed with heritage COBOL-85, COBOL-68, COBOL-2014, COBOL-anytime resources.

With care, the most esoteric COBOL data types can be safely managed with GnuCOBOL. But, for sophisticated data ports, an export to flat file, and import to higher level COBOL data forms is one of the easier ways to build trust in the internal workings of a corporate GnuCOBOL deployment. The data will then be *synchronized* according to local compiler sizings, endian order, sign extensions and other bit configuration optimizations available to *PICTURE* (page 348) and *USAGE* (page 427).

6.3 What about GnuCOBOL in High Performance Computing?

Jim Currey, co-founder of Currey Adkins, recently set a note about GnuCOBOL 1.1 being put to use in an HPCC environment.

HPCC High Performance Computing Cluster

From Jim:

```
I write this note to thank everyone involved with GnuCOBOL and to
encourage their continued progress.

We became involved with a project earlier this year that required us to
become familiar with the provisioning and day-to-day operation of a High
```

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```
Performance Computing Cluster (HPCC).

When delivered the cluster will have several thousand cores. We built a
test bed with 124 cores to gain experience before going live.

The project is entirely open source. We are using CentOS as the operating
system, Warewulf (Lawrence Berkeley National Laboratory) as the
provisioner, and Slurm (Lawrence Livermore National Laboratory) as the
job scheduler.

We wanted a long running chore that could be run in a parallel manner. We
needed to learn about bottlenecks, failures, and the care and feeding of
jobs that run on many processors for many months.

The application that we chose to use was computing prime numbers because
of it's relative simplicity and embarrassingly parallel nature.

We used GnuCOBOL as the application language. As we know it generates C
code so the arithmetic functions should be pretty fast.

We compute primes in groups of one billion (10^9) and store the results on
5TB USB drives.

Today we are computing in the range slightly above 1,430,000,000,000,000
and have consumed about 34TB of storage.

GnuCOBOL has performed like a champ.

Once again please accept our thanks.

jimc
```

And an update:

```
As of November 30, 2015 we are working on the numbers above
1,600,000,000,000,000.

GnuCOBOL tells us that the lowest prime in the block of one billion numbers
below the 1.6 number above is 1,599,999,000,000,041 and that the average gap
between prime numbers in that block is (believe it or not) only 35. Even at
this number there are 28,559,866 primes within the block of one billion.

We plan to continue storing the primes up to 1,699,999,999,999,999 so that
we can realize the maximal prime gap 1,131
(https://primes.utm.edu/notes/GapsTable.html). After that the storage
requirements increase by powers of 10 and that will cost some real money.

Even though we will stop storing the primes we plan to continue computing
them and then analyzing each group of a billion.

jimc
```

COBOL, computing in the quadrillions.

```
As of April 9, 2016 we are working on the numbers above 7,074,943,000,000,000.

We have 118 cores dedicated to the chore. They have been running over 21 days
```

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```
without a computational, network, or hardware error.

What a great product GnuCOBOL is.
```

And of of June 2016, just got a screen shot of the cluster working its way through 9,380,000,000,000,000 and verifying a little over 33,000,000 primes a second within that 9 quadrillion number range.

And in July, GnuCOBOL in this High Performance Computing Cluster starting in on the 11 quadrillion range. From the first set of a billion in that range:

```
the lowest prime is 11,000,000,000,000,003
the highest prime is 11,000,000,999,999,081
there are 27,078,841 primes
the largest gap between primes is 546
the average gap between primes is 36
there are 967,954 twin primes (separated by two)
```

Another thanks goes out to Jim. Proving (over the long haul) that GnuCOBOL can stay up and keep up.

6.3.1 Chapel

GnuCOBOL has also been integrated with code written in the **Chapel** programming language being developed by Cray Inc.

Early draft as proof of concept.

```
extern proc SAMPLE(): int;

SAMPLE();
```

Calling into GnuCOBOL.

```
*> PURPOSE
*>   Chapel calling COBOL.
*> TECTONICS
*>   cobc -fimplicit-init -c hello.cob -g -debug
*>   chpl cobol.chpl hello.o -lcob
 identification division.
 program-id. SAMPLE.

 procedure division.
 display "Hello, chapel" end-display
 goback.
 end program SAMPLE.
```

And a test of:

```
prompt$ cobc -fimplicit-init -c hello.cob -g -debug
prompt$ chpl cobol.chpl hello.o -lcob
In file included from /usr/include/sys/types.h:25:0,
   from /home/btiffin/inst/langs/chapel/chapel-1.11.0/runtime//include/sys_basic.h:75,
   from /tmp/chpl-btiffin-23559.deleteme/chpl__header.h:4,
   from /tmp/chpl-btiffin-23559.deleteme/_main.c:1:
/usr/include/features.h:148:3: warning: #warning "_BSD_SOURCE and _SVID_SOURCE
   are deprecated, use _DEFAULT_SOURCE" [-Wcpp]
 # warning "_BSD_SOURCE and _SVID_SOURCE are deprecated, use _DEFAULT_SOURCE"
```

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```
   ^
In file included from /tmp/chpl-btiffin-23559.deleteme/_main.c:30:0:
/tmp/chpl-btiffin-23559.deleteme/cobol.c: In function 'chpl__init_cobol':
/tmp/chpl-btiffin-23559.deleteme/cobol.c:14:1: warning:
    implicit declaration of function 'SAMPLE' [-Wimplicit-function-declaration]
 SAMPLE();
 ^

prompt$ ./a.out
Hello, chapel
```

So there is a step missing in the chpl command line, as the external proc doesn't seem to be triggering the correct header definition. It works, but `chapel` is still in early development, and this will only get better.

Chapel calling COBOL.

6.4 Mixed programming with GnuCOBOL?

GnuCOBOL excels at mixed language programming. Since GnuCOBOL uses C (or C++) intermediates during the compilation phase, and COBOL allows CALL, GnuCOBOL can be mixed with just about any other C based programming system. Once you look closely, the vast majority of program development systems are based on C, or C++. The next few paragraphs are a generalization, but a fair one.

C compilers are written in C. Fortran compilers are written in C. Java starts with C. Pascal compilers are written in C. Ruby, Python, Perl, Tcl/Tk, Ada, and Rexx all have C implementations. Assemblers are written in C. Operating systems are written in C. REBOL, Icon, the Internet, written in C. GnuCOBOL is written in C, and emits C on its way to producing applications. Name a language, and there are very high odds that there is a C implementation. Programming systems not developed in C are the outliers, and most of those provide a way to link to the C application binary interface.

PHP is written in C, SNOBOL has a C implementation. PostgreSQL, MariaDB are C applications. This list could go on, and on, and on. Then there is C++, slighly harder to directly link with the C ABI due to name mangling issues, but the language itself allows for

```
 extern "C" {
     wondertype awesomefunction(superdata input) {
         earthshatteringcpluplus_code
     }
}
```

Add two lines for wrapping and C++ is available. Install GnuCOBOL C++ and even those lines become unnecessary.

And now back to reality and less over generalizing.

GnuCOBOL, by its nature, can easily interface with C and C++. That means that large investments in COBOL may not need to be tossed and rewritten to keep up with the modern world, but only tweaked, leveraged and integrated.

6.5 Does GnuCOBOL work in the Cloud?

Yes.

6.5.1 Juju Charm

There is an older Juju Charm, based on early GnuCOBOL 2.0, ready for experimentation at

https://jujucharms.com/u/bwtiffin/gnucobol-sample/

6.5.2 cobol.run

Travis Webb has been working on cobol.run:

https://github.com/morecobol/cobol.run

GnuCOBOL deployed to the cloud via OpenWhisk, Trails.js, Docker and Node.js.

Along with some starter videos to help everyone get up and running:

Topic	Link
Up and running	https://www.youtube.com/watch?v=3lx9ZeP47Hg
Copybook to JSON	https://www.youtube.com/watch?v=RTqMMWOyvuU
COBOL on the Cloud	https://www.youtube.com/watch?v=Wn2tE4VVYYQ
COBOL as FaaS	https://www.youtube.com/watch?v=rsezV9vcXek

FaaS Function as a Service

CHAPTER

SEVEN

TUTORIAL

Getting started with GnuCOBOL. This section assumes a GNU/Linux install, but much of the COBOL material is platform agnostic. Command examples will be shown using **bash** inside a terminal console.

Attention: COBOL is a big programming language. There are thousands of details. This tutorial will gloss over many issues in order to try and focus on one or two key points without overwhelming the reader. What may be stated as "fact" is likely less than half the story. You will eventually learn enough COBOL to know where details were omitted during this introduction.

7.1 Working directory

For this tutorial, you will need a working directory to store source code, executables and data files. I use:

```
cd ~/lang/cobol/
```

A subdirectory in my login home, called `lang/cobol`. You are free to choose your own working directory. All you need to remember is that you need to remember where it is, so when you come back to the computer after a break you'll be able to find your work.

Go ahead and create the directory, and/or change into it. For example:

```
cd $HOME
mkdir gcfaq/tutorial
cd gcfaq/tutorial
```

You can use that name, `gcfaq/tutorial`, if you like, but it is much better to pick your own easy to remember favourite. No one will be able to remind you, as it is a personal choice, so pick one you like and that you will be able to remember a few months from now if you ever need to come back for a refresher.

7.2 Hello

We will start with Hello. Of the four main COBOL divisions, this introductory sample only includes IDENTIFICATION and PROCEDURE. There are a few comment lines, some COBOL "paperwork" phrases and only two executable statements. We'll compile and run the program as part of the exercise.

Fire up your favourite editor and type the following into a file called `hello.cob`. (That filename is the name that will be used throughout the rest of this tutorial, so if you pick a different name this time, you are on your own to remember what it is, and to change each of the commands to suit).

```
      *>
      *> hello.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. hello.

       procedure division.
       display "Hello, world"
       goback.

       end program hello.
```

There is a handy download link for that source code if you are browsing this on the web, but as a COBOL developer, you need to get used to typing. So learn some COBOL the hard way and start typing. I use `vim`, but you will want to use a text editor you are comfortable with. Text editing is a tool of the trade that you need to be comfortable using, and there are literally hundreds of choices.

Side trip on source code formats: Don't fret these details, gloss over this next bit if you just want to get on with trying the compiler.

One note about spacing. COBOL uses two formats for source code. Old, FIXED format, harkening back to the days of punch cards, before interactive terminals. And new, FREE format. Old fashioned FORMAT FIXED is the default for the GnuCOBOL compiler, (because it is the default source format in all COBOL Standards so far, 1960 through COBOL 2014). The `hello.cob` example is in that fixed form. The first six columns are a special sequence number field, ignored by the compiler. Column 7 is a special indicator column. Compilable code starts in column 8. For this exercise, make sure the asterisks are in column 7 for the first three lines and the other lines start in column 8.

Older standards even went as far as having a Margin A, and a Margin B. Labels for paragraph and section names started at Margin A, column 8. Executable code statements started at Margin B, column 12. Fixed format GnuCOBOL only cares about Margin A, code and paragraph labels need to start in column 8 for FIXED format sources.

```
Counting columns in a line of COBOL source text (historically important)
IGNORE the first 6 colums
      Indicator column is column 7.  * for comments, - for continuation, others
      |A margin starts in column 8, all "real" source code starts here
      ||   B margin starts in column 12, but B margin is now deemed OBSOLETE
      ||   |       (Columns 73-80 are ignored, just like the first 6)   IGNORE..
      ||   |                                                            |
      || 1 |       2         3         4         5         6         7  |      8
123456*8901234567890123456789012345678901234567890123456789012345678901234567890XXXXXXXX

      * Comment line, the asterisk HAS to be in column 7
      *> New standard "to end of line" comment
      *> Can be anywhere past any FIXED form "A" margin
```

Once you have the Hello source code sample in a file called `hello.cob`, the real fun begins.

7.3 Compiling hello

This is where `cobc` comes in. `cobc` is the GnuCOBOL compiler front end command. It does a lot of nifty things, but for now we will focus on compiling and then running this simple program.

From the command prompt, type:

```
cobc -x hello.cob
```

This starts the compiler and asks `cobc` to generate an executable program.

Example compile:

```
prompt$ cobc -x hello.cob
```

The `-x` switch is what tells `cobc` to create the executable file. `cobc` can generate other forms of output, but we want a runnable program at the moment.

Note the silence in the example compile. If nothing goes wrong, `cobc` is usually quiet, and just does as asked. In this case, generating an executable program.

If there are no *syntax errors* (page 1315) then you should now have another file in your working directory, called `hello`. It will have modes and permissions already set for you to to be allowed to run the program.

Now type:

```
./hello
```

That command will start the new `hello` program. Using that command syntax, the system will not bother searching through the command path to find hello. `hello` is the program to run. The initial `./` part is a short form directory specification meaning *from here, in the current directory*. So, dot-slash hello, `./hello`, means run `hello`, from here in the current terminal workspace.

Example run:

```
prompt$ ./hello
Hello, world
```

Yes, hello to the world, GnuCOBOL is working.

And there is your introductory COBOL program with GnuCOBOL.

The purpose of `Hello, world` programs is to verify that the system is installed to a minimum functioning level. The message on the screen tells the operator that the compiler worked, and the run time system can at least do basic output.

It might seem trivial, but the validation means that a lot of things in the background are properly working. A lot. Really, a huge number of things have to be properly setup for that simple message to be displayed on screen.

If it didn't work, then you have Gary's Programmer's Guide and this document to help you with trouble shooting. There is also an awesome forum on SourceForge, ready and willing to answer any questions you may have regarding `Help getting started` at https://sourceforge.net/p/gnucobol/discussion/help/.

Attention: A short note about Windows. On Windows, without a reasonable console, what will happen is that invoking the program will start a console, display the message and then immediately close the console. All you may see is a flicker. More recent versions of GnuCOBOL now include a default exit handler that will pause the console shutdown, giving you a chance to see the output. Versions of GnuCOBOL older than 2.0-rc3 will not have this feature.

7.4 Line by line

Let's go over `hello.cob` one more time. This time, from a full listing that is available in the downloadable copy.

```
1  GCOBOL*>-<*
2        *> Author: Brian Tiffin
3        *> Dedicated to the public domain
4        *>
5        *> Date started: January 2017
6        *> Modified: 2017-02-02/17:22-0500 btiffin
7        *>
8        *> Tectonics:
9        *>   cobc -x hello.cob
10       *>   ./hello
11       *>+<*
12       *>
13       *> hello.cob, GnuCOBOL FAQ tutorial
14       *>
15        identification division.
16        program-id. hello.
17
18        procedure division.
19        display "Hello, world"
20        goback.
21
22        end program hello.
```

The first 14 lines are comment lines, they introduce the purpose of the program, show some dates, the usage rights and include some hints on how to build from source and how to run the program. I call that last part the *tectonics* (page 1350).

Hopefully all your programs come with this minimal level of preamble. Even if you never share a program, it is nice to be able to just glance at a header to see how to properly build and run a program. This is as simple as it gets, programs only get more complicated from here.

The comment indicator used for GnuCOBOL is `*>`, and this tells the compiler to ignore the rest of the text, up to the end of the line.

Next up is the first actual instruction to the compiler, line 15, the `IDENTIFICATION DIVISION` statement (which ends with a full stop period). This lets the COBOL lexical parser know that a new program definitions is starting. Mandatory with every program or nested sub-program. *(That's not entirely true, but true enough for an introductory tutorial).*

I sometimes refer to these types of COBOL instructions as "paperwork" or "housekeeping". These statements do not actually do anything in terms of run time effect, but they do influence how the compiler sets things up and organizes the technical details.

The next line is the `PROGRAM-ID.` statement, followed by a user defined program name. Both end with full stop periods. The name must follow a few technical rules, both to satisfy COBOL naming conventions and to satisfy operating system linkage rules. The operating system has to know how to find the program name when linking with other code, and COBOL can't let you put things like periods or commas in the name. The literal `hello` is fine for both the language and most operating system naming restrictions. This is a form of COBOL "paperwork" that effects the operating environment.

Then we get to the `PROCEDURE DIVISION` (and full stop) on line 18. This is another trigger phrase to tell the COBOL compiler that executable code follows. A little more paperwork.

Then we finally get to the first actual executable instruction on line 19. A `DISPLAY` statement, which is followed by a quoted literal message `"Hello, world"`. There could be a period following this statement, but it isn't mandatory. Sequential lists of statements form a COBOL "sentence", and this example program is a single sentence, with two statements. All the previous lines of source code are paperwork statements (and comments). This is the first line of code that actually does something when we run the program.

COBOL does not get its reputation for being verbose from lack of trying. As you continue learning COBOL you will find that all these housekeeping instructions are actually a good thing. It keeps code organized and also enforces a minimum level of discipline when developing programs. These factors become much more important once programs grow larger than simple introductory examples.

The next statement is `GOBACK`. This keyword tells the compiler to generate code to return to the caller. Seeing as this is a main program, that means the return goes all the way back to the operating system shell. A status code is implicitly set by default, in this case a success code of 0. You rarely have to worry about COBOL setting a proper status code. It is a built in convenience feature. The `GOBACK` is terminated with a full stop period, the end of the one (and only) executable sentence in this program.

That one sentence contains two statements, `DISPLAY literal` and `GOBACK`.

The last line is `end program hello.` (terminated with a period). This is optional with this particular program, and is another housekeeping phrase. The identifying program name has to match the `program-id`. It tells the compiler that this program unit is complete. Later we will see that this is important (and becomes mandatory) when a source file contains more than one program unit and when nesting sub-programs.

That ends the initial quick tour of a Hello, world program in GnuCOBOL.

With GnuCOBOL being quite flexible, this program could be written in a wide variety of ways, all with the same outcome. We will see different forms of programs that produce equivalent outcomes later on in the tutorial.

Skipping ahead a little: GnuCOBOL is actually quite a sophisticated COBOL compiler, and it can make assumptions about some of the paperwork instructions. All of that typing can be condensed down to a simple

```
        DISPLAY "Hello, world".
```

Even though that looks much simpler, it is actually fairly advanced COBOL. You need to know the first version for this one liner version to really make any sense. To compile the short version, we need to tell the compiler to relax some of the normal COBOL syntax rules.

```
prompt$ cobc -x -frelax-syntax hello-oneliner.cob
hello-oneliner.cob: 1: warning: PROGRAM-ID header missing - assumed
hello-oneliner.cob: 1: warning: PROCEDURE DIVISION header missing - assumed
```

The outcome is the same, but the path getting there is a little different, and this time `cobc` emitted some warnings about some assumptions being made.

```
prompt$ ./hello-oneliner
Hello, world
```

As promised above, there will be other examples of Hello, world programs that look totally different in the pages ahead. COBOL is a comprehensive and feature rich programming language

For the time being, forget that you saw that short-cut version of Hello. To learn COBOL you need to understand the paperwork phrases. They are important. Think of it as learning how to walk before starting to run. We all want to hop, skip and jump, but first we need to practise walking (after putting in some time crawling, which is hard on the knees, but we all start out that way).

7.5 The DIVISIONS

COBOL programs have four major DIVISIONS.

- IDENTIFICATION DIVISION.
- ENVIRONMENT DIVISION.

- DATA DIVISION.
- PROCEDURE DIVISION.

Each DIVISION is broken down into SECTIONS, PARAGRAPHS and SENTENCES. Sentences are broken down into STATEMENTS. Statements are made up of RESERVED WORDS, literals and variable identifiers. Paragraphs and sections have labels. Each of these fragments are terminated by a full stop period, much like in English.

In the `hello.cob` example, we only needed two DIVISION entries. IDENTIFICATION and PROCEDURE. That is a very rare case for COBOL programming. Anything that does useful work will have a DATA DIVISION. Anything that touches on external resources (usually data files on disk) will include the ENVIRONMENT DIVISION.

The order of the divisions is important. They **must** be entered in the same order as the list above.

IDENTIFICATION, ENVIRONMENT, DATA, PROCEDURE. GnuCOBOL will complain (COBOL will complain) if you try and put the PROCEDURE DIVISION before the DATA DIVISION, or mix up the order in any way. A handy mnemonic when starting out:

```
I Enter Data Properly
```

Entire DIVISIONS can be excluded (rarely), but when included, they must be in the proper order.

Let's see what happens if the `hello.cob` source code is out of order:

```
      *>
      *> hello-wrong-order.cob, GnuCOBOL FAQ tutorial error example
      *> This program will NOT compile properly, divisions out of order
      *>
       procedure division.
       display "Hello, world"
       goback.

       identification division.
       program-id. hello-wrong.

       end program hello-wrong.
```

You can skip typing that one in, it has bugs in it.

That code won't compile, and `cobc` will complain:

```
prompt$ cobc -x hello-wrong-order.cob
hello-wrong-order.cob: 15: error: PROGRAM-ID header missing
```

Do yourself the favour and just repeat:

```
I Enter Data Properly
I E D P

IDENTIFICATION
ENVIRONMENT
DATA
PROCEDURE
```

7.6 Full stop, periods

Attention: A side trip, an important one. The *period*, `.`, also known as full stop, is an important character in COBOL. It terminates labels, sentences, paragraphs, sections, and a few other critical pieces of COBOL syntax.

Let's see what happens if we forget a period in one of the critical spots. This version of `hello.cob` is missing the full stop after the IDENTIFICATION DIVISION phrase.

Don't bother typing this one in either, it has different bugs in it.

```
      *>
      *> hello-missing-period.cob, GnuCOBOL FAQ tutorial error
      *> This program will NOT compile, missing a full stop after
      *>  IDENTIFICATION DIVISION
      *>
       identification division
       program-id. hello-missing.

       procedure division.
       display "Hello, world"
       goback.

       end program hello-missing.
```

That code won't compile, and `cobc` will complain again:

```
prompt$ cobc -x hello-missing-period.cob
hello-missing-period.cob: 17: error: syntax error, unexpected PROGRAM-ID, expecting .
```

You need to worry about full stops in COBOL, and later on we'll see how they can effect the interpretation of the instructions in the PROCEDURE DIVISION in weird and wonderful ways.

A small piece of advice is to use the minimum number of full stops to satisfy the rules of COBOL syntax. No more, no less. For now, just know that the period character is an important symbol in COBOL. It terminates a unit of text to let the compiler know when and how to compile source code. Before you know it, it will all make sense and you'll be a master of the COBOL full stop.

7.7 Including Data

Almost all useful programs need to keep track of and manipulate data. Data forms the variable part of the code/data programming duality.

COBOL has a very rigid and technically detailed view of data. Unlike many programming languages, COBOL has a separate division for describing data layouts. Data definitions are not intermingled with code as they are in many other programming environments. This feature is a blessing. It forces a minimum level of discipline when programming. You need to think about, and plan, a COBOL program.

Back to the attention box at the start of the tutorial; in order to avoid overwhelming a beginner, there are many details left out in these initial exercises. The details will be touched on later. In particular, COBOL is very well suited for defining very complex record structures, but that has to wait.

7.8 Characters and numbers

COBOL is designed to help business people solve business problems. Data definitions in COBOL are designed for people to easily reason about the problem at hand. Definitions are rigid, and explicitly sized by PICTURE.

A PICTURE, shortened to PIC, is a human readable view of computer data. And there are two main types, character and number.

Numbers in this case are not for the benefit of the computer, they are defined for the benefit of the human reader. As it turns out, computers have a different natural view of numeric values than us humans. Computer don't have ten fingers to count on, they only have on/off. We all grow up using a base 10 (decimal) assumption about what numbers mean, and COBOL is designed with that fact in mind. Computers inherently have a base 2 (binary) assumption. The designers of COBOL decided that compiler writers should do all the nitty-gritty hard work of converting numbers from human form to machine form, and let business people think and reason about problems using dollars and cents in a human natural decimal format.

Most other programming languages cater to the computer chip point of view of numeric values. COBOL is rare in this design feature, using decimal arithmetic by default. (As does REXX and very few others).

```
01 CUSTOMER-NAME        PIC X(40).
01 ITEMS-PURCHASED      PIC 999999.
```

An X is a place holder for *any character* and here we set aside memory for 40 characters. A 9 is a placeholder for *any digit*, 0-9 inclusive (6 digits worth in this example, which could also be written as PIC 9(6).

You can't do math with a customer name, and you can't stick non-digit characters in the numeric count of items purchased.

The initial 01 on those lines in a field grouping level number. More on that topic soon. For now, the CUSTOMER-NAME and ITEMS-PURCHASED identifiers are known as "elementary items", not grouped or split into sub-fields. *For the impatient:* level number 77 is reserved for defining elementary items, but top level 01 level numbers are used here.

Our next program is going to manage some data. It includes a DATA DIVISION. Inside the DATA DIVISION is the omnipresent WORKING-STORAGE SECTION. The WORKING-STORAGE SECTION is a mainstay of COBOL data storage. It implies that somewhere in the computer's memory banks there is space reserved for the data. During any particular run it will remain fixed in place, ready for retrieval and/or manipulation, the working store.

This next program also introduces more COBOL verbs, MOVE and COMPUTE.

COMPUTE is a verb that tells the compiler to evaluate an arithmetic expression and put the result in a variable.

MOVE is a work horse data movement verb. It does more than simply move data from place to place, it also has rules about the form of the data movement, taking into account both the source and the destination data types. More on that soon.

For this example, quoted character literals are moved into a message area for display. The messages could have simply been literals used with the DISPLAY verb, but for this example the messages are moved into a variable first, and displayed from there.

```
      *>
      *> simple-data.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. simple-data.

       data division.
```

(continues on next page)

(continued from previous page)

```
       working-storage section.
       01 program-message      PIC X(64).
       01 answer               PIC 99.

       procedure division.

       move "simple-data.cob example" to program-message
       display program-message

       move "compute 6 times 7" to program-message
       display program-message

       move "answer is:" to program-message
       display program-message

       compute answer = 6 * 7.
       display answer

       goback.
       end program simple-data.
```

Fire up the text editor, in your tutorial working directory, and type that code into a file called `simple-data.cob`. Or, click the download link and save the file to your working directory.

Once again, a COBOL programmer cannot be afraid of typing, it is part and parcel of the job, so it is recommended that you struggle to type that in. *Spacing counts. COBOL harkens back to a day before modern computer screens, and source text was entered on physical punch cards. Those days are long behind us, but the format used in this example (called FORMAT FIXED) needs to be properly spaced.* Soon, we'll use an updated feature of COBOL so that we won't have to worry about the indentation as much, but for this example, the format is FIXED, code lines start in column 8, and the asterisks that start a comment *have* to be in column 7.

Note: On typing. COBOL programmers are famous for type it once, then copy and change it. There is actually quite a bit of paperwork in the average COBOL program.

See *Do you have a reasonable source code skeleton for GnuCOBOL?* (page 113) for a handy example of this. But keep in mind that you need to practice walking before running ahead to the hop, skip and jump phase.

While you type in these examples you are building up your own personal collection of code templates that can be used later to quick start a project.

7.8.1 run job

This time, we will use a feature of `cobc` that compiles the program and then runs it, all in one step. The `-j` switch is a mnemonic for *job*. Along with `-x` it means, compile this code to executable and then run the job for me.

```
prompt$ cobc -x -j simple-data.cob
simple-data.cob example
compute 6 times 7
answer is:
42
```

If there are no errors, then you are now rewarded with the answer to the ultimate question about the meaning of life, the universe, and everything.

Your working directory will now also have a new executable program file, `simple-data`, ready for more runs without needing to compile the source.

```
prompt$ ./simple-data
simple-data.cob example
compute 6 times 7
answer is:
42
```

Same answer. Which is good. Computers would be much less useful if results were not consistent. *COBOL programmers need to write programs that have consistent results, as this keeps everyone's bank balance from indiscriminately changing.*

Of note is that the identifier `program-message` is a fixed length 64 character variable, defined as `PIC X(64).` COBOL will fill in any remaining character positions with spaces during a `MOVE` to that field. And the `DISPLAY` verb actually prints all 64 characters each time.

For a demonstration, the program is run again with the output passed through the `tr` utility; all spaces translated to dots so you can see them.

```
prompt$ ./simple-data | tr ' ' '.'
simple-data.cob.example.....................................
compute.6.times.7...........................................
answer.is:..................................................
42
```

Don't worry, we'll learn an easy way to avoid displaying the trailing spaces soon enough. *For the impatient, there is an intrinsic function, called TRIM.*

Of other note is that the identifier `answer` is a two digit numeric field, defined with `PIC 99`. That field would be incapable of properly storing or displaying any number less than zero or greater than ninety-nine. And again, don't worry, we'll see ways of allowing for much larger (and negative) values, shortly. *For the impatient, you'll have to wait, as the PICTURE clause includes an overwhelming number of details that require a lot of explanation.*

7.9 Source formats

A short side trip into source formats. GnuCOBOL supports two forms of program text. `SOURCE FORMAT IS FIXED` and `SOURCE FORMAT IS FREE`. For historical reasons, the default compile mode is `FORMAT FIXED`.

Source lines are divided up in parts. Columns 1-6 hold a sequence number, any characters allowed, ignored by the compiler, and historically used to help humans keep track of the order of source lines. (When a deck of punch cards was dropped on the floor, chaos ensued getting the cards back in the proper order). Column 7 is an indicator column, and an asterisk in column 7 informs the compiler to ignore the entire line as a comment line, only meant for human readers. Column 8 through 72 holds the actual compiler instructions.

In the listing below, the line of numbers is just a ruler line to help count the columns. It has a an asterisk in column 7, and COBOL will treat the whole thing as a comment line..

```
123456*8901234567890123456789012345678901234567890123456789012345678901234567890123456789012

000100*  This is a comment line
000200 IDENTIFICATION DIVISION.
000300 ...
```

To avoid that complication from now on we will use a new `cobc` compiler switch, `-free`, which puts the compiler into a more modern free format mode. Because there is no longer a special indicator column, comments will use a

more modern syntax of two characters, `*>`. The two character form of comments can be placed anywhere on the line, and all text afterwards will be ignored by the compiler until the next line starts.

I'm in the habit of placing the two characters such that the asterisk is still in column 7, but that is an old habit, and `-free` compilation will free you from that historical burden (which isn't a burden, but it still looks old, and who wants to look old).

7.10 Flow of control

That heady sounding expression is just another way of stating that programs run in a predictable order. Also termed `control flow`. Unless told otherwise, GnuCOBOL programs execute from the top of the source code down, each line executed in sequence. The first line executes, then the second, then the third, as so on. This sequential processing is built into COBOL, and you don't have to tell the compiler anything special to have that happen. It is a natural state of most programming. Execute statements, in the order given in a source listing, until told otherwise.

Along with sequential processing, computers also do conditional and iterative processing. `IF` statements and `loops`.

Let's start with a conditional expression.

7.11 Conditionals

The `IF` statement. If something is true, do this, otherwise skip it. And a more complete, if something is true, do this, otherwise do that.

More typing, save this file as `just-if.cob`:

```
      *>
      *> just-if.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. just-if.

       data division.
       working-storage section.
       01 result               pic 999.

       procedure division.

       multiply 6 by 7 giving result

       if result is less than 100 then
           display "The ultimate answer seems reasonable: " result
       end-if

       if result is greater than or equal to 100 then
           display "There is something wrong with the universe: " result
       end-if

       goback.
       end program just-if.
```

That program introduces the `IF` statement. The first `IF` is the one we expect to ring true, 6 times 7 being less than 100. There is also the `END-IF` statements. These tell the compiler where to end a conditional branch fragment.

Skipping ahead a little. The full stop period is also a way of terminating a sequence of code in a conditional block, but that use can lead to subtle, hard to spot errors. A full stop will terminate ALL nested `IF` conditionals, and that can sometimes be the wrong thing to do. The recommendation is to use the `scope terminator` reserved words when you need to delimit blocks of code. These are much easier to spot than small dots in the source code.

The second test in `just-if.cob` will not display any message unless there is something seriously wrong with the computer, or the universe in general. We know that 6 times 7 is less than 100. You will rarely see such blatantly predictable false code except in test suites that are verifying a compiler or other unit testing frameworks.

```
prompt$ cobc -free -x -j just-if.cob
The ultimate answer seems reasonable: 042
```

`just-if.cob` also introduces another feature of COBOL. Full English statements for math calculations and conditionals. It is a design feature of COBOL. Some programmers find it far too verbose to have to type `MULTIPLY`; but non programmers have a much higher chance of knowing what is going on when reading the words instead of some computer glyph symbol (like the asterisk, which means multiply in many programming languages, and in COBOL `COMPUTE` statements).

COBOL was designed to help business people solve business problems and it is deemed polite, and beneficial, to at least attempt to allow business managers, that may not be programmers, to reason through some of the calculations performed, when programs are running to manage *their* business.

The same level of verbosity was used for the `IF` statement. Full words for `IS GREATER THAN`, `OR EQUAL TO` and `LESS THAN`. GnuCOBOL will allow for more symbolic forms as well.

```
      *>
      *> just-if-symbols.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. just-if-symbols.

       data division.
       working-storage section.
       01 result               pic 999.

       procedure division.

       compute result = 6 * 7

       if result < 100 then
           display "The ultimate answer seems reasonable: " result
       end-if

       if result > 100 then
           display "There is something wrong with the universe: " result
       end-if

       goback.
       end program just-if-symbols.
```

Same output as before, but using source code slightly less suitable for non programmers. COBOL is flexible enough to allow both, and the context should determine who a program is written for. Some managers, developers and customers will prefer the full long form, others may prefer the shorter symbolic form.

```
prompt$ cobc -free -x -j just-if-symbols.cob
The ultimate answer seems reasonable: 042
```

And a note on the promise of FORMAT FREE versus FORMAT FIXED. The author of this tutorial actually prefers

FIXED format COBOL, but from now on, the source listings are crafted to allow both modes of compile. That code could also be formatted as:

```
*>
*> just-if-free.cob, GnuCOBOL FAQ tutorial FORMAT FREE example
*>
identification division.
program-id. just-if-free.

data division.
working-storage section.
01 result               pic 999.

procedure division.

multiply 6 by 7 giving result

if result is less than 100 then
    display "The ultimate answer seems reasonable: " result
end-if

if result is greater than 100 then
    display "There is something wrong with the universe: " result
end-if

goback.
end program just-if-free.
```

But now `cobc` *has* to be told to compile in a free format friendly manner.

```
prompt$ cobc -free -x -j just-if-free.cob
The ultimate answer seems reasonable: 042
```

All further samples will be written to allow either `-free` or `-fixed` compile modes. `-fixed` is the default, `-free` is more modern.

`cobc` will complain loudly if that last example is compiled assuming fixed format.

```
prompt$ cobc -x -j just-if-free.cob
just-if-free.cob: 2: error: invalid indicator 'h' at column 7
just-if-free.cob: 3: error: invalid indicator 'i' at column 7
just-if-free.cob: 5: error: invalid indicator 'e' at column 7
just-if-free.cob: 6: error: invalid indicator 'i' at column 7
just-if-free.cob: 8: error: invalid indicator 't' at column 7
just-if-free.cob: 9: error: invalid indicator 'o' at column 7
just-if-free.cob: 13: error: invalid indicator 't' at column 7
just-if-free.cob: 15: error: invalid indicator 'f' at column 7
just-if-free.cob: 16: error: invalid indicator 'm' at column 7
just-if-free.cob: 18: error: invalid indicator 'i' at column 7
just-if-free.cob: 19: error: invalid indicator 'g' at column 7
just-if-free.cob: 20: error: invalid indicator 'u' at column 7
just-if-free.cob: 22: error: invalid indicator 'u' at column 7
just-if-free.cob: 24: error: invalid indicator 'l' at column 7
just-if-free.cob: 26: error: invalid indicator 'u' at column 7
just-if-free.cob: 27: error: invalid indicator 's' at column 7
just-if-free.cob: 30: error: invalid indicator 'u' at column 7
just-if-free.cob: 31: error: invalid indicator 's' at column 7
just-if-free.cob: 34: error: invalid indicator '.' at column 7
```

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```
just-if-free.cob: 35: error: invalid indicator 'o' at column 7
just-if-free.cob: 36: error: PROGRAM-ID header missing
```

As a protective measure, GnuCOBOL includes an in source directive that can be used to alleviate remembering to pass `-free` to `cobc` every time. Due to the default way that `cobc` starts, the initial directive must occur at the very top of the file, and it must start in column 8 or greater.

```
>>SOURCE FORMAT IS FREE
```

As a pleasantry, all sources will now include that line, or a similar directive to explicitly state that the assumed source mode is FIXED.

```
*>GCOB >>SOURCE FORMAT IS FREE
      *>-<*
      *> Author: Brian Tiffin
      *> Dedicated to the public domain
      *>
      *> Date started: January 2017
      *> Modified: 2017-01-29/17:28-0500
      *>
      *> Tectonics:
      *>   cobc -x just-if.cob
      *>   ./just-if
      *>+<*
      *>
      *> just-if.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. just-if.

       data division.
       working-storage section.
       01 result               pic 999.

       procedure division.

       multiply 6 by 7 giving result

       if result is less than 100 then
           display "The ultimate answer seems reasonable: " result
       end-if

       if result is greater than 100 then
           display "There is something wrong with the universe: " result
       end-if

       goback.
       end program just-if.
```

That listing, includes all the preamble text that is part of the downloadable copies of these tutorial entries, to show the directive.

Also note the `*>GCOB` marker is ignored by the compiler. Fixed format source (which all programs start out in by default) skips over the first 6 columns of every line in a program. It is one of the reasons I like FIXED form, it allows for *small notes in the margins*. In this case a trick is used, and the marker is actually a valid comment, so that source will work in either mode.

It also satisfies a requirement of being friendly to the markup processor used to produce this document, which uses indentation based highlighting and paragraph detection logic, but that has nothing to do with COBOL really.

Have I ever mentioned that COBOL includes an overwhelming number of details, best left out of an introductory tutorial?

7.12 If else

Now finally to the second form of conditional, `IF true THEN do-this ELSE do-that`.

More typing. This time edit a file called `ifelse.cob`.

```
      *>
      *> ifelse.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. ifelse.

       data division.
       working-storage section.
       01 result               pic 99.

       procedure division.

       multiply 6 by 7 giving result

       if result equals 42 then
           display "The ultimate answer is still " result
       else
           display "There is something wrong with the universe: " result
       end-if

       goback.
       end program ifelse.
```

This time around one of the display statements will execute depending on the conditional test. Same compile command model as before: `cobc -xj`, as captured below.

```
prompt$ cobc -xj ifelse.cob
The ultimate answer is still 42
```

If all is right with the universe then that program just output:

```
The ultimate answer is still 42
```

That program sample is compiled during generation of this document (every time). There is no absolute guarantee that I didn't break something and that the universe is still ok. In all likelihood, the expectation matches the actual. *I work on the compiler, and sometimes mistakes are made on the local install. Those mistakes are always short lived, but may influence the generation of some releases of this tutorial.*

Note: The `THEN` reserved word is optional, and some COBOL programmers find it wasteful to include in source code. I find THEN to be reassuring and it reads well.

And by the way, the whole 42 thing is from *The Hitchhiker's Guide to the Galaxy*, by Douglas Adams. A very worthy "trilogy" of six science fiction books. Along with 42 the books also emphasize a motto of "Don't panic".

7.13 Branching

Along with conditional *do-this* or *do-that* branching, flow of control change in COBOL can also be caused by *jumping around*. And there are two forms of jumping around. A controlled, *visit there and come back here*, and the less controlled, *go there*, with no real *come back here* part.

The controlled form is via `PERFORM`. The less controlled form is via `GO TO`. There is also `CALL`, but we'll get to that very powerful verb a little later.

7.14 Perform branching

COBOL includes various forms of a `PERFORM` statement. A looping form, discussed soon, and a simple branch to and come back here form, discussed here.

Time to fire up the editor again, and create a file called `performing.cob`.

```
      *>
      *> performing.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. performing.

       data division.
       working-storage section.
       01 counter              pic 9   value 1.

       procedure division.

      *> normal flow starts here
       display counter

      *> then branches to a procedure, then returns back
       perform increment-counter

      *> and carries on with the next line
       display counter

      *> then we return to the caller, in this case the operating system
       goback.

      *> a named paragraph
       increment-counter.
           add 1 to counter
       .

       end program performing.
```

That program will start at the top, then branch to a subroutine (formally a `procedure`) and then return to the line following the `PERFORM` to continue sequential line by line execution.

To run it, type `cobc -xj performing.cob` as in this captured example:

```
prompt$ cobc -xj performing.cob
1
2
```

That sample introduces labels, or named paragraphs, to the COBOL repertoire. A user defined identifier used as a named label (requires a full stop as part of the name definition, and that full stop has implications on the normal sequential top down processing rules inherent in COBOL). More on that later.

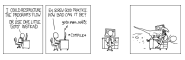
And now for a much maligned form of flow control. Uncontrolled jumping around.

7.15 Going, going, . . .

`GO TO` has been supported in COBOL since times before structured programming became the status quo. ALGOL had structured programming back in those early days, but other contemporaries of the era, like early FORTRAN compilers, did not. There are very few programming languages in current use that do not support structured programming. Assembly may be the only one in the main stream, and even some assemblers allow structured techniques on the way to machine code. Early BASIC programming was also squarely (and famously) in the **not structured** camp.

Some languages include `go to` branching, some do not. Many programmers eschew the `go to`, but there are times when it is a very efficient way of handling control flow. Errors or early exit conditions from a complex function is one common use case. The *C* language allows `goto`, Java does not support this type of branching, even though `goto` has been listed as a reserved word since the very first Oak specifications (pre Java name).

Common structured elements such as `break`, `continue` and/or `next` in other programming languages, are all actually a form of `go` branching', without being named `go to`. Most of these keywords imply "go to the bottom", "go to the top", or "get out" of this code block.



XKCD, http://xkcd.com/292/ by Randall Munroe, `CC BY-NC 2.5`

The next sample is not that brilliant. It simply jumps around for the sake of demonstration.

More typing, this time into a file called `going.cob`.

```
      *>
      *> going.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. going.

       data division.
       working-storage section.
       01 counter              pic 9   value 1.

       procedure division.

      *> normal flow starts here
       display counter

      *> then jumps
       go to the-bottom

      *> this is dead code, never executed
       display "Why am I even here?"

      *> the following full stop is required so that GnuCOBOL
      *> knows that this part of the program is terminated and to allow
      *> the next named paragraph to be recognized.
```

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```
       .

      *> a named paragraph
       the-bottom.
           display "Jumped to the-bottom"

           *> return to the caller, in this case the operating system
           goback.

       end program going.
```

The sample simply starts at the top, jumps to the bottom and exits. Don't write programs like this. Except during development phases where you are experimenting and need to jump over a bunch of code that is unrelated to the task at hand, knowing full well that the `GO TO` will be removed as soon as possible.

To compile and run the job, type `cobc -xj going.cob` as demonstrated below:

```
prompt$ cobc -xj going.cob
1
Jumped to the-bottom
```

GnuCOBOL includes a `cobc` feature to help find fragments of dead code.

```
*>GCOB*>-<*
      *> Author: Brian Tiffin
      *> Dedicated to the public domain
      *>
      *> Date started: January 2017
      *> Modified: 2018-07-21/03:27-0400 btiffin
      *>
      *> Tectonics:
      *>   cobc -x going.cob
      *>   ./going
      *>+<*
      *>
      *> going.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. going.

       data division.
       working-storage section.
       01 counter              pic 9   value 1.

       procedure division.

      *> normal flow starts here
       display counter

      *> then jumps
       go to the-bottom

      *> this is dead code, never executed
       display "Why am I even here?"

      *> the following full stop is required so that GnuCOBOL
      *> knows that this part of the program is terminated and to allow
```

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```
      *> the next named paragraph to be recognized.
       .

      *> a named paragraph
       the-bottom.
           display "Jumped to the-bottom"

           *> return to the caller, in this case the operating system
           goback.

       end program going.
```

```
prompt$ cobc -x going.cob -Wunreachable
going.cob: 31: warning: unreachable statement 'DISPLAY'
```

Not saying much more about that example, other than it should be short lived. It might help during isolation testing. Probably best to not let your peers see code like that unless they are helping you debug a problem.

More practical use of `GO TO` is the common idiom of jumping to the bottom of a long sequence of code. If conditions are met so that further processing is no longer required, just `GO TO bottom-of-routine-label`.

As stated, some purists eschew this idiom, but in practice, using `GO` can often avoid artificial conditional branching blocks, which can become quite messy when nested in complex code sequences. As a GnuCOBOL programmer, you are free to choose the style you prefer. In some cases you are free to choose the style as dictated by the project manager (*or risk expulsion by velociraptor*).

Note: Many languages use a keyword of `goto`, the COBOL verb is actually `GO`, with an optional `TO` reserved word. In GnuCOBOL `GOTO` is a syntax error, use `GO label` or `GO TO label`.

7.16 Selective evaluation

A third form of branching is the selective evaluation mechanism. A complete set of options is listed and tested, and the program will execute the first set that tests true. In COBOL this uses the `EVALUATE` verb in tandem with a practically unlimited number of `WHEN` clauses.

```
*>GCOB*>-<*
      *> Author: Brian Tiffin
      *> Dedicated to the public domain
      *>
      *> Date started: January 2017
      *> Modified: 2017-01-30/01:15-0500
      *>
      *> Tectonics:
      *>   cobc -x evaluating.cob
      *>   ./evaluating
      *>+<*
      *>
      *> evaluating.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. evaluating.
```

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```
       data division.
       working-storage section.
       01 first-field          pic 9.
       01 second-field         pic X.

       procedure division.

       move 1 to first-field
       move "C" to second-field

      *> inside a when conditional, the subject need not be mentioned
       evaluate first-field also second-field
           when = 1         also = "A"
               display "1A"
           when = 1         also = "B"
               display "1B"
           when = 1         also = "C"
               display "1C"
               display "This is the when block that executes"
           when = 1         also any
               display "This is also true, but the first one wins"
           when other
               perform no-matches
       end-evaluate

       goback.

       no-matches.
           display "No matches found: " first-field ", " second-field
       .
       end program evaluating.
```

EVALUATE is a very powerful selective evaluation statement, even when compared to most modern programming languages. The multiple condition testing allows for very concise multi-branch logic tables. Perfect for the business domain with complex conditions within conditions logic layering.

So, go ahead and type in `evaluating.cob`. Then run it with:

```
cobc -xj evaluating.cob
```

Example run:

```
prompt$ cobc -xj evaluating.cob
1C
This is the when block that executes
```

A nice feature of WHEN is that the subject field does not need to be mentioned. Each test assumes the field name before the conditional expression.

Using a fragment from the example above:

```
WHEN = 1 also = "A"
```

That is conceptually equivalent to

```
IF (first-test = 1) AND (second-test = "A")
```

Not only that, but range testing is allowed.

```
WHEN = 1 ALSO = "A" THRU "Z"
```

The `evaluate` verb can compress a lot of conditional testing into a very small table like structure. Multiple statements are allowed within each `WHEN` block.

7.17 Other forms of branching

COBOL includes a few other ways of branching; computed GO TO, ALTER, and DECLARATIVES. These will be covered later.

7.18 Loops

Let's take a look at another form of control flow. The loop. COBOL has a more restrictive take on looping than some other programming languages. All loops are either self managed by labels and `GO TO` statements, or through the `PERFORM` verb.

Strict structured programming practitioners treat `GO TO` as anathema, to be avoided, so let's start with one of those.

More typing, this time into a file called `goloop.cob`.

```
      *>
      *> goloop.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. goloop.

       data division.
       working-storage section.
       01 counter              pic 9   value 1.

       procedure division.

       loop-here.

           display counter
           add 1 to counter
           if counter < 4 then GO TO loop-here end-if
       .

       goback.
       end program goloop.
```

And a sample run:

```
prompt$ cobc -xj goloop.cob
1
2
3
```

Seeing as that listing probably makes some people angry about teaching the `GO` verb, no more will be said about it. Ok, one thing. Use `GO TO` with care and understanding, don't just be jumping around a program because it seems easier at the time.

7.19 Loop forms

A side trip. Most programming languages support:

```
while condition do loop-block
do loop-block until condition
```

COBOL supports:

```
perform paragraph-label until condition

perform until condition loop-block
```

The default for those in `WITH TEST BEFORE` which ends up being equivalent to a `while NOT condition do loop-block` sort of backwards form.

The qualifier clause `WITH TEST AFTER` creates an equivalent of the `do loop-block until condition` form.

All the usual forms of loop are possible, but the syntax is not quite as straight forward as some programmers may be accustomed to. For example, a counted loop form is available:

```
perform varying identifer from n by step until condition
```

A common idiom in COBOL is a "prime the pump" loop form. Do an initial action that sets the condition and other initial data values. Start the loop body, and then end the loop body with the action that sets the condition. This seems redundant, but it is actually a fairly robust and reliable way of programming loops. You have to duplicate an action, but it often means there are less fencing issues and off by one errors inside the loop body proper. This becomes equivalent to:

```
pre-condition
while condition do loop-block
```

For now let's focus on the forms of loops provided by COBOL syntax.

7.20 Perform loops

COBOL includes two types of `PERFORM` loop. Inline and out-of-line. Inline is the modern, out-of-line is an older procedure branch and return form and is still very prevalent in COBOL programs.

First an out-of-line procedure `PERFORM`. Named paragraphs and sections are called *procedures* in COBOL. Sadly they do not accept arguments, nor can they return results. Most COBOL programming comes down to side effect by changing globally accessible variables. Not completely terrible, all things considered, but it is a cause of more verbosity in COBOL, and a reason to show care and attention when developing larger programs.

Functional programming purists probably cringe at the thought of programming via side effect, but it has suited business programming for over 50 years now and banks still seem to keep all our account balances properly tallied.

7.20.1 out-of-line perform

This is the type of PERFORM that was in COBOL-60

```
      *>
      *> perform-loop.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. perform-loop.

       data division.
       working-storage section.
       01 counter              pic 9   value 1.

       procedure division.

      *> normal flow starts here
       display counter

      *> loop using a procedure subroutine
       perform increment-counter until counter > 7

      *> show the result
       display counter

      *> return to the to the operating system
       goback.

      *> a named paragraph
       increment-counter.
           add 1 to counter
       .

       end program perform-loop.
```

More typing as part of learning COBOL the hard way. Then compile and run with:

```
cobc -xj perform-loop.cob
```

An example run:

```
prompt$ cobc -xj perform-loop.cob
1
8
```

See if you can spot one of the glaring maintenance problems with this code? It has to do with the definition of `counter`.

The `counter` variable is defined as `pic 9`. That means the range of legal values that can be stored in the identifier is 0 through 9. 10 would be a size error condition. Testing for `greater than or equal to 10` would never work. The value in `counter` is limited to a maximum value of `9`. If a maintainer was told to increase the loop condition, the `counter` variable definition would also need to be changed. Increasing a condition test will always imply revisiting the definition of the variable and making additional adjustments if necessary.

Here is a fairly hard to spot infinite loop:

```
      *>
      *> perform-loop-infinite.cob, infinite loop error
      *>
       identification division.
       program-id. perform-loop-infinite.
```

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```
       data division.
       working-storage section.
       01 counter              pic 9   value 1.

       procedure division.

       display counter

      *> loop will never terminate, counter limited to max of nine.
       perform increment-counter until counter > 10

      *> show the result, which will never happen
       display counter

      *> return to the to the operating system, never happens
       goback.

      *> this add could have an ON SIZE ERROR clause
       increment-counter.
           add 1 to counter
       .

      *> this program will need operator intervention
       end program perform-loop-infinite.
```

You can try it, if you'd like, but be prepared to press Ctrl-C to abort the run, because this code will just spin forever. `counter` tries to be incremented from 9 to 10, then the rules of COBOL (and `pic 9`) truncates the value to `0` and the `perform` loop never gets a chance to finish. Looping from 0 to 9 over and over again due to the limited storage size (and no size error testing).

7.20.2 inline perform

This type of PERFORM was introduced with COBOL-85. COBOL-85 has had quite the run, and is still a de facto standard COBOL for many installations and production shops. It was extended with intrinsic functions in 1989 with corrections published in 1993. COBOL has been officially superseded by COBOL-2002 and COBOL-2014 standard specifications, but there is still a lot of COBOL-85 source code being maintained. The NIST test suite is based on COBOL-85 with the extensions from 1993.

Below are some examples of inline perform loops.

```
      *>
      *> inline-perform.cob, GnuCOBOL FAQ tutorial
      *>
       identification division.
       program-id. inline-perform.

       data division.
       working-storage section.
       01 counter              pic 99.

       procedure division.

      *> an inline perform loop
       perform varying counter from 1 by 1 until counter > 10
           display counter
```

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```
       end-perform

      *> return to the to the operating system
       goback.
       end program inline-perform.
```

More typing. Create `inline-perform.cob`. Then compile and run with:

```
cobc -xj inline-perform.cob
```

An example run:

```
prompt$ cobc -xj inline-perform.cob
01
02
03
04
05
06
07
08
09
10
```

7.21 Syntax errors

Syntax errors are common when developing programs. A misspelt word, a missed punctuation character, or some critical ordering mix up. The `cobc` compiler will tell you the line numbers where trouble brews, along with an explanatory error message.

Unfortunately, some syntax errors lead to an out of synch compile pass, and a whole raft of unrelated error messages may ensue. Start at the first one, fix it, and then recompile. Keep repeating the Edit -> Compile -> Edit -> Compile cycle until all syntax errors are corrected.

Typos happen. The compiler will tell you about them. It is very rare to have programs work on the very first compile. Get used to that as a normal part of software development. And as a reminder to always test things, even after what seem like insignificant changes. Typos happen.

7.22 Logic errors

Aside from syntax errors, logic errors are much more insidious. The compiler will dutifully compile programs that won't do the correct thing. This is where the human mind wins out over computers. Adding numbers together at speed is a computer strength. Knowing what numbers to add together is the human advantage. Informing a computer of what numbers to add together when (and how) is the job of the computer programmer. Along with support from others to ensure that the calculations are done properly and are of practical use is the domain of software development.

GnuCOBOL has quite a few tools to assist with testing and debugging programs. There are statement tracers to allow capturing the steps taken and in what order. There are low level debuggers, such as `gdb` that can be used for very detailed analysis of what is happening during a program run. There are profiling tools to help find where performance bottle necks are occurring. And a host of other automated and manual techniques that come into play during the verification and validation of COBOL programs.

More to come...

CHAPTER

EIGHT

NOTES

Notes

8.1 big-endian

Binary values stored with the most significant byte at the lowest memory address. Mainframes and networks use this form, more often than not.

Big End First.

See https://en.wikipedia.org/wiki/Endianness for more details.

The GnuCOBOL compiler *default* storage format for *USAGE* (page 427) BINARY and COMP.

A 32-bit unsigned integer value of 168496141, x"0A0B0C0D" would be:

```
Address: 00 01 02 03
  value: 0A 0B 0C 0D
```

with the most significant byte stored at the lowest memory address. This is the TCP/IP network ready format for multi byte values.

8.2 little-endian

Binary values stored with the most significant byte at the highest memory address.

Little End First.

https://en.wikipedia.org/wiki/Endianness for more details.

A 32-bit unsigned integer value of 168496141, x"0A0B0C0D" would be:

```
Address: 00 01 02 03
  value: 0D 0C 0B 0A
```

with the least significant byte stored at the lowest memory address.

This is the common Intel architecture form, and *USAGE* (page 427) clauses of COMPUTATIONAL-5, BINARY-CHAR, BINARY-SHORT, BINARY-LONG, BINARY-DOUBLE are a true performance boost on this hardware, as GnuCOBOL defaults to *big-endian* (page 1318) internal storage, more in keeping with historical COBOL.

From Keisuke Nishida's orginal notes:

```
By default, data items of usage binary or comp are stored in the big-endian
form. On those machines whose native byte order is little-endian, this is not
quite efficient.

If you prefer, you can store binary items in the native form of your machine.
Set the config option binary-byteorder to native in your config file

In addition, setting the option binary-size to 2-4-8 or 1-2-4-8 is more
efficient than others.
```

See *What are the GnuCOBOL compile time configuration files?* (page 105) for more details on compile time settings.

8.3 ASCII notes

American Symbolic Code for Information Interchange.

The character encoding common to personal computers and the early Internet Age, therefore GnuCOBOL. GnuCOBOL also supports the *EBCDIC* (page 251) character encoding so some data transfers and keyboard handling or console display programs may need programmer attention to detail. Although this is a rare case as GnuCOBOL operates using an intelligent choice of encoding for each platform build.

See https://en.wikipedia.org/wiki/American_Standard_Code_for_Information_Interchange for more info. If you are running GNU/Linux, use `man ascii` for quick access to an ASCII table.

Note: Unicode? GnuCOBOL supports PIC N, a two-byte character field.

8.4 currency symbol

COBOL allows a SPECIAL-NAMES clause that determines the currency symbol. This effects both source codes and input/output *PICTURE* (page 348) definitions.

```
CONFIGURATION SECTION.
SPECIAL-NAMES.
CURRENCY SIGN IS "#".
```

8.5 DSO

Dynamic Shared Objects.

Similar to, but conceptually different from *shared libraries*. A COBOL abstraction of .dll Dynamic Link Library and POSIX .so shared libraries along with other platform specific dynamic link and run-time catalog loader systems.

8.6 errno

GnuCOBOL and C are fairly closely related as GnuCOBOL produces intermediate C source code and passes this off to another compiler.

Some C functions had no easy way to report out-of-bound errors so a global int **errno** is defined in the standard C library as a thread safe variable. Conscientious programmers will reset and test this variable for any and all functions documented as setting **errno**.

This is not straight forward for GnuCOBOL, but a small wrapper along the lines of

```
/* set/get errno */

#include <errno.h>

int reset_errno() {
    errno = 0;
    return errno;
}
```

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```
int get_errno() {
    return errno;
}
/**/
```

exposes this critical run-time variable.

Usage:

```
$ cobc -c geterrno.c
$ cobc -x program.cob geterrno.o
```

and then something like

```
CALL "reset_errno" END-CALL
MOVE FUNCTION SQRT(-1) TO root
CALL "get_errno" RETURNING result END-CALL
IF result NOT EQUAL ZERO
   CALL "perror" USING NULL RETURNING OMITTED END-CALL
END-IF
```

Outputs:

```
Numerical argument out of domain
```

Note: errno is a `volatile` system variable, **any** function can change the value.

UPDATE: April 2016, January 2017

GnuCOBOL now sports a stock system library call, `CBL_OC_HOSTED` (rebranded to `CBL_GC_HOSTED`) that provides access to some C hosted and GnuCOBOL internally hosted variables.

See *CBL_GC_HOSTED* (page 125) for more details on this new feature in GnuCOBOL 2.0 and getting at `errno` without need of external helper C source code.

8.7 gdb

The GNU symbolic debugger. Big, deep, wide.

```
$ info gdb for the details.
```

or visit http://www.gnu.org/software/gdb/documentation/

For effective use of `gdb` a developer will have to get used to reading some of the emitted source code generated by `cobc`. Break points and line stepping requires some knowledge of the C layer when dealing with the GNU debugger. Don't worry though, the generated C code actually contains comment lines that allow for a fairly easy conversion from COBOL source line to C source line, and from COBOL identifiers to the C data names.

8.8 GMP

GNU MultiPrecision library, libgmp. A GNU subsystem that is used in support of COBOL friendly decimal arithmetic. See https://gmplib.org/ for complete details on the library advertised as *Arithmetic without limitations*.

8.9 ISAM

Indexed Sequential Access Method. A system to allow a variety of access methods for data records in file storage.

As a term of art, this document is fairly loose on the use of the acronym, ISAM. Within the FAQ, ISAM is used as a generic word for indexed files, record and key management. Technically, there is a lot more to it, and there are many engines that support record/key stores in a wide variety of implementations using a variety of base algorithms. For this document a loose umbrella term of `ISAM` is used throughout; less technically accurate than the subject deserves perhaps.

See https://en.wikipedia.org/wiki/ISAM for more details.

8.10 line sequential

An access method for newline terminated files. GnuCOBOL reads each line and strips off carriage returns and line feeds. Filling the record buffer with the current line and padding with spaces. Spaces trimmed on write.

A handy trick with LINE SEQUENTIAL access for getting the actual read length back is a VARYING FD clause. The DEPENDING ON field is set to the count of bytes input after each read.

```
GCobol >>SOURCE FORMAT IS FREE
      *> ************************************************************
      *>****p* samples/readlen
      *> Author:
      *>   Brian Tiffin
      *> Date:
      *>   20150725
      *> License:
      *>   Copyright 2015 Brian Tiffin
      *>   GNU Library General Public License, LGPL, 3.0 (or greater)
      *> Purpose:
      *>   Retrieve actual length of line sequential read
      *> Tectonics:
      *>   cobc -x -g -debug -W readlen.cob
      *> SOURCE
      *> ************************************************************
       identification division.
       program-id. readlen.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       input-output section.
       file-control.
           select testfile
           assign to "testfile.txt"
           organization is line sequential
           file status is testfile-status
           .

       data division.
       file section.
       fd testfile
```

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```
           record is varying in size from 0 to 132 characters
           depending on actual.
       01 testline.
           05 databytes pic x occurs 0 to 132 times depending on actual.

       working-storage section.
       01 actual pic 999 value 132.
       01 testfile-status pic 99.

      *> ****************************************************************
       procedure division.
       open input testfile
       if testfile-status greater than 9 then
           display
               "error: testfile.txt open failed with " testfile-status
               upon syserr
           end-display
           move 1 to return-code
           goback
       end-if

       perform until exit
           move 132 to actual
           read testfile end-read
           if testfile-status greater than 10 then
               display
                   "error: testfile.txt read failed with " testfile-status
                   upon syserr
               end-display
               move 1 to return-code
               goback
           end-if

           if testfile-status greater than 9 then
               exit perform
           end-if

           display actual ": " testline end-display
       end-perform

       close testfile
       if testfile-status greater than 9 then
           display
               "error: testfile.txt close failed with " testfile-status
               upon syserr
           end-display
           move 1 to return-code
           goback
       end-if

       goback.
       end program readlen.
      *> ****************************************************************
      *>****
```

and given a `testfile.txt` of

```
abcdefghijklmnopqrstuvwxyz
abc
abcde

abc
abcdefghijklmnopqrstuvwxyz
```

results in

```
prompt$ cobc -x -g -debug -W readlen.cob
prompt$ ./readlen
026: abcdefghijklmnopqrstuvwxyz
003: abc
005: abcde
000:
026: abc
026: abcdefghijklmnopqrstuvwxyz
```

The second last line is space filled in `testfile.txt`. Some care must be taken to ensure the depending on field is set to an appropriate value for writes. The FD clause can also be shortened.

```
fd testfile record varying depending on tracking-field.
```

8.11 APT

Advanced Package Tool. One of the strengths of the Debian GNU/Linux system. Allows for dependency checked binary packages.

8.12 ROBODoc Support

Below is a sample of a configuration file for using ROBODoc with GnuCOBOL programs.

```
# robodoc.rc for GnuCOBOL
#
items:
    NAME
    AUTHOR
    DATE
    PURPOSE
    TECTONICS
    SYNOPSIS
    INPUTS
    OUTPUTS
    SIDE EFFECTS
    HISTORY
    BUGS
    EXAMPLE
    SOURCE
ignore items:
    HISTORY
    BUGS
item order:
```

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```
    PURPOSE
    SYNOPSIS
    INPUTS
    OUTPUTS
source items:
    SYNOPSIS
preformatted items:
    INPUTS
    OUTPUTS
format items:
    PURPOSE
    SIDE EFFECTS
options:
#    --src ./
#    --doc ./doc
    --html
    --syntaxcolors
#    --singledoc
#   --multidoc
    --index
    --tabsize 4
headertypes:
    J  "Projects"          robo_projects    2
    F  "Files"             robo_files       1
    e  "Makefile Entries"  robo_mk_entries
    x  "System Tests"      robo_syst_tests
    q  Queries             robo_queries
ignore files:
    README
    CVS
    *.bak
    *~
    "a test_*"
accept files:
    *.cob
    *.COB
    *.cbl
    *.CBL
    *.cpy
    *.CPY
header markers:
    *>****
remark markers:
    *>
end markers:
    *>****
header separate characters:
    ,
header ignore characters:
    [
remark begin markers:
    *>+
remark end markers:
    *>-
source line comments:
    *>
# GnuCOBOL keywords *><*
```

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```
keywords:
    accept
    access
    active-class
    add
    address
    advancing
    after
    aligned
    all
    allocate
    alphabet
    alphabetic
    alphabetic-lower
    alphabetic-upper
    alphanumeric
    alphanumeric-edited
    also
    alter
    alternate
    and
    any
    anycase
    are
    area
    areas
    argument-number
    argument-value
    arithmetic
    as
    ascending
    assign
    at
    attribute
    auto
    auto-skip
    automatic
    autoterminate
    b-and
    b-not
    b-or
    b-xor
    background-color
    based
    beep
    before
    bell
    binary
    binary-c-long
    binary-char
    binary-double
    binary-long
    binary-short
    bit
    blank
    blink
    block
```

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```
    boolean
    bottom
    by
    byte-length
    call
    cancel
    cd
    center
    cf
    ch
    chain
    chaining
    character
    characters
    class
    class-id
    classification
    close
    code
    code-set
    col
    collating
    cols
    column
    columns
    comma
    command-line
    commit
    common
    communication
    comp
    comp-1
    comp-2
    comp-3
    comp-4
    comp-5
    comp-x
    computational
    computational-1
    computational-2
    computational-3
    computational-4
    computational-5
    computational-x
    compute
    condition
    configuration
    constant
    contains
    content
    continue
    control
    controls
    converting
    copy
    corr
    corresponding
```

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```
    count
    crt
    currency
    cursor
    cycle
    data
    data-pointer
    date
    day
    day-of-week
    de
    debugging
    decimal-point
    declaratives
    default
    delete
    delimited
    delimiter
    depending
    descending
    destination
    detail
    disable
    disk
    display
    divide
    division
    down
    duplicates
    dynamic
    ebcdic
    ec
    egi
    else
    emi
    enable
    end
    end-accept
    end-add
    end-call
    end-compute
    end-delete
    end-display
    end-divide
    end-evaluate
    end-if
    end-multiply
    end-of-page
    end-perform
    end-read
    end-receive
    end-return
    end-rewrite
    end-search
    end-start
    end-string
    end-subtract
```

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```
    end-unstring
    end-write
    entry
    entry-convention
    environment
    environment-name
    environment-value
    eo
    eol
    eop
    eos
    equal
    equals
    erase
    error
    escape
    esi
    evaluate
    exception
    exception-object
    exclusive
    exit
    expands
    extend
    external
    factory
    false
    fd
    file
    file-control
    file-id
    filler
    final
    first
    float-extended
    float-long
    float-short
    footing
    for
    foreground-color
    forever
    format
    free
    from
    full
    function
    function-id
    generate
    get
    giving
    global
    go
    goback
    greater
    group
    group-usage
    heading
```

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```
    high-value
    high-values
    highlight
    i-o
    i-o-control
    id
    identification
    if
    ignoring
    implements
    in
    index
    indexed
    indicate
    inherits
    initial
    initialize
    initialized
    initiate
    input
    input-output
    inspect
    interface
    interface-id
    into
    intrinsic
    invalid
    invoke
    is
    just
    justified
    key
    label
    last
    lc_all
    lc_collate
    lc_ctype
    lc_messages
    lc_monetary
    lc_numeric
    lc_time
    leading
    left
    length
    less
    limit
    limits
    linage
    linage-counter
    line
    line-counter
    lines
    linkage
    local-storage
    locale
    lock
    low-value
```

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```
    low-values
    lowlight
    manual
    memory
    merge
    message
    method
    method-id
    minus
    mode
    move
    multiple
    multiply
    national
    national-edited
    native
    negative
    nested
    next
    no
    none
    normal
    not
    null
    nulls
    number
    numbers
    numeric
    numeric-edited
    object
    object-computer
    object-reference
    occurs
    of
    off
    omitted
    on
    only
    open
    optional
    options
    or
    order
    organization
    other
    output
    overflow
    overline
    override
    packed-decimal
    padding
    page
    page-counter
    paragraph
    perform
    pf
    ph
```

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```
    pic
    picture
    plus
    pointer
    position
    positive
    present
    previous
    printer
    printing
    procedure
    procedure-pointer
    procedures
    proceed
    program
    program-id
    program-pointer
    prompt
    property
    prototype
    purge
    queue
    quote
    quotes
    raise
    raising
    random
    rd
    read
    receive
    record
    recording
    records
    recursive
    redefines
    reel
    reference
    relation
    relative
    release
    remainder
    removal
    renames
    replace
    replacing
    report
    reporting
    reports
    repository
    required
    reserve
    reset
    resume
    retry
    return
    returning
    reverse-video
```

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```
    rewind
    rewrite
    rf
    rh
    right
    rollback
    rounded
    run
    same
    screen
    sd
    search
    seconds
    section
    secure
    segment
    select
    self
    send
    sentence
    separate
    sequence
    sequential
    set
    sharing
    sign
    signed
    signed-int
    signed-long
    signed-short
    size
    sort
    sort-merge
    source
    source-computer
    sources
    space
    spaces
    special-names
    standard
    standard-1
    standard-2
    start
    statement
    status
    step
    stop
    string
    strong
    sub-queue-1
    sub-queue-2
    sub-queue-3
    subtract
    sum
    super
    suppress
    symbol
```

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```
    symbolic
    sync
    synchronized
    system-default
    table
    tallying
    tape
    terminal
    terminate
    test
    text
    than
    then
    through
    thru
    time
    times
    to
    top
    trailing
    true
    type
    typedef
    ucs-4
    underline
    unit
    universal
    unlock
    unsigned
    unsigned-int
    unsigned-long
    unsigned-short
    unstring
    until
    up
    update
    upon
    usage
    use
    user-default
    using
    utf-16
    utf-8
    val-status
    valid
    validate
    validate-status
    value
    values
    varying
    when
    with
    working-storage
    write
    yyyyddd
    yyyymmdd
    zero
```

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```
    zeroes
    zeros
```

To be used with

```
$ robodoc --src program.cob --doc program --singlefile --rc robocob.rc
```

Producing a nice HTML file documenting the program using embedded ROBODoc comment line directives. See ROBODoc for more information.

See http://peoplecards.ca/cobweb/cobweb-gtk/ for the output generated from the cobweb-gtk project sources using ROBODoc 4.99.42 and the `--cobol` command line option.

8.13 cobol.vim

Many thanks to the good people at www.vim.org

```
" Vim syntax file
" Language: COBOL
" Maintainers: Davyd Ondrejko
" (formerly Sitaram Chamarty
" James Mitchell
" Last change: 2001 Sep 02

" For version 5.x: Clear all syntax items
" For version 6.x: Quit when a syntax file was already loaded

" Stephen Gennard
" - added keywords - AS, REPOSITORY
" - added extra cobolCall bits

if version < 600
  syntax clear
elseif exists("b:current_syntax")
  finish
endif

" MOST important - else most of the keywords wont work!
if version < 600
  set isk=@,48-57,-
else
  setlocal isk=@,48-57,-
endif

syn case ignore

if exists("cobol_legacy_code")
  syn match cobolKeys "^\a\{1,6\}" contains=cobolReserved
else
  syn match cobolKeys "" contains=cobolReserved
endif

syn keyword cobolReserved contained ACCEPT ACCESS ADD ADDRESS ADVANCING AFTER
syn keyword cobolReserved contained ALPHABET ALPHABETIC
syn keyword cobolReserved contained ALPHABETIC-LOWER ALPHABETIC-UPPER
```

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```
syn keyword cobolReserved contained ALPHANUMERIC ALPHANUMERIC-EDITED ALS
syn keyword cobolReserved contained ALTERNATE AND ANY ARE AREA AREAS
syn keyword cobolReserved contained ASCENDING ASSIGN AT AUTHOR BEFORE BINARY
syn keyword cobolReserved contained BLANK BLOCK BOTTOM BY CANCEL CBLL CD
syn keyword cobolReserved contained CF CH CHARACTER CHARACTERS CLASS
syn keyword cobolReserved contained CLOCK-UNITS CLOSE COBOL CODE CODE-SET
syn keyword cobolReserved contained COLLATING COLUMN COMMA COMMON
syn keyword cobolReserved contained COMMUNICATIONS COMPUTATIONAL COMPUTE
syn keyword cobolReserved contained CONFIGURATION CONTENT CONTINUE
syn keyword cobolReserved contained CONTROL CONVERTING CORR CORRESPONDING
syn keyword cobolReserved contained COUNT CURRENCY DATA DATE DATE-COMPILED
syn keyword cobolReserved contained DATE-WRITTEN DAY DAY-OF-WEEK DE
syn keyword cobolReserved contained DEBUG-CONTENTS DEBUG-ITEM DEBUG-LINE
syn keyword cobolReserved contained DEBUG-NAME DEBUG-SUB-1 DEBUG-SUB-2
syn keyword cobolReserved contained DEBUG-SUB-3 DEBUGGING DECIMAL-POINT
syn keyword cobolReserved contained DELARATIVES DELETE DELIMITED DELIMITER
syn keyword cobolReserved contained DEPENDING DESCENDING DESTINATION
syn keyword cobolReserved contained DETAIL DISABLE DISPLAY DIVIDE DIVISION
syn keyword cobolReserved contained DOWN DUPLICATES DYNAMIC EGI ELSE EMI
syn keyword cobolReserved contained ENABLE END-ADD END-COMPUTE END-DELETE
syn keyword cobolReserved contained END-DIVIDE END-EVALUATE END-IF
syn keyword cobolReserved contained END-MULTIPLY END-OF-PAGE END-PERFORM
syn keyword cobolReserved contained END-READ END-RECEIVE END-RETURN
syn keyword cobolReserved contained END-REWRITE END-SEARCH END-START
syn keyword cobolReserved contained END-STRING END-SUBTRACT END-UNSTRING
syn keyword cobolReserved contained END-WRITE ENVIRONMENT EQUAL ERROR ESI
syn keyword cobolReserved contained EVALUATE EVERY EXCEPTION
syn keyword cobolReserved contained EXTEND EXTERNAL FALSE FD FILE
syn keyword cobolReserved contained FILE-CONTROL FILLER FINAL FIRST FOOTING FOR FROM
syn keyword cobolReserved contained GENERATE GIVING GLOBAL GREATER GROUP
syn keyword cobolReserved contained HEADING HIGH-VALUE HIGH-VALUES I-O
syn keyword cobolReserved contained I-O-CONTROL IDENTIFICATION IN INDEX
syn keyword cobolReserved contained INDEXED INDICATE INITIAL INITIALIZE
syn keyword cobolReserved contained INITIATE INPUT INPUT-OUTPUT INSPECT
syn keyword cobolReserved contained INSTALLATION INTO IS JUST
syn keyword cobolReserved contained JUSTIFIED KEY LABEL LAST LEADING LEFT
syn keyword cobolReserved contained LENGTH LOCK MEMORY
syn keyword cobolReserved contained MERGE MESSAGE MODE MODULES MOVE
syn keyword cobolReserved contained MULTIPLE MULTIPLY NATIVE NEGATIVE NEXT NO NOT
syn keyword cobolReserved contained NUMBER NUMERIC NUMERIC-EDITED
syn keyword cobolReserved contained OBJECT-COMPUTER OCCURS OF OFF OMITTED ON OPEN
syn keyword cobolReserved contained OPTIONAL OR ORDER ORGANIZATION OTHER
syn keyword cobolReserved contained OUTPUT OVERFLOW PACKED-DECIMAL PADDING
syn keyword cobolReserved contained PAGE PAGE-COUNTER PERFORM PF PH PIC
syn keyword cobolReserved contained PICTURE PLUS POSITION POSITIVE
syn keyword cobolReserved contained PRINTING PROCEDURE PROCEDURES PROCEED
syn keyword cobolReserved contained PROGRAM PROGRAM-ID PURGE QUEUE QUOTES
syn keyword cobolReserved contained RANDOM RD READ RECEIVE RECORD RECORDS
syn keyword cobolReserved contained REDEFINES REEL REFERENCE REFERENCES
syn keyword cobolReserved contained RELATIVE RELEASE REMAINDER REMOVAL
syn keyword cobolReserved contained REPLACE REPLACING REPORT REPORTING
syn keyword cobolReserved contained REPORTS RERUN RESERVE RESET RETURN
syn keyword cobolReserved contained RETURNING REVERSED REWIND REWRITE RF RH
syn keyword cobolReserved contained RIGHT ROUNDED SAME SD SEARCH SECTION
syn keyword cobolReserved contained SECURITY SEGMENT SEGMENT-LIMITED
syn keyword cobolReserved contained SELECT SEND SENTENCE SEPARATE SEQUENCE
syn keyword cobolReserved contained SEQUENTIAL SET SIGN SIZE SORT
```

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```
syn keyword cobolReserved contained SORT-MERGE SOURCE SOURCE-COMPUTER
syn keyword cobolReserved contained SPECIAL-NAMES STANDARD
syn keyword cobolReserved contained STANDARD-1 STANDARD-2 START STATUS
syn keyword cobolReserved contained STRING SUB-QUEUE-1 SUB-QUEUE-2
syn keyword cobolReserved contained SUB-QUEUE-3 SUBTRACT SUM SUPPRESS
syn keyword cobolReserved contained SYMBOLIC SYNC SYNCHRONIZED TABLE TALLYING
syn keyword cobolReserved contained TAPE TERMINAL TERMINATE TEST TEXT
syn keyword cobolReserved contained THAN THEN THROUGH THRU TIME TIMES TO TOP
syn keyword cobolReserved contained TRAILING TRUE TYPE UNIT UNSTRING
syn keyword cobolReserved contained UNTIL UP UPON USAGE USE USING VALUE VALUES
syn keyword cobolReserved contained VARYING WHEN WITH WORDS WORKING-STORAGE WRITE

" new
syn keyword cobolReserved contained AS LOCAL-STORAGE LINKAGE SCREEN ENTRY

" new - btiffin
syn keyword cobolReserved contained END-ACCEPT END-DISPLAY

" new
syn keyword cobolReserved contained environment-name environment-value argument-number
syn keyword cobolReserved contained call-convention identified pointer

syn keyword cobolReserved contained external-form division wait national

" new -- oo stuff
syn keyword cobolReserved contained repository object class method-id
syn keyword cobolReserved contained method object static
syn keyword cobolReserved contained class-id class-control private
syn keyword cobolReserved contained inherits object-storage
syn keyword cobolReserved contained class-object protected delegate
syn keyword cobolReserved contained try catch raise end-try super property
syn keyword cobolReserved contained override instance equals

" new - new types
syn match cobolTypes "condition-value"hs=s,he=e
syn match cobolTypes "binary-char"hs=s,he=e
syn match cobolTypes "binary-c-long"hs=s,he=e
syn match cobolTypes "binary-long"hs=s,he=e
syn match cobolTypes "binary-short"hs=s,he=e
syn match cobolTypes "binary-double"hs=s,he=e
syn match cobolTypes "procedure-pointer"hs=s,he=e
syn match cobolTypes "object reference"hs=s,he=e

syn match cobolReserved contained "\<CONTAINS\>"
syn match cobolReserved contained "\<\(IF\|ELSE|INVALID\|END\|EOP\)\>"
syn match cobolReserved contained "\<ALL\>"

syn keyword cobolConstant SPACE SPACES NULL ZERO ZEROES ZEROS LOW-VALUE LOW-VALUES

syn keyword cobolReserved contained fold folder

if exists("cobol_legacy_code")
  syn match cobolMarker "^.\{6\}"
  syn match cobolBadLine "^.\{6\}[^ D\-*$/].*"hs=s+6
  " If comment mark somehow gets into column past Column 7.
  syn match cobolBadLine "^.\{6\}\s\+\*.*"
endif
```

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```
syn match cobolNumber "\<-\=\d*\.\=\d\+\>" contains=cobolMarker,cobolComment
syn match cobolPic "\<S*9\+\>" contains=cobolMarker,cobolComment
syn match cobolPic "\<$*\.\=9\+\>" contains=cobolMarker,cobolComment
syn match cobolPic "\<Z*\.\=9\+\>" contains=cobolMarker,cobolComment
syn match cobolPic "\<V9\+\>" contains=cobolMarker,cobolComment
syn match cobolPic "\<9\+V\>" contains=cobolMarker,cobolComment
syn match cobolPic "\<-\+[Z9]\+\>" contains=cobolMarker,cobolComment
syn match cobolTodo "todo" contained

if exists("cobol_mf_syntax")
  syn region cobolComment start="*>" end="$" contains=cobolTodo,cobolMarker
endif

syn keyword cobolGoTo GO GOTO
syn keyword cobolCopy COPY

" cobolBAD: things that are BAD NEWS!
syn keyword cobolBAD ALTER ENTER RENAMES

" cobolWatch: things that are important when trying to understand a program
syn keyword cobolWatch OCCURS DEPENDING VARYING BINARY COMP REDEFINES
syn keyword cobolWatch REPLACING THROW
syn match cobolWatch "COMP-[123456XN]"

" new - btiffin, added Intrinsics
syn keyword cobolWatch ABS ACOS ANNUITY ASIN ATAN BYTE-LENGTH CHAR
syn keyword cobolWatch COS CURRENT-DATE DATE-OF-INTEGER DATE-TO-YYYYMMDD
syn keyword cobolWatch DAY-OF-INTEGER DAY-TO-YYYYDDD E EXCEPTION-FILE
syn keyword cobolWatch EXCEPTION-LOCATION EXCEPTION-STATEMENT
syn keyword cobolWatch EXCEPTION-STATUS EXP EXP10 FACTORIAL FRACTION-PART
syn keyword cobolWatch INTEGER INTEGER-OF-DATE INTEGER-OF-DAY INTEGER-PART
syn keyword cobolWatch LENGTH LOCALE-DATE LOCALE-TIME LOG LOG10 LOWER-CASE
syn keyword cobolWatch MAX MEAN MEDIAN MIDRANGE MIN MOD NUMVAL NUMVAL-C
syn keyword cobolWatch ORD ORD-MAX ORD-MIN PI PRESENT-VALUE RANDOM RANGE
syn keyword cobolWatch REM REVERSE SECONDS-FROM-FORMATTED-TIME
syn keyword cobolWatch SECONDS-PAST-MIDNIGHT SIGN SIN SQRT
syn keyword cobolWatch STANDARD-DEVIATION STORED-CHAR-LENGTH SUM TAN
syn keyword cobolwatch SUBSTITUTE SUBSTITUTE-CASE
syn keyword cobolWatch TEST-DATE-YYMMDD TEST-DAY-YYYYDDD TRIM UPPER-CASE
syn keyword cobolWatch VARIANCE WHEN-COMPILED YEAR-TO-YYYY

syn region cobolEXECs contains=cobolLine start="EXEC " end="END-EXEC"

syn match cobolComment "^.\{6\}\*.*"hs=s+6 contains=cobolTodo,cobolMarker
syn match cobolComment "^.\{6\}/.*"hs=s+6 contains=cobolTodo,cobolMarker
syn match cobolComment "^.\{6\}C.*"hs=s+6 contains=cobolTodo,cobolMarker

if exists("cobol_legacy_code")
  syn match cobolCompiler "^.\{6\}$.*"hs=s+6
  syn match cobolDecl "^.\{6} \{1,8}\(0\=1\|77\|78\) "hs=s+7,he=e-1␣
↪contains=cobolMarker
  syn match cobolDecl "^.\{6} \+[1-8]\d "hs=s+7,he=e-1 contains=cobolMarker
  syn match cobolDecl "^.\{6} \+0\=[2-9] "hs=s+7,he=e-1 contains=cobolMarker
  syn match cobolDecl "^.\{6} \+66 "hs=s+7,he=e-1 contains=cobolMarker
  syn match cobolWatch "^.\{6} \+88 "hs=s+7,he=e-1 contains=cobolMarker
else
```

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```
  syn match cobolWhiteSpace "^*[ \t]"
  syn match cobolCompiler "$.*"hs=s,he=e contains=cobolWhiteSpace,cobolTypes
  syn match cobolDecl "0\=[1-9] *$"hs=s,he=e-1 contains=cobolWhiteSpace,cobolTypes
  syn match cobolDecl "66 *$"hs=s,he=e-1 contains=cobolWhiteSpace,cobolTypes
  syn match cobolWatch "88 *$"hs=s,he=e-1 contains=cobolWhiteSpace,cobolTypes
endif

syn match cobolBadID "\k\+-\($\|[^-A-Z0-9]\)"

syn keyword cobolCALLs CALL CANCEL GOBACK INVOKE PERFORM END-PERFORM END-CALL RUN
syn match cobolCALLs "STOP \+RUN"
syn match cobolCALLs "EXIT \+PROGRAM"
syn match cobolCALLs "EXIT \+PROGRAM \+RETURNING"
syn match cobolCALLs "EXIT \+PERFORM"
syn match cobolCALLs "EXIT \+METHOD"
syn match cobolCALLs "EXIT \+SECTION"
syn match cobolCALLs "STOP " contains=cobolString

syn match cobolExtras /\<VALUE \+\d\+\./hs=s+6,he=e-1

" zero terminated strings eg: pic x(10) value z"My C String"
if exists("cobol_mf_syntax")
  syn match cobolString /z"[^"]*\("\|$\)/
endif

syn match cobolString /"[^"]*\("\|$\)/
syn match cobolString /'[^']*\('\|$\)/

" new - btiffin, added libcob calls
syn match cobolWatch /\(["']\)SYSTEM\1/
syn match cobolWatch /["']CBL_ERROR_PROC["']/
syn match cobolWatch /["']CBL_EXIT_PROC["']/
syn match cobolWatch /["']CBL_OPEN_FILE["']/
syn match cobolWatch /["']CBL_CREATE_FILE["']/
syn match cobolWatch /["']CBL_READ_FILE["']/
syn match cobolWatch /["']CBL_WRITE_FILE["']/
syn match cobolWatch /["']CBL_CLOSE_FILE["']/
syn match cobolWatch /["']CBL_FLUSH_FILE["']/
syn match cobolWatch /["']CBL_DELETE_FILE["']/
syn match cobolWatch /["']CBL_COPY_FILE["']/
syn match cobolWatch /["']CBL_CHECK_FILE_EXIST["']/
syn match cobolWatch /["']CBL_RENAME_FILE["']/
syn match cobolWatch /["']CBL_GET_CURRENT_DIR["']/
syn match cobolWatch /["']CBL_CHANGE_DIR["']/
syn match cobolWatch /["']CBL_CREATE_DIR["']/
syn match cobolWatch /["']CBL_DELETE_DIR["']/
syn match cobolWatch /["']CBL_AND["']/
syn match cobolWatch /["']CBL_OR["']/
syn match cobolWatch /["']CBL_NOR["']/
syn match cobolWatch /["']CBL_XOR["']/
syn match cobolWatch /["']CBL_IMP["']/
syn match cobolWatch /["']CBL_NIMP["']/
syn match cobolWatch /["']CBL_EQ["']/
syn match cobolWatch /["']CBL_NOT["']/
syn match cobolWatch /["']CBL_TOUPPER["']/
syn match cobolWatch /["']CBL_TOLOWER["']/
syn match cobolWatch /["']\\364["']/
```

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```
syn match cobolWatch /["']\\365["']/
syn match cobolWatch /["']\\221["']/
syn match cobolWatch /["']C$NARG["']/
syn match cobolWatch /["']C$PARAMSIZE["']/
syn match cobolWatch /["']C$MAKEDIR["']/
syn match cobolWatch /["']C$CHDIR["']/
syn match cobolWatch /["']C$SLEEP["']/
syn match cobolWatch /["']C$COPY["']/
syn match cobolWatch /["']C$FILEINFO["']/
syn match cobolWatch /["']C$DELETE["']/
syn match cobolWatch /["']C$TOUPPER["']/
syn match cobolWatch /["']C$TOLOWER["']/
syn match cobolWatch /["']C$JUSTIFY["']/
syn match cobolWatch /["']CBL_OC_NANOSLEEP["']/

if exists("cobol_legacy_code")
  syn region cobolCondFlow contains=ALLBUT,cobolLine start="\
↪<\(IF\|INVALID\|END\|EOP\)\>"
      skip=/\('\|"\)[^"]\{-}\("\|'\|$\)/ end="\." keepend
  syn region cobolLine start="^.\{6} " end="$" contains=ALL
endif

if exists("cobol_legacy_code")
  " catch junk in columns 1-6 for modern code
  syn match cobolBAD "^ \{0,5\}[^ ].*"
endif

" many legacy sources have junk in columns 1-6: must be before others
" Stuff after column 72 is in error - must be after all other "match" entries
if exists("cobol_legacy_code")
  syn match cobolBadLine "^.\{6}[^*/].\{66,\}"
endif

" Define the default highlighting.
" For version 5.7 and earlier: only when not done already
" For version 5.8 and later: only when an item doesn't have highlighting yet
if version >= 508 || !exists("did_cobol_syntax_inits")
  if version < 508
    let did_cobol_syntax_inits = 1
    command -nargs=+ HiLink hi link <args>
  else
    command -nargs=+ HiLink hi def link <args>
  endif
  HiLink cobolBAD Error
  HiLink cobolBadID Error
  HiLink cobolBadLine Error
  HiLink cobolMarker Comment
  HiLink cobolCALLs Function
  HiLink cobolComment Comment
  HiLink cobolKeys Comment
  HiLink cobolCompiler PreProc
  HiLink cobolEXECs PreProc
  HiLink cobolCondFlow Special
  HiLink cobolCopy PreProc
  HiLink cobolDecl Type
  HiLink cobolTypes Type
  HiLink cobolExtras Special
```

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```
  HiLink cobolGoTo Special
  HiLink cobolConstant Constant
  HiLink cobolNumber Constant
  HiLink cobolPic Constant
  HiLink cobolReserved Statement
  HiLink cobolString Constant
  HiLink cobolTodo Todo
  HiLink cobolWatch Special
  delcommand HiLink
endif

let b:current_syntax = "cobol"

" vim: ts=6 nowrap
```

8.14 make check listing

A `make check` from October 2013:

```
## ------------------------------------- ##
## GnuCOBOL 1.1 test suite: Syntax Tests. ##
## ------------------------------------- ##
  1: COPY: file not found                          ok
  2: COPY: replacement order                       ok
  3: COPY: separators                              ok
  4: COPY: partial replacement                     ok
  5: COPY: recursive replacement                   ok
  6: Invalid PROGRAM-ID                            ok
  7: Invalid PROGRAM-ID type clause (1)            ok
  8: Invalid PROGRAM-ID type clause (2)            ok
  9: Undefined data name                           ok
 10: Undefined group name                          ok
 11: Undefined data name in group                  ok
 12: Reference not a group name                    ok
 13: Incomplete 01 definition                      ok
 14: Same labels in different sections             ok
 15: Redefinition of 01 items                      ok
 16: Redefinition of 01 and 02 items               ok
 17: Redefinition of 02 items                      ok
 18: Redefinition of 77 items                      ok
 19: Redefinition of 01 and 77 items               ok
 20: Redefinition of 88 items                      ok
 21: Ambiguous reference to 02 items               ok
 22: Ambiguous reference to 02 and 03 items        ok
 23: Ambiguous reference with qualification        ok
 24: Unique reference with ambiguous qualifiers    ok
 25: Undefined procedure name                      ok
 26: Redefinition of section names                 ok
 27: Redefinition of section and paragraph names   ok
 28: Redefinition of paragraph names               ok
 29: Ambiguous reference to paragraph name         ok
 30: Non-matching level numbers (extension)        ok
 31: Ambiguous AND/OR                              ok
 32: START on SEQUENTIAL file                      ok
```

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```
 33: Subscripted item requires OCCURS clause         ok
 34: The number of subscripts                        ok
 35: OCCURS with level 01, 66, 77, and 88            ok
 36: OCCURS with variable-occurrence data item       ok
 37: Nested OCCURS clause                            ok
 38: OCCURS DEPENDING followed by another field      ok
 39: OCCURS DEPENDING without TO clause              ok
 40: REDEFINES: not following entry-name             ok
 41: REDEFINES: level 02 by 01                       ok
 42: REDEFINES: level 03 by 02                       ok
 43: REDEFINES: level 66                             ok
 44: REDEFINES: level 88                             ok
 45: REDEFINES: lower level number                   ok
 46: REDEFINES: with OCCURS                          ok
 47: REDEFINES: with subscript                       ok
 48: REDEFINES: with variable occurrence             ok
 49: REDEFINES: with qualification                   ok
 50: REDEFINES: multiple redefinition                ok
 51: REDEFINES: size exceeds                         ok
 52: REDEFINES: with VALUE                           ok
 53: REDEFINES: with intervention                    ok
 54: REDEFINES: within REDEFINES                     ok
 55: Numeric item (integer)                          ok
 56: Numeric item (non-integer)                      ok
 57: Numeric item with picture P                     ok
 58: Signed numeric literal                          ok
 59: Alphabetic item                                 ok
 60: Alphanumeric item                               ok
 61: Alphanumeric group item                         ok
 62: Numeric-edited item                             ok
 63: Alphanumeric-edited item                        ok
 64: MOVE SPACE TO numeric or numeric-edited item    ok
 65: MOVE ZERO TO alphabetic item                    ok
 66: MOVE alphabetic TO x                            ok
 67: MOVE alphanumeric TO x                          ok
 68: MOVE alphanumeric-edited TO x                   ok
 69: MOVE numeric (integer) TO x                     ok
 70: MOVE numeric (non-integer) TO x                 ok
 71: MOVE numeric-edited TO x                        ok
 72: Operands must be groups                         ok
 73: MOVE: misc                                      ok
 74: Category check of Format 1                      ok
 75: Category check of Format 2                      ok
 76: Category check of literals                      ok
 77: SET: misc                                       ok

## ------------- ##
## Test results. ##
## ------------- ##

All 77 tests were successful.
PASS: ./syntax
## ----------------------------------- ##
## GnuCOBOL 1.1 test suite: Run Tests. ##
## ----------------------------------- ##
  1: DISPLAY literals                                ok
  2: DISPLAY literals, DECIMAL-POINT is COMMA        ok
```

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```
 3: Hexadecimal literal                              ok
 4: DISPLAY data items with VALUE clause             ok
 5: DISPLAY data items with MOVE statement           ok
 6: GLOBAL at same level                             ok
 7: GLOBAL at lower level                            ok
 8: non-numeric subscript                            ok
 9: The range of subscripts                          ok
10: Subscript out of bounds (1)                      ok
11: Subscript out of bounds (2)                      ok
12: Value of DEPENDING ON N out of bounds (lower)    ok
13: Value of DEPENDING ON N out of bounds (upper)    ok
14: Subscript bounds with ODO (lower)                ok
15: Subscript bounds with ODO (upper)                ok
16: Subscript bounds with ODO                        ok
17: Subscript by arithmetic expression               ok
18: Separate sign positions                          ok
19: Static reference modification                    ok
20: Dynamic reference modification                   ok
21: Static out of bounds                             ok
22: Offset underflow                                 ok
23: Offset overflow                                  ok
24: Length underflow                                 ok
25: Length overflow                                  ok
26: ACCEPT                                           ok
27: INITIALIZE group entry with OCCURS               ok
28: INITIALIZE OCCURS with numeric edited            ok
29: INITIALIZE complex group (1)                     ok
30: INITIALIZE complex group (2)                     ok
31: INITIALIZE with REDEFINES                        ok
32: Source file not found                            ok
33: Comma separator without space                    ok
34: LOCAL-STORAGE                                    ok
35: EXTERNAL data item                               ok
36: EXTERNAL AS data item                            ok
37: cobcrun validation                               ok
38: MOVE to itself                                   ok
39: MOVE with refmod                                 ok
40: MOVE with refmod (variable)                      ok
41: MOVE with group refmod                           ok
42: MOVE indexes                                     ok
43: MOVE X'00'                                       ok
44: Level 01 subscripts                              ok
45: Class check with reference modification          ok
46: Index and parenthesized expression               ok
47: String concatenation                             ok
48: Alphanumeric and binary numeric                  ok
49: Dynamic call with static linking                 ok
50: CALL m1. CALL m2. CALL m1.                       ok
51: CALL binary literal parameter/LENGTH OF          ok
52: INSPECT REPLACING LEADING ZEROS BY SPACES        ok
53: INSPECT: No repeat conversion check              ok
54: INSPECT: REPLACING figurative constant           ok
55: INSPECT: TALLYING BEFORE                         ok
56: INSPECT: TALLYING AFTER                          ok
57: INSPECT REPLACING TRAILING ZEROS BY SPACES       ok
58: INSPECT REPLACING complex                        ok
59: SWITCHES                                         ok
```

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```
 60: Nested PERFORM                                ok
 61: EXIT PERFORM                                  ok
 62: EXIT PERFORM CYCLE                            ok
 63: EXIT PARAGRAPH                                ok
 64: EXIT SECTION                                  ok
 65: 88 with FILLER                                ok
 66: Non-overflow after overflow                   ok
 67: PERFORM ... CONTINUE                          ok
 68: STRING with subscript reference               ok
 69: UNSTRING DELIMITED ALL LOW-VALUE              ok
 70: READ INTO AT-END sequence                     ok
 71: First READ on empty SEQUENTIAL INDEXED file   ok
 72: REWRITE a RELATIVE file with RANDOM access    ok
 73: SORT: table sort                              ok
 74: SORT: EBCDIC table sort                       ok
 75: SORT nonexistent file                         ok
 76: PIC ZZZ-, ZZZ+                                ok
 77: Larger REDEFINES lengths                      ok
 78: PERFORM type OSVS                             ok
 79: Sticky LINKAGE                                ok
 80: COB_PRE_LOAD test                             ok
 81: COB_LOAD_CASE=UPPER test                      ok
 82: 88 level with FALSE IS clause                 ok
 83: ALLOCATE/FREE with BASED item                 ok
 84: INITIZIALIZE with reference modification      ok
 85: CALL with OMITTED parameter                   ok
 86: ANY LENGTH                                    ok
 87: COMP-5                                        ok
 88: Hexadecimal numeric literal                   ok
 89: Semi-parenthesized condition                  ok
 90: ADDRESS OF                                    ok
 91: LENGTH OF                                     ok
 92: WHEN-COMPILED                                 ok
 93: Complex OCCURS DEPENDING ON                   ok
 94: MOVE NON-INTEGER TO ALPHA-NUMERIC             ok
 95: CALL USING file-name                          ok
 96: CALL unusual PROGRAM-ID.                      ok
 97: Case independent PROGRAM-ID                   ok
 98: PROGRAM-ID AS clause                          ok
 99: Quoted PROGRAM-ID                             ok
100: ASSIGN MF                                     ok
101: ASSIGN IBM                                    ok
102: ASSIGN mapping                                ok
103: ASSIGN expansion                              ok
104: ASSIGN with COB_FILE_PATH                     ok
105: NUMBER-OF-CALL-PARAMETERS                     ok
106: PROCEDURE DIVISION USING BY ...               ok
107: PROCEDURE DIVISION CHAINING ...               ok
108: STOP RUN RETURNING                            ok
109: ENTRY                                         ok
110: LINE SEQUENTIAL write                         ok
111: LINE SEQUENTIAL read                          ok
112: ASSIGN to KEYBOARD/DISPLAY                    ok
113: Environment/Argument variable                 ok
114: DECIMAL-POINT is COMMA (1)                    ok
115: DECIMAL-POINT is COMMA (2)                    ok
116: DECIMAL-POINT is COMMA (3)                    ok
```

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```
117: DECIMAL-POINT is COMMA (4)                      ok
118: DECIMAL-POINT is COMMA (5)                      ok
119: 78 Level (1)                                    ok
120: 78 Level (2)                                    ok
121: 78 Level (3)                                    ok
122: Unreachable statement                           ok
123: RETURN-CODE moving                              ok
124: RETURN-CODE passing                             ok
125: RETURN-CODE nested                              ok
126: FUNCTION ABS                                    ok
127: FUNCTION ACOS                                   ok
128: FUNCTION ANNUITY                                ok
129: FUNCTION ASIN                                   ok
130: FUNCTION ATAN                                   ok
131: FUNCTION CHAR                                   ok
132: FUNCTION COMBINED-DATETIME                      ok
133: FUNCTION CONCATENATE                            ok
134: FUNCTION CONCATENATE with reference modding     ok
135: FUNCTION COS                                    ok
136: FUNCTION DATE-OF-INTEGER                        ok
137: FUNCTION DATE-TO-YYYYMMDD                       ok
138: FUNCTION DAY-OF-INTEGER                         ok
139: FUNCTION DAY-TO-YYYYDDD                         ok
140: FUNCTION E                                      ok
141: FUNCTION EXCEPTION-FILE                         ok
142: FUNCTION EXCEPTION-LOCATION                     ok
143: FUNCTION EXCEPTION-STATEMENT                    ok
144: FUNCTION EXCEPTION-STATUS                       ok
145: FUNCTION EXP                                    ok
146: FUNCTION FACTORIAL                              ok
147: FUNCTION FRACTION-PART                          ok
148: FUNCTION INTEGER                                ok
149: FUNCTION INTEGER-OF-DATE                        ok
150: FUNCTION INTEGER-OF-DAY                         ok
151: FUNCTION INTEGER-PART                           ok
152: FUNCTION LENGTH                                 ok
153: FUNCTION LOCALE-DATE                            ok
154: FUNCTION LOCALE-TIME                            ok
155: FUNCTION LOCALE-TIME-FROM-SECONDS               ok
156: FUNCTION LOG                                    ok
157: FUNCTION LOG10                                  ok
158: FUNCTION LOWER-CASE                             ok
159: FUNCTION LOWER-CASE with reference modding      ok
160: FUNCTION MAX                                    ok
161: FUNCTION MEAN                                   ok
162: FUNCTION MEDIAN                                 ok
163: FUNCTION MIDRANGE                               ok
164: FUNCTION MIN                                    ok
165: FUNCTION MOD                                    ok
166: FUNCTION NUMVAL                                 ok
167: FUNCTION NUMVAL-C                               ok
168: FUNCTION ORD                                    ok
169: FUNCTION ORD-MAX                                ok
170: FUNCTION ORD-MIN                                ok
171: FUNCTION PI                                     ok
172: FUNCTION PRESENT-VALUE                          ok
173: FUNCTION RANGE                                  ok
```

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```
174: FUNCTION REM                                    ok
175: FUNCTION REVERSE                                ok
176: FUNCTION REVERSE with reference modding         ok
177: FUNCTION SECONDS-FROM-FORMATTED-TIME            ok
178: FUNCTION SECONDS-PAST-MIDNIGHT                  ok
179: FUNCTION SIGN                                   ok
180: FUNCTION SIN                                    ok
181: FUNCTION SQRT                                   ok
182: FUNCTION STANDARD-DEVIATION                     ok
183: FUNCTION STORED-CHAR-LENGTH                     ok
184: FUNCTION SUBSTITUTE                             ok
185: FUNCTION SUBSTITUTE with reference modding      ok
186: FUNCTION SUBSTITUTE-CASE                        ok
187: FUNCTION SUBSTITUTE-CASE with reference mod     ok
188: FUNCTION TAN                                    ok
189: FUNCTION TRIM                                   ok
190: FUNCTION TRIM with reference modding            ok
191: FUNCTION UPPER-CASE                             ok
192: FUNCTION UPPER-CASE with reference modding      ok
193: FUNCTION VARIANCE                               ok
194: FUNCTION WHEN-COMPILED                          ok

## ------------- ##
## Test results. ##
## ------------- ##

All 194 tests were successful.
PASS: ./run

## Run time tests with -O option ##

## ----------------------------------- ##
## GnuCOBOL 1.1 test suite: Run Tests. ##
## ----------------------------------- ##
  1: DISPLAY literals                                ok
  2: DISPLAY literals, DECIMAL-POINT is COMMA        ok
  3: Hexadecimal literal                             ok
  4: DISPLAY data items with VALUE clause            ok
  5: DISPLAY data items with MOVE statement          ok
  6: GLOBAL at same level                            ok
  7: GLOBAL at lower level                           ok
  8: non-numeric subscript                           ok
  9: The range of subscripts                         ok
 10: Subscript out of bounds (1)                     ok
 11: Subscript out of bounds (2)                     ok
 12: Value of DEPENDING ON N out of bounds (lower)   ok
 13: Value of DEPENDING ON N out of bounds (upper)   ok
 14: Subscript bounds with ODO (lower)               ok
 15: Subscript bounds with ODO (upper)               ok
 16: Subscript bounds with ODO                       ok
 17: Subscript by arithmetic expression              ok
 18: Separate sign positions                         ok
 19: Static reference modification                   ok
 20: Dynamic reference modification                  ok
 21: Static out of bounds                            ok
 22: Offset underflow                                ok
 23: Offset overflow                                 ok
```

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```
 24: Length underflow                                ok
 25: Length overflow                                 ok
 26: ACCEPT                                          ok
 27: INITIALIZE group entry with OCCURS              ok
 28: INITIALIZE OCCURS with numeric edited           ok
 29: INITIALIZE complex group (1)                    ok
 30: INITIALIZE complex group (2)                    ok
 31: INITIALIZE with REDEFINES                       ok
 32: Source file not found                           ok
 33: Comma separator without space                   ok
 34: LOCAL-STORAGE                                   ok
 35: EXTERNAL data item                              ok
 36: EXTERNAL AS data item                           ok
 37: cobcrun validation                              ok
 38: MOVE to itself                                  ok
 39: MOVE with refmod                                ok
 40: MOVE with refmod (variable)                     ok
 41: MOVE with group refmod                          ok
 42: MOVE indexes                                    ok
 43: MOVE X'00'                                      ok
 44: Level 01 subscripts                             ok
 45: Class check with reference modification         ok
 46: Index and parenthesized expression              ok
 47: String concatenation                            ok
 48: Alphanumeric and binary numeric                 ok
 49: Dynamic call with static linking                ok
 50: CALL m1. CALL m2. CALL m1.                      ok
 51: CALL binary literal parameter/LENGTH OF         ok
 52: INSPECT REPLACING LEADING ZEROS BY SPACES       ok
 53: INSPECT: No repeat conversion check             ok
 54: INSPECT: REPLACING figurative constant          ok
 55: INSPECT: TALLYING BEFORE                        ok
 56: INSPECT: TALLYING AFTER                         ok
 57: INSPECT REPLACING TRAILING ZEROS BY SPACES      ok
 58: INSPECT REPLACING complex                       ok
 59: SWITCHES                                        ok
 60: Nested PERFORM                                  ok
 61: EXIT PERFORM                                    ok
 62: EXIT PERFORM CYCLE                              ok
 63: EXIT PARAGRAPH                                  ok
 64: EXIT SECTION                                    ok
 65: 88 with FILLER                                  ok
 66: Non-overflow after overflow                     ok
 67: PERFORM ... CONTINUE                            ok
 68: STRING with subscript reference                 ok
 69: UNSTRING DELIMITED ALL LOW-VALUE                ok
 70: READ INTO AT-END sequence                       ok
 71: First READ on empty SEQUENTIAL INDEXED file     ok
 72: REWRITE a RELATIVE file with RANDOM access      ok
 73: SORT: table sort                                ok
 74: SORT: EBCDIC table sort                         ok
 75: SORT nonexistent file                           ok
 76: PIC ZZZ-, ZZZ+                                  ok
 77: Larger REDEFINES lengths                        ok
 78: PERFORM type OSVS                               ok
 79: Sticky LINKAGE                                  ok
 80: COB_PRE_LOAD test                               ok
```

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```
 81: COB_LOAD_CASE=UPPER test                          ok
 82: 88 level with FALSE IS clause                     ok
 83: ALLOCATE/FREE with BASED item                     ok
 84: INITIZIALIZE with reference modification          ok
 85: CALL with OMITTED parameter                       ok
 86: ANY LENGTH                                        ok
 87: COMP-5                                            ok
 88: Hexadecimal numeric literal                       ok
 89: Semi-parenthesized condition                      ok
 90: ADDRESS OF                                        ok
 91: LENGTH OF                                         ok
 92: WHEN-COMPILED                                     ok
 93: Complex OCCURS DEPENDING ON                       ok
 94: MOVE NON-INTEGER TO ALPHA-NUMERIC                 ok
 95: CALL USING file-name                              ok
 96: CALL unusual PROGRAM-ID.                          ok
 97: Case independent PROGRAM-ID                       ok
 98: PROGRAM-ID AS clause                              ok
 99: Quoted PROGRAM-ID                                 ok
100: ASSIGN MF                                         ok
101: ASSIGN IBM                                        ok
102: ASSIGN mapping                                    ok
103: ASSIGN expansion                                  ok
104: ASSIGN with COB_FILE_PATH                         ok
105: NUMBER-OF-CALL-PARAMETERS                         ok
106: PROCEDURE DIVISION USING BY ...                   ok
107: PROCEDURE DIVISION CHAINING ...                   ok
108: STOP RUN RETURNING                                ok
109: ENTRY                                             ok
110: LINE SEQUENTIAL write                             ok
111: LINE SEQUENTIAL read                              ok
112: ASSIGN to KEYBOARD/DISPLAY                        ok
113: Environment/Argument variable                     ok
114: DECIMAL-POINT is COMMA (1)                        ok
115: DECIMAL-POINT is COMMA (2)                        ok
116: DECIMAL-POINT is COMMA (3)                        ok
117: DECIMAL-POINT is COMMA (4)                        ok
118: DECIMAL-POINT is COMMA (5)                        ok
119: 78 Level (1)                                      ok
120: 78 Level (2)                                      ok
121: 78 Level (3)                                      ok
122: Unreachable statement                             ok
123: RETURN-CODE moving                                ok
124: RETURN-CODE passing                               ok
125: RETURN-CODE nested                                ok
126: FUNCTION ABS                                      ok
127: FUNCTION ACOS                                     ok
128: FUNCTION ANNUITY                                  ok
129: FUNCTION ASIN                                     ok
130: FUNCTION ATAN                                     ok
131: FUNCTION CHAR                                     ok
132: FUNCTION COMBINED-DATETIME                        ok
133: FUNCTION CONCATENATE                              ok
134: FUNCTION CONCATENATE with reference modding       ok
135: FUNCTION COS                                      ok
136: FUNCTION DATE-OF-INTEGER                          ok
137: FUNCTION DATE-TO-YYYYMMDD                         ok
```

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```
138: FUNCTION DAY-OF-INTEGER                          ok
139: FUNCTION DAY-TO-YYYYDDD                          ok
140: FUNCTION E                                       ok
141: FUNCTION EXCEPTION-FILE                          ok
142: FUNCTION EXCEPTION-LOCATION                      ok
143: FUNCTION EXCEPTION-STATEMENT                     ok
144: FUNCTION EXCEPTION-STATUS                        ok
145: FUNCTION EXP                                     ok
146: FUNCTION FACTORIAL                               ok
147: FUNCTION FRACTION-PART                           ok
148: FUNCTION INTEGER                                 ok
149: FUNCTION INTEGER-OF-DATE                         ok
150: FUNCTION INTEGER-OF-DAY                          ok
151: FUNCTION INTEGER-PART                            ok
152: FUNCTION LENGTH                                  ok
153: FUNCTION LOCALE-DATE                             ok
154: FUNCTION LOCALE-TIME                             ok
155: FUNCTION LOCALE-TIME-FROM-SECONDS                ok
156: FUNCTION LOG                                     ok
157: FUNCTION LOG10                                   ok
158: FUNCTION LOWER-CASE                              ok
159: FUNCTION LOWER-CASE with reference modding       ok
160: FUNCTION MAX                                     ok
161: FUNCTION MEAN                                    ok
162: FUNCTION MEDIAN                                  ok
163: FUNCTION MIDRANGE                                ok
164: FUNCTION MIN                                     ok
165: FUNCTION MOD                                     ok
166: FUNCTION NUMVAL                                  ok
167: FUNCTION NUMVAL-C                                ok
168: FUNCTION ORD                                     ok
169: FUNCTION ORD-MAX                                 ok
170: FUNCTION ORD-MIN                                 ok
171: FUNCTION PI                                      ok
172: FUNCTION PRESENT-VALUE                           ok
173: FUNCTION RANGE                                   ok
174: FUNCTION REM                                     ok
175: FUNCTION REVERSE                                 ok
176: FUNCTION REVERSE with reference modding          ok
177: FUNCTION SECONDS-FROM-FORMATTED-TIME             ok
178: FUNCTION SECONDS-PAST-MIDNIGHT                   ok
179: FUNCTION SIGN                                    ok
180: FUNCTION SIN                                     ok
181: FUNCTION SQRT                                    ok
182: FUNCTION STANDARD-DEVIATION                      ok
183: FUNCTION STORED-CHAR-LENGTH                      ok
184: FUNCTION SUBSTITUTE                              ok
185: FUNCTION SUBSTITUTE with reference modding       ok
186: FUNCTION SUBSTITUTE-CASE                         ok
187: FUNCTION SUBSTITUTE-CASE with reference mod      ok
188: FUNCTION TAN                                     ok
189: FUNCTION TRIM                                    ok
190: FUNCTION TRIM with reference modding              ok
191: FUNCTION UPPER-CASE                              ok
192: FUNCTION UPPER-CASE with reference modding       ok
193: FUNCTION VARIANCE                                ok
194: FUNCTION WHEN-COMPILED                           ok
```

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```
## ------------- ##
## Test results. ##
## ------------- ##

All 194 tests were successful.
PASS: ./run-O
## ---------------------------------------------- ##
## GnuCOBOL 1.1 test suite: Data Representation. ##
## ---------------------------------------------- ##
  1: BINARY: 2-4-8 big-endian                        ok
  2: BINARY: 2-4-8 native                            ok
  3: BINARY: 1-2-4-8 big-endian                      ok
  4: BINARY: 1-2-4-8 native                          ok
  5: BINARY: 1--8 big-endian                         ok
  6: BINARY: 1--8 native                             ok
  7: BINARY: full-print                              ok
  8: DISPLAY: Sign ASCII                             ok
  9: DISPLAY: Sign ASCII (2)                         ok
 10: DISPLAY: Sign EBCDIC                            ok
 11: PACKED-DECIMAL dump                             ok
 12: PACKED-DECIMAL display                          ok
 13: PACKED-DECIMAL move                             ok
 14: PACKED-DECIMAL arithmetic (1)                   ok
 15: PACKED-DECIMAL arithmetic (2)                   ok
 16: PACKED-DECIMAL numeric test                     ok
 17: POINTER: display                                ok

## ------------- ##
## Test results. ##
## ------------- ##

All 17 tests were successful.
PASS: ./data-rep

## Data representation tests with -O option ##

## ---------------------------------------------- ##
## GnuCOBOL 1.1 test suite: Data Representation. ##
## ---------------------------------------------- ##
  1: BINARY: 2-4-8 big-endian                        ok
  2: BINARY: 2-4-8 native                            ok
  3: BINARY: 1-2-4-8 big-endian                      ok
  4: BINARY: 1-2-4-8 native                          ok
  5: BINARY: 1--8 big-endian                         ok
  6: BINARY: 1--8 native                             ok
  7: BINARY: full-print                              ok
  8: DISPLAY: Sign ASCII                             ok
  9: DISPLAY: Sign ASCII (2)                         ok
 10: DISPLAY: Sign EBCDIC                            ok
 11: PACKED-DECIMAL dump                             ok
 12: PACKED-DECIMAL display                          ok
 13: PACKED-DECIMAL move                             ok
 14: PACKED-DECIMAL arithmetic (1)                   ok
 15: PACKED-DECIMAL arithmetic (2)                   ok
 16: PACKED-DECIMAL numeric test                     ok
 17: POINTER: display                                ok
```

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```
## ------------- ##
## Test results. ##
## ------------- ##

All 17 tests were successful.
PASS: ./data-rep-0
==================
All 5 tests passed
==================
```

8.15 ABI

Application Binary Interface. An acronym that covers the way object code is managed and the expectations of the run-time system. GnuCOBOL is at home in the "C" ABI.

- Link names are as expected.
- CALL arguments are stacked as expected for C programming.
- etc...

The C application binary interface allows GnuCOBOL to link with many, if not all, existent C libraries. Defaulting to the C ABI does mean that small wrapper source codes may be required for access to C++ runtimes, to inform the C++ linker to use `extern "C"` code handling.

8.16 Tectonics

I use the expression **tectonics** based on the definition below. It's nerd slang, for describing the code building process. Using a lookup from the **dict://** protocol bank of open servers:

```
"Tectonics" gcide "The Collaborative International Dictionary of English v.0.48"
Tectonics \Tec*ton"ics\, n.
1. The science, or the art, by which implements, vessels,
dwellings, or other edifices, are constructed, both
agreeably to the end for which they are designed, and in
conformity with artistic sentiments and ideas.
[1913 Webster]
```

Trying to infer that building with GnuCOBOL is rock solid and artistically pleasing. Ok fine, I mean **wicked cool**!.

8.17 Setting Locale

GnuCOBOL supports LC_ locale settings, during builds and with generated programs.

Languages are being translated, Dutch, French, German. Thanks to Jim Curry and Curry Adkins, (and Simon and others that worked hard on this), we have Spanish message support (along with English and Japanese)

Please note; this is compile and run-time messaging, not COBOL verb translation or change to COBOL syntax, just more inclusive human friendliness

```
sh-4.2$ cobc -x spanish.cob
spanish.cob: 49: Error: 'missing-file' is not defined
spanish.cob: 49: Error: 'missing-file' is not a file name

sh-4.2$ LC_MESSAGES=es_ES cobc -x spanish.cob
spanish.cob: 49: Error: 'missing-file' no esta definido
spanish.cob: 49: Error: 'missing-file' no es nombre de archivo
```

8.18 GNU

GNU is Not Unix, one of the original recursive acronyms. GNU software leads the Free Software movement, and with the Linux kernel is a critical piece in the GNU/Linux operating system. See http://www.gnu.org/ for more details.

The developers of GnuCOBOL follow, as closely as possible, the GNU coding standards. http://www.gnu.org/prep/standards/

GnuCOBOL benefits greatly from integration with GNU tools, and the expression of freedoms within software development.

8.19 Performing FOREVER?

I asked on opencobol.org for some input, and an interesting conversation ensued. I've included most of the forum thread archive, to give a sense of various programmer styles and group thought processing. See *FOREVER* (page 271).

```
Subject: FOREVER and a small request for involvement

I just updated the FAQ and was wondering if anyone could come up with a
better/different short sample program than the one I use in

http://opencobol.add1tocobol.com/#forever

The one I have also demonstrates the CYCLE clause of EXIT PERFORM, but reading
it, it seems a little, umm, lame for what is a pretty powerful program flow
construct.

[i]Plus I'd like to show off a little more community involvement and spread
some credit around.[/i]

Cheers,
Brian
----------------------------------------------------------------------
```

```
I think it's fine and think you should leave it as it is...

human
----------------------------------------------------------------------
```

```
human;

I know it's "fine", kinda, but I'm also trying to get some of the lurkers out
into the open.  :-)

```

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```
Hoping that some small steps will lead to bigger bolder steps.

Plus, the post was a thinly veiled self promotion and the, [i]as always[/i],
greater desire to inform that OpenCOBOL supports FOREVER along with EXIT
PERFORM CYCLE.

As I add reserved words to the FAQ in the future, I may post up more of these
challenges [i]in a thinly veiled disguise to highlight the feature[/i].

Cheers,
Brian
------------------------------------------------------------------
```

```
As one of the "lurkers", may I offer an excuse.  I think that many of us who do
not make a contribution, are ordinary cobol people who know nothing of C or web
based extensions or GUI or database extensions. Much of the discussion here
seems pretty esoteric. There is no place where one feels that it would be
appropriate to post ordinary basic cobol programs or even tips. I think this is
a pity, but I don't have any solutions. Going way back to the computer language
cobol group in the pre YK2 years, it was apparent that cobol programmers were a
most ungenerous lot.  "Do your own homework", and "I do this for money not for
free" were common responses with a few exceptions like WM Klein and J McLendon.
Perhaps the decline of cobol might have made people more open. Even though
cobol is the accounting language, you can't I think find books with debtors,
creditors, stock payroll and general ledger. You can find them in basic, but
not cobol. I think that if there was a place where low level people could
contribute, perhaps they might. It is not approprate to clutter up this forum,
but it would need to be a place which is just as simple to write to, else most
of us would be unable to join in.
John.
------------------------------------------------------------------
```

```
Thanks for the post John.

Exactly the catch-22 I wanted to break here.  OpenCOBOL is for sharing.  And
yes, old school COBOL is/was very much "top-secret, tight lipped programming".
We can change that.

No need to feel you have to talk C bindings, or GUI or highfalutin issues.

A nice challenge on a short sample of
```

```
PERFORM FOREVER
   do some thing
   now get me outta here
   do some other thing
END-PERFORM
```

```
was what I wanted to start up.

A sample on a neat INSPECT trick, or a blurb on preferred section/paragraph
naming.  Anything.  OpenCOBOL doesn't have to be closed like the olden days.
[i]And to be honest, it is to great credit that most COBOLers kept their tight
lips, when I just know that some of them wanted to help, or point out mistakes,
or show off, but couldn't, due to the nature of the work they were/are
```

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```
doing.[/i]  We can, and we should, flap some loose lips.  :-)

Do that here on opencobol.org.  I'd read the posts, and feel better for the
reading, and the learning, of all the old and new techniques.

I blather on with samples and bindings to show what OpenCOBOL is capable of,
but a pure COBOL discussion would be more than welcome.  It'd be appreciated.

Unless it sounds like actual homework and it'd hurt more than help, there won't
be many "Do your own homework" remarks...umm, I hope ([i]no, I'm pretty
sure[/i]).

[b]To everyone[/b]; join in, the water's fine.   ;-)

In the FAQ as it stands, there are over 500 reserved words in section 4 and
only a mere hundred or so have code samples.  I'd gladly read submissions here,
get permission and then include them (with or without credit at author's
desire) for everyone's benefit.

If we start to overwhelm the forum and people want to direct compiler questions
to Roger, we can work out a way to keep his perception of the signal to noise
ratio high enough for productive usage of time.

Cheers,
Brian
------------------------------------------------------------------
```

```
Did not know that existed.
```

```
       >>SOURCE FORMAT IS FREE
id division.
program-id. read_forever.
environment division.
input-output section.
file-control.
    select my-file
        organization line sequential
        assign to "myfile".

data division.
file section.
fd  my-file.
01  my-record         pic x(80).

procedure division.
    open input my-file
    perform forever
        read my-file
        at end
            exit perform
        end-read
        display my-record
    end-perform
    close my-file
    goback.
```

```
Cool.  No need for a goto, a file status, or any working-storage at all.

Too bad it's apparently not standard.
------------------------------------------------------------------
```

```
Yep, no standard - but a real nice extension.

If you want to do this the standard way do [code]
    [...]
    perform until 0 = 1
        read my-file
        at end
           exit perform
        end-read
        display my-record
        end-display
    end-perform
    [...]

OpenCOBOL may supports PERFORM UNTIL EXIT, too (this is a MF extension, if I
remember this correct).

human
------------------------------------------------------------------
```

```
   OK Brian here is how we did this in the original dialects of COBOL.

   In an effort to show how the language has changed, I offer the
following version of Brian's program.  While many styles can be effectively
used in COBOL programming, this program is an example of the style used in
programming shops where I worked.

    The first six columns of each source line were reserved for the source
code sequence number (usually page and line number).  We generally used the
first three columns to represent the ascending page number and the last three
for the line number on the page.  Skipping ten numbers between each original
line allowed us to insert additional lines when needed.  You can see that an
insertion was made at 001045.  These sequence numbers were desirable in that
the program was punched on cards with one card for each line.  If the source
card deck was accidently dropped the sequence numbers allowed us to get the
source deck back into order.

     You will also notice that the code is all in uppercase.  Quite simply,
early line printers could not print lowercase.  Take a look at line 001080.
While even early compilers would have allowed us to write "VALUE 0" we
would spell out the word zero since the difference in appearance between
an alphabetic letter O and a numeric zero was easy to miss when reading
the program.

     All of the environment division has been left out of this program,
although it was almost always necessary.  The numbers after "FOREVERLOOP"
on line 001070 were the version number of the program.  It was our habit
to keep a journal (in comment lines) at the beginning of the program
describing modifications that were made to the program.

     The variable names start with "WS-".  This allowed the reader of the
program to understand that the variable in question was in the WORKING-
```

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```
STORAGE instead of being part of a file descriptor, thus making it easier
to find.

     Numeric fields were almost always signed, both for efficiency
at run-time and to allow for the possibility of a value going negative even
if it should not.  COMP asked the compiler to use the most efficient method
to store the value on the architecture on which the program was going to run.

     You will see that the display statements start their display with "I) ".
We used this to make reading console output easier.  "I)" was for normal
information, "W)" was for warnings, and "T)" was for terminal conditions.

     From a syntactical standpoint this code was written to the COBOL-68
standard.  Structured programming constructs were not available.

     Paragraphs were numbered in ascending sequence in order to make
finding a paragraph easier.

     Sentences were kept short and periods were used as often as we could use them.
```

```
001010 IDENTIFICATION DIVISION.
001020 PROGRAM-ID. FOREVERLOOP.
001030*
001040 DATA DIVISION.
001050 WORKING-STORAGE SECTION.
001060 01  WS-PROGRAM-NAME                 PIC X(16)
001070                                       VALUE "FOREVERLOOP  001".
001080 01  WS-COBOL                        PIC S9 COMP VALUE ZERO.
001090 01  WS-C                            PIC S9 COMP VALUE 1.
001100 01  WS-FORTRAN                      PIC S9 COMP VALUE 2.
001110 01  WS-ED1S                         PIC Z-.
001110*
001010 PROCEDURE DIVISION.
001020     DISPLAY "I) PROGRAM ", WS-PROGRAM-NAME, " BEGINNING".
001030 0100-LOOP.
001040     ADD 1 TO WS-COBOL.
001045     MOVE WS-COBOL TO WS-ED1S.
001050     DISPLAY "I) COBOL AT ", WS-ED1S.
001060     IF WS-COBOL IS GREATER THAN WS-FORTRAN
001070         THEN GO TO 0800-ENDER.
001080     IF WS-COBOL IS EQUAL TO 1
001090         THEN DISPLAY "I) COBOL STILL CREEPING UP ON C".
001100     GO TO 0100-LOOP.
001110*
001120 0800-ENDER.
001130     DISPLAY "I) COBOL SURPASSED C AND FORTRAN".
001140     DISPLAY "I) PROGRAM ", WS-PROGRAM-NAME, " TERMINATED".
001150*
001160     STOP RUN.
```

```
The run-time output is below:

[code]
I) PROGRAM FOREVERLOOP  001 BEGINNING
I) COBOL AT 1
I) COBOL STILL CREEPING UP ON C
```

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```
I) COBOL AT 2
I) COBOL AT 3
I) COBOL SURPASSED C AND FORTRAN
I) PROGRAM FOREVERLOOP  001 TERMINATED
[/code]

Please note that I am not advocating this style.  However it is a good example
of traditional methods.
---------------------------------------------------------------
```

```
You made one "syntax" error for duplicating "old-style" (required for Standard
conformance) programming.

You hae DISPLAY statement immediately following the PROCEDURE DIVISON header.
Up until "more recent" Standards, you were required to have either a section or
paragraph header and could NOT have statements "outside" of a named procedure.

P.S.  In the days of "numbered lines" and all upper-case, you probably would
have also had a REMARKS paragraph, but that was optional.
---------------------------------------------------------------
```

```
As is usually the case, Mr. Klein is correct. :-)

Chalk it up to CRS (Can't Remember Stuff).

Yes the "old-style" relied a lot more on the environment division, including
the ability to specify both a source computer and an object computer.  This
would allow the compilers that supported it to output different object code
depending on the object computer specified.

A compile of a simple listing program done on a four tape 1401 would take about
15 minutes and then you had to run the result through the Autocoder macro
assembler.

The 360's would generally compile directly (without the Autocoder step) and
would get the job done in a few minutes but if you were not authorized to be in
the computer room you had to wait until someone in production saw fit to run
your compile for you.
---------------------------------------------------------------
```

```
Like OMG!  I learned COBOL on the 1401.  And I remember pops letting me
practice on the week ends on the 360.

Good times...  But the PC is so much more convenient!
---------------------------------------------------------------
```

```
Now thats what I'm talking about.

John, Jim, Frank, Bill, human;  If you don't mind, I'd like to include nearly
this entire thread in the FAQ, (under what heading I'm not sure, but this is
some wicked good COBOL technical [i]and cultural[/i] wisdom).

Damon; not to worry, I plan on including as many of your snippets as the future
will bear.  ;-)
```

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```
More of this please...[i]he said, hinting towards the anonymous readers[/i].

Cheers,
Brian
---------------------------------------------------------------
```

```
I added a more contemporary method of doing the same thing for the COBOL
newbies.
```

```
001010 IDENTIFICATION DIVISION.
001020 PROGRAM-ID. FOREVERLOOP.
001030*
021611*****************************************************************
021611*                                                               *
021611*  This program will demonstrate various techniques and         *
021611*  coding styles.                                               *
021611*                                                               *
021611*  Version 001--Shows a COBOL68 technique                       *
021611*               02/15/2011--J C Currey                          *
021611*                                                               *
021611*  Version 002--Shows an OpenCOBOL 1.1 technique                *
021611*               02/16/2011--J C Currey                          *
021611*                                                               *
021611*****************************************************************
001040 DATA DIVISION.
001050 WORKING-STORAGE SECTION.
001060 01  WS-PROGRAM-NAME                 PIC X(16)
021611                                        VALUE "FOREVERLOOP  002".
001080 01  WS-COBOL                        PIC S9 COMP VALUE ZERO.
001090 01  WS-C                            PIC S9 COMP VALUE 1.
001100 01  WS-FORTRAN                      PIC S9 COMP VALUE 2.
001110 01  WS-ED1S                         PIC Z-.
001110*
001010 PROCEDURE DIVISION.
001020     DISPLAY "I) PROGRAM ", WS-PROGRAM-NAME, " BEGINNING".
021611*
021611*    THIS CODE SHOWS HOW WE WOULD DO IT WITH COBOL68
021611*
001030 0100-LOOP.
001040     ADD 1 TO WS-COBOL.
001045     MOVE WS-COBOL TO WS-ED1S.
001050     DISPLAY "I) COBOL AT ", WS-ED1S.
001060     IF WS-COBOL IS GREATER THAN WS-FORTRAN
001070         THEN GO TO 0800-ENDER.
001080     IF WS-COBOL IS EQUAL TO 1
001090         THEN DISPLAY "I) COBOL STILL CREEPING UP ON C".
001100     GO TO 0100-LOOP.
001110*
001120 0800-ENDER.
001130     DISPLAY "I) COBOL SURPASSED C AND FORTRAN".
021611     DISPLAY " ".
021611*
021611*    Now we will do the same thing a newer way
021611*
021611     perform with test after
021611       varying ws-cobol from 1 by 1
```

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```
021611       until ws-cobol is greater than ws-fortran
021611         move ws-cobol to ws-ed1s
021611         display "I) COBOL at ", ws-ed1s
021611         evaluate ws-cobol
021611           when 1
021611             display "I) COBOL still creeping up on C"
021611           when 3
021611             display "I) COBOL surpassed C and FORTRAN"
021611         end-evaluate
021611     end-perform.
021611*
001140     DISPLAY "I) PROGRAM ", WS-PROGRAM-NAME, " TERMINATED".
001150*
001160     STOP RUN.
```

```
The explanation was then updated

    In an effort to show how the language has changed, I offer the
following version of Brian's program.  While many styles can be effectively
used in COBOL programming, this program is an example of the style used in
programming shops where I worked.

    The first six columns of each source line were reserved for the source
code sequence number (usually page and line number).  We generally used the
first three columns to represent the ascending page number and the last three
for the line number on the page.  Skipping ten numbers between each original
line allowed us to insert additional lines when needed.  You can see that an
insertion was made at 001045.  These sequence numbers were desirable in that
the program was punched on cards with one card for each line.  If the source
card deck was accidently dropped the sequence numbers allowed us to get the
source deck back into order.

     You will also notice that the code is all in uppercase.  Quite simply,
early line printers could not print lowercase.  Take a look at line 001080.
While even early compilers would have allowed us to write "VALUE O" we
would spell out the word zero since the difference in appearance between
an alphabetic letter O and a numeric zero was easy to miss when reading
the program.

     All of the environment division has been left out of this program,
although it was almost always necessary.  The numbers after "FOREVERLOOP"
on line 001070 were the version number of the program.  It was our habit
to keep a journal (in comment lines) at the beginning of the program
describing modifications that were made to the program.

     The variable names start with "WS-".  This allowed the reader of the
program to understand that the variable in question was in the WORKING-
STORAGE instead of being part of a file descriptor, thus making it easier
to find.

     Numeric fields were almost always signed, both for efficiency
at run-time and to allow for the possibility of a value going negative even
if it should not.  COMP asked the compiler to use the most efficient method
to store the value on the architecture on which the program was going to run.

     You will see that the display statements start their display with "I) ".
```

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```
We used this to make reading console output easier.  "I)" was for normal
information, "W)" was for warnings, and "T)" was for terminal conditions.

     From a syntactical standpoint this code was written to the COBOL-68
standard.  Structured programming constructs were not available.

     Paragraphs were numbered in ascending sequence in order to make
finding a paragraph easier.

************************

     Version 002 shows how one might code the application with OpenCOBOL 1.1.

     A modification log has been added via comments at the beginning of
the program.

     Note that the sequence numbers are now being used to store the
date that the new or changed code was made.  By looking at the modification
date and then referring to the modification log, one can determine what
changed from version to version.

     Structured programming constructs have been used.

I expect that there may be some discussion as to which method is easier to
read and understand.

jimc
------------------------------------------------------------------
```

```
This is a variation of the 'perform forever' program.
```

```
       >>SOURCE FORMAT IS FREE
program-id. "readForever".
*>
*>
*> Author.       rkeane
*> Written:      16 Feb 2011
*> Purpose:      A variation of submitted "read-forever"
*>
environment division.
input-output section.
file-control.
    select my-file assign to "myFile"
      organization line sequential.

data division.
file section.
fd  myFile.
01  myRecord                          pic x(80).
working-storage section.
*>
procedure division.
main.
  open input myFile

  perform forever
```

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```
    read myFile
      not at end
        display myRecord

      at end
        perform finish
        goback                *>Program exit
    end-read                  *>End read myFile
  end-perform                 *>End perform forever
exit.

finish.
  close my-file
exit.
```

```
Using non-structured statements:
```

```
procedure division.
main.
  open input myFile.
0100-loop.
  read myFile next record
    at end close myFile
           stop run.
  display myRecord.
  go to 0100-loop.
-----------------------------------------------------------------
```

```
I don't know if anyone else is getting this sensation, but is COBOL becoming
cool enough for the internet generation now? Thanks to open folk and OpenCOBOL?
[i]Or did I just jinx the tide?[/i]  :-)

Cheers,
Brian
-----------------------------------------------------------------
```

I found the thread a nice read. And to top it off, for me, Roger added a nice idiom in a separate thread for avoiding paragraphs and sections. Not FOREVER related, but a nice use for an “empty” inline PERFORM.

```
Yep,
One thing that I saw on earlier posts to
the newsgroup cobol was -
What is the need/justification for an
empty inline perform group.
ie.
PERFORM
...
END-PERFORM

None of the discussions then realized that
there is a -
EXIT PERFORM [CYCLE]

Therefore, it is a method to to
define an exit condition without having paragraphs.
```

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```
ie. (very simply)
PERFORM
 READ xxx
 AT END
    EXIT PERFORM
 END-READ
 MOVE something TO somewhere
END-PERFORM

.. test xxx status and somewhere

There are, of course, other variations.
Basically, it means that you code without
using section/paragraphs.
(Recommended, if only from performance point of view)

Note that the CYCLE option offers interesting possibilities.

Roger
```

8.20 POSIX

An acronym first suggested by Richard Stallman for the IEEE specification for maintaining compatibility between operating systems. IEEE Std 1003.1-1988.

POSIX Portable Operating System Interface

8.21 BITWISE

A COBOL source code solution to bit operations.

BITWISE.cbl

```
000100 IDENTIFICATION DIVISION.
000200 PROGRAM-ID. BITWISE.
000300 AUTHOR. PAUL CHANDLER.
000400*************************************************************
000500***                                                       ***
000600*** COPYRIGHT PAUL CHANDLER 1976, 1994, 2012.             ***
000700***                                                       ***
000800*** THIS PROGRAM IS FREE SOFTWARE: YOU CAN                 ***
000900*** REDISTRIBUTE IT AND/OR MODIFY IT UNDER THE TERMS       ***
001000*** OF THE GNU LESSER GENERAL PUBLIC LICENSE AS            ***
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001200*** VERSION 3 OF THE LICENSE, OR (AT YOUR OPTION) ANY      ***
001300*** LATER VERSION.                                         ***
001400***                                                       ***
001500*** THIS PROGRAM IS DISTRIBUTED IN THE HOPE THAT IT        ***
001600*** WILL BE USEFUL,BUT WITHOUT ANY WARRANTY; WITHOUT       ***
001700*** EVEN THE IMPLIED WARRANTY OF MERCHANTABILITY OR        ***
001800*** FITNESS FOR A PARTICULAR PURPOSE.SEE THE GNU           ***
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001900*** LESSER GENERAL PUBLIC LICENSE FOR MORE DETAILS.  ***
002000***                                                   ***
002100*** YOU SHOULD HAVE RECEIVED A COPY OF THE GNU LESSER***
002200*** GENERAL PUBLIC LICENSE ALONG WITH THIS PROGRAM.  ***
002300*** IF  NOT, A COPY MAY BE OBTAINED AT:              ***
002400***            HTTP://WWW.GNU.ORG/LICENSES/         ***
002500***                                                   ***
002600***        ===== BITWISE VERSION 1.0 =====           ***
002700***                                                   ***
002800*** INITIAL VERSION: JULY 1974.                      ***
002900*** LAST UPDATED...: APRIL 2013                      ***
003000***                                                   ***
003100*** THIS PROGRAM PERFORMS BITWISE OPERATIONS ON AN    ***
003200*** INPUT BYTE, USING THE PRINCIPLE  OF 'INVERSE     ***
003300*** BINARY WEIGHTING'.                               ***
003400***                                                   ***
003500*** THE PROCESS IS:                                  ***
003600*** (A) THE CONTENTS OF THE LINKAGE SECTION          ***
003700***     (BITWISE-PARMS) ARE SYNTAX-CHECKED. IF ERRORS***
003800***     ARE ENCOUNTERED, A CODE IDENTIFYING THE      ***
003900***     ERROR IS RETURNED TO THE CALLING PROGRAM IN  ***
004000***     FIELD BWP-RETURN-CODE.                       ***
004100*** (B) THE UNARY OPERAND (AND THE BINARY OPERAND IF ***
004200***     OP IS  'AND', 'OR', OR 'XOR') ARE CONVERTED  ***
004300***     TO AN  8-CHARACTER PATTERN OF THE VALUE'S    ***
004400***     BINARY EQUIVALENT (EG. 'A' IS CONVERTED TO   ***
004500***     '01000001' IN THE ASCII CHARACTER SET.       ***
004600***                                                   ***
004700*** (C) THE OP SPECIFIED IN FLD  BWP-OP IS PERFORMED ***
004800***     USING THE OPERANDS AS APPROPRIATE. THE RESULT***
004900***     IS TEMPORARILY STORED AS AN 8-CHARACTER      ***
005000***     PATTERN IN FIELD BWP-RESULT.                 ***
005100***                                                   ***
005200*** (D) BWP-RESULT IS CONVERTED TO THE FORMAT SET BY ***
005300***     THE CALLING PROGRAM IN FIELD BWP-FMT-RESULT  ***
005400***     AND CONTROL IS RETURNED TO THE CALLER.       ***
005500***                                                   ***
005600*** ADDITIONAL DETAIL FOR THE USE OF THIS PROGRAM    ***
005700*** IS PROVIDED IN THE ACCOMPANYING DOCUMENTATION.   ***
005800*********************************************************
005900 ENVIRONMENT DIVISION.
006000 DATA DIVISION.
006100 FILE SECTION.
006200 WORKING-STORAGE SECTION.
006300 01  WORKBENCH-FLDS.
006400     05  WBF-FLAGS.
006500         10  WBF-FLAG-VALIDATE     PIC X(01).
006600             88  WBF-INPUT-VALID     VALUE 'Y'.
006700     05  WBF-BINARIES              BINARY.
006800         10  WBF-STARTING-WEIGHT   PIC S9(04)
006900                                     VALUE +128.
007000         10  WBF-SCALE             PIC S9(04).
007100         10  WBF-CURRENT-BIT       PIC S9(04).
007200         10  WBF-CHK-PTN-CNT       PIC S9(04).
007300             88 WBF-CHK-PTN-ERR    VALUE 0 THRU 7.
007400     05  WBF-CHAR.
007500         10  WBF-UNARY             PIC X(08).
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```
007600         10  WBF-BINARY            PIC X(08).
007700         10  WBF-CHK               PIC X(08).
007800         10  WBF-CHK-PTN-RDF REDEFINES WBF-CHK.
007900             15 WBF-CHK-PTN        PIC X(08).
008000         10  WBF-CHK-BIN-RDF REDEFINES WBF-CHK.
008100             15 WBF-CHK-BIN        PIC 9(04)  BINARY.
008200                88 WBF-CHK-BIN-OK    VALUE 0 THRU 255.
008300             15 FILLER             PIC X(06).
008400     05  WBF-INPT-VAL.
008500         10 WBF-INPT-AREA-CHR.
008600            15 FILLER              PIC X(01)
008700                                     VALUE LOW-VALUES.
008800            15 WBF-INPT-VAL-CHR    PIC X(01).
008900         10 WBF-INPT-AREA-BIN REDEFINES WBF-INPT-AREA-CHR.
009000            15 WBF-INPT-VAL-BIN    PIC 9(04)  BINARY.
009100     05  WBF-PACK-FMT              PIC X(01).
009200         88  WBF-PACK-FMT-PTRN       VALUE 'P'.
009300         88  WBF-PACK-FMT-BNRY       VALUE 'B'.
009400         88  WBF-PACK-FMT-CHAR       VALUE 'C'.
009500     05  WBF-PACK                  PIC X(08).
009600     05  WBF-PACK-RDF-BIN REDEFINES WBF-PACK.
009700         10  WBF-PACK-BIN          PIC 9(04)  BINARY.
009800         10  WFILLER               PIC X(06).
009900     05  WBF-PACK-RDF-CHR REDEFINES WBF-PACK.
010000         10  FILLER                PIC X(01).
010100         10  WBF-PACK-CHR          PIC X(01).
010200         10  FILLER                PIC X(06).
010300 LINKAGE SECTION.
010400 COPY BWPARMS.
010500 PROCEDURE DIVISION USING BITWISE-PARMS.
010600     PERFORM 10000-VALIDATE
010700     IF  BWP-NO-ERRORS
010800         IF  BWP-OP-XLAT
010900             PERFORM 20000-BWP-OP-XLAT
011000         ELSE
011100             PERFORM 30000-BWP-OP-TEST
011200         END-IF
011300     END-IF
011400     GOBACK
011500     .
011600 10000-VALIDATE.
011700     SET BWP-NO-ERRORS              TO TRUE
011800     IF  NOT BWP-OP-VALID
011900         SET BWP-OP-ERROR           TO TRUE
012000     END-IF
012100     IF  NOT BWP-FMT-UNARY-VALID
012200         SET BWP-FMT-UNARY-ERROR    TO TRUE
012300     END-IF
012400     IF  BWP-FMT-UNARY-PTRN
012500         MOVE BWP-UNARY-PTN         TO WBF-CHK-PTN
012600         PERFORM 11000-CHK-PTN
012700         IF  WBF-CHK-PTN-ERR
012800             SET BWP-PTN-UNARY-ERROR
012900                                    TO TRUE
013000         END-IF
013100     END-IF
013200     IF  BWP-FMT-UNARY-BNRY
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```
013300         MOVE BWP-UNARY-BIN        TO WBF-CHK-BIN
013400         IF  NOT WBF-CHK-BIN-OK
013500             SET BWP-UNARY-OVF-ERROR
013600                                       TO TRUE
013700         END-IF
013800     END-IF
013900     IF  BWP-OP-BINARY
014000         IF NOT BWP-FMT-BINARY-VALID
014100            SET BWP-FMT-BINARY-ERROR
014200                                       TO TRUE
014300         END-IF
014400         IF BWP-FMT-BINARY-PTRN
014500             MOVE BWP-BINARY-PTN   TO WBF-CHK-PTN
014600             PERFORM 11000-CHK-PTN
014700             IF WBF-CHK-PTN-ERR
014800                 SET BWP-PTN-BINARY-ERROR
014900                                       TO TRUE
015000             END-IF
015100         END-IF
015200         IF BWP-FMT-BINARY-BNRY
015300             MOVE BWP-BINARY-BIN    TO WBF-CHK-BIN
015400             IF NOT WBF-CHK-BIN-OK
015500                 SET BWP-BINARY-OVF-ERROR
015600                                          TO TRUE
015700             END-IF
015800         END-IF
015900     END-IF
016000     IF  NOT BWP-FMT-RESULT-VALID
016100         SET BWP-FMT-RESULT-ERROR  TO TRUE
016200     END-IF
016300     .
016400 11000-CHK-PTN.
016500     MOVE ZERO                     TO WBF-CHK-PTN-CNT
016600     INSPECT WBF-CHK-PTN
016700       TALLYING WBF-CHK-PTN-CNT    FOR ALL '0'
016800     INSPECT WBF-CHK-PTN
016900       TALLYING WBF-CHK-PTN-CNT    FOR ALL '1'
017000     .
017100 20000-BWP-OP-XLAT.
017200     MOVE BWP-FMT-UNARY            TO WBF-PACK-FMT
017300     EVALUATE TRUE
017400     WHEN BWP-FMT-UNARY-BNRY
017500         MOVE BWP-UNARY-BIN        TO WBF-PACK-BIN
017600     WHEN BWP-FMT-UNARY-CHAR
017700         MOVE BWP-UNARY-CHR        TO WBF-PACK-CHR
017800     WHEN OTHER
017900         MOVE BWP-UNARY            TO WBF-PACK
018000     END-EVALUATE
018100     PERFORM 40000-PACK
018200     PERFORM 50000-TRANSLATE
018300     IF  BWP-FMT-RESULT-BNRY
018400     OR  BWP-FMT-RESULT-CHAR
018500         MOVE BWP-RESULT           TO WBF-PACK
018600         MOVE 'P'                  TO WBF-PACK-FMT
018700         PERFORM 40000-PACK
018800         IF  BWP-FMT-RESULT-BNRY
018900             MOVE SPACES           TO BWP-RESULT
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```
019000             MOVE WBF-PACK-BIN     TO BWP-RESULT-BIN
019100         ELSE
019200             MOVE SPACES           TO BWP-RESULT
019300             MOVE WBF-PACK-CHR     TO BWP-RESULT-CHR
019400         END-IF
019500     END-IF
019600     .
019700 30000-BWP-OP-TEST.
019800     MOVE BWP-UNARY                TO WBF-PACK
019900     EVALUATE TRUE
020000     WHEN BWP-FMT-UNARY-BNRY
020100         MOVE BWP-UNARY-BIN        TO WBF-PACK-BIN
020200     WHEN BWP-FMT-UNARY-CHAR
020300         MOVE BWP-UNARY-CHR        TO WBF-PACK-CHR
020400     WHEN OTHER
020500         MOVE BWP-UNARY            TO WBF-PACK
020600     END-EVALUATE
020700     MOVE BWP-FMT-UNARY            TO WBF-PACK-FMT
020800     PERFORM 40000-PACK
020900     PERFORM 50000-TRANSLATE
021000     MOVE BWP-RESULT               TO WBF-UNARY
021100     MOVE BWP-BINARY               TO WBF-PACK
021200     MOVE BWP-FMT-BINARY           TO WBF-PACK-FMT
021300     EVALUATE TRUE
021400     WHEN BWP-FMT-BINARY-BNRY
021500         MOVE BWP-BINARY-BIN       TO WBF-PACK-BIN
021600     WHEN BWP-FMT-BINARY-CHAR
021700         MOVE BWP-BINARY-CHR       TO WBF-PACK-CHR
021800     WHEN OTHER
021900         MOVE BWP-BINARY           TO WBF-PACK
022000     END-EVALUATE
022100     PERFORM 40000-PACK
022200     PERFORM 50000-TRANSLATE
022300     MOVE BWP-RESULT               TO WBF-BINARY
022400     MOVE ZEROES                   TO BWP-RESULT
022500     EVALUATE TRUE
022600     WHEN BWP-OP-AND
022700         PERFORM VARYING WBF-CURRENT-BIT FROM 1 BY 1
022800         UNTIL WBF-CURRENT-BIT > 8
022900             IF  WBF-BINARY (WBF-CURRENT-BIT:1) = '1'
023000             AND WBF-UNARY    (WBF-CURRENT-BIT:1) = '1'
023100                 MOVE '1'          TO BWP-RESULT
023200                                      (WBF-CURRENT-BIT:1)
023300             END-IF
023400         END-PERFORM
023500     WHEN BWP-OP-OR
023600         PERFORM VARYING WBF-CURRENT-BIT FROM 1 BY 1
023700         UNTIL WBF-CURRENT-BIT > 8
023800             IF  WBF-BINARY (WBF-CURRENT-BIT:1) = '1'
023900             OR  WBF-UNARY    (WBF-CURRENT-BIT:1) = '1'
024000                 MOVE '1'          TO BWP-RESULT
024100                                      (WBF-CURRENT-BIT:1)
024200             END-IF
024300         END-PERFORM
024400     WHEN BWP-OP-XOR
024500         PERFORM VARYING WBF-CURRENT-BIT FROM 1 BY 1
024600         UNTIL WBF-CURRENT-BIT > 8
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024700             IF  WBF-UNARY    (WBF-CURRENT-BIT:1) NOT EQUAL
024800                 WBF-BINARY (WBF-CURRENT-BIT:1)
024900                 MOVE '1'          TO BWP-RESULT
025000                                     (WBF-CURRENT-BIT:1)
025100             END-IF
025200         END-PERFORM
025300     WHEN BWP-OP-NOT
025400         PERFORM VARYING WBF-CURRENT-BIT FROM 1 BY 1
025500         UNTIL WBF-CURRENT-BIT > 8
025600             IF  WBF-UNARY    (WBF-CURRENT-BIT:1) = '0'
025700                 MOVE '1'          TO BWP-RESULT
025800                                     (WBF-CURRENT-BIT:1)
025900             END-IF
026000         END-PERFORM
026100     END-EVALUATE
026200     IF  BWP-FMT-RESULT-BNRY
026300     OR  BWP-FMT-RESULT-CHAR
026400         MOVE BWP-RESULT           TO WBF-PACK
026500         MOVE 'P'                  TO WBF-PACK-FMT
026600         PERFORM 40000-PACK
026700         IF  BWP-FMT-RESULT-BNRY
026800             MOVE SPACES           TO BWP-RESULT
026900             MOVE WBF-PACK-BIN     TO BWP-RESULT-BIN
027000         ELSE
027100             MOVE SPACES           TO BWP-RESULT
027200             MOVE WBF-PACK-CHR     TO BWP-RESULT-CHR
027300         END-IF
027400     END-IF
027500     .
027600 40000-PACK.
027700     EVALUATE TRUE
027800     WHEN WBF-PACK-FMT-BNRY
027900         MOVE WBF-PACK-BIN         TO WBF-INPT-VAL-BIN
028000     WHEN WBF-PACK-FMT-CHAR
028100         MOVE WBF-PACK-CHR         TO WBF-INPT-VAL-CHR
028200     WHEN OTHER
028300         MOVE 0                    TO WBF-INPT-VAL-BIN
028400         MOVE WBF-STARTING-WEIGHT  TO WBF-SCALE
028500         PERFORM VARYING WBF-CURRENT-BIT FROM 1 BY 1
028600         UNTIL WBF-CURRENT-BIT > 8
028700             IF  WBF-PACK (WBF-CURRENT-BIT:1) = '1'
028800                 ADD WBF-SCALE
028900                                   TO WBF-INPT-VAL-BIN
029000            END-IF
029100            COMPUTE WBF-SCALE = WBF-SCALE / 2
029200         END-PERFORM
029300         MOVE SPACES               TO WBF-PACK
029400         MOVE WBF-INPT-VAL-BIN     TO WBF-PACK-BIN
029500     END-EVALUATE
029600     .
029700 50000-TRANSLATE.
029800     MOVE WBF-STARTING-WEIGHT      TO WBF-SCALE
029900     MOVE ALL ZEROES               TO BWP-RESULT
030000     MOVE 1                        TO WBF-CURRENT-BIT
030100     PERFORM VARYING WBF-CURRENT-BIT FROM 1 BY 1
030200     UNTIL WBF-CURRENT-BIT > 8
030300        IF   WBF-INPT-VAL-BIN >= WBF-SCALE
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```
030400            MOVE '1'               TO BWP-RESULT
030500                                     (WBF-CURRENT-BIT:1)
030600            COMPUTE WBF-INPT-VAL-BIN =
030700                    WBF-INPT-VAL-BIN - WBF-SCALE
030800        END-IF
030900        COMPUTE WBF-SCALE = WBF-SCALE / 2
031000     END-PERFORM
031100     .
031200 END PROGRAM BITWISE.
```

and **BWPARMS.cbl**

```
000010*****************************************************************
000020* CALLING AREA FOR THE 'BITWISE' SUBPROGRAM                     *
000021* WRITTEN BY.....: PAUL CHANDLER.                               *
000022* INITIAL VERSION: JULY 1974.                                   *
000023* LAST MODIFIED..: APRIL 2013.                                  *
000030*****************************************************************
000100 01 BITWISE-PARMS.                                                00010000
000200    05  BWP-UNARY                 PIC X(08).
000210    05  BWP-UNARY-RDF-PTN   REDEFINES BWP-UNARY.
000220        10  BWP-UNARY-PTN         PIC X(08).
000300    05  BWP-UNARY-RDF-BIN   REDEFINES BWP-UNARY.
000400        10  BWP-UNARY-BIN         PIC 9(04) BINARY.
000500        10  FILLER                PIC X(06).
000600    05  BWP-UNARY-RDF-CHR   REDEFINES BWP-UNARY.
000700        10  BWP-UNARY-CHR         PIC X(01).
000800        10  FILLER                PIC X(07).
000900    05  BWP-BINARY                PIC X(08).
000910    05  BWP-BINARY-RDF-PTN  REDEFINES BWP-BINARY.
000920        10  BWP-BINARY-PTN        PIC X(08).
001000    05  BWP-BINARY-RDF-BIN  REDEFINES BWP-BINARY.
001100        10  BWP-BINARY-BIN        PIC 9(04) BINARY.
001200        10  FILLER                PIC X(06).
001300    05  BWP-BINARY-RDF-CHR  REDEFINES BWP-BINARY.
001400        10  BWP-BINARY-CHR        PIC X(01).
001500        10  FILLER                PIC X(07).
001600    05  BWP-RESULT                PIC X(08).
001610    05  BWP-RESULT-RDF-PTN  REDEFINES BWP-RESULT.
001620        10  BWP-RESULT-PTN        PIC X(08).
001700    05  BWP-RESULT-RDF-BIN  REDEFINES BWP-RESULT.
001800        10  BWP-RESULT-BIN        PIC 9(04) BINARY.
001900        10  FILLER                PIC X(06).
002000    05  BWP-RESULT-RDF-CHR  REDEFINES BWP-RESULT.
002100        10  BWP-RESULT-CHR        PIC X(01).
002200        10  FILLER                PIC X(07).
002300    05  BWP-OP                    PIC X(04).
002500        88 BWP-OP-XLAT              VALUE 'XLAT'.
002600        88 BWP-OP-AND               VALUE 'AND '.
002700        88 BWP-OP-OR                VALUE 'OR  '.
002800        88 BWP-OP-XOR               VALUE 'XOR '.
002900        88 BWP-OP-NOT               VALUE 'NOT '.
003000        88 BWP-OP-UNARY             VALUE 'NOT ',
003100                                          'XLAT'.
003200        88 BWP-OP-BINARY            VALUE 'AND ',
003300                                          'OR  ',
003400                                          'XOR '.
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003500         88 BWP-OP-VALID               VALUE 'NOT ',
003600                                              'XLAT',
003700                                              'AND ',
003800                                              'OR  ',
003900                                              'XOR '.
004000     05  BWP-FMTS.
004100         10  BWP-FMT-UNARY           PIC X(01).
004300             88 BWP-FMT-UNARY-PTRN     VALUE 'P'.
004400             88 BWP-FMT-UNARY-BNRY     VALUE 'B'.
004500             88 BWP-FMT-UNARY-CHAR     VALUE 'C'.
004600             88 BWP-FMT-UNARY-VALID    VALUE 'B'
004700                                              'C'
004800                                              'P'.
005000         10  BWP-FMT-BINARY          PIC X(01).
005200             88 BWP-FMT-BINARY-PTRN    VALUE 'P'.
005300             88 BWP-FMT-BINARY-BNRY    VALUE 'B'.
005400             88 BWP-FMT-BINARY-CHAR    VALUE 'C'.
005500             88 BWP-FMT-BINARY-VALID   VALUE 'B'
005600                                              'C'
005700                                              'P'.
005800         10  BWP-FMT-RESULT          PIC X(01).
006000             88 BWP-FMT-RESULT-PTRN    VALUE 'P'.
006100             88 BWP-FMT-RESULT-BNRY    VALUE 'B'.
006200             88 BWP-FMT-RESULT-CHAR    VALUE 'C'.
006300             88 BWP-FMT-RESULT-VALID   VALUE 'B'
006400                                              'C'
006500                                              'P'.
006600         10  BWP-RETURN-CODE         PIC 9(01).
006800             88 BWP-NO-ERRORS          VALUE 0.
006900             88 BWP-OP-ERROR           VALUE 1.
007000             88 BWP-FMT-UNARY-ERROR    VALUE 2.
007100             88 BWP-FMT-BINARY-ERROR   VALUE 3.
007200             88 BWP-FMT-RESULT-ERROR   VALUE 4.
007300             88 BWP-PTN-UNARY-ERROR    VALUE 5.
007400             88 BWP-PTN-BINARY-ERROR   VALUE 6.
007500             88 BWP-UNARY-OVF-ERROR    VALUE 7.
007600             88 BWP-BINARY-OVF-ERROR   VALUE 8.
```

and a small demo program, with intentional errors.

```
000100 IDENTIFICATION DIVISION.                                         00010000
000200 PROGRAM-ID. DEMO.                                                00020016
000300 AUTHOR. PAUL CHANDLER, APRIL 2013.                               00030014
000400*********************************************************       00040000
000500*** THIS PROGRAM DEMO'S THE BITWISE TOOLBOX          ***       00050036
000600*********************************************************       00060000
000700 ENVIRONMENT DIVISION.                                            00070000
000800 DATA DIVISION.                                                   00080000
000900 FILE SECTION.                                                    00090000
001000 WORKING-STORAGE SECTION.                                         00100000
001100 01  WS-BITWISE                    PIC X(08)                    00110036
001200                                     VALUE 'BITWISE '.          00120037
001300 COPY BWPARMS.                                                    00130036
001400 PROCEDURE DIVISION.                                              00140000
001500***===                                    ======*               00150039
001600***===      TEST #1                       ======*               00160039
001700***===  A SIMPLE CONVERSION. GET A DISPLAYABLE =***               00170039
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```
001800******  BIT BATTERN FOR THE CHARACTER 'A'      =***               00180039
001900******                                        ======               00190039
002000     DISPLAY '*                 '                                 00200029
002100     DISPLAY                                                      00210028
002200     '*** CASE 1 - TRANSLATE ''A'', RETURN PATTERN ***'           00220028
002300     DISPLAY '*                 '                                 00230029
002400     MOVE 'XLAT'                   TO BWP-OP                      00240039
002500     MOVE 'A'                      TO BWP-UNARY-CHR               00250039
002600     MOVE 'C'                      TO BWP-FMT-UNARY               00260036
002700     MOVE SPACES                   TO BWP-BINARY                  00270036
002800                                      BWP-FMT-BINARY              00280036
002900     MOVE 'P'                      TO BWP-FMT-RESULT              00290036
003000     PERFORM DISPLAY-INPUT                                        00300023
003100     CALL WS-BITWISE               USING BITWISE-PARMS            00310036
003200     PERFORM DISPLAY-RETURN                                       00320024
003300*                                                                 00330030
003400******                                        ======               00340039
003500******      TEST #2                           ======               00350039
003600******  CONVERT THE PATTERN GENERATED IN CASE 1=***                00360039
003700******  TO ITS NUMERIC EQUIVALENT.              =***               00370039
003800******                                        ======               00380039
003900     DISPLAY '*                 '                                 00390029
004000     DISPLAY                                                      00400029
004100     '*** CASE 2 - TAKE THE PATTERN WE JUST GENERATED      *'      00410039
004200     '***          AND DISPLAY ITS NUMERIC VALUE           *'      00420039
004300     DISPLAY '*                 '                                 00430029
004400     MOVE BWP-RESULT-PTN           TO BWP-UNARY                   00440039
004500     MOVE 'P'                      TO BWP-FMT-UNARY               00450036
004600     MOVE 'B'                      TO BWP-FMT-RESULT              00460036
004700     PERFORM DISPLAY-INPUT                                        00470029
004800     CALL WS-BITWISE               USING BITWISE-PARMS            00480036
004900     PERFORM DISPLAY-RETURN                                       00490029
005000*                                                                 00500030
005100*                                                                 00510039
005200******                                        ======               00520039
005300******      TEST #3                           ======               00530039
005400******  CONVERT THE NUMERIC GENERATED IN CASE 2=***                00540039
005500******  TO ITS CHARACTER EQUIVALENT, BRINGING  =***                00550039
005600******  US BACK TO THE 'A' INPUT OF CASE 1     =***                00560039
005700******                                        ======               00570039
005800     DISPLAY '*                 '                                 00580030
005900     DISPLAY                                                      00590030
006000     '*** CASE 3 - TRANSLATE NUMERIC, RETURN CHAR  ***'           00600030
006100     DISPLAY '*                 '                                 00610030
006200     MOVE BWP-RESULT-BIN           TO BWP-UNARY-BIN               00620039
006300     MOVE 'B'                      TO BWP-FMT-UNARY               00630036
006400     MOVE 'C'                      TO BWP-FMT-RESULT              00640036
006500     PERFORM DISPLAY-INPUT                                        00650030
006600     CALL WS-BITWISE               USING BITWISE-PARMS            00660036
006700     PERFORM DISPLAY-RETURN                                       00670030
006800*                                                                 00680030
006810*                                                                 00681039
006820******                                        ======               00682039
006830******      TEST #4                           ======               00683039
006840******  'OR' 2  NUMERICS TOGETHER AND RETURN ======               00684039
006850******  THE RESULTING BINARY PATTERN            =***               00685039
006870******                                        ======               00687039
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006900     DISPLAY '*                 '                                 00690031
007000     DISPLAY                                                      00700031
007100     '*** CASE 4 - ''OR'' 15 & 240, RETURN PATTERN**'              00710031
007200     DISPLAY '*                 '                                 00720031
007300     MOVE 'OR  '                    TO BWP-OP                     00730036
007400     MOVE 15                        TO BWP-UNARY-BIN              00740036
007500     MOVE 240                       TO BWP-BINARY-BIN             00750036
007600     MOVE 'B'                       TO BWP-FMT-UNARY              00760036
007700                                       BWP-FMT-BINARY             00770036
007800     MOVE 'P'                       TO BWP-FMT-RESULT             00780036
007900     PERFORM DISPLAY-INPUT                                        00790031
008000     CALL WS-BITWISE                USING BITWISE-PARMS           00800036
008100     PERFORM DISPLAY-RETURN                                       00810031
008200*                                                                 00820031
008220******===                                      ===***             00822039
008230******===      TEST #5                         ===***             00823039
008240******===  'AND' 2 NUMERICS TOGETHER AND RETURN ===***             00824039
008250******===  THE RESULTING BINARY PATTERN           =***             00825039
008260******===                                      ===***             00826039
008270*                                                                 00827039
008300     DISPLAY '*                 '                                 00830032
008400     DISPLAY                                                      00840032
008500     '*** CASE 5 - ''AND'' 255 & 70, RETURN PATTERN**'             00850032
008600     DISPLAY '*                 '                                 00860032
008700     MOVE 'AND '                    TO BWP-OP                     00870036
008800     MOVE 255                       TO BWP-UNARY-BIN              00880036
008900     MOVE  70                       TO BWP-BINARY-BIN             00890036
009000     MOVE 'B'                       TO BWP-FMT-UNARY              00900036
009100                                       BWP-FMT-BINARY             00910036
009200     MOVE 'P'                       TO BWP-FMT-RESULT             00920036
009300     PERFORM DISPLAY-INPUT                                        00930032
009400     CALL WS-BITWISE                USING BITWISE-PARMS           00940036
009500     PERFORM DISPLAY-RETURN                                       00950032
009510*                                                                 00951039
009520******===                                      ===***             00952039
009530******===      TEST #6                         ===***             00953039
009540******===  'NOT' A RANDOM PATTERN. WE'LL RETURN ===***             00954039
009550******===  THE RSULT AS A PATTERN SO THAT THE BIT =***             00955039
009551******===  INVERSION IS EASIER TO SEE.            =***             00955139
009560******===                                      ===***             00956039
009570*                                                                 00957039
009700     DISPLAY '*                 '                                 00970033
009800     DISPLAY                                                      00980033
009900     '*** CASE 6 - ''NOT'' A RANDOM PATTERN**'                     00990033
010000     DISPLAY '*                 '                                 01000033
010100     MOVE 'NOT '                    TO BWP-OP                     01010036
010200     MOVE '10110101'                TO BWP-UNARY                  01020036
010300     MOVE 'P'                       TO BWP-FMT-UNARY              01030036
010400     PERFORM DISPLAY-INPUT                                        01040033
010500     CALL WS-BITWISE                USING BITWISE-PARMS           01050036
010600     PERFORM DISPLAY-RETURN                                       01060033
010610*                                                                 01061039
010620******===                                      ===***             01062039
010630******===      TEST #7                         ===***             01063039
010640******===  'XOR' 2 PATTERNS. AGAIN, WE'LL RETURN===***             01064039
010650******===  THE RSULT AS A PATTERN SO THAT THE BIT =***             01065039
010660******===  INTERACTIONS EASIER TO SEE.            =***             01066039
```

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```
010670******                                        ======                01067039
010680*                                                                    01068039
010800     DISPLAY '*                 '                                   01080035
010900     DISPLAY                                                        01090035
011000     '*** CASE 7 - ''XOR'' PATTERN VS PATTERN'                       01100035
011100     DISPLAY '*                 '                                   01110035
011200     MOVE 'XOR '                    TO BWP-OP                       01120036
011300     MOVE '10110101'                TO BWP-UNARY                    01130036
011400     MOVE '01101100'                TO BWP-BINARY                   01140036
011500     MOVE 'P'                       TO BWP-FMT-UNARY                01150036
011600                                       BWP-FMT-BINARY               01160036
011700     PERFORM DISPLAY-INPUT                                          01170035
011800     CALL WS-BITWISE                USING BITWISE-PARMS             01180036
011900     PERFORM DISPLAY-RETURN                                         01190035
011910*                                                                   01191039
011920******                                        ======                01192039
011930******      TESTS #8 AND #9                   ======                01193039
011940******  A COUPLE OF ERROR CASES. #8 TRIES TO ======                01194039
011950******  TRANSLATE A PATTERN NOT CORRECTLY SET  ====                01195039
011960******  TO ONES AND ZEROES, #9 TRIES TO CONVERT=====               01196039
011961******  A NUMERIC VALUE TOO LARGE TO FIT WITHIN=====               01196139
011970******  ONE BYTE.                         ======                   01197039
011971******                                    ======                   01197139
011980*                                                                   01198039
012100     DISPLAY '*                 '                                   01210038
012200     DISPLAY                                                        01220038
012300     '*** CASE 8 - BAD PATTERN INPUT'                               01230039
012400     DISPLAY '*                 '                                   01240038
012500     MOVE 'XLAT'                    TO BWP-OP                       01250038
012600     MOVE '1       '                TO BWP-UNARY                    01260038
012700     MOVE 'P'                       TO BWP-FMT-UNARY                01270038
012800     PERFORM DISPLAY-INPUT                                          01280038
012900     CALL WS-BITWISE                USING BITWISE-PARMS             01290038
013000     PERFORM DISPLAY-RETURN                                         01300038
013100*                                                                   01310038
013200     DISPLAY '*                 '                                   01320038
013300     DISPLAY                                                        01330038
013400     '*** CASE 9 - BAD BINARY INPUT'                                01340039
013500     DISPLAY '*                 '                                   01350038
013600     MOVE 256                       TO BWP-UNARY-BIN                01360038
013700     MOVE 'B'                       TO BWP-FMT-UNARY                01370038
013800     PERFORM DISPLAY-INPUT                                          01380038
013900     CALL WS-BITWISE                USING BITWISE-PARMS             01390038
014000     PERFORM DISPLAY-RETURN                                         01400038
014100*                                                                   01410038
014200     GOBACK                                                         01420038
014300     .                                                              01430004
014400 DISPLAY-INPUT.                                                     01440023
014500     DISPLAY '*                 '                                   01450029
014600     DISPLAY '***** INPUT *****'                                    01460027
014700     DISPLAY '*                 '                                   01470029
014800     DISPLAY 'OP.........: ' BWP-OP                                 01480036
014900     IF  BWP-FMT-UNARY-BNRY                                         01490036
015000         DISPLAY 'UNARY......: ' BWP-UNARY-BIN                      01500036
015100     ELSE                                                           01510027
015200         DISPLAY 'UNARY......: ' BWP-UNARY                          01520036
015300     END-IF                                                         01530027
```

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```
015400     DISPLAY 'UNARY FMT..: ' BWP-FMT-UNARY                        01540036
015500     IF  BWP-OP-BINARY                                            01550036
015600         IF  BWP-FMT-BINARY-BNRY                                  01560036
015700             DISPLAY 'BINARY.....: ' BWP-BINARY-BIN               01570036
015800         ELSE                                                     01580027
015900             DISPLAY 'BINARY.....: ' BWP-BINARY                   01590036
016000         END-IF                                                   01600027
016100         DISPLAY 'BINARY FMT.: ' BWP-FMT-BINARY                   01610036
016200     END-IF                                                       01620023
016300     DISPLAY 'RESULT FMT.: ' BWP-FMT-RESULT                       01630036
016400     .                                                            01640025
016500 DISPLAY-RETURN.                                                  01650023
016600     DISPLAY '***              '                                  01660027
016700     DISPLAY '**** RETURN  ****'                                  01670027
016800     DISPLAY '***              '                                  01680027
016900     IF  BWP-NO-ERRORS                                            01690036
017000         IF  BWP-FMT-RESULT-BNRY                                  01700036
017100             DISPLAY 'RESULT    = ' BWP-RESULT-BIN                01710036
017200         ELSE                                                     01720023
017300             DISPLAY 'RESULT    = ' BWP-RESULT                    01730036
017400         END-IF                                                   01740023
017500     ELSE                                                         01750023
017600         DISPLAY 'ERROR ' BWP-RETURN-CODE                         01760036
017700     END-IF                                                       01770023
017800     DISPLAY '*                '                                  01780031
017900     .                                                            01790025
018000 END PROGRAM DEMO.                                                01800016
```

Giving:

```
*
*** CASE 1 - TRANSLATE 'A', RETURN PATTERN ***
*
*
***** INPUT *****
*
OP.........: XLAT
UNARY......: A
UNARY FMT..: C
RESULT FMT.: P
**** RETURN  ****
RESULT    = 01000001

*
*
*** CASE 2 - TAKE THE PATTERN WE JUST GENERATED      **
**           AND DISPLAY ITS NUMERIC VALUE           *
*
*
***** INPUT *****
*
OP.........: XLAT
UNARY......: 01000001
UNARY FMT..: P
RESULT FMT.: B
**** RETURN  ****
RESULT    = 0065
```

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```
*

*
*** CASE 3 - TRANSLATE NUMERIC, RETURN CHAR  ***
*
*
***** INPUT *****
*
OP.........: XLAT
UNARY......: 0065
UNARY FMT..: B
RESULT FMT.: C
**** RETURN  ****
RESULT    = A
*

*
*** CASE 4 - 'OR' 15 & 240, RETURN PATTERN**
*
*
***** INPUT *****
*
OP.........: OR
UNARY......: 0015
UNARY FMT..: B
BINARY.....: 0240
BINARY FMT.: B
RESULT FMT.: P
**** RETURN  ****
RESULT    = 11111111
*

*
*** CASE 5 - 'AND' 255 & 70, RETURN PATTERN**
*
*
***** INPUT *****
*
OP.........: AND
UNARY......: 0255
UNARY FMT..: B
BINARY.....: 0070
BINARY FMT.: B
RESULT FMT.: P
**** RETURN  ****
RESULT    = 01000110
*

*
*** CASE 6 - 'NOT' A RANDOM PATTERN**
*
*
***** INPUT *****
*
OP.........: NOT
UNARY......: 10110101
UNARY FMT..: P
```

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```
RESULT FMT.: P
**** RETURN  ****
RESULT    = 01001010
*

*
*** CASE 7 - 'XOR' PATTERN VS PATTERN
*
*
***** INPUT *****
*
OP.........: XOR
UNARY......: 10110101
UNARY FMT..: P
BINARY.....: 01101100
BINARY FMT.: P
RESULT FMT.: P
**** RETURN  ****
RESULT    = 11011001
*

*
*** CASE 8 - BAD PATTERN INPUT
*
*
***** INPUT *****
*
OP.........: XLAT
UNARY......: 1
UNARY FMT..: P
RESULT FMT.: P
**** RETURN  ****
ERROR 5
*

*
*** CASE 9 - BAD BINARY INPUT
*
*
***** INPUT *****
*
OP.........: XLAT
UNARY......: 0256
UNARY FMT..: B
RESULT FMT.: P
**** RETURN  ****
ERROR 7
*
```

This code has been in production use for a lot of years now; thanks to Paul for sharing.

8.22 Getting Started with esqlOC

By user ati on the SourceForge GnuCOBOL Discussion group:

We could successfully test esqlOC (by Sergey) for our system and would like to encourage others to give it a chance. So here it comes:

8.22.1 esqlOC example

The author of the system is Sergey Kashyrin: You can download it from: http://www.kiska.net/opencobol/esql/ It provides "Embedded SQL" for GnuCOBOL (formerly OpenCOBOL).

With Embedded SQL you can insert SQL commands into your COBOL program:

```
[...] *
          MOVE 0 TO hVar3
          PERFORM UNTIL hVar3 > 2
            COMPUTE hVar3 = hVar3 + 1
            EXEC SQL
             SELECT
              TestCol1, TestCol2
             INTO
              :hVar1, :hVar2
             FROM
              TestTab
             WHERE TestCol1=:hVar3
            END-EXEC
            IF SQLCODE NOT < 0 AND NOT = 100
             DISPLAY 'SELECTED in LOOP iteration ' hVar3
             DISPLAY '  hVar1 ' hVar1 ' hVar2 ' hVar2
            END-IF
         END-PERFORM.
[...] *
```

8.22.2 What does this code do?

In a PERFORM-loop we count our iterations. For every iteration number *hVar3=1,2,3* we try to select a row from the database table *TestTab*. If there was no error and if we found a row

- the value of column *TestCol1* will be stored in the COBOL field *hVar1*
- the value of column *TestCol2* will be stored in the COBOL field *hVar2*

and we can DISPLAY the values.

Your COBOL compiler won't like the SQL part of the snippet. Therefore you need esqlOC, which translates code with "EXEC SQL" to "normal" COBOL code to make your compiler (*GnuCOBOL* of course) happy. This translation is called "precompilation", so esqlOC is a *precompiler* for ESQL/COBOL. esqlOC comes with a runtime library (DLL) and needs the ODBC driver for your database of choice. It is programmed in C++ with MS Visual Studio but should be portable to other compilers.

8.22.3 And this works with which database systems?

This should work with every serious database system (Definition *serious database system*: One, which has an ODBC driver.)

It worked with MS-SQL, MySQL, IBM-DB2.

Sergey made some valuable choices:

First: Embedded SQL Embedded SQL is an ISO/IEC standard: If you have to change your precompiler, you can keep most of your ESQL/COBOL code. Besides: Existing ESQL/COBOL code can be ported to *GnuCOBOL*.

Second: ODBC ODBC is an ISO/IEC standard: If you have to change your database system, you can keep your precompiler esqlOC.

Yes, we COBOL programmers learned the hard way not to get too dependent...

8.22.4 Does it really work?

After *our* tests for *our* system: YES. As always with software: You have to test and decide for your system.

We have tested esqlOC with Visual Studio-2010/WinXP/MySQL:

1. Load with ESQL/COBOL OpenCOBOL-Sequential file with 500 MB of data into 14 Tables with 412 columns. One of the tables has 132 columns.
2. Unload with ESQL/COBOL all the data to a new OpenCOBOL-Sequential file.
3. File compare: OpenCOBOL-Sequential files are identical.
4. Run different ESQL/COBOL programs with millions of DB interactions up to 50 Minutes: Identical output files, no exceptions, no problems with memory leaks.
5. We have successfully migrated 7 of our programs from files to DB.

8.22.5 Features

- Connection strings with a ODBC data source name (DSN) are possible, e. g.: `'youruser/yourpasswd@yourODBC_DSN'`.
- Using Connection strings without DSN you can set database specific connection parameters (see example below).
- Arbitrary Statements can be send to the database.
- Host variables can also be declared in the `LINKAGE SECTION`. You can hide all your esql/COBOL code in sub programs.
- Indicator Variables (NULL values) are supported. They must be declared as `"PIC S9(4) COMP-5"`
- Dynamic SQL is partly supported (see example below).
- `"EXEC SQL PREPARE"` and `"EXEC SQL DESCRIBE"` are not supported. If you lookup the complex usage of these in COBOL, you won't miss them. If you always know at compile time the number, type and length of your IN and OUT parameters (host variables) you don't need them. Other ways you are invited to contribute to esqlOC, but it will be some work to do.
- There is no programmatic limition (except sizeof(int)?) to the number of columns, number of host variables, length of data exchanged with the database.
- Connection parameters set OFF: `SQL_ATTR_CONNECTION_TIMEOUT, SQL_ATTR_AUTOCOMMIT`

8.22.6 Getting started with esqlOC (WinXP, MySQL, "OpenCOBOL 1.1" build by Sergey)

1. GnuCOBOL You can get Binaries from: http://www.kiska.net/opencobol/1.1/index.html We use this version: "Win32 Windows (32-bit) VS2008" We unzip to: `c:\OpenCobol_bin\`
2. esqlOC Download from: http://www.kiska.net/opencobol/esql/binaries.zip We unzip to: `c:\esqlOC\`

3. MySQL with ODBC drivers see: http://dev.mysql.com/doc/refman/5.6/en/windows-choosing-package.html

   You can get an installer or a zip archive here: http://dev.mysql.com/downloads/mysql/

   Using the installer server and ODBC driver can be installed. Using the zip archive you have to install die ODBC driver separately.

   We install to: `%PROGRAMFILES%\MySQL5.6\`

4. ANSI-C Compiler We use Visual Studio 2010 Express (Visual Studio 2008 Express shoul also work). We install to the default path: `%PROGRAMFILES%\Microsoft Visual Studio 10.0\`

5. Save this example in a file: esqlOCGetStart1.sqb Look at the connection parameters and make changes.

```
GNU   *
Cobol *
       IDENTIFICATION DIVISION.
       PROGRAM-ID. esqlOCGetStart1.
       DATA DIVISION.
       WORKING-STORAGE SECTION.
       EXEC SQL
         BEGIN DECLARE SECTION
       END-EXEC.
       01  HOSTVARS.
           05 BUFFER               PIC X(1024).
           05 hVarD                PIC S9(5)V99.
           05 hVarC                PIC X(50).
           05 hVarN                PIC 9(12).
       EXEC SQL
          END DECLARE SECTION
       END-EXEC.
       PROCEDURE DIVISION.
       MAIN SECTION.
      *-----------------------------------------------------------------*
      * CONNECT TO THE DATABASE
      * also possible with DSN: 'youruser/yourpasswd@yourODBC_DSN'
      *-----------------------------------------------------------------*
          STRING 'DRIVER={MySQL ODBC 5.2w Driver};'
                 'SERVER=localhost;'
                 'PORT=3306;'
                 'DATABASE=test;'
                 'USER=youruser;'
                 'PASSWORD=yourpasswd;'
      * example for DB specific ODBC parameter:
      *   no compressed MySQL connection (would be the DEFAULT anyway)
                 'COMRESSED_PROTO=0;'
            INTO BUFFER.
          EXEC SQL
            CONNECT TO :BUFFER
          END-EXEC.
          PERFORM SQLSTATE-CHECK.
      *-----------------------------------------------------------------*
      * CREATE  TABLEs
      *-----------------------------------------------------------------*
      * TESTPERSON
          MOVE SPACES TO BUFFER.
          STRING
            'CREATE TABLE TESTPERSON('
              'ID DECIMAL(12,0), '
              'NAME CHAR(50) NOT NULL, '
```

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```
             'PRIMARY KEY (ID))'
           INTO BUFFER.
         EXEC SQL
           EXECUTE IMMEDIATE  :BUFFER
         END-EXEC
         IF SQLSTATE='42S01'
           DISPLAY ' Table TESTPERSON already exists.'
         ELSE
           PERFORM SQLSTATE-CHECK
           DISPLAY ' created Table TESTPERSON'
           PERFORM INSDATAPERSON.
      * TESTGAME
         MOVE SPACES TO BUFFER.
         STRING
           'CREATE TABLE TESTGAME('
             'ID DECIMAL(12,0), '
             'NAME CHAR(50) NOT NULL, '
             'PRIMARY KEY (ID))'
           INTO BUFFER.
         EXEC SQL
           EXECUTE IMMEDIATE  :BUFFER
         END-EXEC
         IF SQLSTATE='42S01'
           DISPLAY ' Table TESTGAME already exists.'
         ELSE
           PERFORM SQLSTATE-CHECK
           DISPLAY ' created Table TESTGAME'
           PERFORM INSDATAGAME.
      * TESTPOINTS
         MOVE SPACES TO BUFFER.
         STRING
           'CREATE TABLE TESTPOINTS('
             'PERSONID DECIMAL(12,0), '
             'GAMEID DECIMAL(12,0), '
             'POINTS DECIMAL(6,2), '
             'CONSTRAINT POINTS_CONSTRAINT1 FOREIGN '
               'KEY (PERSONID) REFERENCES TESTPERSON(ID), '
             'CONSTRAINT POINTS_CONSTRAINT2 FOREIGN '
               'KEY (GAMEID) REFERENCES TESTGAME(ID),'
             'PRIMARY KEY (PERSONID, GAMEID))'
           INTO BUFFER.
         EXEC SQL
           EXECUTE IMMEDIATE  :BUFFER
         END-EXEC
         IF SQLSTATE='42S01'
           DISPLAY ' Table TESTPOINTS already exists.'
         ELSE
           PERFORM SQLSTATE-CHECK
           DISPLAY ' created Table TESTPOINTS'
           PERFORM INSDATAPOINTS.
      *-----------------------------------------------------------------*
      * SELECT SUM of POINTS for persons >1
      *-----------------------------------------------------------------*
         EXEC SQL
           SELECT
             SUM(POINTS)
           INTO
```

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```
            :hVarD
          FROM
            TESTPERSON, TESTPOINTS
          WHERE PERSONID>1 AND PERSONID=ID
       END-EXEC
       PERFORM SQLSTATE-CHECK
       IF SQLCODE NOT = 100
         DISPLAY 'SELECTED '
         DISPLAY '  SUM of POINTS for persons >1 ' hVarD
       ELSE
         DISPLAY ' No points found'
       END-IF.
      *-----------------------------------------------------------------*
      * SELECT ALL with CURSORS
      *-----------------------------------------------------------------*
       EXEC SQL
         DECLARE CUR_ALL CURSOR FOR
         SELECT
           TESTPERSON.NAME,
           POINTS
         FROM
           TESTPERSON, TESTPOINTS
         WHERE PERSONID=ID
       END-EXEC
       PERFORM SQLSTATE-CHECK
       EXEC SQL
         OPEN CUR_ALL
       END-EXEC
       PERFORM SQLSTATE-CHECK
       PERFORM UNTIL SQLCODE = 100
         EXEC SQL
           FETCH CUR_ALL
           INTO
             :hVarC,
             :hVarD
         END-EXEC
         PERFORM SQLSTATE-CHECK
         IF SQLCODE NOT = 100
           DISPLAY 'FETCHED '
           DISPLAY '  person ' hVarC ' points: ' hVarD
         ELSE
           DISPLAY ' No points found'
         END-IF
       END-PERFORM.
      *-----------------------------------------------------------------*
      * DROP  TABLEs
      *-----------------------------------------------------------------*
      *   MOVE 'DROP TABLE TESTPOINTS' TO BUFFER.
      *   EXEC SQL
      *     EXECUTE IMMEDIATE  :BUFFER
      *   END-EXEC
      *   PERFORM SQLSTATE-CHECK.
      *   MOVE 'DROP TABLE TESTGAME' TO BUFFER.
      *   EXEC SQL
      *     EXECUTE IMMEDIATE  :BUFFER
      *   END-EXEC
      *   PERFORM SQLSTATE-CHECK.
```

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```
      *   MOVE 'DROP TABLE TESTPERSON' TO BUFFER.
      *   EXEC SQL
      *     EXECUTE IMMEDIATE  :BUFFER
      *   END-EXEC
      *   PERFORM SQLSTATE-CHECK.
      *   DISPLAY ' dropped Tables '
      *-----------------------------------------------------------------*
      * COMMIT CHANGES
      *-----------------------------------------------------------------*
           EXEC SQL
             COMMIT
           END-EXEC.
           PERFORM SQLSTATE-CHECK.
      *-----------------------------------------------------------------*
      * DISCONNECT FROM THE DATABASE
      *-----------------------------------------------------------------*
           EXEC SQL
             CONNECT RESET
           END-EXEC.
           PERFORM SQLSTATE-CHECK.
           STOP RUN.
           .
      *-----------------------------------------------------------------*
      * CHECK SQLSTATE AND DISPLAY ERRORS IF ANY
      *-----------------------------------------------------------------*
       SQLSTATE-CHECK SECTION.
           IF SQLCODE < 0
                      DISPLAY 'SQLSTATE='  SQLSTATE,
                              ', SQLCODE=' SQLCODE
              IF SQLERRML > 0
                 DISPLAY 'SQL Error message:' SQLERRMC(1:SQLERRML)
              END-IF
              MOVE SQLCODE TO RETURN-CODE
              STOP RUN
           ELSE IF SQLCODE > 0 AND NOT = 100
                      DISPLAY 'SQLSTATE='  SQLSTATE,
                              ', SQLCODE=' SQLCODE
              IF SQLERRML > 0
                 DISPLAY 'SQL Warning message:' SQLERRMC(1:SQLERRML)
              END-IF
           END-IF.
           .
       INSDATAPERSON SECTION.
      *-----------------------------------------------------------------*
      * INSERT Data
      *-----------------------------------------------------------------*
      * TESTPERSON
           MOVE 0 TO hVarN.
           PERFORM UNTIL hVarN > 2
             COMPUTE hVarN = hVarN + 1
             STRING 'Testpers '
                    hVarN
               INTO hVarC
             EXEC SQL
              INSERT INTO TESTPERSON SET
               ID=:hVarN,
               NAME=:hVarC
```

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```
           END-EXEC
           PERFORM SQLSTATE-CHECK
           DISPLAY 'INSERTED '
           DISPLAY '  Person ' hVarN ' NAME ' hVarC
         END-PERFORM.
       INSDATAGAME SECTION.
      * TESTGAME
         MOVE 0 TO hVarN.
         PERFORM UNTIL hVarN > 3
           COMPUTE hVarN = hVarN + 1
           STRING 'Testgame '
                  hVarN
             INTO hVarC
           EXEC SQL
            INSERT INTO TESTGAME SET
             ID=:hVarN,
             NAME=:hVarC
           END-EXEC
           PERFORM SQLSTATE-CHECK
           DISPLAY 'INSERTED '
           DISPLAY '  Game ' hVarN ' NAME ' hVarC
         END-PERFORM.
       INSDATAPOINTS SECTION.
      * TESTPOINTS
         MOVE 0 TO hVarN.
         MOVE 0 TO hVarD.
         PERFORM UNTIL hVarN > 2
           COMPUTE hVarN = hVarN + 1
           COMPUTE hVarD = hVarN + 0.75
           EXEC SQL
            INSERT INTO TESTPOINTS SET
             PERSONID=:hVarN,
             GAMEID=:hVarN,
             POINTS=:hVarD
           END-EXEC
           PERFORM SQLSTATE-CHECK
           DISPLAY 'INSERTED '
           DISPLAY '  POINTS for person/game ' hVarN ' : ' hVarD
         END-PERFORM.
```

We store it in: `c:\Temp\`

6. Precompile

```
c:\esqlOC\release\esqlOC.exe -static -o c:\Temp\esqlOCGetStart1.cob \
   c:\Temp\esqlOCGetStart1.sqb
```

7. Compile

```
SET OC_RUNTIME=c:\OpenCobol_bin
SET esqlOC_RUNTIME=c:\esqlOC\release
SET COB_CFLAGS=-I %OC_RUNTIME%
SET COB_LIBS=%OC_RUNTIME%\libcob.lib %OC_RUNTIME%\mpir.lib %esqlOC_RUNTIME%\ocsql.lib
SET COB_CONFIG_DIR=%OC_RUNTIME%\config\
set PATH=C:\WINDOWS\system32;%OC_RUNTIME%
call "%PROGRAMFILES%\Microsoft Visual Studio 10.0\VC\vcvarsall.bat"
%OC_RUNTIME%\cobc.exe -fixed -v -x -static -o c:\Temp\esqlOCGetStart1.exe \
```

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```
   c:\Temp\esqlOCGetStart1.cob
```

8. Execute

To create the schema “test”:

```
%PROGRAMFILES%\MySQL5.6\mysql-5.6.13-win32\bin\mysql -u youruser -p --host=localhost
    --execute "CREATE DATABASE IF NOT EXISTS test;"
```

Execute program:

```
SET OC_RUNTIME=c:\OpenCobol_bin
SET esqlOC_RUNTIME=c:\esqlOC\release
set PATH=%OC_RUNTIME%;%esqlOC_RUNTIME%
c:\Temp\esqlOCGetStart1.exe
```

Output:

```
Microsoft Windows XP [Version 5.1.2600]
(C) Copyright 1985-2001 Microsoft Corp.

c:\~$dir temp
 Volume in Laufwerk C: hat keine Bezeichnung.
 Volumeseriennummer: 75F6-3F89

 Verzeichnis von c:\temp

08.11.2013  18:18    <DIR>          .
08.11.2013  18:18    <DIR>          ..
08.11.2013  18:10             9.169 esqlOCGetStart1.sqb
               1 Datei(en)          9.169 Bytes
               2 Verzeichnis(se), 51.086.712.832 Bytes frei

c:\~$c:\esqlOC\release\esqlOC.exe -static -o c:\Temp\esqlOCGetStart1.cob \
    c:\Temp\esqlOCGetStart1.sqb
c:\esqlOC\release\esqlOC.exe: ESQL for OpenCobol Version 2 Build May  8 2013

c:\~$dir temp
 Volume in Laufwerk C: hat keine Bezeichnung.
 Volumeseriennummer: 75F6-3F89

 Verzeichnis von c:\temp

08.11.2013  18:18    <DIR>          .
08.11.2013  18:18    <DIR>          ..
08.11.2013  18:18            17.973 esqlOCGetStart1.cob
08.11.2013  18:10             9.169 esqlOCGetStart1.sqb
               2 Datei(en)         27.142 Bytes
               2 Verzeichnis(se), 51.086.692.352 Bytes frei

c:\~$SET OC_RUNTIME=c:\OpenCobol_bin

c:\~$SET esqlOC_RUNTIME=c:\esqlOC\release

c:\~$SET COB_CFLAGS=-I %OC_RUNTIME%

c:\~$SET COB_LIBS=%OC_RUNTIME%\libcob.lib %OC_RUNTIME%\mpir.lib \
```

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```
     %esqlOC_RUNTIME%\ocsql.lib

c:\~$SET COB_CONFIG_DIR=%OC_RUNTIME%\config\

c:\~$set PATH=C:\WINDOWS\system32;%OC_RUNTIME%

c:\~$call "%PROGRAMFILES%\Microsoft Visual Studio 10.0\VC\vcvarsall.bat"
Setting environment for using Microsoft Visual Studio 2010 x86 tools.

c:\~$%OC_RUNTIME%\cobc.exe -fixed -v -x -static -o c:\Temp\esqlOCGetStart1.exe \
     c:\Temp\esqlOCGetStart1.cob
Preprocessing:  c:\Temp\esqlOCGetStart1.cob to
                C:\DOKUME~1\DOK-AD~1\LOKALE~1\Temp\cob13.cob
Return status:  0
Parsing:        C:\DOKUME~1\DOK-AD~1\LOKALE~1\Temp\cob13.cob
Return status:  0
Translating:    C:\DOKUME~1\DOK-AD~1\LOKALE~1\Temp\cob13.cob to
                C:\DOKUME~1\DOK-AD~1\LOKALE~1\Temp\cob14.c
Executing:      cl /c -I c:\OpenCobol_bin /MD /Fo"esqlOCGetStart1.obj"
                "C:\DOKUME~1\DOK-AD~1\LOKALE~1\Temp\cob14.c"
Microsoft (R) 32-Bit C/C++-Optimierungscompiler Version 16.00.40219.01 für 80x86
Copyright (C) Microsoft Corporation. Alle Rechte vorbehalten.

cob14.c
Return status:  0
Executing:      cl /MD /Fe"c:\Temp\esqlOCGetStart1" "esqlOCGetStart1.obj"
                c:\OpenCobol_bin\libcob.lib c:\OpenCobol_bin\mpir.lib
                c:\esqlOC\release\ocsql.lib /link /manifest
Microsoft (R) 32-Bit C/C++-Optimierungscompiler Version 16.00.40219.01 für 80x86
Copyright (C) Microsoft Corporation. Alle Rechte vorbehalten.

Microsoft (R) Incremental Linker Version 10.00.40219.01
Copyright (C) Microsoft Corporation.  All rights reserved.

/out:c:\Temp\esqlOCGetStart1.exe
/manifest
esqlOCGetStart1.obj
c:\OpenCobol_bin\libcob.lib
c:\OpenCobol_bin\mpir.lib
c:\esqlOC\release\ocsql.lib
Return status:  0
Executing:      mt /manifest "c:\Temp\esqlOCGetStart1.exe.manifest"
                /outputresource:"c:\Temp\esqlOCGetStart1.exe";#1
Microsoft (R) Manifest Tool version 5.2.3790.2076
Copyright (c) Microsoft Corporation 2005.
All rights reserved.
Return status:  0

c:\~$dir temp
 Volume in Laufwerk C: hat keine Bezeichnung.
 Volumeseriennummer: 75F6-3F89

 Verzeichnis von c:\temp

08.11.2013  18:18    <DIR>          .
08.11.2013  18:18    <DIR>          ..
08.11.2013  18:18            17.973 esqlOCGetStart1.cob
```

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```
08.11.2013  18:18            17.408 esqlOCGetStart1.exe
08.11.2013  18:10             9.169 esqlOCGetStart1.sqb
               3 Datei(en)         44.550 Bytes
               2 Verzeichnis(se), 51.086.667.776 Bytes frei

c:\~$SET OC_RUNTIME=c:\OpenCobol_bin

c:\~$SET esqlOC_RUNTIME=c:\esqlOC\release

c:\~$set PATH=%OC_RUNTIME%;%esqlOC_RUNTIME%

c:\~$c:\Temp\esqlOCGetStart1.exe
 created Table TESTPERSON
INSERTED
  Person 000000000001 NAME Testpers 000000000001
INSERTED
  Person 000000000002 NAME Testpers 000000000002
INSERTED
  Person 000000000003 NAME Testpers 000000000003
 created Table TESTGAME
INSERTED
  Game 000000000001 NAME Testgame 000000000001
INSERTED
  Game 000000000002 NAME Testgame 000000000002
INSERTED
  Game 000000000003 NAME Testgame 000000000003
INSERTED
  Game 000000000004 NAME Testgame 000000000004
 created Table TESTPOINTS
INSERTED
  POINTS for person/game 000000000001 : +00001.75
INSERTED
  POINTS for person/game 000000000002 : +00002.75
INSERTED
  POINTS for person/game 000000000003 : +00003.75
SELECTED
  SUM of POINTS for persons >1 +00006.50
FETCHED
  person Testpers 000000000001                              points: +00001.75
FETCHED
  person Testpers 000000000002                              points: +00002.75
FETCHED
  person Testpers 000000000003                              points: +00003.75
 No points found

c:\~$
```

ati's post modified for ReStructuredText

8.23 UDF

User Defined Function. See *FUNCTION-ID* (page 273) for an example putting user defined functions to use.

This is a new paradigm in COBOL programming. It is now possible to deliver repositories of functions, that can provide code with less need to pre-allocate *WORKING-STORAGE* (page 433) areas. For instance

```
ENVIRONMENT DIVISION.
configuration section.
repository.
    function current-stock-price
    function all intrinsic.

PROCEDURE DIVISION.
display current-stock-price("GOOG") end-display
```

doesn't even need to know what type of data `current-stock-price` returns. The result may be passed in a pipeline expressions, easing burdens on application developers.

`UDF` will be a good thing for GnuCOBOL. `cobc` can include the repositories from source code or *DSO* (page 1319); let the sharing begin.

8.24 GUI

Graphical User Interface. GnuCOBOL is well suited to programming with GTK+, but more than capable of leveraging just about any GUI framework. Including the Java Advanced Window Toolkit through COBJAPI.

8.25 Elvis support for GnuCOBOL

Provides `:display syntax` mode support to the venerable, and feature rich, **`elvis`** text editor.

```
# GnuCOBOL
# Contributed by Brian Tiffin (btiffin@gnu.org)
#   add to local data/elvis.syn installation
#   Permission given to copy, modify, and redistribute
#
# Comments in COBOL are
#     * in column 7 (for fixed format sources) or
#     *> anywhere in a line
#
language gnucobol cobol
extension .cob .cbl .cpy .COB .CBL .CPY
comment *>
comment *
anchor 7 *
preprocessor #
keyword accept access active-class add address advancing
keyword after aligned all allocate alphabet alphabetic
keyword alphabetic-lower alphabetic-upper alphanumeric
keyword alphanumeric-edited also alter alternate and any
keyword anycase are area areas argument-number
keyword argument-value arithmetic as ascending ascii
keyword assign at attribute auto auto-skip automatic
keyword autoterminate away-from-zero b-and b-not b-or
keyword b-xor background-color background-colour based
keyword beep before bell binary binary-c-long binary-char
keyword binary-double binary-int binary-long
keyword binary-long-long binary-short bit blank blink
keyword block boolean bottom by byte-length call cancel
keyword capacity cd center cf ch chain chaining character
```

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```
keyword characters class class-id classification close
keyword code code-set col collating cols column columns
keyword comma command-line commit common communication
keyword comp comp-1 comp-2 comp-3 comp-4 comp-5 comp-6
keyword comp-x computational computational-1
keyword computational-2 computational-3 computational-4
keyword computational-5 computational-x compute condition
keyword configuration constant contains content continue
keyword control controls conversion converting copy corr
keyword corresponding count crt crt-under currency cursor
keyword cycle data data-pointer date day day-of-week de
keyword debugging decimal-point declaratives default
keyword delete delimited delimiter depending descending
keyword destination detail disable disc disk display
keyword divide division down duplicates dynamic ebcdic ec
keyword egi else emi empty-check enable end end-accept
keyword end-add end-call end-chain end-compute end-delete
keyword end-display end-divide end-evaluate end-if
keyword end-multiply end-of-page end-perform end-read
keyword end-receive end-return end-rewrite end-search
keyword end-start end-string end-subtract end-unstring
keyword end-write entry entry-convention environment
keyword environment-name environment-value eo eol eop eos
keyword equal equals erase error escape esi evaluate
keyword exception exception-object exclusive exit expands
keyword extend external factory false fd file file-control
keyword file-id filler final first float-binary-128
keyword float-binary-32 float-binary-64 float-decimal-16
keyword float-decimal-34 float-extended float-infinity
keyword float-long float-not-a-number float-short footing
keyword for foreground-color foreground-colour forever
keyword format free from full function function-id
keyword function-pointer generate get giving global go
keyword goback greater group group-usage heading
keyword high-value high-values highlight i-o i-o-control
keyword id identification if ignore ignoring implements in
keyword index indexed indicate indirect inherits initial
keyword initialise initialised initialize initialized
keyword initiate input input-output inspect interface
keyword interface-id intermediate into intrinsic invalid
keyword invoke is just justified kept key keyboard label
keyword last lc_all lc_collate lc_ctype lc_messages
keyword lc_monetary lc_numeric lc_time leading left
keyword left-justify leftline length length-check less
keyword limit limits linage linage-counter line
keyword line-counter lines linkage local-storage locale
keyword lock low-value low-values lower lowlight manual
keyword memory merge message method method-id minus mode
keyword move multiple multiply name national
keyword national-edited native nearest-away-from-zero
keyword nearest-even nearest-toward-zero negative nested
keyword next no no-echo none normal not null nulls number
keyword numbers numeric numeric-edited object
keyword object-computer object-reference occurs of off
keyword omitted on only open optional options or order
keyword organisation organization other output overflow
keyword overline override packed-decimal padding page
```

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```
keyword page-counter paragraph perform pf ph pic picture
keyword plus pointer position positive prefixed present
keyword previous printer printing procedure
keyword procedure-pointer procedures proceed program
keyword program-id program-pointer prohibited prompt
keyword property prototype purge queue quote quotes raise
keyword raising random rd read receive record recording
keyword records recursive redefines reel reference
keyword references relation relative release remainder
keyword removal renames replace replacing report reporting
keyword reports repository required reserve reset resume
keyword retry return returning reverse-video reversed
keyword rewind rewrite rf rh right right-justify rollback
keyword rounded rounding run same screen scroll sd search
keyword seconds section secure segment segment-limit
keyword select self send sentence separate sequence
keyword sequential set sharing sign signed signed-int
keyword signed-long signed-short size sort sort-merge
keyword source source-computer sources space space-fill
keyword spaces special-names standard standard-1
keyword standard-2 standard-binary standard-decimal start
keyword statement static status stdcall step stop string
keyword strong sub-queue-1 sub-queue-2 sub-queue-3
keyword subtract sum super suppress symbol symbolic sync
keyword synchronised synchronized system-default tab table
keyword tallying tape terminal terminate test text than
keyword then through thru time time-out timeout times to
keyword top toward-greater toward-lesser trailing
keyword trailing-sign transform true truncation type
keyword typedef ucs-4 underline unit universal unlock
keyword unsigned unsigned-int unsigned-long unsigned-short
keyword unstring until up update upon upper usage use user
keyword user-default using utf-16 utf-8 val-status valid
keyword validate validate-status value values varying wait
keyword when with words working-storage write yyyyddd
keyword yyyymmdd zero zero-fill zeroes zeros author
keyword date-compiled date-modified date-written
keyword installation remarks security return-code
keyword sort-return number-of-call-parameters
keyword cob-crt-status sysin sysipt
keyword stdin sysout syslist syslst stdout printer syserr
keyword stderr console c01 c02 c03 c04 c05 c06 c07 c08 c09
keyword c10 c11 c12 csp formfeed call-convention switch-0
keyword switch-1 switch-2 switch-3 switch-4 switch-5
keyword switch-6 switch-7 switch-8 switch-9 switch-10
keyword switch-11 switch-12 switch-13 switch-14 switch-15
keyword sw0 sw1 sw2 sw3 sw4 sw5 sw6 sw7 sw8 sw9 sw10 sw11
keyword sw12 sw13 sw14 sw15 system cbl_and cbl_change_dir
keyword cbl_check_file_exist cbl_close_file cbl_copy_file
keyword cbl_create_dir cbl_create_file cbl_delete_dir
keyword cbl_delete_file cbl_eq cbl_error_proc
keyword cbl_exit_proc cbl_flush_file cbl_get_csr_pos
keyword cbl_get_current_dir cbl_get_scr_size cbl_imp
keyword cbl_nimp cbl_nor cbl_not cbl_oc_getopt
keyword cbl_oc_nanosleep cbl_open_file cbl_or
keyword cbl_read_file cbl_rename_file cbl_tolower
keyword cbl_toupper cbl_write_file cbl_xor c$calledby
```

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```
keyword c$chdir c$copy c$delete c$fileinfo c$getpid
keyword c$justify c$makedir c$narg c$paramsize c$printable
keyword c$sleep c$tolower c$toupper x91 xe4 xe5
keyword xf4 xf5 abs acos annuity asin atan
keyword boolean-of-integer byte-length char char-national
keyword combined-datetime concatenate cos currency-symbol
keyword current-date date-of-integer date-to-yyyymmdd
keyword day-of-integer day-to-yyyyddd display-of e
keyword exception-file exception-file-n exception-location
keyword exception-location-n exception-statement
keyword exception-status exp exp10 factorial
keyword formatted-current-date formatted-date
keyword formatted-datetime formatted-time fraction-part
keyword highest-algebraic integer integer-of-boolean
keyword integer-of-date integer-of-day
keyword integer-of-formatted-date integer-part length
keyword length-an locale-compare locale-date locale-time
keyword locale-time-from-seconds log log10 lower-case
keyword lowest-algebraic max mean median midrange min mod
keyword module-caller-id module-date module-formatted-date
keyword module-id module-path module-source module-time
keyword monetary-decimal-point
keyword monetary-thousands-separator national-of
keyword numeric-decimal-point numeric-thousands-separator
keyword numval numval-c numval-f ord ord-max ord-min pi
keyword present-value random range rem reverse
keyword seconds-from-formatted-time seconds-past-midnight
keyword sign sin sqrt standard-compare standard-deviation
keyword stored-char-length substitute substitute-case sum
keyword tan test-date-yyyymmdd test-day-yyyyddd
keyword test-formatted-datetime test-numval test-numval-c
keyword test-numval-f trim upper-case variance
keyword when-compiled year-to-yyyy debug
keyword fixed defined parameter override else-if source
startword -_
inword -_$
string '
string "
function (
ignorecase true
```

8.26 FAQ

Frequently Asked Questions.

This file isn't just a FAQ, it is more of a Stuff Some Guy Thinks You Should Know About GnuCOBOL document.

8.27 Hercules

A System/370, ESA/390 and z/Architecture emulator for personal computers.

http://www.hercules-390.eu/

Relevant to those wishing to practise mainframe skills at home. Due to changes in copyright laws of the time, there are versions of the MVS (and other) operating systems (circa 1970) available for personal use, as the code was deemed to have passed into the public domain. The public domain builds put together by enthusiasts include the UCOB COBOL compiler, and JCL engine for submitting COBOL jobs.

That, and much more, but mentioned here for the COBOL.

Windows users of Hercules will want to check out http://www.bsp-gmbh.com/hercules/index.shtml for operating system builds.

But I find http://www.jaymoseley.com/hercules/ a better place to start, when using Hercules with GNU/Linux, with instructions on bootstrapping MVS 3.8j. Jay's tutorials are world class, and some of his code is used by permission in the entry for the *REPORT* (page 369) reserved word.

See http://www.jaymoseley.com/hercules/compiling/cobolrw.htm when you want to come to grips with the GnuCOBOL ReportWriter features.

8.27.1 TK4-

Skipping ahead a little; Jay Moseley documented the steps for building up functional operating systems for the Hercules emulator. A very nice Turnkey system for MVS 3.8J was put together by Volker Bandke, of BSP GmbH. 10 years later Juergen Winkelmann put together `OS/VS2 MVS 3.8j Service Level 8505, Tur(n)key Level 4- Version 1.00`, or `TK4-`, a new Turnkey system, but not a continuation of TK#3 by Volker, so Juergen used TK4minus.

The *JCL* (page 1393) entry below documents a sample run through a sysgen'ed MVT 21.8; the listings here skip ahead to the later TK4- bundle from 2013, which built on the works of Turnkey #3 from 2002.

Starting TK4- is pretty straight forward.

`cd` to where the zip files were extracted, `~/tk4/`, for example.

Kick the system with

```
./mvs
```

and wait a little bit, until the console displays the TK4- banner page.

then

```
x3270 -model 3279-2-E -once 127.0.0.1 3270 &
```

to bring up a 3270 emulator. x3270 is pretty nice, but there are others.

You will likely need to send RESET, CLEAR when you first open the terminal. x3270 makes that easy with the little keyboard icon, and clearly labelled *GUI* (page 1385) buttons. The RESET, CLEAR clears the banner page and opens the LOGON screen.

The turnkey systems come loaded with

- IBMUSER (for emergency and recovery logins, password IBMPASS)
- HERC01 (system programmer access, password CUL8TR)
- HERC02 (another fully authorized user, password CUL8TR)
- HERCO3 (a regular user, password PASS4U)
- HERC04 (another user, password PASS4U)

After the logon, hit enter twice to get and then get passed the friendly fortune of the day message. Then a full blown TSO application layer is at the ready.

Using some of the features from Turnkey #3, the Jay Moseley tutorials, creating a batch job wasn't too difficult.

Starting with a `HELLO, WORLD` COBOL example, then modifying some JCL statements and using `sub` to `netcat` the file to the Hercules card reader port, the following JCL stream was submitted:

```
//COBUCLG  JOB (001),'COBOL BASE TEST',                                 00010000
//             CLASS=A,MSGCLASS=A,MSGLEVEL=(1,1)                        00020000
//BASETEST EXEC COBUCLG                                                 00030000
//COB.SYSIN DD *                                                        00040000
 00000* VALIDATION OF BASE COBOL INSTALL                               00050000
 01000 IDENTIFICATION DIVISION.                                         00060000
 01100 PROGRAM-ID. 'HELLO'                                              00070000
 02000 ENVIRONMENT DIVISION.                                            00080000
 02100 CONFIGURATION SECTION.                                           00090000
 02110 SOURCE-COMPUTER.  GNULINUX.                                      00100000
 02120 OBJECT-COMPUTER.  HERCULES.                                      00110000
 02200 SPECIAL-NAMES.                                                   00120000
 02210     CONSOLE IS CONSL.                                            00130000
 03000 DATA DIVISION.                                                   00140000
 04000 PROCEDURE DIVISION.                                              00150000
 04100 00-MAIN.                                                         00160000
 04110     DISPLAY 'HELLO, WORLD' UPON CONSL.                           00170000
 04120     STOP RUN.                                                    00180000
//LKED.SYSLIB DD DSNAME=SYS1.COBLIB,DISP=SHR                            00190000
//            DD DSNAME=SYS1.LINKLIB,DISP=SHR                           00200000
//GO.SYSPRINT DD SYSOUT=A                                               00210000
//                                                                      00220000
```

Which produced a printer listing (less the first line of First banner page info) ala:

```
First banner page, other page breaks removed. This line was added by hand, and was not part of the generated listing.

                    CCCCCCCCCC   OOOOOOOOOOOO  BBBBBBBBBB   UU        UU   CCCCCCCCCC   LL             GGGGGGGGGG
                  CCCCCCCCCCCC  OOOOOOOOOOOO  BBBBBBBBBBB  UU        UU  CCCCCCCCCCCC  LL           GGGGGGGGGGGG
                 CC        CC  OO        OO  BB        BB  UU        UU  CC        CC  LL           GG        GG
                CC           OO        OO  BB        BB  UU        UU  CC            LL           GG
               CC            OO        OO  BB        BB  UU        UU  CC            LL           GG
              CC             OO        OO  BBBBBBBBBB    UU        UU  CC            LL           GG
             CC              OO        OO  BBBBBBBBBB    UU        UU  CC            LL           GG
            CC               OO        OO  BB        BB  UU        UU  CC            LL           GG     GGGGG
           CC                OO        OO  BB        BB  UU        UU  CC            LL           GG     GGGGG
          CC                 OO        OO  BB        BB  UU        UU  CC            LL           GG        GG
         CC        CC  OO     OO        OO  BB        BB  UU        UU  CC        CC  LL           GG        GG
        CCCCCCCCCCCC  OOOOOOOOOOOO  BBBBBBBBBBB  UUUUUUUUUUUU  CCCCCCCCCCCC  LLLLLLLLLLLL  GGGGGGGGGGG
        CCCCCCCCCC   OOOOOOOOOOOO  BBBBBBBBBB    UUUUUUUUUU    CCCCCCCCCC   LLLLLLLLLLLL   GGGGGGGGG


                  JJJJJJJJJJ      11                                                      AAAAAAAAA
                  JJJJJJJJJJ     111                                                     AAAAAAAAAAA
                      JJ        1111                                                     AA        AA
                      JJ          11                                                     AA        AA
                      JJ          11                                                     AA        AA
                      JJ          11                                                     AAAAAAAAAAA
                      JJ          11                                                     AAAAAAAAAAA
                      JJ          11                                                     AA        AA
                JJ    JJ          11                                                     AA        AA
                JJ    JJ          11                                                     AA        AA
                JJJJJJJJ      1111111111                                               AA        AA
                 JJJJJJ       1111111111                                               AA        AA


****A  START  JOB    1  COBUCLG   COBOL BASE TEST       ROOM       5.07.22 AM 20 JUL 15  PRINTER1  SYS TK4-  JOB    1  START  A****
****A  START  JOB    1  COBUCLG   COBOL BASE TEST       ROOM       5.07.22 AM 20 JUL 15  PRINTER1  SYS TK4-  JOB    1  START  A****
****A  START  JOB    1  COBUCLG   COBOL BASE TEST       ROOM       5.07.22 AM 20 JUL 15  PRINTER1  SYS TK4-  JOB    1  START  A****
****A  START  JOB    1  COBUCLG   COBOL BASE TEST       ROOM       5.07.22 AM 20 JUL 15  PRINTER1  SYS TK4-  JOB    1  START  A****

                                    J E S 2   J O B   L O G


05.07.21 JOB    1  IEF677I WARNING MESSAGE(S) FOR JOB COBUCLG  ISSUED
05.07.21 JOB    1  $HASP373 COBUCLG  STARTED - INIT  1 - CLASS A - SYS TK4-
05.07.21 JOB    1  IEF403I COBUCLG - STARTED - TIME=05.07.21
05.07.21 JOB    1  IEC130I SYSPUNCH DD STATEMENT MISSING
05.07.21 JOB    1  IEC130I SYSLIB   DD STATEMENT MISSING
05.07.22 JOB    1  IEC130I SYSPUNCH DD STATEMENT MISSING
05.07.22 JOB    1  IEFACTRT - Stepname  Procstep  Program   Retcode
05.07.22 JOB    1  COBUCLG    BASETEST  COB       IKFCBL00  RC= 0000
05.07.22 JOB    1  COBUCLG    BASETEST  LKED      IEWL      RC= 0000
05.07.22 JOB    1  +HELLO, WORLD
05.07.22 JOB    1  COBUCLG    BASETEST  GO        PGM=*.DD  RC= 0000
05.07.22 JOB    1  IEF404I COBUCLG - ENDED - TIME=05.07.22
05.07.22 JOB    1  $HASP395 COBUCLG  ENDED


------ JES2 JOB STATISTICS ------
```

```
 20 JUL 15 JOB EXECUTION DATE

        22 CARDS READ

       179 SYSOUT PRINT RECORDS

         0 SYSOUT PUNCH RECORDS

      0.00 MINUTES EXECUTION TIME

    1     //COBUCLG  JOB (001),'COBOL BASE TEST',                                JOB    1
          //             CLASS=A,MSGCLASS=A,MSGLEVEL=(1,1)                      00020000
    2     //BASETEST EXEC COBUCLG                                                00030000
    3     XXCOBUCLG PROC SOUT='*'                                              00000100
    4     XXCOB  EXEC  PGM=IKFCBL00,                                           00000200
          XX           PARM='LOAD,SUPMAP,SIZE=2048K,BUF=1024K'                 00000300
    5     XXSYSPRINT  DD SYSOUT=&SOUT                                          00000400
    6     XXSYSUT1 DD UNIT=SYSDA,SPACE=(460,(700,100))                         00000500
    7     XXSYSUT2 DD UNIT=SYSDA,SPACE=(460,(700,100))                         00000600
    8     XXSYSUT3 DD UNIT=SYSDA,SPACE=(460,(700,100))                         00000700
    9     XXSYSUT4 DD UNIT=SYSDA,SPACE=(460,(700,100))                         00000800
   10     XXSYSLIN DD DSNAME=&LOADSET,DISP=(MOD,PASS),UNIT=SYSDA,              00000900
          XX             SPACE=(80,(500,100))                                  00001000
   11     //COB.SYSIN DD *                                                     00040000
   12     XXLKED EXEC PGM=IEWL,PARM='LIST,XREF,LET',COND=(5,LT,COB)            00001100
   13     XXSYSLIN  DD DSNAME=&LOADSET,DISP=(OLD,DELETE)                       00001200
   14     XX  DD  DDNAME=SYSIN                                                 00001300
   15     XXSYSLMOD DD DSNAME=&GODATA(RUN),DISP=(NEW,PASS),UNIT=SYSDA,         00001400
          XX             SPACE=(1024,(50,20,1))                                00001500
   16     //LKED.SYSLIB DD DSNAME=SYS1.COBLIB,DISP=SHR                         00190000
          X/SYSLIB DD   DSNAME=SYS1.COBLIB,DISP=SHR                            00001600
   17     //            DD DSNAME=SYS1.LINKLIB,DISP=SHR                        00200000
   18     XXSYSUT1 DD UNIT=(SYSDA,SEP=(SYSLIN,SYSLMOD)),SPACE=(1024,(50,20))   00001700
   19     XXSYSPRINT DD SYSOUT=&SOUT                                           00001800
   20     XXGO  EXEC PGM=*.LKED.SYSLMOD,COND=((5,LT,COB),(5,LT,LKED))          00001900
   21     //GO.SYSPRINT DD SYSOUT=A                                            00210000
          //                                                                   00220000

 STMT NO. MESSAGE
-
    5     IEF653I SUBSTITUTION JCL - SYSOUT=*
   19     IEF653I SUBSTITUTION JCL - SYSOUT=*
   20     IEF686I DDNAME REFERRED TO ON DDNAME KEYWORD IN PRIOR STEP WAS NOT RESOLVED
IEF236I ALLOC. FOR COBUCLG COB BASETEST
IEF237I JES2 ALLOCATED TO SYSPRINT
IEF237I 140  ALLOCATED TO SYSUT1
IEF237I 170  ALLOCATED TO SYSUT2
IEF237I 190  ALLOCATED TO SYSUT3
IEF237I 180  ALLOCATED TO SYSUT4
IEF237I 190  ALLOCATED TO SYSLIN
IEF237I JES2 ALLOCATED TO SYSIN
IEC130I SYSPUNCH DD STATEMENT MISSING
IEC130I SYSLIB   DD STATEMENT MISSING
IEC130I SYSPUNCH DD STATEMENT MISSING
IEF142I COBUCLG COB BASETEST - STEP WAS EXECUTED - COND CODE 0000
IEF285I   JES2.JOB00001.SO0102                        SYSOUT
IEF285I   SYS15201.T050721.RA000.COBUCLG.R0000001     DELETED       *--------6
IEF285I   VOL SER NOS= WORK00.
IEF285I   SYS15201.T050721.RA000.COBUCLG.R0000002     DELETED       *--------6
IEF285I   VOL SER NOS= WORK01.
IEF285I   SYS15201.T050721.RA000.COBUCLG.R0000003     DELETED       *--------9
IEF285I   VOL SER NOS= WORK03.
IEF285I   SYS15201.T050721.RA000.COBUCLG.R0000004     DELETED       *--------3
IEF285I   VOL SER NOS= WORK02.
IEF285I   SYS15201.T050721.RA000.COBUCLG.LOADSET      PASSED        *-------15
IEF285I   VOL SER NOS= WORK03.
IEF285I   JES2.JOB00001.SI0101                        SYSIN
IEF373I STEP /COB     / START 15201.0507
IEF374I STEP /COB     / STOP  15201.0507 CPU    0MIN 00.05SEC SRB    0MIN 00.03SEC VIRT   820K SYS   208K
*****************************************************************************************************************************
*     1. Jobstep of job: COBUCLG     Stepname: COB         Program name: IKFCBL00   Executed on 20.07.15 from 05.07.21 to 05.07.22 *
*         elapsed time  00:00:00,13                 CPU-Identifier:  TK4-          Page-in:      0                          *
*             CPU time  00:00:00,08              Virtual Storage used:    820K       Page-out:      0                          *
*           corr. CPU:  00:00:00,08   CPU time has been corrected by  1 / 1,0  multiplier                                     *
*                                                                                                                             *
*     I/O Operation                                                                                                           *
*     Number of records read via DD * or DD DATA:     14                                                                      *
*     DMY.......0 140.......6 170.......6 190.......9 180.......3 190......15 DMY.......0                                     *
*                                                                                                                             *
*                                      Charge for step (w/o SYSOUT):          0,13                                        *
*****************************************************************************************************************************
IEF236I ALLOC. FOR COBUCLG LKED BASETEST
IEF237I 190  ALLOCATED TO SYSLIN
IEF237I DMY  ALLOCATED TO
IEF237I 170  ALLOCATED TO SYSLMOD
IEF237I 148  ALLOCATED TO SYSLIB
IEF237I 148  ALLOCATED TO
IEF237I 140  ALLOCATED TO SYSUT1
IEF237I JES2 ALLOCATED TO SYSPRINT
IEF142I COBUCLG LKED BASETEST - STEP WAS EXECUTED - COND CODE 0000
IEF285I   SYS15201.T050721.RA000.COBUCLG.LOADSET      DELETED       *-------16
IEF285I   VOL SER NOS= WORK03.
IEF285I   SYS15201.T050721.RA000.COBUCLG.GODATA       PASSED        *--------9
IEF285I   VOL SER NOS= WORK01.
IEF285I   SYS1.COBLIB                                 KEPT          *--------7
IEF285I   VOL SER NOS= MVSRES.
IEF285I   SYS1.LINKLIB                                KEPT          *--------0
IEF285I   VOL SER NOS= MVSRES.
IEF285I   SYS15201.T050721.RA000.COBUCLG.R0000005     DELETED       *--------0
IEF285I   VOL SER NOS= WORK00.
IEF285I   JES2.JOB00001.SO0103                        SYSOUT
IEF373I STEP /LKED    / START 15201.0507
```

```
IEF374I STEP /LKED    / STOP  15201.0507 CPU    0MIN 00.02SEC SRB    0MIN 00.00SEC VIRT   264K SYS   200K
*************************************************************************************************************************
*     2. Jobstep of job: COBUCLG     Stepname: LKED        Program name: IEWL       Executed on 20.07.15 from 05.07.22 to 05.07.22 *
*          elapsed time  00:00:00,05                    CPU-Identifier:  TK4-           Page-in:      0                        *
*              CPU time  00:00:00,02               Virtual Storage used:    264K         Page-out:     0                        *
*            corr. CPU:  00:00:00,02   CPU time has been corrected by  1 / 1,0  multiplier                                    *
*                                                                                                                             *
*     I/O Operation                                                                                                           *
*     Number of records read via DD * or DD DATA:      0                                                                      *
*     190......16 DMY.......0 170.......9 148.......7 148.......0 140.......0 DMY.......0                                     *
*                                                                                                                             *
*                                        Charge for step (w/o SYSOUT):          0,03                                      *
*************************************************************************************************************************
IEF236I ALLOC. FOR COBUCLG GO BASETEST
IEF237I 170  ALLOCATED TO PGM=*.DD
IEF237I JES2 ALLOCATED TO SYSPRINT
HELLO, WORLD
IEF142I COBUCLG GO BASETEST - STEP WAS EXECUTED - COND CODE 0000
IEF285I   SYS15201.T050721.RA000.COBUCLG.GODATA        KEPT          *--------0
IEF285I   VOL SER NOS= WORK01.
IEF285I   JES2.JOB00001.SO0104                         SYSOUT
IEF373I STEP /GO      / START 15201.0507
IEF374I STEP /GO      / STOP  15201.0507 CPU    0MIN 00.00SEC SRB    0MIN 00.00SEC VIRT     8K SYS   188K
IEF237I 170  ALLOCATED TO SYS00001
IEF285I   SYS15201.T050722.RA000.COBUCLG.R0000001      KEPT          *--------0
IEF285I   VOL SER NOS= WORK01.
IEF285I   SYS15201.T050721.RA000.COBUCLG.GODATA        DELETED
IEF285I   VOL SER NOS= WORK01.
IEF375I  JOB /COBUCLG / START 15201.0507
IEF376I  JOB /COBUCLG / STOP  15201.0507 CPU    0MIN 00.07SEC SRB    0MIN 00.03SEC

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   1


00001    00000* VALIDATION OF BASE COBOL INSTALL                                 00050000
00002    01000 IDENTIFICATION DIVISION.                                          00060000
00003    01100 PROGRAM-ID. 'HELLO'                                               00070000
00004    02000 ENVIRONMENT DIVISION.                                             00080000
00005    02100 CONFIGURATION SECTION.                                            00090000
00006    02110 SOURCE-COMPUTER.  GNULINUX.                                       00100000
00007    02120 OBJECT-COMPUTER.  HERCULES.                                       00110000
00008    02200 SPECIAL-NAMES.                                                    00120000
00009    02210     CONSOLE IS CONSL.                                             00130000
00010    03000 DATA DIVISION.                                                    00140000
00011    04000 PROCEDURE DIVISION.                                               00150000
00012    04100 00-MAIN.                                                          00160000
00013    04110     DISPLAY 'HELLO, WORLD' UPON CONSL.                            00170000
00014    04120     STOP RUN.                                                     00180000
   2


*STATISTICS*     SOURCE RECORDS =    14     DATA DIVISION STATEMENTS =           PROCEDURE DIVISION STATEMENTS =     2
*OPTIONS IN EFFECT*     SIZE = 2097152  BUF = 1048576  LINECNT = 57  SPACE1, FLAGW,   SEQ,   SOURCE
*OPTIONS IN EFFECT*     NODMAP, NOPMAP, NOCLIST,   SUPMAP, NOXREF,   LOAD, NODECK, APOST, NOTRUNC, NOLIB, NOVERB
*OPTIONS IN EFFECT*       ZWB

 F64-LEVEL LINKAGE EDITOR OPTIONS SPECIFIED LIST,XREF,LET
          DEFAULT OPTION(S) USED -  SIZE=(231424,55296)


                                        CROSS REFERENCE TABLE


  CONTROL SECTION                       ENTRY

    NAME    ORIGIN  LENGTH                NAME   LOCATION     NAME   LOCATION     NAME   LOCATION     NAME   LOCATION
  HELLO         00     2F2
  ILBOSTP0*    2F8      35
                                        ILBOSTP1     30E


  LOCATION  REFERS TO SYMBOL  IN CONTROL SECTION             LOCATION  REFERS TO SYMBOL  IN CONTROL SECTION
      278           ILBOSTP0        ILBOSTP0                   27C           ILBOSTP1        ILBOSTP0

 ENTRY ADDRESS       00

 TOTAL LENGTH       330
****RUN       DOES NOT EXIST BUT HAS BEEN ADDED TO DATA SET
AUTHORIZATION CODE IS         0.

                     CCCCCCCCCC   OOOOOOOOOOOO  BBBBBBBBBB   UU        UU   CCCCCCCCCC   LL             GGGGGGGGGG
                   CCCCCCCCCCCC  OOOOOOOOOOOO  BBBBBBBBBBB  UU        UU  CCCCCCCCCCCC  LL           GGGGGGGGGGGG
                  CC         CC  OO        OO  BB        BB  UU        UU  CC         CC  LL           GG         GG
                 CC            OO        OO  BB        BB  UU        UU  CC            LL            GG
                CC             OO        OO  BB        BB  UU        UU  CC            LL            GG
               CC              OO        OO  BBBBBBBBBB    UU        UU  CC            LL            GG
              CC               OO        OO  BBBBBBBBBB    UU        UU  CC            LL            GG     GGGGG
             CC                OO        OO  BB        BB  UU        UU  CC            LL            GG     GGGGG
            CC                 OO        OO  BB        BB  UU        UU  CC            LL            GG        GG
           CC         CC  OO   OO        OO  BB        BB  UU        UU  CC         CC  LL            GG        GG
          CCCCCCCCCCCC  OOOOOOOOOOOO  BBBBBBBBBBB  UUUUUUUUUUU  CCCCCCCCCCCC  LLLLLLLLLLL  GGGGGGGGGGG
          CCCCCCCCCC   OOOOOOOOOOOO  BBBBBBBBBB    UUUUUUUUU    CCCCCCCCCC   LLLLLLLLLLL   GGGGGGGGG


                JJJJJJJJJJ      11                                                    AAAAAAAAAA
                JJJJJJJJJJ     111                                                   AAAAAAAAAAAA
                    JJ        1111                                                   AA        AA
                    JJ          11                                                   AA        AA
                    JJ          11                                                   AA        AA
                    JJ          11                                                   AAAAAAAAAAAA
```

```
                    JJ          11                                                          AAAAAAAAAAA
                    JJ          11                                                          AA       AA
                JJ  JJ          11                                                          AA       AA
                JJ  JJ          11                                                          AA       AA
                JJJJJJJJ   1111111111                                                       AA       AA
                 JJJJJJ    1111111111                                                       AA       AA


****A  END  JOB   1  COBUCLG  COBOL BASE TEST      ROOM       5.07.22 AM 20 JUL 15  PRINTER1  SYS TK4-  JOB   1  END  A****
****A  END  JOB   1  COBUCLG  COBOL BASE TEST      ROOM       5.07.22 AM 20 JUL 15  PRINTER1  SYS TK4-  JOB   1  END  A****
****A  END  JOB   1  COBUCLG  COBOL BASE TEST      ROOM       5.07.22 AM 20 JUL 15  PRINTER1  SYS TK4-  JOB   1  END  A****
****A  END  JOB   1  COBUCLG  COBOL BASE TEST      ROOM       5.07.22 AM 20 JUL 15  PRINTER1  SYS TK4-  JOB   1  END  A****
```

And Hercules console output of

```
05.07.21 JOB    1  IEF677I WARNING MESSAGE(S) FOR JOB COBUCLG  ISSUED
05.07.21 JOB    1  $HASP373 COBUCLG  STARTED - INIT  1 - CLASS A - SYS TK4-
05.07.21 JOB    1  IEF403I COBUCLG - STARTED - TIME=05.07.21
05.07.21 JOB    1  IEC130I SYSPUNCH DD STATEMENT MISSING
05.07.21 JOB    1  IEC130I SYSLIB   DD STATEMENT MISSING
05.07.22 JOB    1  IEC130I SYSPUNCH DD STATEMENT MISSING
05.07.22 JOB    1  IEFACTRT - Stepname  Procstep  Program   Retcode
05.07.22 JOB    1  COBUCLG    BASETEST  COB       IKFCBL00  RC= 0000
05.07.22 JOB    1  COBUCLG    BASETEST  LKED      IEWL      RC= 0000
05.07.22 JOB    1  +HELLO, WORLD
05.07.22 JOB    1  COBUCLG    BASETEST  GO        PGM=*.DD  RC= 0000
05.07.22 JOB    1  IEF404I COBUCLG - ENDED - TIME=05.07.22
05.07.22 JOB    1  $HASP395 COBUCLG  ENDED
```

And from what little I know of 1972 billing practises, I think that job (without the printed paper) would have cost `0,16` charge units, converting into some reasonable number of money units.

`TK4-` can be found at http://wotho.ethz.ch/tk4-/

8.28 JCL

Job Control Language

Batch job scripting, circa 1960, and still managing mainframes to this day.

https://en.wikipedia.org/wiki/Job_Control_Language

8.28.1 Hello, System/370 and MVT 21.8

The *Hercules* (page 1388) emulator, allows for practising JCL and ANS COBOL-68, UCOB, along with all the other nifty software that people have ported over to Hercules. The JCL below, *from an era that pre-dates the tradition of Hello, world* would have been punched on 80 column cards, and fed into to a card reader as a deck.

This is from Jay Moseley's tutorial site, reprinted with permission.

```
//COBUCLG  JOB CLASS=A,MSGCLASS=A,MSGLEVEL=(1,1)
//HELOWRLD EXEC COBUCLG,PARM.COB='MAP,LIST,LET'
//COB.SYSIN DD *
  001  IDENTIFICATION DIVISION.
  002  PROGRAM-ID.  'HELLO'.
  003  ENVIRONMENT DIVISION.
  004  CONFIGURATION SECTION.
  005  SOURCE-COMPUTER.  IBM-360.
  006  OBJECT-COMPUTER.  IBM-360.
  0065 SPECIAL-NAMES.
```

(continues on next page)

(continued from previous page)

```
  0066      CONSOLE IS CNSL.
  007   DATA DIVISION.
  008   WORKING-STORAGE SECTION.
  009   77   HELLO-CONST    PIC X(12) VALUE 'HELLO, WORLD'.
  075   PROCEDURE DIVISION.
  090   000-DISPLAY.
  100       DISPLAY HELLO-CONST UPON CNSL.
  110       STOP RUN.
//LKED.SYSLIB DD DSNAME=SYS1.COBLIB,DISP=SHR
//             DD DSNAME=SYS1.LINKLIB,DISP=SHR
//GO.SYSPRINT DD SYSOUT=A
//
```

The // lines are Job Control Language statements, surrounding COBOL sequence numbered source code. The main step of the job is the ANS COBOL Compile, Link and Go module COBUCLG. HELLO, WORLD output would have been displayed on the operator's console, and the system printer would detail the run. Lots of details. The summary output of this run is about 12 lines from the bottom of the listing.

```
//COBUCLG  JOB CLASS=A,MSGCLASS=A,MSGLEVEL=(1,1)
//HELOWRLD EXEC COBUCLG,PARM.COB='MAP,LIST,LET'
XXCOB  EXEC  PGM=IKFCBL00,REGION=86K,PARM='LOAD,SUPMAP'                 05000018
XXSYSPRINT  DD SYSOUT=A                                                 10000018
XXSYSUT1 DD UNIT=SYSDA,SPACE=(460,(700,100))                            15000018
XXSYSUT2 DD UNIT=SYSDA,SPACE=(460,(700,100))                            20000018
XXSYSUT3 DD UNIT=SYSDA,SPACE=(460,(700,100))                            25000018
XXSYSUT4 DD UNIT=SYSDA,SPACE=(460,(700,100))                            30000018
XXSYSLIN DD DSNAME=&LOADSET,DISP=(MOD,PASS),UNIT=SYSDA,                 35000018
XX             SPACE=(80,(500,100))                                     40000018
//COB.SYSIN DD *
IEF236I ALLOC. FOR COBUCLG  COB      HELOWRLD
IEF237I 352   ALLOCATED TO SYSPRINT
IEF237I 151   ALLOCATED TO SYSUT1
IEF237I 352   ALLOCATED TO SYSUT2
IEF237I 150   ALLOCATED TO SYSUT3
IEF237I 352   ALLOCATED TO SYSUT4
IEF237I 151   ALLOCATED TO SYSLIN
IEF237I 150   ALLOCATED TO SYSIN

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00001     001  IDENTIFICATION DIVISION.
00002     002  PROGRAM-ID.  'HELLO'.
00003     003  ENVIRONMENT DIVISION.
00004     004  CONFIGURATION SECTION.
00005     005  SOURCE-COMPUTER.  IBM-360.
00006     006  OBJECT-COMPUTER.  IBM-360.
00007     0065 SPECIAL-NAMES.
00008     0066     CONSOLE IS CNSL.
00009     007  DATA DIVISION.
00010     008  WORKING-STORAGE SECTION.
00011     009  77  HELLO-CONST   PIC X(12) VALUE 'HELLO, WORLD'.
00012     075  PROCEDURE DIVISION.
00013     090  000-DISPLAY.
00014     100      DISPLAY HELLO-CONST UPON CNSL.
00015     110      STOP RUN.
                           2


*STATISTICS*     SOURCE RECORDS =    15     DATA DIVISION STATEMENTS =     1     PROCEDURE DIVISION STATEMENTS =     2
*OPTIONS IN EFFECT*     SIZE =   81920  BUF =    2768  LINECNT = 57  SPACE1, FLAGW,    SEQ,    SOURCE
*OPTIONS IN EFFECT*     NODMAP, NOPMAP, NOCLIST, NOSUPMAP, NOXREF,   LOAD, NODECK, APOST, NOTRUNC, NOLIB, NOVERB
*OPTIONS IN EFFECT*       ZWB

IEC130I SYSPUNCH DD STATEMENT MISSING
IEC130I SYSLIB   DD STATEMENT MISSING
IEC130I SYSPUNCH DD STATEMENT MISSING
```

```
IEF142I - STEP WAS EXECUTED - COND CODE 0000
IEF285I   SYS84056.T093538.SV000.COBUCLG.R0000001      SYSOUT
IEF285I   VOL SER NOS= WORK02.
IEF285I   SYS84056.T093538.RV000.COBUCLG.R0000002      DELETED
IEF285I   VOL SER NOS= WORK01.
IEF285I   SYS84056.T093538.RV000.COBUCLG.R0000003      DELETED
IEF285I   VOL SER NOS= WORK02.
IEF285I   SYS84056.T093538.RV000.COBUCLG.R0000004      DELETED
IEF285I   VOL SER NOS= SYSRES.
IEF285I   SYS84056.T093538.RV000.COBUCLG.R0000005      DELETED
IEF285I   VOL SER NOS= WORK02.
IEF285I   SYS84056.T093538.RV000.COBUCLG.LOADSET       PASSED
IEF285I   VOL SER NOS= WORK01.
IEF285I   SYS84056.T093538.RV000.COBUCLG.S0000006      SYSIN
IEF285I   VOL SER NOS= SYSRES.
IEF285I   SYS84056.T093538.RV000.COBUCLG.S0000006      DELETED
IEF285I   VOL SER NOS= SYSRES.
IEF373I STEP /COB     / START 84056.0937
IEF374I STEP /COB     / STOP  84056.0937 CPU   0MIN 00.08SEC MAIN  84K LCS   0K
XXLKED EXEC PGM=IEWL,PARM='LIST,XREF,LET',COND=(5,LT,COB),REGION=96K    45000018
XXSYSLIN  DD DSNAME=&LOADSET,DISP=(OLD,DELETE)                          50000018
XX  DD  DDNAME=SYSIN                                                    55000018
XXSYSLMOD DD DSNAME=&GODATA(RUN),DISP=(NEW,PASS),UNIT=SYSDA,            60000018
XX             SPACE=(1024,(50,20,1))                                   65000018
//LKED.SYSLIB DD DSNAME=SYS1.COBLIB,DISP=SHR
X/SYSLIB DD   DSNAME=SYS1.COBLIB,DISP=SHR                               70000018
//            DD DSNAME=SYS1.LINKLIB,DISP=SHR
XXSYSUT1 DD UNIT=(SYSDA,SEP=(SYSLIN,SYSLMOD)),SPACE=(1024,(50,20))      75000018
XXSYSPRINT DD SYSOUT=A                                                  80000018
IEF236I ALLOC. FOR COBUCLG  LKED     HELOWRLD
IEF237I 151   ALLOCATED TO SYSLIN
IEF237I 151   ALLOCATED TO SYSLMOD
IEF237I 350   ALLOCATED TO SYSLIB
IEF237I 350   ALLOCATED TO
IEF237I 150   ALLOCATED TO SYSUT1
IEF237I 151   ALLOCATED TO SYSPRINT

F128-LEVEL LINKAGE EDITOR OPTIONS SPECIFIED LIST,XREF,LET
          DEFAULT OPTION(S) USED -  SIZE=(131072,18432)


                                              CROSS REFERENCE TABLE


  CONTROL SECTION                       ENTRY

    NAME    ORIGIN  LENGTH                NAME   LOCATION     NAME   LOCATION     NAME   LOCATION     NAME   LOCATION

  HELLO         00     308
  ILBODSP0*    308     700
  ILBOSTP0*    A08      35
                                       ILBOSTP1     A1E


  LOCATION  REFERS TO SYMBOL  IN CONTROL SECTION             LOCATION  REFERS TO SYMBOL  IN CONTROL SECTION

     260            ILBOSTP0        ILBOSTP0                    264            ILBODSP0        ILBODSP0
     268            ILBOSTP1        ILBOSTP0
 ENTRY ADDRESS       00
 TOTAL LENGTH       A40

****RUN       DOES NOT EXIST BUT HAS BEEN ADDED TO DATA SET


IEF142I - STEP WAS EXECUTED - COND CODE 0000
IEF285I   SYS84056.T093538.RV000.COBUCLG.LOADSET       DELETED
IEF285I   VOL SER NOS= WORK01.
IEF285I   SYS84056.T093538.RV000.COBUCLG.GODATA        PASSED
IEF285I   VOL SER NOS= WORK01.
IEF285I   SYS1.COBLIB                                  KEPT
IEF285I   VOL SER NOS= MVTRES.
IEF285I   SYS1.LINKLIB                                 KEPT
IEF285I   VOL SER NOS= MVTRES.
IEF285I   SYS84056.T093538.RV000.COBUCLG.R0000007      DELETED
IEF285I   VOL SER NOS= SYSRES.
IEF285I   SYS84056.T093538.SV000.COBUCLG.R0000008      SYSOUT
IEF285I   VOL SER NOS= WORK01.
IEF373I STEP /LKED    / START 84056.0937
IEF374I STEP /LKED    / STOP  84056.0937 CPU   0MIN 00.04SEC MAIN  96K LCS   0K
XXGO  EXEC PGM=*.LKED.SYSLMOD,COND=((5,LT,COB),(5,LT,LKED))             85000018
//GO.SYSPRINT DD SYSOUT=A
```

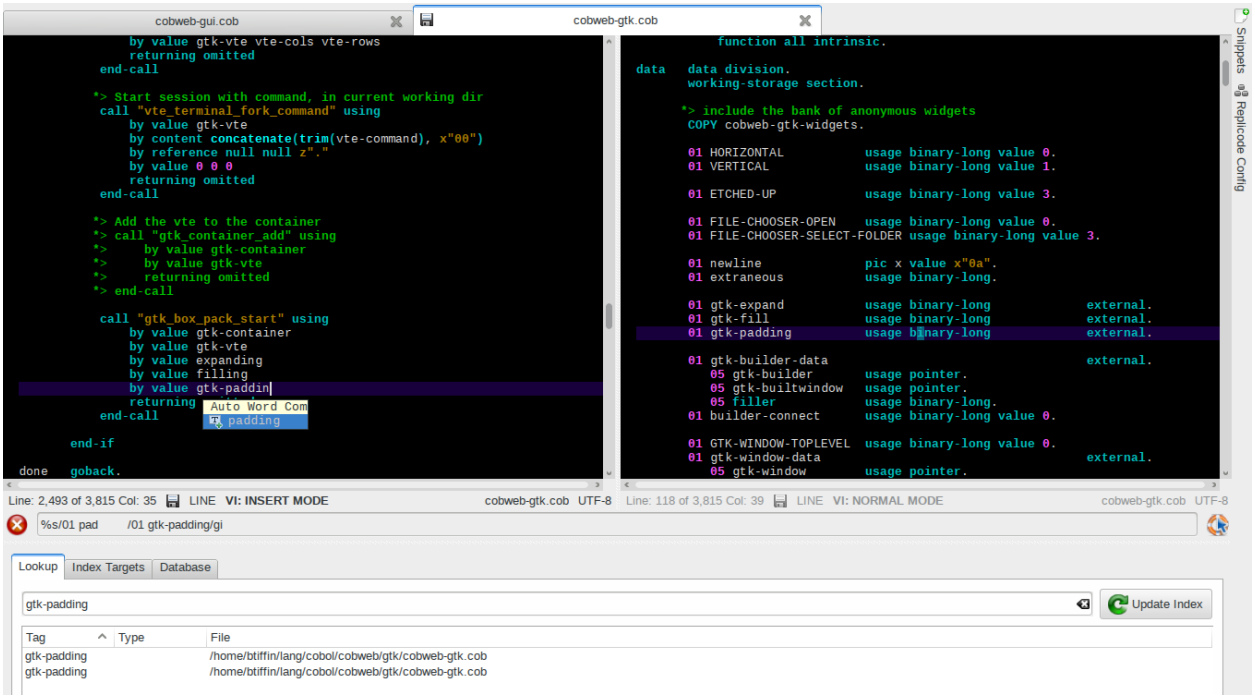
```
//
IEF236I ALLOC. FOR COBUCLG  GO       HELOWRLD
IEF237I 151   ALLOCATED TO PGM=*.DD
IEF237I 352   ALLOCATED TO SYSPRINT
HELLO, WORLD
IEF142I - STEP WAS EXECUTED - COND CODE 0000
IEF285I   SYS84056.T093538.RV000.COBUCLG.GODATA        PASSED
IEF285I   VOL SER NOS= WORK01.
IEF285I   SYS84056.T093538.SV000.COBUCLG.R0000009      DELETED
IEF285I   VOL SER NOS= WORK02.
IEF373I STEP /GO      / START 84056.0937
IEF374I STEP /GO      / STOP  84056.0937 CPU   0MIN 00.01SEC MAIN   8K LCS   0K
IEF285I   SYS84056.T093538.RV000.COBUCLG.GODATA        DELETED
IEF285I   VOL SER NOS= WORK01.
IEF375I  JOB /COBUCLG / START 84056.0937
IEF376I  JOB /COBUCLG / STOP  84056.0937 CPU   0MIN 00.13SEC
```

Produced using the Hercules emulator, running OS/360 MVT 21.8f, sourced at http://www.jaymoseley.com/hercules/install.htm

8.29 Kate

Kate is the KDE Advanced Text Editor and it has some nice features when it comes to GnuCOBOL development. Capable of a Vi input mode, this graphical based editor is a nice mix of modal editing power and gui.

Kate with a dark theme, using CTags to assist with a bulk change to a variable name.



8.29.1 cobol.xml

Here is a COBOL syntax highlighting file, posted to the OpenCOBOL mailing list in 2007 by Bob Willan. Updated slightly for GnuCOBOL, and to be friendlier to free format COBOL sources. This would be placed in `/usr/share/kde4/apps/katepart/syntax/cobol.xml` (or similar directory, depending on operating system setup). Then choose Tools->Mode->Sources->Cobol.

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE language SYSTEM "language.dtd">
<!-- Cobol highlighting for Kate by Robert G. Willan
     Thanks to Matthias M. Schneider, who's COBOL mode for JEdit I copied
     the list of keywords from.  Tweaks for GnuCOBOL by Brian Tiffin.
     -->
<language name="Cobol" version="1.00" kateversion="2.4" section="Sources"
          extensions="*.cbl;*.cob;*.pco"
          mimetype="application/x-cobol;text/x-cobol"
          casesensitive="0"
          author="Robert G. Willan" license="">
  <highlighting>
    <list name="keyword">
      <item> ACCEPT </item>
      <item> ACCESS </item>
      <item> ACTUAL </item>
      <item> ADD </item>
      <item> ADDRESS </item>
      <item> ADVANCING </item>
      <item> AFTER </item>
      <item> ALL </item>
      <item> ALLOCATE </item>
      <item> ALPHABET </item>
      <item> ALPHABETIC </item>
      <item> ALPHABETIC-LOWER </item>
      <item> ALPHABETIC-UPPER </item>
      <item> ALPHANUMERIC </item>
      <item> ALPHANUMERIC-EDITED </item>
      <item> ALSO </item>
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      <item> CONCATENATE </item>
      <item> COS </item>
      <item> CURRENT-DATE </item>
      <item> DATE-OF-INTEGER </item>
      <item> DATE-TO-YYYYMMDD </item>
      <item> DAY-OF-INTEGER </item>
      <item> DAY-TO-YYYYDD </item>
      <item> E </item>
      <item> EXCEPTION-FILE </item>
      <item> EXCEPTION-LOCATION </item>
      <item> EXCEPTION-STATEMENT </item>
      <item> EXCEPTION-STATUS </item>
      <item> EXP </item>
      <item> EXP10 </item>
      <item> FACTORIAL </item>
      <item> FORMATTED-CURRENT-DATE </item>
      <item> FORMATTED-DATE </item>
      <item> FORMATTED-DATETIME </item>
      <item> FORMATTED-TIME </item>
      <item> FRACTION-PART </item>
      <item> HIGHEST-ALGEBRAIC </item>
      <item> INTEGER </item>
      <item> INTEGER-OF-DATE </item>
      <item> INTEGER-OF-DAY </item>
      <item> INTEGER-OF-FORMATTED-DATE </item>
      <item> INTEGER-PART </item>
      <item> LENGTH-AN </item>
      <item> LOCALE- </item>
      <item> LOG </item>
      <item> LOCALE-COMPARE </item>
      <item> LOCALE-DATE </item>
```

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```
      <item> LOCALE-TIME </item>
      <item> LOCALE-TIME-FROM-SECONDS </item>
      <item> LOG10 </item>
      <item> LOWER-CASE </item>
      <item> HIGHEST-ALGEBRAIC </item>
      <item> MAX </item>
      <item> MEAN </item>
      <item> MEDIAN </item>
      <item> MIDRANGE </item>
      <item> MIN </item>
      <item> MODULE-CALLER-ID </item>
      <item> MODULE-DATE </item>
      <item> MODULE-FORMATTED-TIME </item>
      <item> MODULE-ID </item>
      <item> MODULE-PATH </item>
      <item> MODULE-SOURCE </item>
      <item> MODULE-TIME </item>
      <item> MONETARY-DECIMAL-POINT </item>
      <item> MONETARY-THOUSANDS-SEPARATOR </item>
      <item> NUMERIC-DECIMAL-POINT </item>
      <item> NUMERIC-THOUSANDS-SEPARATOR </item>
      <item> NUMVAL </item>
      <item> NUMVAL-C </item>
      <item> NUMVAL-F </item>
      <item> ORD </item>
      <item> ORD-MAX </item>
      <item> ORD-MIN </item>
      <item> PI </item>
      <item> PRESENT-VALUE </item>
      <item> RANDOM </item>
      <item> RANGE </item>
      <item> REM </item>
      <item> REVERSE </item>
      <item> SECONDS-FROM-FORMATTED-TIME </item>
      <item> SECONDS-PAST-MIDNIGHT </item>
      <item> SIGN </item>
      <item> SIN </item>
      <item> SQRT </item>
      <item> STANDARD-DEVIATION </item>
      <item> STORED-CHAR-LENGTH </item>
      <item> SUBSTITUTE </item>
      <item> SUBSTITUTE-CASE </item>
      <item> SUM </item>
      <item> TAN </item>
      <item> TEST-DATE-YYYYMMDD </item>
      <item> TEST-DAY-YYYYDDD </item>
      <item> TEST-FORMATTED-DATETIME </item>
      <item> TEST-NUMVAL </item>
      <item> TEST-NUMVAL-C </item>
      <item> TEST-NUMVAL-F </item>
      <item> TRIM </item>
      <item> UPPER-CASE </item>
      <item> VARIANCE </item>
      <item> WHEN-COMPILED </item>
      <item> YEAR-TO-YYYY </item>
    </list>
```

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```
    <list name="operators">
      <item> AND </item>
      <item> OR </item>
      <item> NOT </item>
    </list>

    <list name="prep">
      <item> [COPY-PREFIX] </item>
      <item> [COUNT] </item>
      <item> [DISPLAY] </item>
      <item> [EXECUTE] </item>
      <item> [PG] </item>
      <item> [PREFIX] </item>
      <item> [PROGRAM] </item>
      <item> [SPECIAL-PREFIX] </item>
      <item> [TESTCASE] </item>
    </list>

    <contexts>
      <context name="Normal" attribute="Normal Text" lineEndContext="#stay">
        <!-- Embedded SQL, treated as a special code block.  Must be first,
             before the Keywords are declared (EXEC is also a keyword). -->
        <StringDetect attribute="Embedded SQL" String="EXEC SQL" context="sql-code"/>

        <keyword attribute="Preprocessor"     String="prep"         context="#stay"/>
        <keyword attribute="Keyword"          String="keyword"      context="#stay"/>
        <keyword attribute="Builtin Function" String="builtinfuncs" context="#stay"/>
        <keyword attribute="Operator"         String="operators"    context="#stay"/>
        <keyword attribute="Embedded SQL"     String="specialvars"  context="#stay"/>

        <!-- Note that these comment lines must be before the operators, etc,
             because the RegExpr's are searched in the order they are declared
             in this file, and if the '*' operator comes first, then the
             comments starting with '*' in col 7 don't get recognized. -->
        <!-- Comment: * in col 7 means rest of line is a comment -->
        <DetectChar   attribute="Comment" char="*"         context="line-comment"
                      column   ="6"/>
        <DetectChar   attribute="Comment" char="*"         context="line-comment"
                      column   ="0"/>
        <RegExpr      attribute="Comment" String="\*&gt;"  context="line-comment" />

        <!-- Comment: columns 73-80 are always comments -->
        <!-- <RegExpr      attribute="Comment" String=".+"      context="#stay"
                    column   ="72"/> -->
        <!-- Comment: columns 1-6 are line-numbering or comments (Micro Focus) -->
        <!-- <RegExpr      attribute="Comment" String="^......" context="#stay"/> -->

        <!-- Special highlighting for paragraph names - Starts in col7 and ends with
             either a period or the word SECTION. -->
        <RegExpr attribute="Paragraph" String="[-0-9a-zA-Z]+(?=( *\.)|( +SECTION *\.))
↪"
                 context  ="#stay"     column="7"/>

        <!-- Single Quoted and Double Quoted strings -->
        <!-- Note that strings continued across lines using continuation '-' in
             column 7 are not considered.  Any program having such continuations
             will get its highlighting messed up because of unmatched quotes. -->
```

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```
    <DetectChar   attribute="String"  char="'"      context="single-Q-string"/>
    <DetectChar   attribute="String"  char="&quot;" context="double-Q-string"/>

    <RegExpr attribute="String"  String="z'"
             context="single-Q-string"/>
    <RegExpr attribute="String"  String="z&quot;"
             context="double-Q-string"/>

    <!-- compiler directives -->
    <RegExpr attribute="String"       String=">>"        context="#stay"/>

    <!-- This is required so identifiers stay normal.  Otherwise, you have to
         mess with the Integers regex to try to allow S9V99 and such, which
          I couldn't make work. -->
    <RegExpr attribute="Normal" String="[0-9a-zA-Z]+[-a-zA-Z][\-0-9a-zA-Z]*"
             context  ="#stay"/>

    <!-- Highlighting for numbers -->
    <RegExpr attribute="Int"     String="[0-9]+"
             context  ="#stay"/>
    <RegExpr attribute="Int"     String="[-+]?[0-9]*\.?[0-9]+([eE][-+]?[0-9]+)?"
             context  ="#stay"/>
    <RegExpr attribute="String"  String="[Xx]&quot;[0-9a-fA-F]+&quot;"
             context  ="#stay"/>

    <!-- Hex strings X, and hex integers, H -->
    <RegExpr attribute="String"  String="[Xx]'[0-9a-fA-F]+'"
             context="#stay"/>
    <RegExpr attribute="Int"     String="[Hh]'[0-9a-fA-F]+'"
             context="#stay"/>
    <RegExpr attribute="Int"     String="[Hh]&quot;[0-9a-fA-F]+&quot;"
             context="#stay"/>

    <RegExpr attribute="Octal"   String="%[1-9]\d*"
             context  ="#stay"/>

    <!-- Operators defined here.  The minus is separate because it must be
         separated by spaces, since otherwise it could just be part of an
          identifier name. -->
    <RegExpr      attribute="Operator" context="#stay"
                  String="[\-+*/%\|\[\]\{\}=\!&lt;&gt;!^&amp;~]"/>
    <StringDetect attribute="Operator" String=" - "     context="#stay"/>
    <RegExpr      attribute="Keyword"  String="[\(\)]"  context="#stay"/>
  </context>

  <context name="line-comment" attribute="Comment" lineEndContext="#pop">
    <HlCChar      attribute="Comment"                   context="#stay"/>
  </context>

  <context name="sql-code" attribute="Embedded SQL" lineEndContext="#stay">
    <HlCChar      attribute="Embedded SQL"                    context="#stay"/>
    <StringDetect attribute="Embedded SQL" String="END-EXEC" context="#pop"/>

    <!-- Comment: * in col 7 means rest of line is a comment -->
    <DetectChar attribute="Comment" char="*"         context="line-comment"
                column   ="6"/>
    <DetectChar   attribute="Comment" char="*"         context="line-comment"
```

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```
                    column   ="0"/>
      <RegExpr      attribute="Comment" String="\*&gt;"  context="line-comment" />

      <!-- Comment: columns 73-80 are always comments -->
      <!-- <RegExpr    attribute="Comment" String=".+"      context="#stay"
                    column   ="72"/> -->
      <!-- Comment: columns 1-6 are line-numbering or comments (Micro Focus) -->
      <!-- <RegExpr    attribute="Comment" String="^......" context="#stay"/> -->
    </context>

    <context name="single-Q-string" attribute="String" lineEndContext="#stay">
      <HlCStringChar attribute="String"                      context="#stay"/>
      <RegExpr       attribute="Operator" String="%[a-zA-Z]" context="#stay"/>
      <DetectChar    attribute="String"   char="'"           context="#pop"/>
    </context>

    <context name="double-Q-string" attribute="String" lineEndContext="#stay">
      <HlCStringChar attribute="String"                      context="#stay"/>
      <RegExpr       attribute="Operator" String="%[a-zA-Z]" context="#stay"/>
      <DetectChar    attribute="String"   char="&quot;"      context="#pop"/>
    </context>

   </contexts>
   <itemDatas>
     <itemData name="Normal Text"      defStyleNum="dsNormal"/>
     <itemData name="Keyword"          defStyleNum="dsKeyword"/>
     <itemData name="Operator"         defStyleNum="dsChar"/>
     <itemData name="Builtin Function" defStyleNum="dsDataType"/>
     <itemData name="Paragraph"        defStyleNum="dsRegionMarker"/>
     <itemData name="Embedded SQL"     defStyleNum="dsOthers"/>
     <itemData name="Preprocessor"     defStyleNum="dsChar"/>
     <itemData name="Comment"          defStyleNum="dsComment"/>
     <itemData name="String"           defStyleNum="dsString"/>
     <itemData name="Int"              defStyleNum="dsDecVal"/>
     <itemData name="Hex"              defStyleNum="dsString"/>
     <itemData name="Octal"            defStyleNum="dsString"/>
    </itemDatas>
  </highlighting>
   <general>
     <!-- Must use WeakDelimiter because some keywords are made up of two
          words separated by a dash. -->
     <keywords casesensitive   = "0"
               weakDeliminator = "-"/>
   </general>
</language>
<!--
// kate: space-indent on; indent-width 2; replace-tabs on;
-->
```

8.30 libpgsql.cob

Posted to opencobol.org back in 2009.

```
>>SOURCE FORMAT IS FREE
*>*****************************************************************
*> OpenCobol/Postgresql engine
*>
*> Compile with:
*>
*>
*>     cobc -m -free libpgsql.cbl -lpq
*>
*> Refer to libpq-fe.h for data definitions
*> Refer to http://www.postgresql.org/docs/8.3/static/libpq.html
*>
*> Change History:
*> 2008-Oct-3 gc Created from lessons learned in psqltest.cbl
*> 2009-Nov   gc return a list of base tables
*> 2009-Dec   gc Clean up libpq field translation errors
*>
*> Roger While says the USAGE BINARY-XXX [SIGNED/UNSIGNED]
*> where XXX is CHAR, SHORT, LONG, DOUBLE
*> giving 1, 2, 4, 8 byte binary fields
*>
*> Copyright (c) 2008 Gerald Chudyk <gchudyk@ekotech.com>
*>
*> Permission to use, copy, modify, and distribute this software for any
*> purpose with or without fee is hereby granted, provided that the above
*> copyright notice and this permission notice appear in all copies.
*>
*> THE SOFTWARE IS PROVIDED "AS IS" AND THE AUTHOR DISCLAIMS ALL WARRANTIES
*> WITH REGARD TO THIS SOFTWARE INCLUDING ALL IMPLIED WARRANTIES OF
*> MERCHANTABILITY AND FITNESS. IN NO EVENT SHALL THE AUTHOR BE LIABLE FOR
*> ANY SPECIAL, DIRECT, INDIRECT, OR CONSEQUENTIAL DAMAGES OR ANY DAMAGES
*> WHATSOEVER RESULTING FROM LOSS OF USE, DATA OR PROFITS, WHETHER IN AN
*> ACTION OF CONTRACT, NEGLIGENCE OR OTHER TORTIOUS ACTION, ARISING OUT OF
*> OR IN CONNECTION WITH THE USE OR PERFORMANCE OF THIS SOFTWARE.
*>
*>
*>*****************************************************************
 identification division.
 program-id. libpgsql.
 environment division.
 configuration section.
 special-names.
 crt status is crtStatus.
 Repository.
    Function all intrinsic. *> removes need for 'function' keyword
 input-output section.
 file-control.
 select log-file assign to "psqlog.txt"
     organization is line sequential.
 data division.
 file section.
 fd  log-file.
 01  log-rec                pic x(80).
 01  filler redefines log-rec.
     05 log-date            pic 999/99/99.
     05 filler              pic x.
     05 log-text            pic x(70).
```

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```
working-storage section.
01  sw-debug-switch         pic x value space.
    88 sw-debug             value "D" false space.

01  charCommand             pic x(10).
01  charConninfo            pic x(512).
01  charConninfoStatus      pic x(128).
01  charDate                pic 999/999/99.
01  charFrom                pic x(1023).
01  charPQerrorMessage      pic x(1024).
01  charParameterStatus     pic x(128).
01  charParamName           pic x(30).
01  charSelectTables        pic x(100) value
    "SELECT table_name, table_type FROM INFORMATION_SCHEMA.TABLES" &
    " where table_schema='public';" & x"00".
01  charTo                  pic x(2048).
01  charVersion             pic x(4) value "v1.0".

01  crtStatus.
     05 crtStatusKey1        pic 9.
     05 crtStatusKey2        pic 9.
     05 crtStatusFunctionKey redefines crtStatusKey2 pic 99 comp.
     05 crtStatusKey3        pic 99 comp.
     05 filler               pic x.

01  vTemp                    pic x(1024)  based.

01  ptrFieldName            usage pointer.
01  ptrExecStatusType       usage pointer.
01  ptrPQcmdStatus          usage pointer.
01  ptrPQcmdTuples          usage pointer.
01  ptrPGconn               usage pointer.
01  ptrPQerrorMessage       usage pointer.
01  ptrPQescapeByteaConn    usage pointer.
01  ptrPGExecStatusType     usage pointer.
01  ptrPQfname              usage pointer.
01  ptrPQgetvalue           usage pointer.
01  ptrPQoidStatus          usage pointer.
01  ptrPQparameterStatus    usage pointer.
01  ptrPQprint              usage pointer.
01  ptrPQresStatus          usage pointer.
01  ptrPGresult             usage pointer.
01  intptrPGresult      redefines ptrPGresult usage binary-long.
01  ptrPQresultErrorMessage usage pointer.
01  ptrPQresultErrorField   usage pointer.
01  intptrPQresultErrorField redefines ptrPQresultErrorField usage binary-long.
01  ptrPQftablecol          usage pointer.
01  ptrReturn               usage pointer.
01  ptrTableOID             usage pointer.


01  dbName                  pic x(128) value "mentor".
01  dbUser                  pic x(128) value "gc".
01  dbPassword              pic x(128) value "2manysecrets".
01  dbHost                  pic x(128) value "amnesiac.eko.lan".
01  dbHostAddr              pic x(128) value "192.168.2.4".
01  dbPort                  pic x(128) value "5432".
```

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```
 01  dbOptions               pic x(128).
 01  dbServerVersion         usage binary-long.
 01  dbErrorMsg              pic x(1000).

 01  intCharCount                    usage binary-long.
 01  intColumnCount                  usage binary-long.
 01  intColumnNumber                 usage binary-long.
 01  intConnStatusType               usage binary-long. *> connection status.
     88 CONNECTION_OK               value 0.
     88 CONNECTION_BAD              value 1.
*>   Additional asynchronous (nonblocking) connection status values follow:
*>   The existence of these should never be relied upon.
*>   They should only be used for user feedback or similar purposes.
     88 CONNECTION_STARTED          value 2. *> Waiting for connection to be made.
     88 CONNECTION_MADE             value 3. *> Connection OK; waiting to send.
     88 CONNECTION_AWAITING_RESPONSE value 4. *> Waiting for a response from the␣
↪postmaster.
     88 CONNECTION_AUTH_OK          value 5. *> Received authentication; waiting for␣
↪backend startup.
     88 CONNECTION_SETENV        value 6. *> Negotiating SSL.
     88 CONNECTION_SSL_STARTUP       value 7. *> Negotiating SSL.
     88 CONNECTION_NEEDED        value 8. *> Negotiating SSL.

 01  intDate                         pic 9(8) comp-5.

 01  intError                        usage binary-long.

 01  intExecStatusType               usage binary-long.
     88 PGRES_EMPTY_QUERY           value 0. *> Empty query string was executed
     88 PGRES_COMMAND_OK            value 1. *> A query command that doesn't return
                                             *>   anything was executed properly by␣
↪the
                                             *>   backend
     88 PGRES_TUPLES_OK             value 2. *> A query command that returns tuples␣
↪was
                                             *>   executed properly by the backend,␣
↪PGresult
                                             *>   contains the result tuples
     88 PGRES_COPY_OUT              value 3. *> Copy Out data transfer in progress
     88 PGRES_COPY_IN               value 4. *> Copy In data transfer in progress
     88 PGRES_BAD_RESPONSE          value 5. *> An unexpected response was recv'd␣
↪from the backend
     88 PGRES_NONFATAL_ERROR        value 6. *> Notice or warning message
     88 PGRES_FATAL_ERROR           value 7. *> Query failed

 01  intFieldCode                    usage binary-long.
     88 PG_DIAG_SEVERITY          value "S".
     88 PG_DIAG_SQLSTATE          value "C".
     88 PG_DIAG_MESSAGE_PRIMARY       value "M".
     88 PG_DIAG_MESSAGE_DETAIL        value "D".
     88 PG_DIAG_MESSAGE_HINT      value "H".
     88 PG_DIAG_STATEMENT_POSITION    value "P".
     88 PG_DIAG_INTERNAL_POSITION     value "p".
     88 PG_DIAG_INTERNAL_QUERY        value "q".
     88 PG_DIAG_CONTEXT           value "W".
     88 PG_DIAG_SOURCE_FILE       value "F".
     88 PG_DIAG_SOURCE_LINE       value "L".
```

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```
    88 PG_DIAG_SOURCE_FUNCTION       value "R".

01  intFromLength                    usage binary-long.

01  intPGresult                usage binary-long.

01  intPostgresPollingStatusType     usage binary-long.
    88  PGRES_POLLING_FAILED         value 0.
    88  PGRES_POLLING_READING        value 1. *> These two indicate that one may
    88  PGRES_POLLING_WRITING        value 2. *> use select before polling again
    88  PGRES_POLLING_OK             value 3. *>
01  intPGexecStatusType              usage binary-long.
01  intPGTransactionStatusType       usage binary-long.
    88 PQTRANS_IDLE                   value 0. *> connection idle
    88 PQTRANS_ACTIVE                 value 1. *> command in progress
    88 PQTRANS_INTRANS                value 2. *> idle, within transaction block
    88 PQTRANS_INERROR                value 3. *> idle, within failed transaction
    88 PQTRANS_UNKNOWN                value 4. *> cannot determine status
01  intPGVerbosity                   usage binary-long.
    88 PQERRORS-TERSE                 value 0. *> single-line error messages
    88 PQERRORS-DEFAULT               value 1. *> recommended style
    88 PQERRORS-VERBOSE               value 2. *> all the facts, ma'am
01  intPQbackendPID                  usage binary-long.
01  intPQconnectionNeedsPassword     usage binary-long.
01  intPQconnectionUsedPassword      usage binary-long.
01  intPQntuples                     usage binary-long.
01  intPQnfields                     usage binary-long.
01  intPQfnumber                     usage binary-long.
01  intPQftablecol                   usage binary-long.
01  intPQfformat                     usage binary-long.
    88 PQFFORMAT_TEXT                value 0.
    88 PQFFORMAT_BINARY              value 1.
01  intPQfsize                       usage binary-long.
01  intPQbinaryTuples                usage binary-long.
01  intPQfmod                        usage binary-long.
01  intPQgetisnull                   usage binary-long.
88 PQGETISNULL-TRUE           value 1.
88 PQGETISNULL-FALSE          value zero.
01  intPQgetlength                   usage binary-long.
01  intPQnparams                     usage binary-long.
01  intPQsocket                usage binary-long.
01  intResult                        usage binary-long.
01  intRowNumber                     usage binary-long.
01  intToLength                      usage binary-long.

01  lngFieldLength                   usage binary-long.

01  oidPQftype                       usage binary-long.
01  oidPQparamtype                   usage binary-long.
01  oidPQoidValue                    usage binary-long.

01  sqlCommand                       pic x(1024).
01  sqlRequest                       pic x(50).
    88 sqlRequestConnect_timeout     value "connect_timeout".
    88 sqlRequestCreate              value "create".
    88 sqlRequestDelete              value "delete".
    88 sqlRequestDbname              value "dbname".
```

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```
    88 sqlRequestGsslib              value "gsslib".
    88 sqlRequestHost                value "host".
    88 sqlRequestHostaddr            value "hostaddr".
    88 sqlRequestKrbsrvname          value "krbsrvname".
    88 sqlRequestOptions             value "options".
    88 sqlRequestPassword            value "password".
    88 sqlRequestPort                value "port".
    88 sqlRequestRequiressl          value "requiressl".
    88 sqlRequestSelect              value "sql".
    88 sqlRequestService             value "service".
    88 sqlRequestSslmode             value "sslmode".
    88 sqlRequestTty                 value "tty".
    88 sqlRequestUser                value "user".

01  sqlString                        pic x(1024).

01  tblPGtype.
    05 tblPGtype-tuple               occurs 300 times.
      10 tblPGtypeOID                pic x(4) comp-x.
      10 tblPGtypeName               pic x(23).

Linkage Section.

copy '../cpy/lsrecord.cpy'.

procedure division using lsRecord lsRequest lsReply.

main.
    perform a-initialize
    evaluate true
    when DEBUG_COMMAND
   perform b-set-debug
    when START_DB_COMMAND
       perform c-start-db
    when CLOSE_DB_COMMAND
       perform d-close-db
    when START_CONN_COMMAND
       perform e-start-connection
when POLL_COMMAND
   perform f-poll-connection
    when CLOSE_CONN_COMMAND
       perform g-close-connection
    when GET_DBNAME_COMMAND
       perform h-get-db-name
    when GET_BASE_TABLES_COMMAND
       perform j-get-base-table-list
    when SQL_COMMAND
       perform x-sql-exec
    when MORE_COMMAND
       perform y-reply-to-select
    when other
       set LS_BAD_COMMAND to true
    end-evaluate
    exit program
    stop run
    .
a-initialize.
```

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```
    if lsConnHandle not = null
       set ptrPGconn to lsConnHandle
    end-if
    .
b-set-debug.
    set SW-DEBUG to true
    open output log-file
    initialize log-rec
    accept intDate from date
    move intDate to log-date
    string charVersion " Debug started " delimited by size into log-text
    write log-rec
    .
c-start-db.
    if lsConnHandle = null
       if lsRequest > space
          move lsRequest to charConnInfo
  initialize intCharCount
          compute intCharCount = length(charConnInfo)
          perform varying intCharCount from intCharCount by -1
             until intCharCount = 1
             or charConnInfo(intCharCount:1) > space
          end-perform
          add 1 to intCharCount
          move low-value to charConnInfo(intCharCount:1)
          perform pq-connect-db
          set lsConnHandle to ptrPGconn
          perform pq-status
          if CONNECTION_OK
             set LS_RESULT_OK to true
          else
  if CONNECTION_STARTED
      display "Waiting for connection to be made"
  else
  if CONNECTION_MADE
      display "Connection OK; waiting to send"
  else
  if CONNECTION_AWAITING_RESPONSE
      display "Waiting for a response from the postmaster"
  else
              set LS_CONNECTION_ATTEMPT_FAILED to true
          end-if
       else
          set LS_CONNECTION_DATA_REQUIRED to true
       end-if
else
       set LS_CONNECTION_HANDLE_NOT_EMPTY to true
    end-if
    .
d-close-db.
    perform pq-clear
    initialize lsRecordHandle
    .
e-start-connection.
    if lsConnHandle = null
       if lsRequest > space
          move lsRequest to charConnInfo
```

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```
   initialize intCharCount
           compute intCharCount = length(charConnInfo)
           perform varying intCharCount from intCharCount by -1
              until intCharCount = 1
              or charConnInfo(intCharCount:1) > space
           end-perform
           add 1 to intCharCount
           move low-value to charConnInfo(intCharCount:1)
           perform pq-connect-start
           set lsConnHandle to ptrPGconn
           perform pq-status
           if CONNECTION_OK
              set LS_RESULT_OK to true
           else
   if CONNECTION_STARTED
       display "Waiting for connection to be made"
   else
   if CONNECTION_MADE
       display "Connection OK; waiting to send"
   else
   if CONNECTION_AWAITING_RESPONSE
       display "Waiting for a response from the postmaster"
   else
               set LS_CONNECTION_ATTEMPT_FAILED to true
           end-if
         else
           set LS_CONNECTION_DATA_REQUIRED to true
         end-if
 else
         set LS_CONNECTION_HANDLE_NOT_EMPTY to true
     end-if
     .

 f-poll-connection.
     perform pq-connect-poll
 if PGRES_POLLING_OK
         set LS_RESULT_OK to true
 else if PGRES_POLLING_READING
    set LS_CONNECTION_POLL_READING to true
 else if PGRES_POLLING_WRITING
    set LS_CONNECTION_POLL_WRITING to true
 else if PGRES_POLLING_FAILED
         set LS_CONNECTION_ATTEMPT_FAILED to true
         set lsConnHandle to null
 end-if
 .
 g-close-connection.
     perform pq-finish
     initialize lsRecord
     .
 h-get-db-name.
     perform pq-db
 move dbName to lsReply
     .
 j-get-base-table-list.
*> This paragraph will return a list of base tables
*> in the current database.
```

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```
*>
*> If this paragraph is called with lsRecordCount initialized
*> to zero then the lsRecordCount will be set to the number
*> of base tables in the list, lsRecordCusor will be set to 1,
*>  lsFieldLength will give the length of the first record,
*> and the first record will be in lsReply.
*>
*> Subsequent calls will result in lsRecordCursor being incremented
*> by 1 until all valid records have been returned.
*>
*> Fields in record will be separated by 1 low-value character.
*>
*>
 Move charSelectTables to sqlCommand
     perform pq-exec
     perform pq-result-status
 if (PGRES_BAD_RESPONSE
 or PGRES_NONFATAL_ERROR
 or PGRES_FATAL_ERROR)
        initialize lsReply vTemp
        perform pq-error-message
        set address of vTemp to ptrPQerrorMessage
        unstring vTemp delimited by low-value into lsReply
        set LS_RESULT_SELECT_FAILED to true
    else
        perform pq-n-tuples               *> how many rows?
   if lsRecordCursor > intPQntuples
   or intPQntuples = zero
           set LS_RESULT_AT_END to true
  initialize lsRecordCount
        else
            move intPQntuples to lsRecordCount
        perform pq-n-fields               *> How many columns?
            if intPQnfields = zero
               set LS_RESULT_AT_END to true
            else
               move intPQnfields to lsColumnCount
      move lsRecordCursor to intRowNumber
      if intRowNumber > zero
         subtract 1 from intRowNumber     *> count starts at zero
      end-if
      move lsColumnCursor to intColumnNumber
      if intColumnNumber > zero
         subtract 1 from intColumnNumber      *> count starts at zero
      end-if
      perform pq-get-length
      move intPQgetlength to lsFieldLength
      perform pq-f-format
      move intPQfformat to lsFieldFormat
      perform pq-get-is-null
      if PQGETISNULL-TRUE
     set FIELD_IS_NULL to true
      else
     set FIELD_IS_NULL to false
         perform pq-f-name
         initialize lsFieldName lsFieldNameLength
         set address of vTemp to ptrPQfname
```

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```
          unstring vTemp delimited by low-value into lsFieldName
          count in lsFieldNameLength
          perform pq-get-value
          initialize lsReply
          set address of vTemp to ptrPQgetValue
          unstring vTemp delimited by low-value into lsReply
       end-if
            end-if
        end-if
 end-if
 perform pq-clear
 .
*>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
 x-sql-exec.
     if lsRecordHandle not = zero
        set LS_HANDLE_MISSING to true
        exit paragraph
     end-if

 move lsRequest to sqlCommand
 perform varying intCharCount from function length(sqlCommand) by -1
  until sqlCommand(intCharCount:1) > space
 end-perform
 add 1 to intCharCount
 move low-value to sqlCommand(intCharCount:1)
     perform pq-exec
     perform pq-result-status
 evaluate true
 when PGRES_EMPTY_QUERY
    set LS_PGRES_EMPTY_QUERY to true
     when PGRES_COMMAND_OK
        set LS_PGRES_COMMAND_OK to true
 when PGRES_TUPLES_OK
    set LS_PGRES_TUPLES_OK to true
    perform x1-get-tuple-info
    perform x2-get-field-info
    perform x3-get-length-info
 when PGRES_COPY_OUT
    set LS_PGRES_COPY_OUT to true
 when PGRES_COPY_IN
    set LS_PGRES_COPY_IN to true
 when PGRES_BAD_RESPONSE
    set LS_PGRES_BAD_RESPONSE to true
 when PGRES_NONFATAL_ERROR
    set LS_PGRES_NONFATAL_ERROR to true
 when PGRES_FATAL_ERROR
    set LS_PGRES_FATAL_ERROR to true
     end-evaluate

*>  This will return the above evaluate results in text form
 perform pq-res-status
 set address of vTemp to ptrPQresStatus
 initialize lsReply
     unstring vTemp delimited by low-value into lsReply
     perform pq-result-error-message

 perform pq-error-message
```

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```
     set address of vTemp to ptrPQerrorMessage
     initialize lsReply
     unstring vTemp delimited by low-value into lsReply

*> fieldcode is an error field identifier;
*> NULL is returned if the PGresult is not an error or warning result,
*> or does not include the specified field.

 set PG_DIAG_SEVERITY to true
 perform pq-result-error-field
 if ptrPQresultErrorField > null
        set address of vTemp to ptrPQresultErrorField
        initialize lsReply
        unstring vTemp delimited by low-value into lsReply
 end-if

 *> The SQLSTATE code identifies the type of error that has occurred;
 *> it can be used by front-end applications to perform specific operations
 *> (such as error handling) in response to a particular database error.
 *> This field is not localizable, and is always present.
 set PG_DIAG_SQLSTATE to true
 perform pq-result-error-field
 if ptrPQresultErrorField > null
        set address of vTemp to ptrPQresultErrorField
        initialize lsState
        move vTemp(1:5) to lsState
 end-if
     .
 x1-get-tuple-info.
     perform pq-n-tuples
     move intPQntuples to lsRecordCursor
 .
 x2-get-field-info.
     perform pq-n-fields
 subtract 1 from intPQnfields giving lsColumnCount
*>           move intPQnfields to lsColumnCount
 .
 x3-get-length-info. *> length of first row
 initialize lsFieldLength intPQgetlength intRowNumber intColumnNumber
 perform with test after
  varying intColumnNumber from 0 by 1
  until intColumnNumber = lsColumnCount
     perform pq-get-length
     add intPQgetlength to lsFieldLength
 end-perform
 .
 y-reply-to-select.
     set ptrPGresult to lsRecordHandle
     perform pq-n-tuples
     if intPQntuples = zero
        set LS_RESULT_AT_END to true
     else
        if lsRecordCursor = zero
           move intPQntuples to lsRecordCursor
        end-if
        perform pq-n-fields
        if intPQnfields = zero
```

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```
           set LS_RESULT_AT_END to true
        else
           if lsColumnCount = zero
              move intPQnfields to lsColumnCount
           end-if
           move lsColumnCount to intColumnNumber
           perform pq-f-name     *> return current column name
           set address of vTemp to ptrPQfname
           unstring vTemp delimited by low-value into lsFieldName
           set address of vTemp to null
           perform pq-get-length *> length of current field
           move intPQgetlength to lsFieldLength
           perform pq-get-value  *> value of current field
           set address of vTemp to ptrPQgetValue
           unstring vTemp delimited by low-value into lsReply
           perform pq-f-type     *> oid of current field data type
           move oidPQftype to lsFieldFormat
        end-if
     end-if
     .

*>****************************************************************
*> Postgresql libpq library routines.
*>
*> see http://www.postgresql.org/docs/8.3/interactive/libpq.html
*> (the PostgreSQL online documentation is very good)
*>
*>****************************************************************

*>>>>>>>>>>>>>>>>>>>>>
*> Status routines.
*>
 pq-status.
     *> Returns the status of the connection.
     initialize intConnStatusType
     call "PQstatus"
          using by value ptrPGconn,
          returning intConnStatusType
     .
 pq-error-message.
     *>Returns the error message most recently
     *> generated by an operation on the connection.
     initialize ptrPQerrorMessage
     call "PQerrorMessage"
          using by value ptrPGconn
          returning ptrPQerrorMessage
     .
 pq-result-status.
     *> Returns the result status of the command.
     call "PQresultStatus"
          using by value ptrPGresult
          returning intExecStatusType
     .
 pq-res-status.
     *> Converts the enumerated type returned by PQresultStatus
     *> into a string constant describing the status code.
     *> The caller should not free the result.
```

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```
    initialize ptrPQresStatus
    call "PQresStatus"
         using by value intExecStatusType
         returning ptrPQresStatus
    .
pq-result-error-message.
    *> Returns the error message associated with the command
    *> Returns an empty string if there was no error.
*>
*> Immediately following a PQexec or PQgetResult call,
*> PQerrorMessage (on the connection) will return the same
*> string as PQresultErrorMessage (on the result).
*> However, a PGresult will retain its error message until
*> destroyed, whereas the connection's error message will
*> change when subsequent operations are done.
*> Use PQresultErrorMessage when you want to know the status
*> associated with a particular PGresult; use PQerrorMessage
*> when you want to know the status from the latest operation
*> on the connection.
*>
    call "PQresultErrorMessage"
         using by value ptrPGresult
         returning ptrPQresultErrorMessage
    set address of vTemp to ptrPQresultErrorMessage
      .
pq-result-error-field.
    *> Returns an individual field of an error report.
    call "PQresultErrorField"
         using by value ptrPGresult
         by value intFieldCode
         returning ptrPQresultErrorField
    .
pq-transaction-status.
    *> Returns the current in-transaction status of the server.
    initialize intPGTransactionStatusType
    call "PQtransactionStatus"
         returning intPGTransactionStatusType
    display "dbExecErrorCode: " intPGTransactionStatusType
    .
pq-parameter-status.
    *> Looks up a current parameter setting of the server.
    call "PQparameterStatus"
         using by value ptrPGconn
         by value charParamName
         returning ptrPQparameterStatus
    set address of vTemp to ptrPQparameterStatus
    unstring vTemp delimited by low-value into charParameterStatus
    .
pq-backend-PID.
    *> Returns the process ID (PID) of the
    *> backend server process handling this connection.
    call "PQbackendPID"
          using by value ptrPGconn
          returning intPQbackendPID
    .
pq-connection-needs-password.
    *> Returns true (1) if the connection
```

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```
     *>  authentication method required a password,
     *>  but none was available. Returns false (0) if not.
     *> This function can be applied after a failed connection
     *> attempt to decide whether to prompt the user for a password.
     call "PQconnectionNeedsPassword"
           using by value ptrPGconn
           returning intPQconnectionNeedsPassword
     .
 pq-connection-used-password.
     *> Returns true (1) if the connection authentication
     *> method used a caller-supplied password. Returns false (0) if not.
     *> This function detects whether a password supplied
     *> to the connection function was actually used.
     *> Passwords obtained from other sources (such as the .pgpass file)
     *> are not considered caller-supplied.
     call "PQconnectionUsedPassword"
           using by value ptrPGconn
           returning intPQconnectionUsedPassword
     .
*>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
*> Database information
*>
 pq-db.
     initialize ptrReturn dbName
     call "PQdb"
          using by value ptrPGconn
          returning ptrReturn
     set address of vTemp to ptrReturn
     unstring vTemp delimited by low-value into dbName
     .
  pq-user.
     initialize ptrReturn dbUser
     call "PQuser"
          using by value ptrPGconn
          returning ptrReturn
     set address of vTemp to ptrReturn
     unstring vTemp delimited by low-value into dbUser
     .
  pq-pass.
     initialize ptrReturn dbPassword
     call "PQpass"
          using by value ptrPGconn
          returning ptrReturn
     set address of vTemp to ptrReturn
     unstring vTemp delimited by low-value into dbPassword
     .
 pq-host.
     initialize ptrReturn dbHost
     call "PQhost"
          using by value ptrPGconn
          returning ptrReturn
     set address of vTemp to ptrReturn
     unstring vTemp delimited by low-value into dbHost
     .
 pq-port.
     initialize ptrReturn dbPort
     call "PQport"
```

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```
          using by value ptrPGconn
          returning ptrReturn
     set address of vTemp to ptrReturn
     unstring vTemp delimited by low-value into dbPort
     .
 pq-options.
     initialize ptrReturn dbOptions
     call "PQoptions"
          using by value ptrPGconn
          returning ptrReturn
     set address of vTemp to ptrReturn
     unstring vTemp delimited by low-value into dbOptions
     .
 pq-server-version.
     initialize ptrReturn dbServerVersion
     call "PQserverVersion"
          using by value ptrPGconn
          returning dbServerVersion
     .

*>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
*> Connection routines
*>
 pq-connect-db.
     *> Connect to the db server in a Synchronous (blocking) manner.
     *> An application program can have several backend connections open at one time.
     *> Note that this function will always return a non-null object pointer,
     *> unless perhaps there is too little memory even to allocate the PGconn object.
     *> The PQstatus function should be called to check whether a connection was
     *> successfully made before queries are sent via the connection object.
     set ptrPGconn to null.
     call "PQconnectdb"
           using by reference charConninfo
           returning ptrPGconn
     .
 pq-connect-start.
     *> Connect to the db server in an Asynchronous (nonblocking) manner.
     *> An application program can have several backend connections open at one time.
     *> Note that this function will always return a non-null object pointer,
     *> unless perhaps there is too little memory even to allocate the PGconn object.
     *> The PQstatus function should be called to check whether a connection was
     *> successfully made before queries are sent via the connection object.
     set ptrPGconn to null.
     call "PQconnectStart"
          using by reference charConninfo
          returning ptrPGconn
     .
 pq-connect-poll.
     call "PQconnectPoll"
          using by value ptrPGconn,
          returning intPostgresPollingStatusType
     .
 pq-socket.
     call "PQsocket"
          using by value ptrPGconn,
          returning intPQsocket
     .
```

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```
 pq-reset.
     *> Resets the communication channel to the server.
     call "PQreset"
          using by value ptrPGconn
     .
 pq-finish.
     *> Closes the connection to the server.
     *> Also frees memory used by the PGconn object.
     call "PQfinish"
          using by value ptrPGconn
      .

*>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
*> Command execution routines
*>
*>    pw-escape-string.
*>       *> PQescapeStringConn escapes a string for use within an SQL command.
*>        initialize charTo intFromLength intToLength
*>        inspect charFrom tallying intFromLength for trailing space
*>        compute intFromLength = (length of charFrom) - intFromLength
*>
*>        call "PQescapeStringConn"
*>             using by value ptrPGconn
*>             by reference charTo
*>             by reference charFrom
*>             by value intFromLength
*>             by value intError
*>             returning intToLength
*>        .
 pq-exec.
    *> Submits a command to the server and waits for the result.
     call "PQexec"
          using by value ptrPGconn
          by reference sqlCommand
          returning ptrPGresult
     .
 pq-make-empty-pg-result.
    *> Constructs an empty PGresult object with the given status.

     call "PQmakeEmptyPGresult"
          using by value ptrPGconn
          by reference ptrPGExecStatusType
          returning ptrPGresult
     .
 pq-clear.
    *> Frees the storage associated with a PGresult.
    *> Every command result should be freed via PQclear
    *> when it is no longer needed.

     call "PQclear"
          using by value ptrPGresult
     set ptrPGresult to null
     .
*>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
*> Replies to command execution.
*>
 pq-n-tuples.
```

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```
    *> Returns the number of rows (tuples) in the query result.
    call "PQntuples"
         using by value ptrPGresult
         returning intPQntuples
    .
pq-n-fields.
    *> Returns the number of Fields (fields)
    *> in each row of the query result.
    call "PQnfields"
         using by value ptrPGresult
         returning intPQnfields
    .
pq-f-name.
    *> Returns the Field name associated with the given Field number.
    *> Field numbers start at 0.
    call "PQfname"
         using by value ptrPGresult
         by value intColumnNumber
         returning ptrPQfname
    .
pq-f-number.
    *> Returns the Field number associated with the given Field name.
    *> -1 is returned if the given name does not match any Field.
    call "PQfnumber"
         using by value ptrPGresult
         by value ptrFieldName
         returning intPQfnumber
    .
pq-f-table-col.
    *> Returns the Field number (within its table)
    *> of the Field making up the specified query result Field.
    *> Query-result Field numbers start at 0,
    *> but table Fields have nonzero numbers.
    *> Zero is returned if the Field number is out of range,
    *> or if the specified Field is not a simple reference
    *> to a table Field, or when using pre-3.0 protocol.
    call "PQftablecol"
         using by value ptrPGresult
         by value intColumnNumber
     returning intPQftablecol
    .
pq-f-format.
    *> Returns the Field number (within its table)
    *> of the Field making up the specified query result Field.
    *> Query-result Field numbers start at 0,
    *> but table Fields have nonzero numbers.
    *> Format code zero indicates textual data representation,
    *> while format code one indicates binary representation.
    call "PQfformat"
         using by value ptrPGresult
         by value intColumnNumber
     returning intPQfformat
    .
pq-f-type.
    *> Returns the data type associated with the given Field number.
    *> The integer returned is the internal OID number of the type.
    *> Field numbers start at 0.
```

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```
    *> You can query the system table pg_type to obtain the names
    *> and properties of the various data types. The OIDs of the built-in
    *> data types are defined in the file src/include/catalog/pg_type.h.
    call "PQftype"
         using by value ptrPGresult
         by value intColumnNumber
     returning oidPQftype
    .
pq-f-mod.
    *> Returns the type modifier of the Field associated with the given Field number.
    *> Field numbers start at 0.
    *> The interpretation of modifier values is type-specific;
    *> they typically indicate precision or size limits.
    *> The value -1 is used to indicate "no information available".
    *> Most data types do not use modifiers, in which case the value is always -1.
    call "PQfmod"
         using by value ptrPGresult
         by value intColumnNumber
     returning intPQfmod
    .
pq-get-value.
    *> Returns a single field value of one row of a PGresult.
    *> Row and Field numbers start at 0.
    *> The caller should not free the result directly.
    *> It will be freed when the associated PGresult handle is passed to PQclear.
    *> For data in text format, the value returned by PQgetvalue
    *> is a null-terminated character string representation of the field value.
    *> An empty string is returned if the field value is null.
    *> See PQgetisnull to distinguish null values from empty-string values.
    *>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
call "PQgetvalue"
         using by value ptrPGresult
         by value intRowNumber
         by value intColumnNumber
         returning ptrPQgetValue
end-call
    *<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
    .
pq-get-is-null.
    *> Tests a field for a null value. Row and Field numbers start at 0.
    *> This function returns 1 if the field is null
    *> and 0 if it contains a non-null value.
    call "PQgetisnull"
         using by value ptrPGresult
         by value intRowNumber
         by value intColumnNumber
         returning intPQgetisnull
    .
pq-get-length.
    *> Returns the actual length of a field value in bytes.
    *> Row and column numbers start at 0.
    *> This is the actual data length for the particular data value,
    *> that is, the size of the object pointed to by PQgetvalue.
    *> For text data format this is the same as strlen().
    *> For binary format this is essential information.
    call "PQgetlength"
         using by value ptrPGresult
```

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```
          by value intRowNumber
          by value intColumnNumber
       returning intPQgetlength
      .

*>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
*> These functions are used to extract information from PGresult objects
*> that are not SELECT results.
*>
 pq-cmd-status.
     *> Returns the command status tag from the SQL command that generated the␣
↪PGresult.
     *> Commonly this is just the name of the command,
     *> but it might include additional data such as the number of rows processed.
     *> The caller should not free the result directly.
     *> It will be freed when the associated PGresult handle is passed to PQclear.
     call "PQcmdStatus"
          using by value ptrPGresult
       returning ptrPQcmdStatus
      .
 pq-cmd-tuples.
     *> This function returns a string containing the number of rows
     *> affected by the SQL statement that generated the PGresult.
     call "PQcmdTuples"
          using by value ptrPGresult
       returning ptrPQcmdTuples
      .
 end program libpgsql.
```

And `lsrecord.cpy`

```
01  lsRecord.
    05 lsConnHandle          usage pointer.
    05 lsRecordHandle            usage pointer.
    05 lsRequestHandle           usage pointer.
    05 lsReplyHandle         usage pointer.
    05 lsRequestLength           pic 9(9) comp-5.
    05 lsReplyLength         pic 9(9) comp-5.
    05 lsRecordCount         pic 9(9) comp-5.
    05 lsRecordCursor            pic 9(9) comp-5.
    05 lsColumnCount         pic 9(9) comp-5.
    05 lsColumnCursor            pic 9(9) comp-5.
    05 lsFieldFormat         pic 9(9) comp-5.
   88 FIELD_FORMAT_IS_TEXT               value zero.
   88 FIELD_FORMAT_IS_BINARY             value zero.
05 lsFieldNull           pic 9.
   88 FIELD_IS_NULL                  value 1 false is zero.
    05 lsFieldLength         pic 9(9) comp-5.
05 lsFieldNameLength         pic 9(9) comp-5.
05 lsFieldName           pic x(128).
    05 lsCommand             pic x(10).
       88 ABORT_COMMAND                  value "ABORT".
       88 CLOSE_CONN_COMMAND             value "CLOSECONN".
       88 CLOSE_DB_COMMAND               value "CLOSEDB".
       88 CREATE_COMMAND                 value "CREATE".
       88 DEBUG_COMMAND                  value "DEBUG".
       88 DELETE_COMMAND                 value "DELETE".
```

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```
      88 DROP_COMMAND                    value "DROP".
      88 GET_BASE_TABLES_COMMAND             value "GETBASETBL".
      88 GET_DBNAME_COMMAND              value "GETDBNAME".
      88 GET_HOSTNAME_COMMAND                value "GETHOST".
      88 GET_PORT_COMMAND                value "GETPORT".
      88 GET_USER_COMMAND                value "GETUSER".
      88 INSERT_COMMAND                  value "INSERT".
      88 MORE_COMMAND                    value "MORE".
      88 POLL_COMMAND                    value "POLL".
      88 SQL_COMMAND                     value "SQL".
      88 START_CONN_COMMAND              value "STARTCONN".
      88 START_DB_COMMAND                value "STARTDB".
   05 lsResult              pic 9(9) comp-5.
      88 LS_RESULT_OK                    value 0.
      88 LS_CONNECTION_ATTEMPT_FAILED           value 1.
      88 LS_CONNECTION_DATA_REQUIRED            value 2.
      88 LS_CONNECTION_HANDLE_NOT_EMPTY         value 3.
      88 LS_CONNECTION_HANDLE_EMPTY          value 4.
   88 LS_CONNECTION_RETURNED_NULL            value 5.
   88 LS_CONNECTION_POLL_FAILED          value 6.
   88 LS_CONNECTION_POLL_READING         value 7.
   88 LS_CONNECTION_POLL_WRITING         value 8.
      88 LS_RESULT_AT_END                value 10.
      88 LS_RESULT_SELECT_FAILED             value 11.
      88 LS_HANDLE_MISSING               value 13.
   88 LS_BAD_COMMAND                 value 14.
      88 LS_PGRES_EMPTY_QUERY                value 20.
   88 LS_PGRES_COMMAND_OK                value 21.
      88 LS_PGRES_TUPLES_OK              value 22.
      88 LS_PGRES_COPY_OUT               value 23.
      88 LS_PGRES_COPY_IN                value 24.
      88 LS_PGRES_BAD_RESPONSE               value 25.
   88 LS_PGRES_NONFATAL_ERROR            value 26.
      88 LS_PGRES_FATAL_ERROR                value 27.
   88 ls_TEST                     value 99.
    05  lsResultStatus           pic x(1024).
    05  lsDiagSeverity           pic x(10).
   88 LS_Diag_Severity_ERROR             value "ERROR".
   88 LS_Diag_Severity_FATAL             value "FATAL".
   88 LS_Diag_Severity_PANIC             value "PANIC".
   88 LS_Diag_Severity_WARNING           value "WARNING".
   88 LS_Diag_Severity_NOTICE            value "NOTICE".
   88 LS_Diag_Severity_DEBUG             value "DEBUG".
   88 LS_Diag_Severity_INFO              value "INFO".
   88 LS_Diag_Severity_LOG               value "LOG".
    05  lsState              pic x(5).
   88 SUCCESSFULL_COMPLETION         value "00000".
   88 WARNING                 value "01000".
   88 NO_DATA                 value "02000".
   88 SQL_STATEMENT_NOT_YET_COMPLETE     value "03000".
   88 CONNECTION_EXCEPTION           value "08000".
   88 TRIGGERED_ACTION_EXCEPTION     value "09000".
   88 FEATURE_NOT_SUPPORTED          value "0A000".
   88 INVALID_TRANSACTION_INITIATION     value "0B000".
   88 LOCATOR_EXCEPTION          value "0F000".
   88 INVALID_GRANTOR            value "0L000".
   88 INVALID_ROLE_SPECIFICATION     value "0P000".
```

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```
   88 CARDINALITY_VIOLATION          value "21000".
   88 DATA_EXCEPTION             value "22000".
   88 INTEGRITY_CONSTRAINT_VIOLATION     value "23000".
   88 INVALID_CURSOR_STATE           value "24000".
   88 INVALID_TRANSACTION_STATE      value "25000".
   88 INVALID_SQL_STATEMENT_NAME     value "26000".
   88 TRIGGERED_DATA_CHANGE_VIOLATION    value "27000".
   88 INVALID_AUTHORIZATION_SPEC     value "28000".
   88 DEPENDENT_PRIVILEGE_DESCRIPTORS    value "2B000".
   88 INVALID_TRANSACTION_TERMINATION    value "2D000".
   88 SQL_ROUTINE_EXCEPTION          value "2F000".
   88 INVALID_CURSOR_NAME            value "34000".
   88 EXTERNAL_ROUTINE_EXCEPTION     value "38000".
   88 EXTERNAL_ROUTINE_INVOCATION        value "39000".
   88 SAVEPOINT_EXCEPTION            value "3B000".
   88 INVALID_CATALOG_NAME           value "3D000".
   88 INVALID_SCHEMA_NAME            value "3F000".
   88 TRANSACTION_ROLLBACK           value "40000".
   88 SYNTAX_ERROR_OR_ACCESS_RULE        value "42000".
   88 WITH_CHECK_OPTION_VIOLATION        value "44000".
   88 INSUFFICIENT_RESOURCES         value "53000".
   88 PROGRAM_LIMIT_EXCEEDED         value "54000".
   88 OBJ_NOT_IN_PREREQUISITE_STATE      value "55000".
   88 OPERATOR_INTERVENTION          value "57000".
   88 EXTERNAL_SYSTEM_ERROR          value "58000".
   88 CONFIGURATION_FILE_ERROR       value "F0000".
   88 PLPGSQL_ERROR              value "P0000".
   88 RAISE_EXCPTION             value "P0001".
   88 NO_DATA_FOUND              value "P0002".
   88 TOO_MANY_ROWS              value "P0003".
   88 INTERNAL_ERROR             value "XX000".
   88 DATA_CORRUPTED             value "XX001".
   88 INDEX_CORRUPTED            value "XX002".

01  lsRequest                pic x(4000).
01  lsReply              pic x(1024).
```

8.31 Sample shortforms

Some of the samples in this *FAQ* (page 1388) use a short hand that places much of the COBOL boilerplate code in a copybook include file.

`sample-template.cob`

```
*> Modified: 2015-12-08/06:46-0500
 identification division.
 program-id. SAMPLE.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 data division.
```

(continues on next page)

(continued from previous page)

```
 working-storage section.
 :DATABOOK:

 procedure division.
 demonstration section.
 :CODEBOOK:

 goback.

*> informational warnings and abends
 soft-exception.
   display space upon syserr
   display "--Exception Report-- " upon syserr
   display "Time of exception:   " current-date upon syserr
   display "Module:              " module-id upon syserr
   display "Module-path:         " module-path upon syserr
   display "Module-source:       " module-source upon syserr
   display "Exception-file:      " exception-file upon syserr
   display "Exception-status:    " exception-status upon syserr
   display "Exception-location:  " exception-location upon syserr
   display "Exception-statement: " exception-statement upon syserr
 .

 hard-exception.
     perform soft-exception
     stop run returning 127
 .

 end program SAMPLE.
```

This sample replaces the :DATABOOK: and :CODEBOOK: pseudo-text with the actual working storage and procedure division lines required to make a working, compilable example.

```
#!/usr/local/bin/cobc -xj

       COPY template REPLACING
       ==:DATABOOK:== BY
       ==

       01 x            pic s9v99.
       01 domain       pic s9v9(5).
       01 degrees      pic s999v9.
       01 answer       pic s9(5)v9(5).

       ==
       ==:CODEBOOK:== BY
       ==

       perform varying x from -1.0 by 0.25 until x > 1.0
           compute domain = pi * x
           compute degrees rounded = domain * 180 / pi
           move tan(domain) to answer
           display "tan(" domain ") = tan(" degrees "°)  = " answer
       end-perform

       ==
       .
```

becomes the *practical equivalent* of

```
*> Modified: 2015-12-08/06:46-0500
 identification division.
 program-id. SAMPLE.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 data division.
 working-storage section.

 01 x            pic s9v99.
 01 domain       pic s9v9(5).
 01 degrees      pic s999v9.
 01 answer       pic s9(5)v9(5).

 procedure division.
 demonstration section.

 perform varying x from -1.0 by 0.25 until x > 1.0
     compute domain = pi * x
     compute degrees rounded = domain * 180 / pi
     move tan(domain) to answer
     display "tan(" domain ") = tan(" degrees "°)  = " answer
 end-perform

 goback.

*> informational warnings and abends
 soft-exception.
   display space upon syserr
   display "--Exception Report-- " upon syserr
   display "Time of exception:   " current-date upon syserr
   display "Module:              " module-id upon syserr
   display "Module-path:         " module-path upon syserr
   display "Module-source:       " module-source upon syserr
   display "Exception-file:      " exception-file upon syserr
   display "Exception-status:    " exception-status upon syserr
   display "Exception-location:  " exception-location upon syserr
   display "Exception-statement: " exception-statement upon syserr
 .

 hard-exception.
     perform soft-exception
     stop run returning 127
 .

 end program SAMPLE.
```

when passed to the compiler. The *technical equivalent* is quite a bit more complicated, as the GnuCOBOL text processing phase does more than a simple include, but there is an effective result equivalency.

The POSIX interpreter directive line:

```
#!/usr/local/bin/cobc -xj
```

invokes the compiler to produce a compiled binary and then execute the job. The line is also effectively ignored by `cobc`. These samples can be processed with either:

```
prompt$ cobc -xj tan-sample.cob
```

or:

```
prompt$ chmod +x tan-sample.cob
prompt$ ./tan-sample.cob
```

`cobc` and the POSIX shell are that smart.

The `line-sequential-sample.cob` template is used when samples require input or/and output text files.

```
*> Modified: 2015-12-09/02:58-0500
 identification division.
 program-id. SAMPLE.

 environment division.
 configuration section.
 repository.
     function all intrinsic.

 input-output section.
 file-control.
     select optional input-file
         assign to :INPUT-NAME:
         organization is line sequential
         file status is input-status.

     select output-file
         assign to :OUTPUT-NAME:
         organization is line sequential
         file status is output-status.

 data division.
 file section.
 fd input-file record varying depending on input-actual.
    01 input-line pic x(8192).
 fd output-file record varying depending on output-actual.
    01 output-line pic x(8192).

 working-storage section.
 01 input-status         pic xx.
 01 input-actual         pic 9(4).
 01 output-status        pic xx.
 01 output-actual        pic 9(4).
 01 status-number        pic 99.

 :DATABOOK:

 procedure division.
 demonstration section.

 :CODEBOOK:

 goback.
```

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```
 open-files.
 open input input-file
 perform input-check

 open output output-file
 perform output-check
 .

 close-files.
 close input-file
 perform input-check

 close output-file
 perform output-check
 .

 delete-output.
 delete file output-file
 .

 read-input.
 read input-file
 perform input-check
 .

 write-output.
 write output-line
 perform output-check
 .

 input-check.
 move input-status to status-number
 if status-number greater than 9 then
     display "Error with input-file: " :INPUT-NAME:
        " status: " status-number
        upon syserr
     perform hard-exception
 end-if
 .

 output-check.
 move output-status to status-number
 if status-number greater than 9 then
     display "Error with ouput-file: " :OUTPUT-NAME:
        " status: " status-number
        upon syserr
     perform hard-exception
 end-if
 .

*> informational warnings and abends
 warnings section.
 soft-exception.
   display space upon syserr
   display "--Exception Report-- " upon syserr
   display "Time of exception:   " current-date upon syserr
   display "Module:              " module-id upon syserr
```

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```
   display "Module-path:         " module-path upon syserr
   display "Module-source:       " module-source upon syserr
   display "Exception-file:      " exception-file upon syserr
   display "Exception-status:    " exception-status upon syserr
   display "Exception-location:  " exception-location upon syserr
   display "Exception-statement: " exception-statement upon syserr
 .

 hard-exception.
     perform soft-exception
     stop run returning 127
 .

 end program SAMPLE.
```

This template needs to be used with

```
COPY line-sequential-template REPLACING
==:INPUT-NAME:==  BY =="quoted-name-optional"==
==:OUTPUT-NAME:== BY =="quoted-name-created"==
==:DATABOOK:==    BY ==working-storage definitions==
==:CODEBOOK:==    BY ==procedure statements==
.
```

The data division has I/O fields for

- input-line and input-actual (for the length of the last read)
- output-line and output-actual (for setting a write length)

The procedure division has helper paragraphs for

- open-files (with status checks)
- close-files (with status checks)
- read-input (with status check)
- write-output (with status check)
- delete-output (as given by :OUTPUT-NAME:)
- soft-exception
- hard-exception

8.32 y2k

The Year 2000 problem.

Many COBOL programmers were tasked with scanning ALL source codes to ensure the calendar rollover from the second to third millennium (1999 to 2000) would not fail catastrophically, and result in fidiciary responsibilty claims against the individuals in charge of the world's computer systems.

This was due to the common human practise of using two digit years, and assuming the current century. Computer programmers followed this same convention for many decades and financial (and other) digital records held that same shortform. Financial calculations would fail when the two digit year rolled past 99, back to 00. This became known as **Y2K** and it was a costly problem. Almost all source code had to be inventoried, and possibly corrected, to ensure compliance with safe rollover from 1999 to 2000.

A similar issue will reappear in 2038. This time C programmers will be tasked with looking though source codes, as the historical 4 byte "epoch" integer seconds rolls over, back to 0, from when it was set counting from January 1st, 1970. In this author's opinion, this is likely a far more insidious problem. It will be much harder to pinpoint who to sue for fidiciary responsibility, so the epoch problem will likely have much less legal department pressure on ensuring fixes are in place before the clocks do hit the roll over condition. Instead of bank reports failing, it will be embedded computer clocks and timers failing. What may happen then, is up to the future.

This rollover issue occurs at **03:14:08 UTC on 19 January 2038**. GnuCOBOL systems are potentially at risk of failure during this time interval if they are still using 32bit time fields in the C libraries underlying libcob run-time support, even if libcob.so itself looks correct. Where y2k was mostly an application problem, the year 2038 epoch problem starts much deeper in the software stack, at the operating system level, and then up into application programs. There will be money to be made for people that understand the epoch problem, and there will, sadly, be money to be fleeced from those that do not understand well enough to protect themselves from unscrupulous or ill-informed developers.

8.33 Quine

A quine is a non-empty computer program which takes no input and produces a copy of its own source code as its only output. The standard terms for these programs in the computability theory and computer science literature are "self-replicating programs", "self-reproducing programs", and "self-copying programs".

For example:

```
identification division.
author. Brian Tiffin.
date-written. 2015-12-16/06:07-0500.
remarks. Self replicating code, Public Domain.
installation. tectonics: cobc -xj quine.cob.
program-id. quine.
data division.
working-storage section.
01 s pic x(7).
01 n pic 99.
01 source-code.
   05 value "identification division.                        ".
   05 value "author. Brian Tiffin.                          ".
   05 value "date-written. 2015-12-16/06:07-0500.           ".
   05 value "remarks. Self replicating code, Public Domain. ".
   05 value "installation. tectonics: cobc -xj quine.cob.   ".
   05 value "program-id. quine.                             ".
   05 value "data division.                                 ".
   05 value "working-storage section.                       ".
   05 value "01 s pic x(7).                                 ".
   05 value "01 n pic 99.                                   ".
   05 value "01 source-code.                                ".
   05 value "01 redefines source-code.                      ".
   05 value "   05 t pic x(48) occurs 24 times.             ".
   05 value "procedure division.                            ".
   05 value "perform varying n from 1 by 1 until n > 11     ".
   05 value "   display s function trim(t(n) trailing)       ".
   05 value "end-perform                                    ".
   05 value "perform varying n from 1 by 1 until n > 24     ".
   05 value "   display s '   05 value ' quote t(n) quote '.'".
   05 value "end-perform                                    ".
   05 value "perform varying n from 12 by 1 until n > 24    ".
```

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```
   05 value "   display s function trim(t(n) trailing)       ".
   05 value "end-perform                                     ".
   05 value "goback.                                         ".
01 redefines source-code.
   05 t pic x(48) occurs 24 times.
procedure division.
perform varying n from 1 by 1 until n > 12
   display s function trim(t(n) trailing)
end-perform
perform varying n from 1 by 1 until n > 24
   display s '   05 value ' quote t(n) quote '.'
end-perform
perform varying n from 13 by 1 until n > 25
   display s function trim(t(n) trailing)
end-perform
goback.
```

And a sample run

```
prompt$ cobc -xj quine.cob
       identification division.
       author. Brian Tiffin.
       date-written. 2015-12-16/06:07-0500.
       remarks. Self replicating code, Public Domain.
       installation. tectonics: cobc -xj quine.cob.
       program-id. quine.
       data division.
       working-storage section.
       01 s pic x(7).
       01 n pic 99.
       01 source-code.
          05 value "identification division.                      ".
          05 value "author. Brian Tiffin.                         ".
          05 value "date-written. 2015-12-16/06:07-0500.          ".
          05 value "remarks. Self replicating code, Public Domain.  ".
          05 value "installation. tectonics: cobc -xj quine.cob.    ".
          05 value "program-id. quine.                            ".
          05 value "data division.                                ".
          05 value "working-storage section.                      ".
          05 value "01 s pic x(7).                                ".
          05 value "01 n pic 99.                                  ".
          05 value "01 source-code.                               ".
          05 value "01 redefines source-code.                     ".
          05 value "   05 t pic x(48) occurs 24 times.            ".
          05 value "procedure division.                           ".
          05 value "perform varying n from 1 by 1 until n > 11    ".
          05 value "   display s function trim(t(n) trailing)     ".
          05 value "end-perform                                   ".
          05 value "perform varying n from 1 by 1 until n > 24    ".
          05 value "   display s '   05 value ' quote t(n) quote '.'".
          05 value "end-perform                                   ".
          05 value "perform varying n from 12 by 1 until n > 24   ".
          05 value "   display s function trim(t(n) trailing)     ".
          05 value "end-perform                                   ".
          05 value "goback.                                       ".
       01 redefines source-code.
          05 t pic x(48) occurs 24 times.
```

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```
       procedure division.
       perform varying n from 1 by 1 until n > 11
          display s function trim(t(n) trailing)
       end-perform
       perform varying n from 1 by 1 until n > 24
          display s '   05 value ' quote t(n) quote '.'
       end-perform
       perform varying n from 12 by 1 until n > 24
          display s function trim(t(n) trailing)
       end-perform
       goback.
```

And a small proof:

```
prompt$ cobc -xj quine.cob  | diff quine.cob -
prompt$
```

There was no real attempt to make this sample as small as it could be. Free format source would help, as would removing the identification division comment words. Shortening some of the names would also lower the character count.

So, a challenge was posted to the SourceForge forums, and a much shorter version came up as:

```
local-storage section.
1 n pic 99.
1 c. 5 value
"local-storage section.                  " &
"1 n pic 99.                             " &
"1 c. 5 value                            " &
". 1 redefines c.                        " &
"5 t pic x(40) occurs 12.                " &
"perform varying n from 1 by 1 until n>3 " &
"display function trim(t(n) trailing).   " &
"perform varying n from 1 by 1 until n>12" &
"display quote t(n) quote ' &'.          " &
"display quote ' ' quote no advancing.   " &
"perform varying n from 4 by 1 until n>12" &
"display function trim(t(n) trailing).   " &
" ". 1 redefines c.
5 t pic x(40) occurs 12.
perform varying n from 1 by 1 until n>3
display function trim(t(n) trailing).
perform varying n from 1 by 1 until n>12
display quote t(n) quote ' &'.
display quote ' ' quote no advancing.
perform varying n from 4 by 1 until n>12
display function trim(t(n) trailing).
```

Courtesy of Simon and Bill. Self referential COBOL programming.

And then they came up with a one liner, 150 bytes.

```
linkage section. 78 c value "display 'linkage section. 78 c value
' x'22' c x'222e20' c.". display 'linkage section. 78 c value ' x'22' c x'222e20' c.
```

Due to page width limitations, the listing is split here. To recreate the real thing, there is one space between `78 c value` and the second line shown above. And a small proof:

```
prompt$ cobc -xjF -frelax shortest-quine.cob | diff shortest-quine.cob -
shortest-quine.cob: 1: Warning: PROGRAM-ID header missing - assumed
shortest-quine.cob: 1: Warning: DATA DIVISION header missing - assumed
shortest-quine.cob: 1: Warning: PROCEDURE DIVISION header missing - assumed
prompt$
```

No diff output. And:

```
$ ./shortest-quine.cob
linkage section. 78 c value "display 'linkage section. 78 c value
' x'22' c x'222e20' c.". display 'linkage section. 78 c value ' x'22' c x'222e20' c.
```

Nice. *And again, listing split into 2 lines.*

See *Does GnuCOBOL work with shell scripting?* (page 1081) for an alernative sample that isn't really a Quine, but is another form of self replicating code. The scripting sample breaks the rules of a true Quine: it uses more than one progamming language and reads external data to achieve the replication effect.

8.34 bubble-cobol.tcl

The changes made to bubble-generator.tcl used to produce the GnuCOBOL syntax diagrams:

```
--- /home/btiffin/wip/writing/gcfaq/bubble-generator.tcl
+++ /home/btiffin/wip/writing/gcfaq/bubble-cobol.tcl
@@ -4,7 +4,7 @@
 # text descriptions.
 #

-source [file join [file dirname [info script]] bubble-generator-data.tcl]
+source [file join [file dirname [info script]] bubble-cobol-data.tcl]

 # Top-level displays
 #
@@ -36,6 +36,8 @@
 set tagcnt 0                      ;# tag counter
 set font1 {Helvetica 16 bold}     ;# default token font
 set font2 {GillSans 14 bold}      ;# default variable font
+set font3 {Helvetica 16}          ;# GnuCOBOL extension font
+set font4 {GillSans 14}           ;# GnuCOBOL extension variable font
 set RADIUS 9                      ;# default turn radius
 set HSEP 17                       ;# horizontal separation
 set VSEP 9                        ;# vertical separation
@@ -123,12 +125,37 @@
     set txt [string range $txt 1 end]
     set font $::font2
     set istoken 1
+    set iswide 0
   } elseif {[regexp {^[a-z]} $txt]} {
     set font $::font2
     set istoken 0
+    set iswide 0
+  } elseif {[regexp {^\+[A-Z>$]} $txt]} {
+    set txt [string range $txt 1 end]
+    set font $::font3
+    set istoken 1
```

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```
+    set iswide 0
+  } elseif {[regexp {^\+[a-z]} $txt]} {
+    set txt [string range $txt 1 end]
+    set font $::font4
+    set istoken 0
+    set iswide -26
+  } elseif {[regexp {^_[a-z_]} $txt]} {
+    set txt [string range $txt 1 end]
+    set txt [string map {"_" " "} $txt]
+    set font $::font4
+    set istoken 0
+    set iswide -38
+  } elseif {[regexp {^_[A-z]} $txt]} {
+    set txt [string range $txt 1 end]
+    set txt [string map {"_" " "} $txt]
+    set font $::font1
+    set istoken 1
+    set iswide 0
   } else {
     set font $::font1
     set istoken 1
+    set iswide 0
   }
   set id1 [.c create text 0 0 -anchor c -text $txt -font $font -tags $tag]
   foreach {x0 y0 x1 y1} [.c bbox $id1] break
@@ -136,7 +163,7 @@
   set rad [expr {($h+1)/2}]
   set top [expr {$y0-2}]
   set btm [expr {$y1}]
-  set fudge [expr {int(3*$istoken + [string length $txt]*1.4)}]
+  set fudge [expr {int(3*$istoken + [string length $txt]*1.4 + $iswide)}]
 #puts "fudge($txt)=$fudge"
   set left [expr {$x0+$fudge}]
   set right [expr {$x1-$fudge}]
@@ -660,7 +687,7 @@
   .c postscript -file $name.ps -width [expr {$x1+2}] -height [expr {$y1+2}]
   global DPI
   .c delete bgrect
-  exec convert -density ${DPI}x$DPI -antialias $name.ps $name.gif
+  exec convert -density "${DPI}x$DPI" -antialias $name.ps $name.gif
   if {$do_xv} {
     if {[catch {exec xv $name.gif &}]} {
       exec display $name.gif &
@@ -671,6 +698,11 @@
 proc draw_all_graphs {} {
   global all_graphs
   set f [open all.html w]
+  puts {
+<h2>GnuCOBOL syntax diagrams</h2>
+<p>By Brian Tiffin, modelled on code and data used for the SQLite project developed␣
↪by Dr. Richard Hipp.</p>
<p><i>These diagrams are dedicated to the public domain.</i></p>
}
  foreach {name graph} $all_graphs {
    if {[regexp {^X-} $name]} continue
    puts $f "<h3>$name:</h3>"
```

All credits due to Dr. Richard Hipp, from work he did to produce the diagrams used for the SQLite project.

And the data file:

```
# This file contains the data used to generate the GnuCOBOL syntax diagrams
#  with bubble-cobol.tcl

# Graphs:
#
set all_graphs {
    cobc-marketing {
        line {or Heritage Experience {or _Data_stores /eSQL /macros} past /present␣
↪future}
            /cobc {or
            {opt {line -m module}}
            {line -x executable}
            {line -b build-together}
            {line -c object}
            {line -h help}
            {line ... _much_more}
            GnuCOBOL
        } {loop {or COBOL
                    {line {or C C++} {or nil Ada BASIC Java Lua Python Tcl/Tk Rexx
                      _myriad_others}}
                    Assembler _Object_Code
                    _Static_Archive _[Dynamic]_Shared_Object}}
        _Bank_on_IT
    }

    cobol-directive {
        line {or
                nil
                copy-directive
                replace-directive
                if-directive
                define-directive
        }
    }
    copy-directive {
        stack
            {line COPY {or literal-1 text-name-1} {opt {line {or OF IN} literal-2}}
                {opt {line SUPPRESS {opt PRINTING}}}}
            {opt {line REPLACING {loop {or
                {line {or ==pseudo-text-1== text-1 literal-3 word-1}
                    BY {or ==pseudo-text-2== text-2 literal-4 word-2}}
                {line {or LEADING TRAILING} ==partial-word-1== BY ==partial-word-2==}}
↪}
        }}
        .
    }

    replace-directive {
        stack
        {line REPLACE {or
            {line {opt ALSO} {loop {or
                {line ==pseudo-text-1== BY ==pseudo-text-2==}
                {line {or LEADING TRAILING} ==partial-word-1== BY ==partial-word-2==}
            }}}
```

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```
            {line {opt LAST} OFF}}}
        .
    }

    define-directive {
        line {or >>DEFINE +$DEFINE} {opt +CONSTANT} compilation-variable-1 {opt AS}
            {or
                {line {or arithmetic-expression-1 literal-1 PARAMETER} {opt OVERRIDE}}
                OFF}
    }


    if-directive {
       stack
           {line {or >>IF +$IF} {or constant-conditional-1 {line compilation-variable-
↪1
               {opt IS} {line {opt NOT} DEFINED}}} {opt text-1}}
           {opt {line {loop {line {or +>>ELSE-IF +>>ELIF +$ELSE-IF +$ELIF}
               {or +constant-conditional-2 {line +compilation-variable-2
               {opt +IS} {line {opt +NOT} +DEFINED}}} {opt +text-2}}}}}
           {opt {line {or >>ELSE +$ELSE} {opt text-3}}}
           {or >>END-IF +$END-IF}
    }

    cobol-statement {
        or
            nil
            accept-statement
            add-statement
            allocate-statement
            call-statement
            cancel-statement
            close-statement
            compute-statement
            continue-statement
            delete-statement
            display-statement
            divide-statement
            evaluate-statement
            exit-statement
            free-statement
            generate-statement
            go-statement
            goback-statement
            if-statement
            initialize-statement
            initiate-statement
            inspect-statement
            invoke-statement
            merge-statement
            move-statement
            multiply-statement
            open-statement
            perform-statement
            raise-statement
            read-statement
            release-statement
```

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```
            resume-statement
            return-statement
            rewrite-statement
            search-statement
            set-statement
            sort-statement
            start-statement
            stop-statement
            string-statement
            subtract-statement
            suppress-statement
            terminate-statement
            transform-statement
            unlock-statement
            unstring-statement
            use-statement
            validate-statement
            write-statement
    }

    accept-statement {
        stack
        {line ACCEPT
            {or +OMITTED
                {line identfier-1
                    {or {opt FROM CONSOLE}
                        {line FROM device}
                        {line FROM DATE {opt YYYYMMDD}}
                        {line FROM DAY {opt YYYYDDD}}
                        {line FROM DAY-OF-WEEK}
                        {line FROM TIME}
                        {line +FROM +COMMAND-LINE}
                        {line +FROM +ARGUMENT-NUMBER}
                        {line +FROM +ARGUMENT-VALUE}
                        {line +FROM +ENVIRONMENT +environment-variable}
                        {line +FROM +ENVIRONMENT-VALUE}
                        {line +FROM +ESCAPE-KEY}
                        {line +FROM +USER +NAME}
                        {line +FROM +EXCEPTION +STATUS}
                        {line +FROM +COLUMNS}
                        {line +FROM +LINES}
                        {line AT line-column {opt +WITH +extended-attributes}}
                    }
                }
            }}
            {opt {line
                {opt {line {opt ON} EXCEPTION imperative-1}}
                {opt {line NOT {opt ON} EXCEPTION imperative-2}}
            }}
            {opt END-ACCEPT}
    }

    add-statement {
        stack
            {line ADD {or
                {line
                    {loop {or literal-1 identifier-1}}
```

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```
                    {or
                        {line {or TO GIVING}
                            {loop {line identifier-2 {opt rounded-phrase}}}}
                        {line TO {or literal-2 identifier-2}
                              GIVING {loop {line identifier-3 {opt rounded-phrase}}}
                        }
                    }
                }
                {line {or CORRESPONDING CORR} identifier-4 TO identifier-5
                    {opt rounded-phrase}}
            }}
            {opt {line
                {opt {line {opt ON} SIZE ERROR imperative-1}}
                {opt {line NOT {opt ON} SIZE ERROR imperative-2}}}}
            {opt END-ADD}
    }
    rounded-phrase {
        line ROUNDED
            {opt {line MODE {opt IS} {or
                AWAY-FROM-ZERO
                NEAREST-AWAY-FROM-ZERO
                NEAREST-EVEN
                NEAREST-TOWARD-ZERO
                PROHIBITED
                TOWARD-GREATER
                TOWARD-LESSER
                TRUNCATION}
            }
        }
    }

    allocate-statement {
        line ALLOCATE {or
            {line arithmetic-expression-1 CHARACTERS}
            data-name-1
        }
        {opt {or INITIALIZED +INITIALISED}}
        {opt {line RETURNING data-name-2}}
    }

    alter-statement {
        line +ALTER {loop {line +procedure-name-1 +TO
            {opt +PROCEED +TO} +procedure-name-2}}
    }

    call-statement {
        stack {
            line CALL {opt {or +STATIC +STDCALL +mnemonic-name}}
                {or identifier-1 literal-1}}
            {opt {line USING {loop {or
                {line {loop {line {opt {opt {line {opt BY} REFERENCE}}}
                    {or identifier-2 literal-2 OMITTED}}}}
                {line {loop {line {opt {line {opt BY} CONTENT}}
                    {or expression-1 identifier-2 literal-2}}}}
                {line {loop {line {opt {line {opt BY} VALUE {opt +size-mod}}}
                    {or identifier-2 literal-2}}}}
            }}}}
```

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```
            {opt {line {or RETURNING +GIVING}
                {opt {or +INTO {line +ADDRESS {opt +OF}}}}
                    {or identifier-3 {or +NULL +OMITTED}}}}
            {opt {line {opt {or {line {opt ON} EXCEPTION}
              {line {opt ON} OVERFLOW}} imperative-1}
            {opt {or {line NOT {opt ON} EXCEPTION imperative-2}
              {line +NOT {opt +ON} +OVERFLOW +imperative-2}}}}}
            {opt END-CALL}
    }

    cancel-statement {
        line CANCEL {loop {or identifier-1 literal-1}}
    }

    close-statement {
        line CLOSE {loop {line file-name-1 {opt {or
            {line {or REEL UNIT} {opt FOR} REMOVAL}
            {line {opt WITH} {or {line NO REWIND} LOCK}}
        }}}}
    }

    compute-statement {
        stack
            {line COMPUTE {loop {line identifier-1
                {opt rounded-phrase}}} = arithmetic-expression-1}
            {opt {line
                {opt {line {opt ON} SIZE ERROR imperative-1}}
                {opt {line NOT {opt ON} SIZE ERROR imperative-2}}}}
            {opt END-COMPUTE}
    }

    commit-statement {
        line +COMMIT
    }

    continue-statement {
        line CONTINUE
    }

    delete-statement {
        stack
            {line DELETE {or
                {line +FILE {loop +file-name-1}}
                {line file-name-2 {opt RECORD}
                    {opt {line INVALID {opt KEY} imperative-1}}
                    {opt {line NOT INVALID {opt KEY} imperative-2}}
            }}}
            {opt END-DELETE}
    }

    display-statement {
        stack
        {line DISPLAY
            {or
            {line {loop {or identifier-1 literal-1}}
                {opt {line UPON mnemonic-name}} {opt {line {opt WITH}
                  NO ADVANCING}}}
```

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```
            {line {or identifier-1 literal-1} AT line-column
                {opt +WITH +extended-attributes}}
            {line {or +identfier-1 +literal-1}
                {or
                    {line +UPON +ENVIRONMENT-NAME}
                    {line +UPON +ENVIRONMENT-VALUE}
                    {line +UPON +ARGUMENT-NUMBER}
                    {line +UPON +ARGUMENT-VALUE}
                    {line +UPON +COMMAND-LINE}
                }}}}
        {opt {line
             {opt {line {opt ON} EXCEPTION imperative-1}}
             {opt {line NOT {opt ON} EXCEPTION imperative-2}}}}
        {opt END-DISPLAY}
    }

    divide-statement {
        stack
            {line DIVIDE {or identifier-1 literal-1}}
            {or
                 {line INTO {loop {line identifier-2 {opt rounded-phrase}}}}
                 {line BY {line identifier-2 {opt rounded-phrase}}}
                 {line {or INTO BY} {or identifier-2 literal-2}
                     GIVING {loop {line identifier-3 {opt rounded-phrase}}}}
                 {line {or INTO BY} {or identifier-2 literal-2}
                     {line GIVING {line identifier-3 {opt rounded-phrase}}}
                     {line REMAINDER identifier-4}}
            }
            {opt {line
                {opt {line {opt ON} SIZE ERROR imperative-1}}
                {opt {line NOT {opt ON} SIZE ERROR imperative-2}}}}
            {opt END-DIVIDE}
    }

    evaluate-statement {
        stack
            {line EVALUATE selection-subject
                {opt {loop {line ALSO selection-subject}}}}
            {line {loop {line WHEN selection-object
                {opt {loop {line ALSO selection-object}}}}} imperative-1}
            {opt {line WHEN OTHER imperative-2}}
            {opt END-EVALUATE}
    }

    exit-statement {
        stack
            {line EXIT {or
            nil
            {line {or PARAGRAPH SECTION FUNCTION
                      {line PROGRAM {opt {or +RETURNING +GIVING}}}}}
            {line PERFORM {opt CYCLE}}}}
    }

    free-statement {
        line FREE {loop data-name-1}
    }
```

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```
    generate-statement {
        line GENERATE {or data-name-1 report-name-1}
    }

    go-statement {
        or
            {line GO {opt TO} {or
                procedure-name-1
                {line {loop procedure-names} {line DEPENDING {opt ON}
                  identifier-1}}}}
            {line +GO {opt +TO} {opt _target-procedure_(modified_by_alter)}}
    }

    goback-statement {
        line GOBACK
    }

    if-statement {
        line IF condition-1 {opt THEN} statement-1 {opt {line ELSE statement-2}}
            {opt END-IF}
    }

    initialize-statement {
        stack
            {line {or INITIALIZE +INITIALISE} {loop identifier-1}
                {opt {line {opt WITH} FILLER}}}
            {opt {line {or ALL category-name} {opt TO} VALUE}}
            {opt {line {opt THEN} REPLACING {loop {line category-name
                {opt DATA} BY {or identifier-1 literal-1}}}}}
            {opt {line {opt THEN} {opt TO} DEFAULT}}
    }
    category-name {
        line {or ALPHABETIC ALPHANUMERIC ALPHANUMERIC-EDITED DATA-POINTER
                 FUNCTION-POINTER NATIONAL NATIONAL-EDITED PROGRAM-POINTER}
    }

    initiate-statement {
        line INITIATE {loop report-name-1}
    }

    inspect-statement {
        line INSPECT identifier-1 {or
            {line TALLYING tallying-phrase}
            {line REPLACING replacing-phrase}
            {line TALLYING tallying-phrase REPLACING replacing-phrase}
            {line CONVERTING {or identifier-2 literal-1} TO
                {or identifier-3 literal-2} {opt before-after-phrase}}
        }
    }

    tallying-phrase {
        loop {line identifier-2 FOR {or
            {line CHARACTERS {opt before-after-phrase}}
            {loop {line ALL {or identifier-3 literal-1}
                {opt before-after-phrase}}}
            {loop {line LEADING {or identifier-3 literal-1}
                {opt before-after-phrase}}}
```

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```
            {loop {line +TRAILIING {or +identifier-3 +literal-1}
                {opt +before-after-phrase}}}
        }}
    }

    before-after-phrase {
        or {line BEFORE {opt INITIAL} {or identifier-4 literal-2}}
            {line AFTER {opt INITIAL} {or identifier-4 literal-2}}
    }

    replacing-phrase {
        or
            {line CHARACTERS BY {opt identifier-5 literal-3}
                {opt before-after-phrase}}
            {loop {line ALL {or identifier-5 literal-3}
                {opt before-after-phrase}}}
            {loop {line LEADING {or identifier-5 literal-3}
                {opt before-after-phrase}}}
            {loop {line FIRST {or identifier-5 literal-3}
                {opt before-after-phrase}}}
            {loop {line +TRAILIING {or +identifier-5 +literal-3}
                {opt +before-after-phrase}}}
    }

    merge-statement {
        stack
            {line MERGE filename-1 {opt {loop {line {opt ON}
                {or ASCENDING DESCENDING} {opt KEY} {loop data-name-1}}}}}
            {opt {line {opt COLLATING} SEQUENCE {or
                {line IS alphabet-name-1 {opt alphabet-name-2}}
                {or
                    {line {opt FOR} ALPHANUMERIC {opt IS} alphabet-name-1}
                    {line {opt FOR} NATIONAL {opt IS} alphabet-name-2}}}}}
            {line USING filename-2 {loop file-name-3}}
            {or
                {line OUTPUT PROCEDURE {opt IS} procedure-name-1
                    {opt {line {or THROUGH THRU}} procedure-name-2}}
                {line GIVING {loop file-name-4}}}
    }

    move-statement {
        line MOVE {or
            {line {or identifier-1 literal-1} TO {loop identifier-2}}
            {line {or CORRESPONDING CORR} identifier-3 TO identifier-4}}
    }

    multiply-statement {
        stack
            {line MULTIPLY {or
                {line {or identifier-1 literal-1} BY {loop {line identifier-2
                    {opt rounded-phrase}}}}
                {line {or identifier-1 literal-1} BY {or identifier-2 literal-2}
                    GIVING {loop {line identifier-3 {opt rounded-phrase}}}}}}
            {opt {line
                {opt {line {opt ON} SIZE ERROR imperative-1}}
                {opt {line NOT {opt ON} SIZE ERROR imperative-2}}}}
            {opt END-MULTIPLY}
```

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```
}

open-statement {
    line OPEN {loop {line {or INPUT OUTPUT I-O EXTEND}
            {opt {line SHARING {opt WITH} {or
                {line ALL {opt OTHER}} {line NO {opt OTHER}}
                  {line READ ONLY}}}} {loop {line file-name-1 {opt {or
                    {line {opt WITH} {or {line NO REWIND} LOCK}}
                    +REVERSED}}}}}}
}

perform-statement {
    line {or /perform-procedure /perform-inline}
}

perform-procedure-statement {
    stack
    {line PERFORM procedure-1 {opt {line {or THROUGH THRU} procedure-2}}}
    {opt {line {or
        {line {or identifier-1 integer-1} TIMES}
        {line {opt {line {opt WITH} TEST {or BEFORE AFTER}}}
        {or
            {line UNTIL condition-1}
            varying-phrase}}}}}
}

perform-inline-statement {
    line PERFORM {or nil
        {line {or identifier-1 integer-1} TIMES}
        {line {opt {line {opt WITH} TEST {or BEFORE AFTER}}}
            {or
                {line UNTIL condition-1}
                varying-phrase}}
        +FOREVER}
    imperative-1 END-PERFORM
}

varying-phrase {
    indentstack 2
    {line VARYING {or identifier-2 index-name-1}
      FROM {or identifier-3 index-name-2 literal-1}
      /by {or identifier-4 literal-2} UNTIL condition-1}
    {opt {loop {line AFTER {or identifier-5 index-name-3}
      FROM {or identifier-6 index-name-4 literal-3}
      /by {or identifier-7 literal-4} UNTIL condition-2}}}
}

read-statement {
    stack
    {line READ file-name-1 {opt {or {opt NEXT} PREVIOUS}} {opt RECORD}
      {opt {line INTO identifier-1}}}
    {opt {line
      {opt {line ADVANCING {opt ON} LOCK}}
      {opt {line IGNORING LOCK}}
      {opt {line {opt WITH} {opt NO} LOCK}}}}
    {opt {line
      {opt {line {opt AT} END imperative-1}}
```

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```
          {opt {line NOT {opt AT} END imperative-2}}}}
        {opt END-READ}
    }

    ready-statement {
        line +READY +TRACE
    }

    release-statement {
        line RELEASE record-name-1 {opt {line FROM {or identifier-1 literal-1}}}
    }

    reset-statement {
        line +RESET +TRACE
    }

    return-statement {
        stack
            {line RETURN file-name-1 {opt RECORD} {opt {line INTO identifier-1}}}
            {line {opt AT} END imperative-1 {opt {line NOT {opt AT}
              END imperative-2}}}
            {opt END-RETURN}
    }

    rewrite-statement {
        stack
            {line REWRITE {or record-name-1 {line FILE file-name-1}} {opt RECORD}
              {opt {line FROM {or identifier-1 literal-1}}}}
            {opt {line {opt WITH} {opt NO} LOCK}}
            {opt {line {opt {line INVALID {opt KEY} imperative-1}}
              {opt {line NOT INVALID {opt KEY} imperative-2}}}}
            {opt END-REWRITE}
    }

    rollback-statement {
        line +ROLLBACK
    }

    search-statement {
        line {or /search-linear /search-all}
    }

    search-linear-statement {
        stack
            {line SEARCH identifier-1 {opt {line VARYING
              {or identifier-2 index-name-1}}}}
            {opt {line {opt AT} END imperative-1}}
            {line {loop {line WHEN condition-1
              {or imperative-2 {line NEXT SENTENCE}}}}}
            {opt {line {opt END-SEARCH}}}
    }

    search-all-statement {
        stack
            {line SEARCH ALL identifier-1 {opt {line {opt AT} END imperative-1}}}
            {line WHEN {or
                {line data-name-1 {or {line {opt IS} EQUAL {opt TO}}
```

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```
                {line {opt IS} =}}
                {or identifier-3 literal-1 arithmetic-expression-1}}
            condition-name-1}}
        {opt {line {loop {line AND {or
            {line data-name-2 {or {line {opt IS} EQUAL {opt TO}}
              {line {opt IS} =}}
              {or identifier-4 literal-2 arithmetic-expression-2}}
            condition-name-2}}}}}
        {or imperative-2 {line NEXT SENTENCE}}
        {opt END-SEARCH}
}

set-statement {
    line SET {or
        {line {loop {or index-name-1 identifier-1}}
          TO {or arithmetic-expression-1 index-name-2 identifier-2}}
        {line {loop {line {opt ADDRESS {opt OF}} identifier-1}}
          TO ADDRESS {opt OF} identifier-2}
        {line {loop index-name-1} {line {or UP DOWN} BY
          arthimetic-expression-1}}
        {line {loop {line {loop mnemonic-name-1} TO {or ON OFF}}}}
        {line {loop {line {loop condition-name-1} TO {or TRUE FALSE}}}}
        {line screen-name-1 ATTRIBUTE {loop {line
            {or BELL BLINK HIGHLIGHT LOWLIGHT REVERSE-VIDEO UNDERLINE
              +LEFTLINE +OVERLINE } {or ON OFF}}}}
        {line {loop +identifier-1}
          +TO {line +ENTRY {or +identifier-2 +literal-1}}}
        {line +ENVIRONMENT {or +identifier-1 +literal-1}
          +TO {or +identifier-2 +literal-2}}
    }
}

sort-statement {
    line {or /sort-file /sort-table}
}

sort-file-statement {
    stack
        {line SORT file-name-1
          {opt {loop {line {opt ON} {or ASCENDING DESCENDING}
          KEY {loop data-name-1}}}}}
        {opt {line {opt WITH} DUPLICATES {opt IN} {opt ORDER}}}
        {opt {line {opt COLLATING} SEQUENCE {opt IS} alphabet-1
          {opt alphabet-2}}}
        {opt {line {or
            {line INPUT PROCEDURE {opt IS} procedure-name-1
              {opt {line {or THROUGH THRU} procedure-name-2}}}
            {line USING {loop file-name-2}}}}}
        {opt {line {or
            {line OUTPUT PROCEDURE {opt IS} procedure-name-3
              {opt {line {or THROUGH THRU} procedure-name-4}}}
            {line GIVING {loop file-name-3}}}}}
}

sort-table-statement {
    stack
        {line SORT data-name-1
```

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```
            {opt {loop {line {opt ON} {or ASCENDING DESCENDING}
            KEY {loop data-name-1}}}}}
          {opt {line {opt WITH} DUPLICATES {opt IN} {opt ORDER}}}
          {opt {line {opt COLLATING} SEQUENCE {opt IS} alphabet-1
            {opt alphabet-2}}}
    }

    start-statement {
        stack
          {line START file-name-1 {or
            FIRST
            {line KEY relational-1 {or data-name-1 record-key-1}
              {opt {line {opt WITH} {or LENGTH +SIZE} arithmetic-expression-1}}}
            LAST}}
          {opt {line {opt {line INVALID {opt KEY} imperative-1}}
                     {opt {line NOT INVALID {opt KEY} imperative-2}}}}
          END-START
    }

    stop-statement {
        line STOP {or
          {line RUN {opt {or
              {line {opt WITH} {or ERROR NORMAL} {opt STATUS}
                {or identifier-1 literal-1}}
              {line {or +RETURNING +GIVING} {or +identifier-2 +literal-2}}}}}
          +literal-3}
    }

    string-statement {
        stack
          {line STRING {line {loop {line {loop {or identifier-1 literal-1}}
            {opt {line DELIMITED {opt BY}} {or identifier-2 literal-2 SIZE}}}}}}
          {line INTO identifier-3 {opt {line {opt WITH} POINTER identifier-4}}}
          {opt {line {opt {line {opt ON} OVERFLOW imperative-1}}
                     {opt {line NOT {opt ON} OVERFLOW imperative-2}}}}
          {opt END-STRING}
    }

    subtract-statement {
        stack
          {line SUBTRACT {or
              {line
                  {loop {or literal-1 identifier-1}}
                  {or
                      {line FROM
                          {loop {line identifier-2 {opt rounded-phrase}}}}
                      {line FROM {or literal-2 identifier-2}
                            GIVING {loop {line identifier-3 {opt rounded-phrase}}}
                      }
                  }
              }
              {line {or CORRESPONDING CORR} identifier-4 FROM identifier-5
                  {opt rounded-phrase}}
          }}
          {opt {line
              {opt {line {opt ON} SIZE ERROR imperative-1}}
              {opt {line NOT {opt ON} SIZE ERROR imperative-2}}}}
```

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```
            {opt END-SUBTRACT}
    }

    suppress-statement {
        line SUPPRESS {opt PRINTING}
    }

    terminate-statement {
        line TERMINATE {loop report-name-1}
    }

    transform-statement {
        line +TRANSFORM +identifier-1 +FROM {or +identifier-2 +literal-1}
          +TO {or +identifier-3 {line {opt +ALL} +literal-2}}
    }

    unlock-statement {
        line UNLOCK file-name-1 {opt {or RECORD RECORDS}}
    }

    unstring-statement {
        stack
            {line UNSTRING identifier-1
                {opt {line DELIMITED {opt BY} {opt ALL} {or identifier-2 literal-1}
                    {opt {loop {line OR {opt ALL} {or identifier-3 literal-2}}}}}}}
            {line INTO {loop {line identifier-4
              {opt {line DELIMITER {opt IN} identifier-5}}
              {opt {line COUNT {opt IN} identifier-6}}}}}
            {opt {line {opt WITH} POINTER identifier-7}}
            {opt {line TALLYING {opt IN} identifier-8}}
            {opt {line {opt {line {opt ON} OVERFLOW imperative-1}}
              {opt {line NOT {opt ON} OVERFLOW imperative-2}}}}
            {opt END-UNSTRING}
    }

    use-statement {
       line USE {or
           {line {opt GLOBAL} {opt AFTER} {opt STANDARD} {or EXCEPTION ERROR}
             {opt PROCEDURE} {opt ON} {or {loop file-name-1} INPUT OUTPUT IO EXTEND}}
           {line {opt GLOBAL} BEFORE REPORTING identifier-1}
           {line {opt +FOR} +DEBUGGING {opt +ON} {loop {or
             {line {or +procedure {line +ALL +PROCEDURES}}}
             {line +ALL {opt +REFERENCES} {opt +OF} +identifier-2}}}}
           {line {opt +AT} +PROGRAM {or +START +END}}
           {line {opt AFTER} {loop {line {or {line EXCEPTION CONDITION} EC}
             {or exception-name-1 {line exception-name-2 {loop {line FILE file-name-2}
↪}}}}}}}
    }

    write-statement {
        line {or write-sequential write-random}
    }

    write-sequential-statement {
        stack
            {line WRITE {or record-name-1 {line {opt FILE} file-name-1}}
              {opt {line FROM {or identifier-1 literal-1}}}}
```

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```
            {opt {line {or BEFORE AFTER} ADVANCING {or
              {line {or identifier-2 integer-1} {or LINE LINES}}
                {or mnemonic-name-1 PAGE}}}}
            {opt {line {opt WITH} {opt NO} LOCK}}
            {opt {line {opt {line {opt AT} {or END-OF-PAGE EOP} imperative-1}}
              {opt {line NOT {opt AT} {or END-OF-PAGE EOP} imperative-2}}}}
            {opt END-WRITE}
    }
    write-random-statement {
        stack
            {line WRITE {or record-name-1 {line {opt FILE} file-name-1}}
              {opt {line FROM {or identifier-1 literal-1}}}}
            {opt {line {opt WITH} {opt NO} LOCK}}
            {opt {line {opt {line INVALID {opt KEY} imperative-1}}
              {opt {line NOT INVALID {opt KEY} imperative-2}}}}
            {opt END-WRITE}
    }
}
```

8.35 Rosetta Code

There is a programming chrestomathy web site, http://rosettacode.org, chock full of programming language solutions to many different problems. The site objective is to present many different solutions to many different tasks, to demonstrate how programming languages are similar and different. The site boasts close to 1,000 programming tasks, with solutions shown in many of the over 600 programming languages documented on the site (as of June 2016).

chrestomathy a collection of choice literary passages, used especially as an aid in learning a subject.

COBOL has over 200 task solutions listed, in an ever growing list of entries.

http://rosettacode.org/wiki/Category:COBOL

The range of tasks can provide good hints on how to solve many different programming problems. As a generic site meant to cover as many languages and language features as possible, Rosetta Code tends to be more Computer Science than the stock and trade Computer Business that COBOL is famous for, but there is still a lot to learn when reading through the site pages.

Aside from tasks that demonstrate the basics (there are many of these on the Rosetta Code site; variables, loops, conditionals, literals, etc) examples include:

- Anagrams
- Playing Cards
- Sorting
- IBAN
- hundreds more

8.36 cobweb-periodic listing

Periodic table of the elements as GTK+ buttons. *Old code, and it should be rewritten to take advantage of the* `cobweb-gtk` *function repository, and PROCEDURE DIVISION RETURNING OMITTED for the callback handlers.*

```
GNU     >>SOURCE FORMAT IS FIXED
Cobol *> ***************************************************
cob   *> Author:    Brian Tiffin
  web *> Date:      20130308, 20140712
      *> Purpose:   A cobweb extension, periodic table
atomic*> License:   GPL 3.0 or greater
chart *> Tectonics:
      *>  cobc -x -g -debug cobweb-periodic.cob support-cobweb.cob
      *>    voidcall.c `pkg-config --libs gtk+-3.0`
      *> ***************************************************
       identification division.
       program-id. cobweb-periodic.

       environment division.
       configuration section.
       repository.
           function all intrinsic.

       input-output section.
       file-control.
           select element-data
           assign to "elements.txt"
           organization is line sequential
           status is element-data-status
           .

       data division.
       file section.
       fd element-data.
          01 element-record.
             05 element-id     pic 999.
             05 filler         pic x.
             05 element-short  pic xxx.
             05 filler         pic x.
             05 element-period pic 99.
             05 filler         pic x.
             05 element-group  pic 99.
             05 filler         pic x.
             05 element-color  pic x(24).
             05 filler         pic x.
             05 element-info   pic x(64).

       working-storage section.
      *>
      *> the periodic table of the elements, shared with a callback
      *>   updates here need to be synched with support-cobweb.cob
      *>
       01 elements is external.
          05 element occurs 118 times indexed by elem.
             10 sym            pic xxx.
             10 cg             pic 99.
             10 rp             pic 99.
             10 color          pic x(24).
             10 info           pic x(64).
       01 element-data-status  pic 9999.

      *> cheat C out of chasing a null byte
```

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```
       01 button-zname.
          05 button-number           pic zzzz9.
          05 filler                  pic x value x"0a".
          05 button-name             pic xxx.
          05 filler                  pic x value x"00".

       01 venue                      pic x(8).
          88 broadway                    values "broadway", "BROADWAY".

       01 gtk-window                 usage pointer.
       01 gtk-settings               usage pointer.
       01 gtk-box                    usage pointer.
       01 gtk-label                  usage pointer.
       01 gtk-spacer                 usage pointer.
       01 gtk-grid                   usage pointer.
       01 gtk-button                 usage pointer.
       01 gtk-quit-callback          usage program-pointer.
       01 gtk-quit-handler-id        usage pointer.
       01 gtk-void-callback          usage program-pointer.
       01 cob-button-callback        usage program-pointer.

       01 gdk-color                  pic x(32).

       01 gtk-info-label             is external usage pointer.

       01 p usage index.
       01 g usage index.

       01 GTK-WINDOW-TOPLEVEL        constant as 0.

       01 GTK-ORIENTATION-HORIZONTAL constant as 0.
       01 GTK-ORIENTATION-VERTICAL   constant as 1.

       01 banner-msg           pic x(27)
                                 value z"GNU Cobol periodic buttons".

      *> destined to be a callable, not a main, linkage in the future
       linkage section.
       01 gtk-widget                 usage pointer.
       01 gtk-data                   usage pointer.

      *> *******************************************************

gui   *> *******************************************************
       procedure division.

      *> populate the element data
       open input element-data
       if element-data-status not equal zero then
           display
               "Sorry, no elements.txt data" upon syserr
           end-display
           stop run returning 1
       end-if

      *> pull in the element data, fill a table
       perform varying elem from 1 by 1 until elem > 118
```

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```
           read element-data at end exit perform end-read
           if element-data-status not equal 0 then exit perform end-if
           move element-short to sym(elem)
           move element-group to cg(elem)
           move element-period to rp(elem)
           move element-color to color(elem)
           move element-info to info(elem)
       end-perform
       close element-data

      *> Start up the GIMP/Gnome Tool Kit
       call "gtk_init" using
           by value 0                          *> argc int
           by value 0                          *> argv pointer to pointer
           returning omitted                   *> void return, requires cobc 2010+
           on exception
               display
                   "gtk_init link error, see pkg-config --libs gtk+-3.0"
                   upon syserr
               end-display
               stop run returning 1
       end-call

      *> Create a new window, returning handle as pointer
       call "gtk_window_new" using
           by value GTK-WINDOW-TOPLEVEL        *> it's a zero or a 1 popup
           returning gtk-window                *> and remember the handle
       end-call

      *> More fencing, skimped on after this first test
       if gtk-window equal null then
           display
               "GTK service error; gtk_window_new NULL"
               upon syserr
           end-display
           stop run returning 1
       end-if

      *> Hint to not let the sample window be too small
       call "gtk_window_set_default_size" using
           by value gtk-window                 *> by value is used to get the C␣
↪address
           by value 270                        *> a rectangle, wider than tall
           by value 90
           returning omitted                   *> another void
       end-call

      *> Put in the title, it'll be truncated in a size request window
       call "gtk_window_set_title" using
           by value gtk-window                 *> pass the C handle
           by reference banner-msg
           returning omitted
       end-call

      *> Connect death signals.
       set gtk-quit-callback to entry "gtk_main_quit"
       call "g_signal_connect_data" using
```

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```
           by value gtk-window
           by reference z"destroy"              *> with inline Z string
           by value gtk-quit-callback           *> function call back pointer
           by value 0                           *> pointer to data
           by value 0                           *> closure notify to manage data
           by value 0                           *> connect before or after flag
           returning gtk-quit-handler-id        *> not used in this sample
       end-call
       call "g_signal_connect_data" using
           by value gtk-window
           by reference z"delete_event"         *> with inline Z string
           by value gtk-quit-callback           *> function call back pointer
           by value 0                           *> pointer to data
           by value 0                           *> closure notify to manage data
           by value 0                           *> connect before or after flag
           returning gtk-quit-handler-id        *> not used in this sample
       end-call

      *> Define a container. Boxey, but nice.  Layout top to bottom.
       call "gtk_box_new" using
           by value GTK-ORIENTATION-VERTICAL
           by value 8                           *> pixels between widgets
           returning gtk-box
       end-call

      *> Add the label
       call "gtk_label_new" using
           by reference banner-msg
           returning gtk-label
       end-call

      *> Add the label to the box
       call "gtk_container_add" using
           by value gtk-box
           by value gtk-label
           returning omitted
       end-call

      *> Instead of fiddling with each button, make a grid
       call "gtk_grid_new" returning gtk-grid end-call

        *> row and column for the chart is in the elements data
        *>  g is element group, p is period
       perform varying elem from 1 by 1 until elem > 118
           move cg(elem) to g
           move rp(elem) to p

          *> name the button
           move sym(elem) to button-name
           move elem to button-number

          *> Add a button
           call "gtk_button_new_with_label" using
               by reference button-zname
               returning gtk-button
           end-call
```

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```
           *> BOO! no background color mod with the default GNOME
           *>  theme, Adwaita, due to the theme wanting to apply
           *>  gradients...  Rassafrassa, Styling... for color?

           *> possible workaround, turn off the Adwaita theme
            call "gtk_settings_get_default"
                returning gtk-settings
            end-call
            call "g_object_set" using
                by value gtk-settings
                by content z"gtk-theme-name"
                by value 0
                by value 0
                returning omitted
            end-call

            call "gdk_rgba_parse" using
                by reference gdk-color
                by content concatenate(trim(color(elem)), x"00")
            end-call
            call "gtk_widget_override_background_color" using
                by value gtk-button
                by value 0
                by reference gdk-color
                returning omitted
            end-call

            call "gtk_grid_attach" using
                by value gtk-grid
                by value gtk-button
                by value p                *> column, element group
                by value g                *> row, element period
                by value 1                *> cells width
                by value 1                *> cells height
                returning omitted
            end-call

       *> Connect a signal.  GNU Cobol doesn't generate void returns
       *>  so this calls a C function two-liner that calls the
       *>  COBOL entry, but returns void to the runtime stack frame
            set cob-button-callback to entry "buttonclick"
            set gtk-void-callback to entry "voidcall"
            call "g_signal_connect_data" using
                by value gtk-button
                by reference z"clicked"             *> with inline Z string
                by value gtk-void-callback          *> function call back pointer
                by value cob-button-callback        *> pointer to COBOL proc
                by value 0                          *> closure notify to manage data
                by value 0                          *> connect before or after flag
                returning gtk-quit-handler-id       *> not used in this sample
            end-call

        end-perform

       *> Force the empty row 8
        call "gtk_label_new" using
            by content z"---"
```

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```
           returning gtk-spacer
       end-call
       call "gtk_grid_attach" using
           by value gtk-grid
           by value gtk-spacer
           by value 3               *> left-side attached to
           by value 8               *> top-of-cell row, element period
           by value 1               *> cells width
           by value 1               *> cells height
           returning omitted
       end-call

      *> the info box
       call "gtk_label_new" using
           by content "Click an element to see more information," &
                      " including;" & x"0a" &
                      "name, class, normal state," &
                     z" atomic weight and electron orbits"
           returning gtk-info-label
       end-call
       call "gdk_rgba_parse" using
           by reference gdk-color
           by content z"white"
       end-call
       call "gtk_widget_override_background_color" using
           by value gtk-info-label
           by value 0
           by reference gdk-color
           returning omitted
       end-call
       call "gtk_grid_attach" using
           by value gtk-grid
           by value gtk-info-label
           by value 3               *> left-side attached to
           by value 2               *> top-of-cell row, element period
           by value 10              *> cells width
           by value 2               *> cells height
           returning omitted
       end-call


      *> Add the big fat grid to the box
       call "gtk_container_add" using
           by value gtk-box
           by value gtk-grid
           returning omitted
       end-call

      *> Add some control buttons to the box, only the self destruct button in this␣
↪case
       call "gtk_button_new_with_label" using
           by content z"Exit"
           returning gtk-button
       end-call
       call "gtk_container_add" using
           by value gtk-box
           by value gtk-button
```

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```
            returning omitted
        end-call
        set gtk-quit-callback to entry "gtk_main_quit"
        call "g_signal_connect_data" using
            by value gtk-button
            by reference z"clicked"
            by value gtk-quit-callback
            by value 0
            by value 0
            by value 0
            returning gtk-quit-handler-id
        end-call

       *> Add the box to the window
        call "gtk_container_add" using
            by value gtk-window
            by value gtk-box
            returning omitted
        end-call

       *> ready to display
        call "gtk_widget_show_all" using
            by value gtk-window
            returning omitted
        end-call

       *> Enter the GTK event loop
        call "gtk_main" returning omitted end-call

       *> Control can pass back and forth to COBOL subprograms,
       *>  by event, but control flow stops above, until the
       *>  window is torn down and the event loop exits
        display
            "GNU Cobol: GTK main eventloop terminated normally"
            upon syserr
        end-display

        accept venue from environment "GDK_BACKEND" end-accept
        if broadway then
            display "Ken sends his regards" upon syserr end-display
        end-if

done    goback.
COOL    end program cobweb-periodic.
```

And the `elements.txt` data

```
  1 H   01x01 medium spring green      Hydrogen nonmetal gas 1.00794 [1]
  2 He  18x01 peru                     Helium noble gas 4.002602 [2]
  3 Li  01x02 coral                    Lithium alkali-metal solid 6.941 [2 1]
  4 Be  02x02 moccasin                 Beryllium alkaline-earth-metal solid 9.01218 [2 2]
  5 B   13x02 tan                      Boron metalloid solid 10.811 [2 3]
  6 C   14x02 medium spring green      Carbon nonmetal solid 12.011 [2 4]
  7 N   15x02 medium spring green      Nitrogen nonmetal gas 14.00674 [2 5]
  8 O   16x02 medium spring green      Oxygen nonmetal gas 15.9994 [2 6]
  9 F   17x02 orange                   Fluorine halogen gas 18.998403 [2 7]
 10 Ne  18x02 peru                     Neon noble gas 20.1797 [2 8]
```

```
 11 Na  01x03 coral                  Sodium alkali-metal solid 22.989768 [2 8 1]
 12 Mg  02x03 moccasin               Magnesium alkaline-earth-metal solid 24.305 [2 8 2]
 13 Al  13x03 silver                 Aluminum poor-metal solid 26.981539 [2 8 3]
 14 Si  14x03 tan                    Silicon metalloid solid 28.0855 [2 8 4]
 15 P   15x03 medium spring green    Phosphorus nonmetal solid 30.973762 [2 8 5]
 16 S   16x03 medium spring green    Sulphur nonmetal solid 32.066 [2 8 6]
 17 Cl  17x03 orange                 Chlorine halogen gas 35.4527 [2 8 7]
 18 Ar  18x03 peru                   Argon noble gas 39.948 [2 8 8]
 19 K   01x04 coral                  Potassium alkali-metal solid 39.0983 [2 8 8 1]
 20 Ca  02x04 moccasin               Calcium alkaline-earth-metal solid 40.078 [2 8 8 2]
 21 Sc  03x04 thistle                Scandium transition-metal solid 44.95591 [2 8 9 2]
 22 Ti  04x04 thistle                Titanium transition-metal solid 47.88 [2 8 10 2]
 23 V   05x04 thistle                Vanadium transition-metal solid 50.9415 [2 8 11 2]
 24 Cr  06x04 thistle                Chromium transition-metal solid 51.9961 [2 8 13 1]
 25 Mn  07x04 thistle                Manganese transition-metal solid 54.93805 [2 8 13 2]
 26 Fe  08x04 thistle                Iron transition-metal solid 55.847 [2 8 14 2]
 27 Co  09x04 thistle                Cobalt transition-metal solid 58.9332 [2 8 15 2]
 28 Ni  10x04 thistle                Nickel transition-metal solid 58.6934 [2 8 16 2]
 29 Cu  11x04 thistle                Copper transition-metal solid 63.546 [2 8 18 1]
 30 Zn  12x04 thistle                Zinc transition-metal solid 65.39 [2 8 18 2]
 31 Ga  13x04 silver                 Gallium poor-metal solid 69.723 [2 8 18 3]
 32 Ge  14x04 tan                    Germanium metalloid solid 72.61 [2 8 18 4]
 33 As  15x04 tan                    Arsenic metalloid solid 74.92159 [2 8 18 5]
 34 Se  16x04 medium spring green    Selenium nonmetal solid 78.96 [2 8 18 6]
 35 Br  17x04 orange                 Bromine halogen liquid 79.904 [2 8 18 7]
 36 Kr  18x04 peru                   Krypton noble gas 83.8 [2 8 18 8]
 37 Rb  01x05 coral                  Rubidium alkali-metal solid 85.4678 [2 8 18 8 1]
 38 Sr  02x05 moccasin               Strontium alkaline-earth-metal solid 87.62 [2 8 18 8 2]
 39 Y   03x05 thistle                Yttrium transition-metal solid 88.90585 [2 8 18 9 2]
 40 Zr  04x05 thistle                Zirconium transition-metal solid 91.224 [2 8 18 10 2]
 41 Nb  05x05 thistle                Niobium transition-metal solid 92.90638 [2 8 18 12 1]
 42 Mo  06x05 thistle                Molybdenum transition-metal solid 95.94 [2 8 18 13 1]
 43 Tc  07x05 thistle                Technetium transition-metal solid 97.9072 [2 8 18 13 2]
 44 Ru  08x05 thistle                Ruthenium transition-metal solid 101.07 [2 8 18 15 1]
 45 Rh  09x05 thistle                Rhodium transition-metal solid 102.9055 [2 8 18 16 1]
 46 Pd  10x05 thistle                Palladium transition-metal solid 106.42 [2 8 18 18 0]
 47 Ag  11x05 thistle                Silver transition-metal solid 107.8682 [2 8 18 18 1]
 48 Cd  12x05 thistle                Cadmium transition-metal solid 112.411 [2 8 18 18 2]
 49 In  13x05 silver                 Indium poor-metal solid 114.818 [2 8 18 18 3]
 50 Sn  14x05 silver                 Tin poor-metal solid 118.71 [2 8 18 18 4]
 51 Sb  15x05 tan                    Antimony metalloid solid 121.760 [2 8 18 18 5]
 52 Te  16x05 tan                    Tellurium metalloid solid 127.6 [2 8 18 18 6]
 53 I   17x05 orange                 Iodine halogen solid 126.90447 [2 8 18 18 7]
 54 Xe  18x05 peru                   Xenon noble gas 131.29 [2 8 18 18 8]
 55 Cs  01x06 coral                  Cesium alkali-metal solid 132,90543 [2 8 18 18 8 1]
 56 Ba  02x06 moccasin               Barium alkaline-earth-metal solid 137.327 [2 8 18 18 8 2]
 57 La  03x09 orchid                 Lanthanum lanthanide solid 138.9055 [2 8 18 18 9 2]
 58 Ce  04x09 orchid                 Cerium lanthanide solid 140.115 [2 8 18 20 8 2]
 59 Pr  05x09 orchid                 Praseodymium lanthanide solid 140.90765 [2 8 18 21 8 2]
 60 Nd  06x09 orchid                 Noedymium lanthanide solid 144.24  [2 8 18 22 8 2]
 61 Pm  07x09 orchid                 Promethium lanthanide solid 144.9127 [2 8 18 23 8 2]
 62 Sm  08x09 orchid                 Samarium lanthanide solid 150.36 [2 8 18 24 8 2]
 63 Eu  09x09 orchid                 Europium lanthanide solid 151.965 [2 8 18 25 8 2]
 64 Gd  10x09 orchid                 Gadolinium lanthanide solid 157.25 [2 8 18 25 9 2]
 65 Tb  11x09 orchid                 Terbium lanthanide solid 158.92534 [2 8 18 27 8 2]
 66 Dy  12x09 orchid                 Dysprosium lanthanide solid 162.50 [2 8 18 28 8 2]
 67 Ho  13x09 orchid                 Holmium lanthanide solid 164.93032 [2 8 18 29 8 2]
 68 Er  14x09 orchid                 Erbium lanthanide solid 167.26 [2 8 18 30 8 2]
 69 Tm  15x09 orchid                 Thulium lanthanide solid 168.93421 [2 8 18 31 8 2]
 70 Yb  16x09 orchid                 Ytterbium lanthanide solid 173.04 [2 8 18 32 8 2]
 71 Lu  17x09 orchid                 Lutetium  lanthanide solid 174.967 [2 8 18 32 9 2]
 72 Hf  04x06 thistle                Hafnium transition-metal solid 178.49 [2 8 18 32 10 2]
 73 Ta  05x06 thistle                Tantalum transition-metal solid 180.9479 [2 8 18 32 11 2]
 74 W   06x06 thistle                Tungsten transition-metal solid 183.84 [2 8 18 32 12 2]
 75 Re  07x06 thistle                Rhenium transition-metal solid 186.207 [2 8 18 32 13 2]
 76 Os  08x06 thistle                Osmium transition-metal solid 190.23 [2 8 18 32 14 2]
 77 Ir  09x06 thistle                Iridium transition-metal solid 192.22 [2 8 18 32 15 2]
 78 Pt  10x06 thistle                Platinum transition-metal solid 195.08 [2 8 18 32 17 1]
```

```
 79 Au  11x06 thistle                Gold transition-metal solid 196.96654 [2 8 18 32 18 1]
 80 Hg  12x06 thistle                Mercury transition-metal liquid 200.59 [2 8 18 32 18 2]
 81 Tl  13x06 silver                 Thallium poor-metal solid 204.3833 [2 8 18 32 18 3]
 82 Pb  14x06 silver                 Lead poor-metal solid 207.2 [2 8 18 32 18 4]
 83 Bi  15x06 silver                 Bismuth poor-metal solid 208.98037 [2 8 18 32 18 5]
 84 Po  16x06 tan                    Polonium metalloid solid 208.9824 [2 8 18 32 18 6]
 85 At  17x06 orange                 Astatine halogen solid 209.9871 [2 8 18 32 18 7]
 86 Rn  18x06 peru                   Radon noble gas 222.0176 [2 8 18 32 18 8]
 87 Fr  01x07 coral                  Francium alkali-metal solid 223.0197 [2 8 18 32 18 8 1]
 88 Ra  02x07 moccasin               Radium alkaline-earth-metal solid 226.0254 [2 8 18 32 18 8 2]
 89 Ac  03x10 salmon                 Actinium actinide solid 227.0278 [2 8 18 32 18 9 2]
 90 Th  04x10 salmon                 Thorium actinide solid 232.0381 [2 8 18 32 18 10 2]
 91 Pa  05x10 salmon                 Protactinium actinide solid 231.03588 [2 8 18 32 20 9 2]
 92 U   06x10 salmon                 Uranium actinide solid 238.0289 [2 8 18 32 21 9 2]
 93 Np  07x10 salmon                 Neptunium actinide solid 237.048 [2 8 18 32 22 9 2]
 94 Pu  08x10 salmon                 Plutonium actinide solid 244.0642 [2 8 18 32 24 8 2]
 95 Am  09x10 salmon                 Americium actinide solid 243.0614 [2 8 18 32 25 8 2]
 96 Cm  10x10 salmon                 Curium actinide solid 247.0703 [2 8 18 32 25 9 2]
 97 Bk  11x10 salmon                 Berkelium actinide solid 247.0703 [2 8 18 32 26 9 2]
 98 Cf  12x10 salmon                 Californium actinide solid 251.0796 [2 8 18 32 28 8 2]
 99 Es  13x10 salmon                 Einsteinium actinide solid 252.083 [2 8 18 32 29 8 2]
100 Fm  14x10 salmon                 Fermium actinide solid 257.0951 [2 8 18 32 30 8 2]
101 Md  15x10 salmon                 Mendelevium actinide solid 258.1 [2 8 18 32 31 8 2]
102 No  16x10 salmon                 Nobelium actinide solid 259.1009 [2 8 18 32 32 8 2]
103 Lr  17x10 salmon                 Lawrencium actinide solid 262.11 [2 8 18 32 32 9 2]
104 Rf  04x07 thistle                Rutherfordium transition-metal solid 261 [2 8 18 32 32 10 2]
105 Db  05x07 thistle                Dubnium transition-metal solid 262 [2 8 18 32 32 11 2]
106 Sg  06x07 thistle                Seaborgium transition-metal solid 266 [2 8 18 32 32 12 2]
107 Bh  07x07 thistle                Bohrium transition-metal solid 264 [2 8 18 32 32 13 2]
108 Hs  08x07 thistle                Hassium transition-metal solid 269 [2 8 18 32 32 14 2]
109 Mt  09x07 thistle                Meitnerium transition-metal solid 268 [2 8 18 32 32 15 2]
110 Ds  10x07 thistle                Darmstadmium transition-metal solid 269 [2 8 18 32 32 17 1]
111 Rg  11x07 thistle                Roentgenium transition-metal solid 272 [2 8 18 32 32 18 1]
112 Uub 12x07 thistle                Ununbium transition-metal liquid 277 [2 8 18 32 32 18 2]
113 Uut 13x07 silver                 Ununtrium poor-metal solid n/a [2 8 18 32 32 18 3]
114 Uuq 14x07 silver                 Ununquadium poor-metal solid 289  [2 8 18 32 32 18 4]
115 Uup 15x07 silver                 Ununpentium poor-metal solid n/a [2 8 18 32 32 18 5]
116 Uuh 16x07 silver                 Ununhexium poor-metal solid n/a [2 8 18 32 32 18 6]
117 Uus 17x07 orange                 Ununseptium halogen solid n/a [2 8 18 32 32 18 7]
118 Uuo 18x07 peru                   Ununoctium noble gas n/a [2 8 18 32 32 18 8]
```

8.37 JNA

Java Native Access, a layer on top on JNI, the Java Native Interface.

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The full source for this documentation is available at

http://gnucobol.sourceforge.net/faq/gcfaq.rst

http://gnucobol.sourceforge.net/faq/conf.py

Building from source requires the Sphinx documentation generation system, Python 2.7, and Sphinx extensions listed in conf.py. To recreate a PDF form, an install of TexLive Full is required.

```
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the interface presents a list of user commands or options, such as a
menu, a prominent item in the list meets this criterion.

  1. Source Code.
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  The "source code" for a work means the preferred form of the work
for making modifications to it.  "Object code" means any non-source
form of a work.

  A "Standard Interface" means an interface that either is an official
standard defined by a recognized standards body, or, in the case of
interfaces specified for a particular programming language, one that
is widely used among developers working in that language.

  The "System Libraries" of an executable work include anything, other
than the work as a whole, that (a) is included in the normal form of
packaging a Major Component, but which is not part of that Major
Component, and (b) serves only to enable use of the work with that
Major Component, or to implement a Standard Interface for which an
implementation is available to the public in source code form.  A
"Major Component", in this context, means a major essential component
(kernel, window system, and so on) of the specific operating system
(if any) on which the executable work runs, or a compiler used to
produce the work, or an object code interpreter used to run it.

  The "Corresponding Source" for a work in object code form means all
the source code needed to generate, install, and (for an executable
work) run the object code and to modify the work, including scripts to
control those activities.  However, it does not include the work's
System Libraries, or general-purpose tools or generally available free
programs which are used unmodified in performing those activities but
which are not part of the work.  For example, Corresponding Source
includes interface definition files associated with source files for
the work, and the source code for shared libraries and dynamically
linked subprograms that the work is specifically designed to require,
such as by intimate data communication or control flow between those
subprograms and other parts of the work.

  The Corresponding Source need not include anything that users
can regenerate automatically from other parts of the Corresponding
Source.

  The Corresponding Source for a work in source code form is that
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    additional terms, to the whole of the work, and all its parts,
    regardless of how they are packaged.  This License gives no
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    (including a physical distribution medium), accompanied by a
    written offer, valid for at least three years and valid for as
    long as you offer spare parts or customer support for that product
    model, to give anyone who possesses the object code either (1) a
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    product that is covered by this License, on a durable physical
    medium customarily used for software interchange, for a price no
    more than your reasonable cost of physically performing this
    conveying of source, or (2) access to copy the
    Corresponding Source from a network server at no charge.

    c) Convey individual copies of the object code with a copy of the
    written offer to provide the Corresponding Source.  This
    alternative is allowed only occasionally and noncommercially, and
    only if you received the object code with such an offer, in accord
    with subsection 6b.

    d) Convey the object code by offering access from a designated
    place (gratis or for a charge), and offer equivalent access to the
    Corresponding Source in the same way through the same place at no
    further charge.  You need not require recipients to copy the
    Corresponding Source along with the object code.  If the place to
    copy the object code is a network server, the Corresponding Source
    may be on a different server (operated by you or a third party)
    that supports equivalent copying facilities, provided you maintain
    clear directions next to the object code saying where to find the
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    Corresponding Source.  Regardless of what server hosts the
    Corresponding Source, you remain obligated to ensure that it is
    available for as long as needed to satisfy these requirements.

    e) Convey the object code using peer-to-peer transmission, provided
    you inform other peers where the object code and Corresponding
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  A separable portion of the object code, whose source code is excluded
from the Corresponding Source as a System Library, need not be
included in conveying the object code work.

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tangible personal property which is normally used for personal, family,
or household purposes, or (2) anything designed or sold for incorporation
into a dwelling.  In determining whether a product is a consumer product,
doubtful cases shall be resolved in favor of coverage.  For a particular
product received by a particular user, "normally used" refers to a
typical or common use of that class of product, regardless of the status
of the particular user or of the way in which the particular user
actually uses, or expects or is expected to use, the product.  A product
is a consumer product regardless of whether the product has substantial
commercial, industrial or non-consumer uses, unless such uses represent
the only significant mode of use of the product.

  "Installation Information" for a User Product means any methods,
procedures, authorization keys, or other information required to install
and execute modified versions of a covered work in that User Product from
a modified version of its Corresponding Source.  The information must
suffice to ensure that the continued functioning of the modified object
code is in no case prevented or interfered with solely because
modification has been made.

  If you convey an object code work under this section in, or with, or
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fixed term (regardless of how the transaction is characterized), the
Corresponding Source conveyed under this section must be accompanied
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if neither you nor any third party retains the ability to install
modified object code on the User Product (for example, the work has
been installed in ROM).

  The requirement to provide Installation Information does not include a
requirement to continue to provide support service, warranty, or updates
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the User Product in which it has been modified or installed.  Access to a
network may be denied when the modification itself materially and
adversely affects the operation of the network or violates the rules and
protocols for communication across the network.

  Corresponding Source conveyed, and Installation Information provided,
in accord with this section must be in a format that is publicly
documented (and with an implementation available to the public in
source code form), and must require no special password or key for
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You are invited to make suggestions, point out mistakes, and add general comments regarding this document, in a special thread in the GnuCOBOL project space, set up for just that purpose, at

http://sourceforge.net/p/gnucobol/discussion/contrib/thread/c67ea739

You can also contact the author via email at btiffin@users.sourceforge.net

CHAPTER

NINE

AUTHORS

9.1 Maintainers and Contributors

Robert added macro processing, László added Java API and science, Steve adding general processing and nifty world data analysis. Paul contributed BITWISE, and a very nice Computus solution. James raised the issue of the IN ORDER default as something to be aware of when checking GnuCOBOL against other COBOL compiler SORT routines.

Arnold Trembley put together the MinGW installer.

Colin Duquesnoy writes the OpenCOBOLIDE interactive development environment.

Sauro Menna updated the GCSORT utility, originally by Cedric Issaly.

Wim Niemans contributed various CGI solutions.

Gary Cowell wrote up a Java JNA sample.

Eugenio Di Lorenzo offered up a TUI Tools collection.

Many names missing.

CHAPTER

TEN

CHANGELOG

04-Mar-2020+2 Point out that historical opencobol.org pages can be viewed on the Wayback Machine.

18-Feb-2020+2 Mention new CONTINUE AFTER B-AND B-OR B-NOT B-XOR support.

22-Sep-2020+1, 23-Sep Typos, and starting in on highlighting the educational potential of the compiler build integrity checks, added GO TO ENTRY blurb, mention the -Q cobc option instead of export COB_LD_FLAGS, and Simon's hint about using –include for FastCGI compiles. Rerun book with example.com back online.

05-Jun-2020+1 Added new cobfile and gcdiff utility blurbs.

02-Mar-2020+1 Moved the Tutorial to its own chapter.

25-Feb-2020+1, 27-Feb Added initial list of online compiler sites that support GnuCOBOL, bulk change of opencobol sourceforge links to new gnucobol project name, update the quick start links in the latest-download.txt file, update copyright year, adds some links to the esqlOC entry. Touched on question 1, updated recent version list, updated authors and contributor list, added Gix-IDE entry, fixed repo link for esqlOC, fixed some typos.

07-May-2020, 08-May, 09-May, 10-May, 11-May, 18-May, 19-May, 20-May, 24-May Correct (at least one) reference to D-ISAM being IBM and not the correct attribution for Byte Design Ltd. Correct mistaken bit-width for SIGNED-LONG and UNSIGNED-LONG which are actually platform dependent, update copyright to 2020, behind the scenes updates for new Sphinx doc releases and changes to basic.css and Pygments. Add cbl-gdb entry. Fixed reference to en.DK.utf8 being Denmark, not Germany. Pump up the Arnold, make note of DPC in ISO 8601 time spec. Mention Job run in the compiler steps list, small fixes. Tone down the LD_RUN_PATH entry. Update links in latest-download.txt. Refresh source build info. Add entry for defining user defined function.

11-Dec-2019 Correct SELECT entry with ORG INDEXED not INDEX.

24-Nov-2019, 25-Nov Added blurb on mouse support from cdg forum post. Some corrections to mouse support entry.

05-Sep-2019, 28-Sep Added clarification of GO DEPENDING ON indexes being one relative. Add to the REDEFINES blurb.

04-Aug-2019 Small clarification to GO entry to explicitly mention backward jumps.

24-May-2019 Added some Windows specific info for BLINK (from Eugenio).

13-Jan-2019, 26-Jan Updated BINARY reserved word entry and copyright date. Expand on the MODULE-function entries, add code listings for MONETARY-DECIMAL-POINT and MONETARY-THOUSANDS-SEPARATOR.

02-Oct-2018, 03-Oct Updated ALPHABET entry. More Agar documentation.

07-Aug-2018, 20-Aug, 27-Aug Change references to CONTENTS-OF to renamed CONTENT-OF. Added gcv.c and commands.sed listings, started expanding on the Agar entry. Remove leftover experiment with source listing download links; rightalign wins, touched up libmatheval entry, moved some Haxe sourcecode to literalinclude downloadable listings.

13-Jul-2018, 15-Jul, 17-Jul, 20-Jul, 21-Jul Updated CALL to mention PROGRAM-POINTER then tweaked the entry, added NOTHING. New reserved word counts (900), touch INSPECT entry, new dialect list and blurb on -strict versions. Touch up C idioms entry. Update DB2 contribution links and for OCESQL and add new PostgreSQL sample links. Touch up and typo fix in the Tutorial section.

19-Jun-2018, 25-Jun, 28-Jun Fixed some ODO without FROM lower TO, added new CobCurses link, update GnuCOBOL versions to 2.2 official and 3.0 pending. Added CONTENT-LENGTH and CONTENTS-OF function descriptions, tweaked Special Data Levels blurb. Fixed some typos.

10-Mar-2018, 11-Mar, 12-Mar Removed some unused data definitions in the libwebsockets code sample, updated links for dbpre MySQL preprocessor, update links to draft copies of the COBOL 2014 spec, copyright to 2018. Change some data names in the errno CBL_GC_HOSTED example for sake of clarity. Simon suggested a patch to the indexing.cob program to avoid looping on error, mention that 3.0 release now includes split key support from the reportwriter branch.

22-Nov-2017 Add libagar.

04-Sep-2017, 24-Sep Add CobolSQLite3, clarify OF, add ACCEPT to OMITTED entry. Update current release information including new rules for build_aux/bootstrap.

29-Aug-2017 Added XForms gui samples.

01-Jul-2017, 07-Jul, 08-Jul, 14-Jul Canada celebrates the sesquicentennial, updated the refmod entry, added OpenCobolIDE installer for Windows link. Update gtkhello (ocgtk) listing. Update list of predefined IS SET symbols, add mentions of FUNCTION JVM, FUNCTION LUA, FUNCTION PYTHON, FUNCTION TCL, mention Duktape ECMAScript. Add more of source literal types, LString??.

10-Jun-2017, 20-Jun, 30-Jun Added libwebsockets. Mention SimoTime. Add blurb on reference modification.

07-May-2017, 14-May Added Eugenio's numeric data entry screen sample. Expand on DELETE FILE entry.

28-Apr-2017, 29-Apr, 30-Apr Added libarchive and .incbin blurbs, add Vedis and PH7. Toolchain change to automate the title numbering edit. Added cobol.run and cloud entry. Update Rust calling GnuCOBOL.

05-Apr-2017, 12-Apr, 16-Apr, 21-Apr, 22-Apr, 23-Apr, 25-Apr, 26-Apr, 27-Apr Start expanding on Intrinsic REXX, update swichblade's Go lang entry. Add Intrinsic REXX examples. Clarify that Pure compiles via LLVM JIT. Add GT.M MUMPS, add Elixir. Place Intrinsic REXX first and expand on the entry, make REXX RESTRICTED by default and add REXX-UNRESTRICTED, dropping REXX-RESTRICTED (which is now just REXX()). Add Intrinsic Python. Add link to Mario's MEO Cloud pile of files. Add FUNCTION PYTHON, update MinGW build link to 2.0-rc1. Add Rust, tweak comment in Paul's Computus.

02-Mar-2017, 03-Mar, 06-Mar, 12-Mar, 19-Mar, 27-Mar, 29-Mar Updated mailing list links to the new Savannah hosting. Mention COB_EXIT_WAIT and update runtime.cfg blurb, assorted tweaks. Rebuild with fix for hello-oneliner.cob compiler error. Add editor list, discuss the new builtin-script branch –with-rexx. Update Intrinsic REXX entry, fix some typos, added FUNCTION REXX and REXX-RESTRICTED entries, supported-functions.txt updated. Add MINIX build story. Update homebrew OS/X instructions.

24-Feb-2017, 25-Feb, 28-Feb Added entry describing steps to produce statically linked executables. Extra clarification on licensing re static vs dynamic from Simon. Upgrade Sphinx to Python3, bump release to 2.4.

01-Feb-2017, 02-Feb, 03-Feb, 05-Feb. 06-Feb, 07-Feb, 11-Feb, 20-Feb, 23-Feb CSS mods to set max-width (still work to do), bump to version 2.3. More tutorial and an image from XKCD. Added thank-you note from Gerhard. Added Pascal entry, added CBL_GC_FORK sample, expanded on level numbers explanations. Telco benchmark source now downloadable. Fix up the Pascal entry. More tutorial. Explicit mention of database@host:port for OCESQL network access in the CONNECT ... USING phrase. Added Scala.

25-Jan-2017, 27-Jan, 29-Jan, 30-Jan, 31-Jan Updating CHAINING entry, update make check coverage numbers, update cobcide info. Started in on Tutorial along with customized css, diagram fixes and additions starting with extended-attributes, started adding inline highlighting, typo fixes. More tutorial. More tutorial. More tutorial, update stock library list.

04-Jan-2017, 10-Jan, 14-Jan, 15-Jan, 18-Jan, 19-Jan, 21-Jan, 22-Jan, 23-Jan Started in on blurb discussing mapping C types to COBOL. Add new UNBOUNDED reserved word. Small typo fixes. Ron's new C access API. Added GTK-server sample, fixed LaTex numbering bug in titlesec, new code listing background colour VerbatimColor. Updated ASSIGN entry with some details on accepted clauses, ACCEPT OMITTED updated, added a link to SQLite as UDF repo thread, updated Golang entry, fixed some typos. Add UnQLite sample. Add Duktape and cJSON samples. Update OPTIONS entry, mention OCSort rebranding to GCSORT and the updates by Sauro Menna.

15-Dec-2016, 23-Dec, 25-Dec Added swichblade's golang integration page, added libcox entry, updated current version and expanded on release history. Update the various information listing cobc/cobcrun options. Finally added a usage license (GPL 3 or greater, unless otherwise specified in an included source code listing, in which case the explicit source notice for that listing fragment take precedence, once unbundled from this documentation), release count now includes all cuts, removing the reset when 2 version bump occurred, version bump to 2.2.

26-Oct-2016 Fixes for Sphinx/Pygments upgrade, name correction for Mickey.

23-Jul-2016 Added cobweb-math.

03-Jul-2016, 05-Jul, 09-Jul, 11-Jul, 12-Jul, 17-Jul, 19-Jul, 20-Jul, 21-Jul Adding CBL_OC_SOCKET entry. Added Haxe/Neko entry. Updated haXe/Neko. Added cobweb-periodic listing. Updated Jim Currey's prime search results, added -j blurb in the initial how does cobc work section. Re-ordered special-names before repository in all listings. Add details for COB_SYNC. Started adding a list of known bugs, touched on COPY REPLACING. Added sample of variable length sequential file processing, corrected code fragment in FROM entry that contained a missing scope terminator, added printable characters entry. Updated INTO, added card punch image, various tweaks. Updated GNU Lighting entry.

03-Jun-2016, 07-Jun, 14-Jun, 16-Jun, 17-Jun, 18-Jun, 28-Jun Added future of COBOL entry. Clarified need for smjs libraries and development headers for the spidermonkey javascript linkage sample. Expanded on FUNCTION RANDOM. Updated 2.0 –help and –info listings, added Rosetta Code blurb. Lots of small updates to reserved words. Added PARI/GP sample, added initial gretl integration example. Added FastCGI blurb, expanded on JRecord entry, added Unicon entry.

18-May-2016, 22-May Touch ups, ADD CORRESPONDING. lynda.com video tutorials by Peggy Fisher, jaymoseley.com.

03-Apr-2016, 07-Apr, 08-Apr, 13-Apr, 14-Apr, 15-Apr, 25-Apr, 29-Apr, 30-Apr Fixed missing ADDRESS OF in OMITTED word reference code example. Added Red integration entry, updated CBL_OC_HOSTED with timezone, updated entry on void returns with a yes answer, added signal handling entry. Updated signal entry with sigaction sample. Added link to feedback in the top sidebar, added X11 samples. Updated D-Bus entry, added details for the various computational data types. Continue comp data details. Add some performance analysis blurbs, added CDF ENDIAN and CHARSET. Added code sample to REWRITE, expanded on SEQUENTIAL.

12-Mar-2016, 15-Mar, 22-Mar, 24-Mar, 26-Mar, 27-Mar, 28-Mar Adding JRecord info, updated Python with proper DECREF. Added DB2sample by László. Updated out of tree build blurb with shell function. Clarify where split key isam support is available, add Piet. Added D-Bus. Added embedded TCC, and deadfish. Added mention of CBL_OC_HOSTED.

01-Feb-2016, 02-Feb, 06-Feb, 07-Feb, 08-Feb, 21-Feb More diagrams. Finished first pass of syntax diagrams, added motto.cob and suggested a new acronym in Common Objective Business Oriented Language. Added VBISAM blurb, finally moved FILE STATUS codes out of the ISAM note and into main FILE entry, added checkfilestatus callable by Steve Williams, tweaked FILLER entry, started hyping more Fossil, fixing up new version of highlighter, Roger passed away one year ago, today. Added Icon. SET ATTRIBUTE is supported. Started in on typo hunting.

14-Jan-2016, 19-Jan, 21-Jan, 29-Jan, 30-Jan, 31-Jan Move gcfaq.rst link to SourceForge. Added JNA Java entry by Gary Cowell. Added blurb from Steve's Simple ODBC sample. Typo corrections, and JNA run sample. Started adding syntax diagrams (from http://wiki.tcl.tk/21708), update to Sphinx 1.3.5 to get PDf table of contents back, tweaks. Adding more syntax diagrams, filled out entries for ROUNDED MODEs, tweaks, fixed Tcl,

Rexx and Makefile highlighters (added > recipe prefix to the highlighter for make), semi-colon to Rexx and hex numerics with octothorpe for Tcl, added some details to LINAGE reserved words.

16-Dec-2015, 17-Dec, 19-Dec, 23-Dec Expanded on some reserved words, added shell scripting entry, added Quine, expanded on ocesql entry. Added a shorter Quine, added mruby. Added some Mac/OS info from Martin. Expand on float-decimal-16 and -34, tweak some reserved word entries, add some commentary from users. Tweak decimal-34, added Ghostscript embedding. Update installing entry.

01-Dec-2015, 02-Dec, 04-Dec, 06-Dec, 08-Dec, 09-Dec, 10-Dec, 11-Dec, 13-Dec Adding news from Jim on the prime number scan, expanded on link module entry, expanded on FUNCTION STORED-CHAR-LENGTH. Updated FORMATTED-DATE and TIME function entries, fill in Falcon PL entry. Another linkcheck pass. Correction to CLASS and extend CHARACTERS, update Hercules url, Changed the Intrinsic function indexed table, added sample to SUBSTITUTE-CASE. Added TAN, TEST-DATE-YYYYMMDD, TEST-DAY-YYYYDDD sample, Samples shortform note, y2k and 2038 blurb. Expanded on ACOS, ASIN, ATAN, COS, SIN, DATE-OF-INTEGER. Added sysinfo. Expanded on TEST-NUMVAL-C and TEST-NUMVAL-F, started in on CBL_OC_GETOPT (the routine needs work), blurb on supported literals. Expanded on ZERO, YYYYMMDD.

02-Nov-2015, 10-Nov, 11-Nov, 13-Nov, 14-Nov, 15-Nov, 16-Nov, 24-Nov, 27-Nov Finding link modules entry and –no-as-needed. Added ESCDELAY blurb, added READY, TRACE, and expanded on RESET, added Bill's aligning tip, and touched on 32 bit/64 bit determination. Rememberance Day in Canada, where we observe two minutes of silence on 11/11 at 11:00 to honour those that have fought, and those that have fallen; Lest we forget. Updating the overflowing.cob sample run. Explain -A cobc option, add cpuid.cob. Added .RECIPEPREFIX to Makefile listings, update SIZE, SENTENCE, and SEPARATE entries. Added raw latex code to resize code listings. Remove the line size debug paragraph. Fixed currency symbol link and added to PICTURE entry. Added GNU lightning to the assembler entry, update SQL entry with more Oracle 12.1 info thanks to Reinhard Prehofer, added HPCC entry by Jim Currey, fixing opencobol.org links, added libpgsql full listing.

03-Oct-2015, 10-Oct, 15-Oct, 17-Oct, 18-Oct, 21-Oct, 26-Oct, 28-Oct, 29-Oct Added SWIG. Updated assembler sample. Updated Can I help. Tweaked SMCUP/RMCUP entry, started adding Micro Focus port issues from James, corrected Makefile contract-swig.i in the SWIG entry, added ROUNDED MODE examples table, temporarily removed Micro Focus entry. Added >>DISPLAY to compiler directives blurb, added Open Object Rexx listing, added COB_MAX_FIELD_SIZE to run-time limits entry. Updated ooRexx listings to reflect new function rexx(), added sample to GLOBAL entry. Updated ACCESS, COLUMN, LINE, and WHEN-COMPILED entries, added entry for getting lengths with LINE SEQUENTIAL reads and writes, added samples to GO and ALTER, with some commentary from Bill. Add more commentary, some from Simon, added small s.c.r.i.p.t., start in on purging extraneous END-DISPLAY and some other explicit but cluttering END-words.

03-Sep-2015, 05-Sep, 06-Sep, 12-Sep, 22-Sep Clarified that STOP literal is a temporary stop. Fixed banner yellow with convert gcbanner.png -fuzz 5% -fill '#ffffee' -opaque '#f2efc2' new.png. convert new.png -bordercolor '#ddddbb' newer.png. Started new Production chapter (mostly empty for now, will list details). Adding to reserved word samples. Added Kate.

15-Aug-2015, 18-Aug, 21-Aug, 22-Aug Added blurb about Ionică Bizău's NodeJS bridge, tweaked some name indexes. Added a picture of Grace Hopper, linked an ARS Technica article about node-cobol, updated some jokes. Added László's complete cgiform sample. Added cobol-unit-test blurb, by Dave Nicoletter, general cleanup of PDF by not putting in large index sidebars, vs.py types and colours tweaked, added some reserved words along with a list of words when generating Latex and PDF outputs.

04-Jul-2015, 07-Jul, 08-Jul, 09-Jul, 14-Jul, 18-Jul, 20-Jul, 24-Jul Update 3.20 to ACCEPT OMITTED, mention table sort when describing IN ORDER. Added a D interface blurb, Started in on data level numbers, corrected the wording of CONSTANT. CSS fix for toc, highlight colour updates in vs.py, added runtime.cfg notes, more debugging of business.py lexer, updated the dedication. Updated Intrinsic list, fixed highlighter, added links to tutotialspoint COBOL courseware, and more mention of the Hercules System/370 emulator. Added Bill's warning about tutorialspoint and added the University of Limerick pages as a better learning option, more name dropping in the credits, updated MinGW and ROBODoc info. Added Hercules, JCL listings. Adding TK4- to the MVS 3.8J information. Corrected APL inventor as Ken Iverson, not Eric, his son. Added code sample to

line sequential note. Added CBL_READ_FILE sample. Fleshed out VARYING and WAIT entries.

02-Jun-2015, 07-Jun, 16-Jun, 17-Jun, 23-Jun, 27-Jun Some clarifications and corrections regarding versions and build instructions, shortened some SWITCH and SW lists and indexes, corrected mismatch in cobolmac macro and the listed expansion. Added mention of OpenCOBOLIDE 4.6.2 and it including a MinGW 1.1 build Simon posted. Updated the COPY book search path entry, credits, and some cheerleading. Admit to the mythical Someday, added assembler linkage question, update FAQ banner to GnuCOBOL spelling, added Sire (unofficial fan art). Tweak banner and update credits. Added note about IN ORDER being a default in the SORT verb blurb.

22-May-2015, 28-May, 30-May Update CALL, minor spelling and wording corrections. Filled out COPY, added cobolmac macro preprocessor notes, added prime numbers with Proth, added split key listing in indexing.cob sample. Purged references to 2.1 in preference to reportwriter branch.

05-Apr-2015, 09-Apr, 10-Apr, 23-Apr, 25-Apr, 26-Apr Fixed some unicode for latexpdf build. Adding COBJAPI. Added elvis blurb and GnuCOBOL color syntax file, added cobweb-pipes. Still winter, April, winter. Corrected the OCSort entry. Added to OCSort entry from Bill Woodger, ran linkcheck and fixed some stales. Added some hyperlinks.

07-Mar-2015, 11-Mar Added the predefined >>IF ... IS SET directive conditionals, including OPENCOBOL, P64, EXECUTABLE, MODULE, more; added LC_MESSAGES blurb to the notes; expanded on GNU a little; marking more extensionsr; tweaked test suite entry. Update to translationproject.org link.

09-Feb-2015 Dedicated to Roger While (1950-2015). "The time has come", dear friend.

> The sea was wet as wet could be, The sands were dry as dry. You could not see a cloud, because No cloud was in the sky: No birds were flying overhead– There were no birds to fly.

03-Feb-2015, 07-Feb, 10-Feb, 12-Feb Roger's update to the telco billing module. Added Nim, tweaks to rmcup/smcup. Borked Sphinx and Pygments install, fixed. Added meta tags, corrected the 20xx draft references to proper 2014.

16-Jan-2015, 17-Jan, 18-Jan, 26-Jan, 29-Jan Added some run time environment variable blurbs, started genindex. Indexing, merged authors and contributors. More indexing. Typos. Simon's awesome 1.1 delta lists. Added CentOS.

02-Dec-2014, 12-Dec, 16-Dec, 27-Dec Corrected slangkey; moved tty-reset to a proper procedure division, dropped hints in errorproc.cob. GNUCobol to GnuCOBOL. Added info to ALLOCATE and DELETE FILE, added libseed-gtk sample. Typo, added a personal blurb about production use, warning about abusing dev/urandom in Jim/TCL. Added to ACCEPT and PROHIBITED.

11-Nov-2014, 12-Nov, 18-Nov, 20-Nov Added the motto. New GnuCOBOL 1.1 MinGW installer. Added STDCALL. Added BaCon.

12-Oct-2014, 21-Oct Updated the Can I help out blurb, added a SourceForge six tilde markup example. Version 42, 2.1.42, on 1021 2014, 42, fixed some BINARY-LONG docs.

04-Sep-2014, 05-Sep, 10-Sep, 15-Sep, 22-Sep, 25-Sep Added some missing 2.0 intrinsic functions, and reserved words. List updates (system.def) and other misc 2.0 updates. Missing commas and more on ROUNDED, touched COMPUTE, CONTINUE, CGI entry, renamed voidcall, endiannes. Updated pgcob.cob for clarity. GNU Cobol is now GnuCOBOL. Fixed some links, MinGW installer and s-lang.

14-Aug-2014, 15-Aug, 16-Aug, 17-Aug, 23-Aug, 29-Aug Turn 51, remove the no commerical support available statement, fix some formatting, add a new FUNCTION-ID teaser for GTK+. Added the Common Object Business Oriented Language possiblilty, added some COBOL is dead anti-rhetoric. Touch ups. Added sample for EXTERNAL. Included gccurlsym.cpy in the read-url FUNCTION-ID sample. Changed some wording around ENTRY in the error proc sample. Added telco billing code listing, links to vc11 windows native, fixed some https forge links. No vc12.

10-Jul-2014, 12-Jul, 16-Jul, 22-Jul Removed target from banner image, updated CobXRef entry. Added Perl sample. Added the platform port story, put in the acknowledgment, many small tweaks to things like ocobol to gcobol.

Added GTK periodic buttons. Added news about COBOL 2014 being published back in May.

10-Jun-2014, 11-Jun, 21-Jun Adding jQuery to AJAX sample, updated MERGE entry and PACKED-DECIMAL. Added RLIB. Tweaks.

03-May-2014, 07-May, 17-May, 20-May, 24-May, 31-May Addded a blurb about null terminated strings, added example for compiler directives, added blurb on UDF. Bragged about MathGL some more, added printenv.cob and voidcall.c. Enumerated the build time and run time environment variables tested by ./configure ; make, cobc and libcob, changed Hello World! to Hello, world just because, tweaks and new 5-7-5, added Jim TCL. Added limits, reformatted for Pandoc (no tabs, less unicode) sourcecode directive changed to code, modified /usr/lib/python2.7/site-packages/sphinx/directives/code.py. Tweaks and small adds. Added wget tip for getting source from the forge, TRANSFORM. Moved Broadway image below TOC index.

15-Apr-2014, 16-Apr, 20-Apr, 25-Apr, 26-Apr Added Arnold's INNO installer link. Fleshed out some entries, added FUNCTION-ID sample. Typos, more color, libmicrohttpd sample. Updated NUMERIC entry, touched on ACCEPT. Odds and sods.

04-Mar-2014, 15-Mar, 29-Mar More typos. More typos. Still winter, updated development history blurb, added head-full.cob skeleton, added OpenCOBOLIDE link, March 29th and still winter.

28-Feb-2014 Better credits and typo fixes.

04-Jan-2014, 28-Jan Added the DB2 link from Dick Rietveld. Updated the indexing.cob sample, updated docs on cobcrun.

04-Dec-2013 Updated some credits. Added Ron as an author. More Simon credits.

13-Nov-2013, 23-Nov, 27-Nov Added esqlOC article by ati from SourceForge, more credits for Sergey. Clarified Rexx sample with a new variable instead of sharing. Added first hint of Report Writer support by Ron Norman. Example by Jay Moseley. Started mentioning reportwriter.

23-Oct-2013 GnuCOBOL FAQ now. Updated CGI sample.

11-Oct-2013 OpenCOBOL FAQ finalized at 1.1.

25-Aug-2013, 27-Aug Updated the EXEC SQL entry. Filled out FILLER, FILE, FILE-ID and FALSE.

03-Jul-2013, 19-Jul Added Pure embedding sample. Cleaned up some sourcecode types, got rid of warnings. Wim's stickleback project.

08-Jun-2013, 11-Jun Added the missing tests blurb for NIST, some corrections. Added more open source COBOL project links. Added SMCUP, RMCUP terminfo blurb. Fixes.

15-May-2013, 29-May Added BITWISE from Paul Chandler. Started list of open source projects. Tweaked the development history, fixed Fossil image placement.

30-Mar-2013 Added another haiku (using cbrain).

08-Feb-2013, 09-Feb, 25-Feb, 26-Feb Moving to Sphinx, started documenting new SourceForge project site. Fixed cobxref listing, no truncated lines. Added 'nosidebar' to the sphinx-doc theme settings in conf.py. Added some Computus, and Latin. Updating current version information. Added Python embedding. Added ficl Forth notes. Added Shakespeare. Touched on ocsort. Reversed the ChangeLog order with tac -r -s "^$". Moved the Sphinx output to main. Added Ruby.

03-Jun-2012 Added site favicon.ico from Silk/help.png, credited Mark James. Fleshed out telco benchmark entry.

27-May-2012 Added LLVM and clang reference.

22-Apr-2012 Typos. Added the size listing for hello.

07-Mar-2012, 19-Mar Added carpe diem farberistic joke.

05-Feb-2012, 29-Feb Added to DIVIDE, put in some lists in the RESERVED words. Added Public Accounting.

12-Jan-2012, 14-Jan, 15-Jan, 20-Jan Added a criticism of easter.cob. Updated CURSOR and FOREVER entries. Version to 1.1rc01. FOREVER thread listing moved. cupsPrintFile documented. Rid of the >< comment output. LOCALE-DATE update. Removed Organization from attributions, there is no official group.

06-Dec-2011, 26-Dec Added Gambas interface link. Fixed INDEXED entry. Added INITIAL source sample.

03-Sep-2011, 25-Sep, 28-Sep Fixed the ocgtk.c files, getting rid of void returns. Updated list of platforms with 1.1pre-rel running. Added COBOLUnit.

26-Aug-2011 Finished the last FUNCTION.

01-Aug-2011, 05-Aug, 06-Aug, 07-Aug, 08-Aug, 09-Aug, 13-Aug, 14-Aug, 22-Aug Done M, N. Done O. Fixed the colours after a Pygments update. P's in. Q, R done. Doing S. Just passed 750000 bytes of FAQ. Done S to Z. Started documenting the GNU build tool options available. Fixed a DSO misnomer.

01-Jul-2011, 02-Jul, 10-Jul, 11-Jul, 12-Jul, 20-Jul, 23-Jul Updated CALL reserved word entry to show off ON EXCEPTION CONTINUE. Updated a few more reserved words; DATE, DAY, DEBUGGING. D's are done. Fleshed out a few reserved words, E's done. Added links to the Doxygen API passes. Started on some future 2.0 entries with the Directives. Added blurb about LD_RUN_PATH. Added initial entry on APL/J linkage. Into the Fs. Done A thru K. Done L.

25-Jun-2011, 26-Jun Added sourceforge link. Updated shortest program entries. Updated a few reserved words.

07-May-2011 Added gfortran sample.

13-Feb-2011 Fixed an unnecessary css import, small corrections. Added REPOSITORY, CYCLE and FOREVER entries.

02-Jan-2011, 23-Jan Added errorproc.cob sample. Added some vim and Fossil info.

12-Dec-2010, 31-Dec Added libsoup HTTP server sample. Changed EOP file status 52 copy sample. Updated Falcon entry.

01-Nov-2010, 06-Nov, 18-Nov, 20-Nov, 27-Nov Added a Genie sample. Some small touch-ups. Restored borked colouring. Added DECLARATIVES entry and a few small tweaks. Added a few RESERVED words entries. Added ROOT/CINT info. Expanded install instructions.

18-Oct-2010, 19-Oct, 24-Oct, 30-Oct, 31-Oct Added some working Vala code samples. Added DamonH's AJAX code to the CGI section. Updated the CBL_OC_DUMP listings. Added a few minor reserved word entries. Added translation help request note. Added mkfifo sample. Added call Genie sample. Added CBL_OC_GTKHTML sample. Updated the PI and PRESENT-VALUE entries. Updated CHARACTERS entry.

13-Jun-2010 Reorganized table of contents boxes. Split SEARCH sample source code.

05-May-2010, 06-May Added the SEARCH and SORT sample. Updated Rexx. Image for GNAT GPS.

04-Apr-2010, 05-Apr, 11-Apr, 15-Apr Fixed up the source code listings. Added telco benchmark. Added print to PDF. Added COB_LIBRARY_PATH info. Expanded the Tcl/Tk entry. Added Mac install instructions from Ganymede. Rexx.

01-Mar-2010, 28-Mar Added Oracle procob news. Added FILE STATUS codes to ISAM note. Mention TP-COBOL-DEBUGGER. Updated INSPECT sample and COB_SCREEN_ESC entry. Added ocgtk.c

15-Feb-2010, 20-Feb, 25-Feb, 27-Feb, 28-Feb Added advocacy, and a few tweaks. Added Jim's PRTCBL. Added Angus' ocsort. Added cobol.vim and Easter Day programs. Updated CBL_OC_DUMP source code listing. Added a REPLACE text preprocessor sample. Added pgcob.cob PostgreSQL sample.

12-Oct-2009 Added some links, credits.

13-Sep-2009 Some printing information.

29-Jul-2009 more human assisted corrections.

01-Jun-2009, 03-Jun, 05-Jun, 28-Jun Added errno, makefile, a few samples and some reserved word explanations. Added filter.cob the stdin stdout sample. Added some reserved word blurbs and the message queue sample. human assisted corrections. Many thanks to human.

01-May-2009, 09-May, 28-May, 31-May Started a structural and TOC reorg. Mention S-Lang. Continue re-org. Added some FUNCTION samples. Getting close to a complete Intrinsic list.

17-Apr-2009, 18-Apr, 19-Apr Clarified -fsource-location option. Added a production use posting. Added START and ISAM sample.

09-Mar-2009, 31-Mar Added Vala and a few more RESERVED word entries. Added -ext clarification.

16-Feb-2009, 18-Feb Added JavaScript, Lua, Guile embedding samples and mention Tcl/Tk, GTK. Added CBL_OC_DUMP sample by Asger Kjelstrup and human

02-Feb-2009, 06-Feb, 09-Feb, 11-Feb Coloured Source codes. Added info on COB_PRE_LOAD, added LINAGE sample, fixed colours (kinda). Added Haiku, disclaimer about no claim to Standards conformance. Updated look.

01-Jan-2009, 10-Jan, 12-Jan, 22-Jan Lame attempt at clarifying (excusing) poor use of Standards references. Small corrections and additions to SQL entry. Added a few RESERVED entries and Vincent's STOCK library expansion. Typos.

28-Dec-2008, 29-Dec, 30-Dec Added info on CobXRef, some debugging tricks and an entry on recursion.

12-Dec-2008, 16-Dec, 21-Dec Added new links to OpenCOBOL 1.1 binary builds by Sergey. Updated header templates. Added a few keywords.

28-Nov-2008 OpenCOBOL passes the NIST test suite.

13-Oct-2008, 15-Oct,19-Oct, 22-Oct, 29-Oct Added a few samples. Added TABLE SORT sample. Added configure script information. Added dialect configuration information.

23-Sep-2008 Adds and a trial skin

10-Aug-2008, 21-Aug, 28-Aug, 29-Aug, 30-Aug Started in on the intrinsic functions. Dropped the pre from the alpha designation. Still some Look into this entries. Move to add1tocobol.com Publish link to 1.0rc Skeleton of the reserved words list Let the tweaking begin

17-Jul-2008, 20-Jul, 24-Jul, 28-Jul Last-last-last 0.0 pre-alpha. Second DIFF. Corrections pass. Expanded the SCREEN SECTION questions. Another correction pass, with clarifications from Roger While

02-Jul-2008, 06-Jul, 07-Jul, 11-Jul, 13-Jul Experimental version for comment. First 0.0 pre-alpha release. Second 0.0 pre-alpha. Last 0.0 pre-alpha. Checked in for diffs. Last-last 0.0 pre-alpha. Verify DIFF functionality.

BIBLIOGRAPHY

[Keisuke] Keisuke Nishida

Initial developer and creator of OpenCOBOL. From the 1990s through 2004, and still active was the primary developer and GnuCOBOL project lead. His efforts are greatly appreciated by the userbase of GnuCOBOL.

[Roger] Roger While (1950-2015)

GnuCOBOL 2.0 is currently *(March 2018)* in development, based on Roger's excellent work and leadership with releases up to 2.0.

[Ron] Ron Norman

Ron added Report Writer features to GnuCOBOL 2, under the branches/reportwriter SVN subdirectory.

[Joe] Joe Robbins

Joe is tweaking the fileio.c code base.

[Sergey] Sergey Kashyrin

Sergey supports many platform builds, authored esqlOC, and the C++ emitting version of GnuCOBOL 2.0.

[human] Simon Sobisch

The GnuCOBOL project lead, officially as of 2014, though he had, for all intents and purposes, been filling the role admirably for some many years prior.

Samples, style, manager of the SoureForge code repositories and a GNU maintainer responsible for the GnuCOBOL project.

[Philipp] Philipp Böhme

Source changes increasing Windows build support.

[Hart] Edward Hart

Patches filling out the feature set.

[James] James K. Lowden

Pushing GnuCOBOL further into the 3rd millennium.

[Vince] Vincent Coen

CobXRef author, an external source code cross reference utility accessible via `cobc -Xref`. Vince also publishes the free Applewood Computer Accounting System, *ACAS* (page **??**)

[Luke] Luke Smith

Extended IO support.

[Pitts] Dave Pitts

cobc -t internal listing enhancements.

[Swarbrick] Frank Swarbrick

BASED and OCCURS UNBOUNDED suppport.

[btiffin] Brian Tiffin

This FAQ. Sample programs for GnuCOBOL. Compiler patches. GNU Maintainer, along with Simon.

[aoirthoir] Joseph James Frantz

Hosting, support

[woodger] Bill Woodger

Moderating the forge

[John] John Ellis

Samples, how-to's and advice

[wmklein] Bill Klein

Keeper of the COBOL FAQ and all round COBOL myth buster

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