OpenCOBOL

A FULL FEATURED, OPEN SOURCE
COBOL COMPILER

OPENCOBOL TECHNICAL INFORMATION
AND RANDOM TIDBITS

Frequently Asked Questions

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Contents

Listings

List of Figures

Well met,

Welcome to the OpenCOBOL FAQ. This document tries to answer some of the questions that may arise when using OpenCOBOL, and acts as a advocacy piece to entice people to **USE** OpenCOBOL.

As it's advocating OpenCOBOL, here is a Hello *from OpenCOBOL*

```
identification division.
program-id. hello.

procedure division.
display "Hello, OpenCOBOL's world!" end-display
goback.
end program hello.
```

Credits

OpenCOBOL by Keisuke Nishida and Roger While.

Original FAQ Formatted for docutils, ReStructuredText. rst-buidhtml Texinfo form created using Pandoc.

As of March 2011, a special thanks to the LaTeX people.

> **Status**
> This is a 1.0 release candidate of the OpenCOBOL FAQ. Sourced at ocfaq.rst and Courtesty of ReStructuredText and Pygments.
> ocfaq.pdf is also available, sourced at ocfaq.tex and associated Makefile.
> This FAQ is more than a FAQ and less than a FAQ. Someday that will change and this document will be split into an OpenCOBOL manual and a simplified Frequently Asked Questions file.
>

```
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```

```
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    |   Keisuke Nishida [Keisuke]_,
    |   (with the invaluable assistance of many others)
    |
    | Special credits to
    |   **Gary Cutler** author of the 'OpenCOBOL Programmers Guide'_
    |   Joseph James Frantz for hosting and advocacy [aoirthoir]_
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:Copyright:
    |copyleft|
:ChangeLog:
    ChangeLog_
```

> 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?

Chapter 1

OpenCOBOL

1.1 What is OpenCOBOL?

OpenCOBOL is an open-source COmmon Business Oriented Language (COBOL) compiler. The home site for OpenCOBOL is `http://opencobol.org` OpenCOBOL implements a substantial part of the COBOL 85 and COBOL 2002 standards, as well as many extensions of the existent COBOL compilers.

OpenCOBOL translates COBOL into C and compiles the translated code using the native C compiler. You can build your COBOL programs on various platforms, including Unix/Linux, Mac OS X, and Microsoft Windows.

The most excellent **OpenCOBOL Programmer's Guide** by Gary Cutler [2], can be found at `http://opencobol.add1tocobol.com/OpenCOBOLProgrammersGuide.pdf`

1.2 What is COBOL?

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

1.3 How is OpenCOBOL licensed?

The compiler is licensed under GNU General Public License.

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

```
All source codes are copyright by the respective authors.

OpenCOBOL 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.
```

1.4 What platforms are supported by OpenCOBOL?

OpenCOBOL 1.0 the current official release version, 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

OpenCOBOL 1.1, has been built on

- MS Windows native
- MS Windows with Cygwin
- POSIX Systems including OpenSolaris
- OS/X
- OS/400

1.5 Are there pre-built OpenCOBOL packages?

Yes. Debian Advanced Package Tool (apt), and RedHat Package Manager (rpm) packages exist. Packages for NetBSD. Many. Google `opencobol packages` for any late breaking news.

A Debian Advanced Package Tool binary package exists for OpenCOBOL 1.0 as **open-cobol** and lists dependencies of

- libc6 ($\geq$ 2.7-1),
- libcob1,
- libcob1-dev (= 1.0-1),
- libdb4.5 ($\geq$ 4.5.20-3),
- libdb4.5-dev,
- libgmp3-dev,
- libgmp3c2,
- libltdl3-dev,
- libncurses5 ($\geq$ 5.6+20071006-3)

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

1.5.1 kiska.net repository

Also check out kiska.net for binary builds on various platforms. Thanks to Sergey Kashyrin.

1.6 What is the most recent version of OpenCOBOL?

See `What is the current version of OpenCOBOL?` 2.4

1.7 How complete is OpenCOBOL?

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.

OpenCOBOL 1.1 implements a more substantial portion of the COBOL 85 Dialect, COBOL 2002 and a growing number of vendor extensions. Some proposed COBOL 20xx features have also been implemented. Compatibility support includes:

- MF for Micro Focus
- IBM for IBM compatibility
- MVS
- BS2000

OpenCOBOL also includes some advanced features allowing source code such as

Listing 1.1: OpenCOBOL BY REFERENCE ADDRESS OF

```
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 OpenCOBOL.

Listing 1.2: OpenCOBOL showing off

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

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

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

no claims While OpenCOBOL 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.

1.8 Will I be amazed by OpenCOBOL?

This author believes so. For an open source implementation of COBOL, OpenCOBOL may surprise you in the depth and breadth of its COBOL feature support, usability and robustness.

1.9 Who do I thank for OpenCOBOL?

Many people. In particular Keisuke Nishida and Roger While.

See the THANKS file in the source code archive for more names of people that have worked on the OpenCOBOL 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 OpenCOBOL 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.

From the development tarball:

Listing 1.3: OpenCOBOL make check

```
$ make check
```

will evaluate and report on the test suite. See A.14 for a current output listing of a `make check` run.

1.11 Does OpenCOBOL pass the NIST Test Suite?

OpenCOBOL passes many of the tests included in the NIST sponsored COBOL 85 test suite. While it passes over 9000 of the tests, OpenCOBOL does not claim conformance to any level of COBOL *Standard*.

The National Institute of Standards and Technology, NIST, maintains a COBOL 85 implementation verification suite of tests. An archive of the tests can be found at

`http://www.itl.nist.gov/div897/ctg/cobol_form.htm`

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 OpenCOBOL over some 364 programs/modules and includes thousands of test passes.

```
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

Advanced facilities:

  IF - Intrinsic Function tests
```

With the addition of GLOBAL support, the OpenCOBOL 1.1 pre-release fails none of the attempted tests.

The summary.log from a run in February 2009:

```
------ Directory Information -------   --- Total Tests Information ---
Module Programs Executed Error Crash   Pass Fail Deleted Inspect Total
------ -------- -------- ----- -----  ----- ---- ------- ------- -----
NC           92       92     0     0   4363    0       6      11  4380
SM           15       15     0     0    290    0       3       1   294
IC           24       24     0     0    246    0       4       0   250
SQ           81       81     0     0    512    0       6      81   599
RL           32       32     0     0   1827    0       5       0  1832
IX           39       39     0     0    507    0       1       0   508
ST           39       39     0     0    278    0       0       0   278
SG            5        5     0     0    193    0       0       0   193
OB            5        5     0     0     16    0       0       0    16
IF           42       42     0     0    732    0       0       0   732
------ -------- -------- ----- -----  ----- ---- ------- ------- -----
Total       374      374     0     0   8964    0      25      93  9082
```

1.12 What about OpenCOBOL 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 OpenCOBOL developer will likely be using.

OpenCOBOL, by default, generates code optimized for big-endian, A.1 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 [5], there is a COBOL entry.

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 hundreths. 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
```

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
------------+-----------------------------------------+-------------
   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. Not bad.
```

1.13 Can OpenCOBOL be used for CGI?

Yes. Through standard IO redirection and the extended `ACCEPT ... FROM ENVIRONMENT ...` feature, OpenCOBOL is more than capable of supporting advanced Common Gateway Interface programming. See 5.1 for a sample **Hello Web** program.

1.14 Does OpenCOBOL support a GUI?

Yes, but not out of the box. There is not, as of March 13, 2011,anything that ships with the product.

Third party extensions for Tcl/Tk and bindings for GTK+ do allow for graphical user interfaces. See 5.53 and 5.15.

The expectation is that GTK+ will be completely bound as a callable interface. That is, as of March 13, 2011, not the case, with perhaps 2% of the GTK+ functionality wrapped (but with that 2%, fully functional graphical interfaces are possible).

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

Vala will also open up a quick path to GUI development with OpenCOBOL. There is already an embedded web browser using the Vala bindings to WebKit. See `Can OpenCOBOL interface with Vala?` 5.18 for a lot more details.

1.15 Does OpenCOBOL have an IDE?

Yes and no. There is no IDE that ships with the product. The add1tocobol team is, as of March 13, 2011, at work creating extensions for the GNAT Programming Studio. This is working out quite nicely and will likely be the IDE of choice for the add1tocobol OpenCOBOL developers.

See Can the GNAT Programming Studio be used with OpenCOBOL? for more information.

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

Many text editors have systems in place for invoking compilers. SciTE, Crimson Editor, vi and emacs to name but a few of the hundreds that support edit/compile/test development cycles.

See Does OpenCOBOL work with make? for some information on command line compile assistance.

1.16 Can OpenCOBOL be used for production applications?

Depends. OpenCOBOL 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 analyzed and risks evaluated before commitment to production use.

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

There may be a time when commercial support of OpenCOBOL is offered, but at the time of writing no known offering exists.

Search google just in case!

And yes, OpenCOBOL is used in production environments.

From Roger [8]

```
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 Nagasaki Prefecture

Reported on `http://opencobol.org`, The Nagasaki Prefecture, population 1.44 million and 30,000 civil employees is using OpenCOBOL 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.

1.16.2 more stories

Another post from `http://opencobol.org` in April 2009, *reprinted with permission*.

```
OpenCOBOL 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.
```

```
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
```

Update that to March 2011, Jim's company is still churning out applications powered by OpenCOBOL ***and kicking back piles of wisdom to the internet****.*

1.17 Where can I get more information about COBOL?

The COBOL FAQ by William M Klein [5] is a great place to start.

A google of the search words "COBOL" 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.

The COBUG site, *COBOL User Groups* is also a wonderful resource for OpenCOBOL developers.

This is highly subject to change, but at least as of March 13, 2011 a Draft of 20xx is available at `http://www.cobolstandard.info/j4/index.htm` and in particular `http://www.cobolstandard.info/j4/files/std.zip`

> **no claims** While OpenCOBOL 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.

1.18 Where can I get more information about OpenCOBOL?

The `http://opencobol.org` website is probably the best place to find out more about the OpenCOBOL system. `http://add1tocobol.com` is a place to find out about a few of the fan initiatives. (An older archive has been stashed at `http://oldsite.add1tocobol.co`

1.18.1 The OpenCOBOL Programmer's Guide

A very well written and masterful OpenCOBOL reference and COBOL development guide. By Gary Cutler [2], OpenCOBOL Programmers Guide.

1.19 Can I help out with the OpenCOBOL project?

Absolutely. Visit the `http://opencobol.org` website 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 1.20 for some details. OpenCOBOL is a GPL licensed open source project and while Roger [8] is the lead developer he is quite open to code submissions. Having a central point of development allows for consistency and the very high level of quality control enjoyed by OpenCOBOL users.

1.19.1 Translation Efforts

A new project has started to see native language support in the `cobc` compile and run-time systems. Please see http://www.opencobol.org/modules/newbb/viewtopic.php?topic_id=1127&forum=1 for details if you think you can help.

```
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.

...
```

1.20 Is there an OpenCOBOL mailing list?

Yes. Visit `http://opencobol.org` for details. The OpenCOBOL development mailing list is graciously hosted by SourceForge. The ML archive is available at `http://sourceforge.net/mailarchive/forum.php?forum_name=open-cobol-list` and once you have subscribed, the list will accept messages at the open-cobol-list email destination at lists.sourceforge.net.

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 as of March 2011 a Draft of 20xx is available at `http://www.cobolstandard.info/j4/index.htm` and in particular `http://www.cobolstandard.info/j4/files/std.zip`

> **no claims** While OpenCOBOL 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 OpenCOBOL source codes?

Absolutely. Being an open source system, all sources that are used to build the compiler are available and free.

The `http://opencobol.org` site has links to release and pre-release archives. Most distributions of GNU/Linux will also have source code bundles. For example

Listing 1.4: OpenCOBOL Debian source

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

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

A ROBODoc experimental project to document the source codes is hosted at ocrobo. See ROBODoc Support in A.12 for a sample configuration file.

1.22.1 What was used to color the source code listings?

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

Well, you will be seeing LaTeXlstlisting source code highlighting as of March 2011, but I still appreciate the grand efforts of the Pygments team, and this is an open invitation to anyone that what's a COBOL lexer file `...ocpygments.py` for source code.

1.23 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 OpenCOBOL
  ```

- A common disrepect 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 plops 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 OpenCOBOL 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:

Listing 1.5: OpenCOBOL freezes over

```
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.
```

1.23.1 A 5-7-5 haiku?

How about a 5-7-5 haiku?

Listing 1.6: OpenCOBOL 5-7-5

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

      *btiffin*
```

Compiles to a program that returns 1 to the shell, *fails*, when run. Fails as poetry, fails as code. *Your welcome*.

Chapter 2

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.

Admiral Grace Hopper [4] is affectionately referred to as `the mother of the COBOL language` as she and her previous work with FLOW-MATIC programming language (FLOW-MATIC) greatly influenced the specifications of the first COBOL.

Standards have been published for:

- COBOL-68
- COBOL-74
- COBOL-85
- COBOL-2002
- Draft work for COBOL-20xx is, as of March 13, 2011, underway

and these roughly correspond to the year they were produced. Note the y2k flavour of four digit naming occurred after the millennium change.

Estimates vary, but it is entirely reasonable to believe that of the some 300,000,000,000 (three hundred thousand million) lines of computer source code in production today,

200,000,000,000 (two hundred thousand million) lines are COBOL. A full 2/3rds of the world's source code.

See the Wikipedia entry for COBOL for a lot more details.

2.2 What are the Official COBOL Standards?

Many thanks to William Klein [5], 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.
```

> While OpenCOBOL 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 OpenCOBOL?

OpenCOBOL was initially developed by Keisuke Nishida [6] from experience working on TinyCOBOL originally developed by Rildo Pragana [7].

0.9.0

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

0.30
Development continued apace, with version 0.30 released by Keisuke [**?**, Nishida]n August 8th, 2004.

Roger While [8] then took up the role as lead developer on October 30th, 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.

pre-release 1.1
was release on February 6th, 2009, and as of March 13, 2011 is the most up to date.

2.4 What is the current version of OpenCOBOL?

OpenCOBOL 1.0 was released December 27th, 2007 by Roger While [8].

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 is as of March 13, 2011 in active development towards OpenCOBOL 2.0. The pre-release source tar can be found at open-cobol-1.1.tar.gz with installer instructions at http://www.opencobol.org/modules/bwiki/index.php and in the `INSTALLING` text file of the sources.

After the download, and ensuring the development library and dependencies mentioned in the Install Guide are on you system.

Listing 2.1: OpenCOBOL compile from source

```
$ ./configure
$ make
$ make check
$ sudo make install
```

will place a new set of binaries rooted off `/usr/local`

Be sure to see What are the configure options available for building OpenCOBOL? for all the available options for building from sources.

2.4.1 occurlrefresh

If you build a pre-release OC1.1, 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.

Thanks to aoirthoir [3] for hosting these; (as of March 13, 2011) 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 `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.

Chapter 3

Using OpenCOBOL

3.1 How do I install OpenCOBOL?

Installation instructions can be found at OpenCOBOL Install.

3.1.1 From source with GNU/Linux

```
$ wget http://www.sim-basis.de/open-cobol-1.1.tar.gz
$ tar xvf open-cobol-1.1.tar.gz
$ cd open-cobol-1.1
$ ./configure
$ make
$ make check
$ sudo make install
$ sudo ldconfig
```

3.1.2 Debian

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

```
$ apt-get install open-cobol
```

3.1.3 Fedora

From the main Fedora repositories

```
$ yum install open-cobol
```

3.1.4 Windows™

Build from sources under Cygwin or MinGW. Follow the instructions from the site listed above, or read the OC_GettingStarted_Windows document by Bill Klein [5] available online at

- urlhttp://opencobol.add1tocobol.com/oc_gettingstarted_windows.html
- urlhttp://opencobol.add1tocobol.com/OC_GettingStarted_Windows.pdf

Also see `What is the current version of OpenCOBOL?` 2.4.

3.1.5 Macintosh

From Ganymede on `http://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: --

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
```

3.2 What are the configure options available for building OpenCOBOL?

`configure` is a defacto standard development tool for POSIX 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 OpenCOBOL, the `configure` script accepts `--help` as a command line option to display all of the available configuration choices.

```
‘configure’ configures OpenCOBOL 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]
  --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   (OpenCOBOL) enable experimental code (Developers only!)
  --enable-param-check    (OpenCOBOL) 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>          (OpenCOBOL) specify the C compiler used by cobc
  --with-seqra-extfh      (OpenCOBOL) Use external SEQ/RAN file handler
  --with-cisam            (OpenCOBOL) Use CISAM for ISAM I/O
  --with-disam            (OpenCOBOL) Use DISAM for ISAM I/O
  --with-vbisam           (OpenCOBOL) Use VBISAM for ISAM I/O
  --with-index-extfh      (OpenCOBOL) Use external ISAM file handler
  --with-db1              (OpenCOBOL) use Berkeley DB 1.85 (libdb-1.85)
  --with-db               (OpenCOBOL) use Berkeley DB 3.0 or later (libdb)(default)
  --with-lfs64            (OpenCOBOL) use large file system for file I/O (default)
  --with-dl               (OpenCOBOL) use system dynamic loader (default)
  --with-patch-level      (OpenCOBOL) define a patch level (default 0)
  --with-varse         (OpenCOBOL) 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]
  --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>.
```

3.3 Does OpenCOBOL have any other dependencies?

OpenCOBOL relies on a native C compiler **??** with POSIX compatibility. GCC **??** being a freely available compiler collection supported by most operating systems in use as of March 13, 2011.

OpenCOBOL 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 pay royalty to
    Oracle Corporation. For more information about Oracle Berkeley DB dual
    licensing go to : Oracle / Embedded / Oracle Berkeley DB

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 OpenCOBOL compiler work?

OpenCOBOL 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

OpenCOBOL 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.

3.4.1 Example of OpenCOBOL stages

Documenting the output of the various stages of OpenCOBOL compilation.

3.4.2 Original source code

```
$ cat hello.cob

000100* HELLO.COB OpenCOBOL 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 4.1.111 includes are also read in along with REPLACE 4.1.386 substitution. The above command displayed:

```
# 1 "hello.cob"

IDENTIFICATION DIVISION.
PROGRAM-ID. hello.
PROCEDURE DIVISION.
 DISPLAY "Hello World!".
 STOP RUN.
```

to standard out.

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 OpenCOBOL environment interacts with the native C facilities. OpenCOBOL 1.1 produced `hello.c.h` and `hello.c`.

3.4.5 hello.c.h

Listing 3.1: OpenCOBOL hello.c.h

```
/* Generated by            cobc 1.1.0 */
/* Generated from          hello.cob */
/* Generated at            Oct 04 2008 00:19:36 EDT */
/* OpenCOBOL build date    Oct 01 2008 22:15:19 */
/* OpenCOBOL 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 */
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

Listing 3.2: OpenCOBOL hello.c

```
/* Generated by            cobc 1.1.0 */
/* Generated from          hello.cob */
/* Generated at            Oct 04 2008 00:19:36 EDT */
/* OpenCOBOL build date    Oct 01 2008 22:15:19 */
/* OpenCOBOL 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];
  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:;

/* 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

Listing 3.3: OpenCOBOL cobc -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
    .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
.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)
    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
```

Build dynamically loadable module. The is the *default behaviour*. This example produces `hello.so` or `hello.dll`.

3.4.11 Module run

```
$ cobcrun hello
Hello World!
```

Will scan the DSO A.5 `hello.so`, and then link, load, and execute `hello`.

3.4.12 Create executable

```
$ cobc -x hello.cob
```

Create an executable program. This examples produces `hello` or `hello.exe`.

This is important. `cobc` produces a Dynamic Shared Object (DSO) by default. *To create executables*, you need to use `-x`.

```
$ ./hello
Hello World!
```

OpenCOBOL also supports features for multiple source, multiple language programming, detailed in the FAQ at Does OpenCOBOL support modules 5.6.

3.5 What is cobc?

`cobc` is the OpenCOBOL compiler. It processes source code into object, library or executable code.

See What compiler options are supported? for more information.

3.6 What is cobcrun?

`cobcrun` is the OpenCOBOL driver program that allows the execution of programs stored in OpenCOBOL 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 `hello.so`, and `cobcrun` resolves the entry point and executes the code, right from the DSO.

`cobcrun` *is the compiler author's preferred way to manage OpenCOBOL development.* It alleviates knowing which source file needs `-x` while encouraging proper modular programming, a mainstay of OpenCOBOL.

3.7 What is cob-config?

`cob-config` is a program that can be used to find 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 OpenCOBOL 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 OpenCOBOL compile time configuration files? for more details on this finely tuned control.

```
$ cobc -V
cobc (OpenCOBOL) 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 :
                        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)
-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
```

3.9 What dialects are supported by OpenCOBOL?

Using the `std=<dialect>` compiler option, OpenCOBOL can be configured to compile using specific historical COBOL compiler features and quirks.

Supported dialects include:

- default
- cobol85
- cobol2002
- ibm
- mvs
- mf
- bs2000

For details on what options and switches are used to support these dialect compiles, see the `config/` directory of your OpenCOBOL installation. For Debian GNU/Linux, that will be `/usr/share/open-cobol/config/` if you used APT to install an OpenCOBOL package or `/usr/local/share/open-cobol/config/` after a build from the source archive.

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.

3.10 What extensions are used if cobc is called with-/without "-ext" for COPY

From Roger on `http://opencobol.org`

```
In the following order -
CPY, CBL, COB, cpy, cbl, cob and finally with no extension.

User specified extensions (in the order as per command line) are inspected
PRIOR to the above defaults.

ie. They take precedence.
```

3.11 What are the OpenCOBOL compile time configuration files?

To assist in the support of the various existent COBOL compilers, OpenCOBOL 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: "OpenCOBOL"

# 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

# 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)

# 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
```

3.12 Does OpenCOBOL work with make?

makefile Absolutely. Very well.

A sample `makefile`

Listing 3.4: OpenCOBOL Makefile sample

```
# OpenCOBOL rules

COBCWARN = -W

# create an executable
%: %.cob
        cobc $(COBCWARN) -x $^ -o $@

# create a dynamic module
%.so: %.cob
        cobc $(COBCWARN) -m $^ -o $@

# create a linkable object
%.o: %.cob
        cobc $(COBCWARN) -c $^ -o $@

# generate C code
%.c: %.cob
        cobc $(COBCWARN) -C $^

# generate assembly
%.s: %.cob
        cobc $(COBCWARN) -S $^

# generate intermediate suitable for cobxref
%.i: %.cob
        [ -d tmps ] || mkdir tmps
```

```
        cobc $(COBCWARN) --save-temps=tmps -c $^

# hack extension; create an executable; if errors, call vim in quickfix
%.q: %.cob
        cobc $(COBCWARN) -x $^ 2>errors.err || vi -q

# hack extension; make binary; capture warnings, call vim quickfix
%.qw: %.cob
        cobc $(COBCWARN) -x $^ 2>errors.err ; vi -q

# run ocdoc to get documentation
%.html: %.cob
        ./ocdoc $^ $*.rst $*.html $*.css

# run cobxref and get a cross reference listing  (leaves tmps dir around)
# THIS GETS EASIER in V2.0. Cross referencer will be built in
%.lst: %.cob
        [ -d tmps ] || mkdir tmps
        cobc $(COBCWARN) --save-temps=tmps -c $^ -o tmps/$*.o
        ~/writing/add1/tools/cobxref/cobxref tmps/$*.i

# tectonics for occurlrefresh
occurlrefresh: occurl.c occurlsym.cpy occurlrefresh.cbl
        cobc -c -Wall occurl.c
        cobc -x -lcurl occurlrefresh.cbl occurl.o
```

And now to compile a small program called `program.cob`, just use

```
$ make program       # for executables
$ make program.o     # for object files
$ make program.so    # for shared library
$ make program.q     # attempt comile and call vi in quickfix mode
```

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 timestamp of the binary.

See Tectonics for another word to describe building code.

3.13 Do you have a reasonable source code skeleton for OpenCOBOL?

Maybe. Style is a very personal developer choice. OpenCOBOL pays homage to this freedom of choice.

Here is the FIXED form header that this author uses. It includes `ocdoc` lines.

Listing 3.5: OpenCOBOL empty header

```
OCOBOL >>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
      *>   organization is
      *>   .

       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? for more information on (*one method of*) inline documentation.

Here are some templates that can cut and pasted.

Fixed form in lowercase

Listing 3.6: OpenCOBOL empty header

```
OCOBOL >>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
      *>     organization is
      *>     .

       data division.
      *> file section.
      *> fd .
      *>     01 .

       working-storage section.

       local-storage section.

       linkage section.

       screen section.

      *> ***************************************************************
       procedure division.

       goback.
       end program .
```

Fixed form in UPPERCASE

Listing 3.7: OpenCOBOL empty header

```
OCOBOL >>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
           ORGANIZATION IS
           .

       DATA DIVISION.
       FILE SECTION.
       FD .
           01 .

       WORKING-STORAGE SECTION.

       LOCAL-STORAGE SECTION.

       LINKAGE SECTION.

       SCREEN SECTION.

      ******************************************************************
       PROCEDURE DIVISION.

       GOBACK.
       END PROGRAM .
```

The OCOBOL *"sequence number"* can safely be removed. It is there to ensure proper alignment in the browser.

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.

Listing 3.8: OpenCOBOL empty header

```
*> **  >>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.

local-storage section.

linkage section.

screen section.

procedure division.

goback.
end program .
```

These files can be downloaded from

- http://opencobol.add1tocobol.com/sources/headfix.cob
- http://opencobol.add1tocobol.com/sources/headfixupper.cob
- http://opencobol.add1tocobol.com/sources/headfree.cob

```
There are tricks to ensure that FIXED FORMAT source code can be
compiled in a FREE FORMAT mode.  That includes using free form end of
line comments, no sequence numbers, free form DEBUG line directives with
the >>D starting in column 5 (so the D ends up in column 7).
```

3.13.1 vi autoload of skeleton headers

Inside `/.vimrc` put

```
" Auto load COBOL template
autocmd BufNewFile  *.cob      0r ~/lang/cobol/header.cob
```

and then, when you

```
$ vi newprogram.cob
```

and it is an empty new file, you will start with a nice starter skeleton. *You will need to change the filename,* `/lang/cobol/header.cob` *to the name you use for your personal stash.*

3.14 Can OpenCOBOL 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
```

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.

Listing 3.9: OpenCOBOL filter

```
OCOBOL >>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.
       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.
    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
```

3.15 How do you print to printers with OpenCOBOL?

OpenCOBOL 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 OpenCOBOL be used to write command line stdin, stdout filters? 3.14 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

Listing 3.10: lp printing

```
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.

Listing 3.11: CUPS quick print

```
OCOBOL >>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"
           "OpenCOBOL CUPS interface" & x"00"
           by value 0
           by reference NULL
         returning result
       end-call

       if result equals zero
           call "cupsLastError" returning cupsError end-call
           display "Err: " cupsError end-display

           call "cupsLastErrorString" returning msgPointer end-call
           set address of msgBuffer to msgPointer
           string
               msgBuffer delimited by x"00"
             into msgDisplay
           end-string
           display function trim(msgDisplay) end-display
       else
           display "Job: " result end-display
       end-if
```

```
       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

Listing 3.12: Install CUPS

```
$ apt-get install cups cups-pdf
```

under Debian, you can then

Listing 3.13: OpenCOBOL cupsPrintFile

```
       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
it's 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
```

3.15.5 Jim Currey's prtcbl

Jim kindly donated this snippet. One of his earliest efforts establishing a base of OpenCOBOL 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.*

Listing 3.14: PRTCBL

```
OCOBOL 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.
           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).
      *
       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.
           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"
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
             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 OpenCOBOL?

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.

Listing 3.15: OpenCOBOL spawn background process

```
CALL "SYSTEM"
    USING
        "nohup whatever 0</dev/null 1>mystdout 2>mystderr &"
    RETURNING result
END-CALL
```

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.

Chapter 4

Reserved Words

4.1 What are the OpenCOBOL RESERVED WORDS?

COBOL is a reserved word rich language. The OpenCOBOL compiler recognizes:
514 words in OC 1.1, 136 of which are marked not yet implemented. 378 functional reserved words, as of August 2008.

4.1.1 ACCEPT

Listing 4.1: OpenCOBOL ACCEPT

```
ACCEPT variable FROM CONSOLE.
ACCEPT variable FROM ENVIRONMENT "path".
ACCEPT variable FROM COMMAND LINE.
ACCEPT variable AT 0101.
ACCEPT screen-variable.
```

4.1.2 ACCESS

Defines a file's access mode. One of DYNAMIC 4.1.143, RANDOM 4.1.369, or SEQUENTIAL 4.1.422.

Listing 4.2: OpenCOBOL ACCESS

```
SELECT filename
    ASSIGN TO "filename.dat"
    ACCESS MODE IS RANDOM
    RELATIVE KEY IS keyfield.
```

ACTIVE-CLASS

Not yet implemented. Object COBOL feature.

4.1.3 ADD

Listing 4.3: OpenCOBOL ADD

```
ADD 1 TO cobol GIVING OpenCOBOL END-ADD.
```

4.1.4 ADDRESS

Listing 4.4: OpenCOBOL ADDRESS

```
SET pointer-variable TO ADDRESS OF linkage-store.
```

4.1.5 ADVANCING

Listing 4.5: OpenCOBOL ADVANCING

```
DISPLAY "Legend: " WITH NO ADVANCING END-DISPLAY.
WRITE printrecord AFTER ADVANCING PAGE END-WRITE.
```

4.1.6 AFTER

A multi purpose clause.

For one use, allows nested loops inside a PERFORM 4.1.340 verb. Another usage can influence when loop conditional testing occurs.

Listing 4.6: OpenCOBOL 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-DISPLAY
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.

4.1.7 ALIGNED

Not yet implemented feature that will influence the internal alignment of not yet implemented `USAGE` 4.1.495 `BIT` fields.

4.1.8 ALL

A multipurpose reserved in context word.

Listing 4.7: OpenCOBOL ALL

```
INSPECT variable REPLACING ALL "123" WITH "456".
```

4.1.9 ALLOCATE

Allocates actual working storage for a BASED 4.36 element.

Listing 4.8: OpenCOBOL ALLOCATE

```
    ALLOCATE based-var INITIALIZED RETURNING pointer-var.
```

4.1.10 ALPHABET

Listing 4.9: OpenCOBOL ALPHABET

```
* Set up for a mixed case SORT COLLATING SEQUENCE IS
 CONFIGURATION SECTION.
 SPECIAL-NAMES.
     ALPHABET name IS "AaBbCcDdEe..".
```

4.1.11 ALPHABETIC

One of the OpenCOBOL data class *category* tests.

Listing 4.10: OpenCOBOL ALPHABETIC

```
    IF variable IS ALPHABETIC
        DISPLAY "alphabetic" END-DISPLAY
    END-IF
```

4.1.12 ALPHABETIC-LOWER

One of the OpenCOBOL data class *category* tests.

Listing 4.11: OpenCOBOL ALPHABETIC-LOWER

```
    IF variable IS ALPHABETIC-LOWER
        DISPLAY "alphabetic-lower" END-DISPLAY
    END-IF
```

4.1.13 ALPHABETIC-UPPER

One of the OpenCOBOL data class *category* tests.

Listing 4.12: OpenCOBOL ALPHABETIC-UPPER

```
    DISPLAY variable "alphabetic-upper " WITH NO ADVANCING
    IF variable IS ALPHABETIC-UPPER
        DISPLAY "true" END-DISPLAY
    ELSE
        DISPLAY "false" END-DISPLAY
    END-IF
```

4.1.14 ALPHANUMERIC

Listing 4.13: OpenCOBOL ALPHANUMERIC

```
INITIALIZE data-record REPLACING ALPHANUMERIC BY literal-value
```

4.1.15 ALPHANUMERIC-EDITED

Listing 4.14: OpenCOBOL

```
INITIALIZE data-record
    REPLACING ALPHANUMERIC-EDITED BY identifier-1
```

4.1.16 ALSO

A powerful, multiple conditional expression feature of EVALUATE4.79.

Listing 4.15: OpenCOBOL

```
EVALUATE variable ALSO second-test
    WHEN "A" ALSO 1 THRU 5 PERFORM first-case
    WHEN "A" ALSO 6        PERFORM second-case
    WHEN "A" ALSO 7 THRU 9 PERFORM third-case
    WHEN OTHER             PERFORM invalid-case
END-EVALUATE
```

4.1.17 ALTER

Obsolete and unsupported verb that altered the jump target for GO TO statements.

Yeah, just don't.

Rumour is, 2.0 may support this verb, to increase support for legacy code, and NOT as *homage to a good idea*. But to be honest, I do look forward to seeing the first OpenCOBOL Flying Spaghetti Monster for the giggles of righteous indignation.

4.1.18 ALTERNATE

Defines an ALTERNATE key for Indexed Sequential Access Methods (ISAM) data structures.

Listing 4.16: OpenCOBOL

```
SELECT file
    ASSIGN TO filename
    ACCESS MODE IS RANDOM
    RECORD KEY IS key-field
    ALTERNATE KEY IS alt-key WITH DUPLICATES.
```

4.1.19 AND

COBOL rules of precedence are; NOT, AND, OR.

Listing 4.17: OpenCOBOL

```
IF field = "A" AND num = 3
    DISPLAY "got 3" END-DISPLAY
END-IF
```

COBOL also allows abbreviated combined relational conditions.

Listing 4.18: OpenCOBOL

```
IF NOT (a NOT > b AND c AND NOT d)
   code
END-IF
```

is equivalent to

Listing 4.19: OpenCOBOL

```
IF NOT (((a NOT > b) AND (a NOT > c)) AND (NOT (a NOT > d)))
    code
END-IF
```

4.1.20 ANY

Allows for any value is TRUE in an EVALUATE statement.

Listing 4.20: OpenCOBOL

```
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
```

4.1.21 ANYCASE

Not yet implemented. Will allow case insentive match of currency symbols with `FUNCTION NUMVAL-C`.

4.1.22 ARE

Allows for multiple conditional VALUES.

Listing 4.21: OpenCOBOL VALUES

```
01 cond-1   PIC X.
   88 first-truth   VALUES ARE "A" "B" "C".
   88 second-truth  VALUES ARE "X" "Y" "Z".
```

4.1.23 AREA

Controls SORT, MERGE and RECORD data definitions.

Listing 4.22: OpenCOBOL AREA

```
I-O-CONTROL.
    SAME RECORD AREA FOR file1, file2.
```

4.1.24 AREAS

Plural readability option for AREA.

Listing 4.23: OpenCOBOL AREAS

```
SAME RECORD AREAS
```

4.1.25 ARGUMENT-NUMBER

Holds the number of OS parsed command line arguments, and can act as the explicit index when retrieving ARGUMENT-VALUE data. ARGUMENT-NUMBER can be used in `ACCEPT FROM` and `DISPLAY UPON` expressions.

Listing 4.24: OpenCOBOL ARGUMENT-NUMBER

```
ACCEPT command-line-argument-count FROM ARGUMENT-NUMBER END-ACCEPT

DISPLAY 2 UPON ARGUMENT-NUMBER END-DISPLAY
ACCEPT indexed-command-line-argument FROM ARGUMENT-VALUE END-ACCEPT
```

See COMMAND-LINE for more information on the unparsed command invocation string.

4.1.26 ARGUMENT-VALUE

Returns the next command line argument. This post from John on `http://opencobol.org` is an excellent idiom for parsing command line arguments without too much worry as to the order.

Listing 4.25: OpenCOBOL ARGUMENT-VALUE Sample, parsing command lines

```
         >>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 "l".
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
   else
      move "l"            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
```

4.1.27 ARITHMETIC

Not yet implemented feature of the not yet implemented OPTIONS paragraph of the **??** DIVISION.

4.1.28 AS

Listing 4.26: OpenCOBOL AS

```
PROGRAM-ID. program-name AS literal.
```

4.1.29 ASCENDING

COBOL table suport.

Listing 4.27: OpenCOBOL ASCENDING

```
01 CLUBTABLE.
   05 MEMBER-DATA OCCURS 1 TO 6000000000 TIMES
        DEPENDING ON PEOPLE
        ASCENDING KEY IS HOURS-DONATED.
```

4.1.30 ASSIGN

Assign a name to a file or other external resource.

Listing 4.28: OpenCOBOL

```
SELECT input-file
ASSIGN TO "filename.ext"
```

The actual filename used is dependent on a configuration setting. Under default configuration settings, `filename-mapping` is set to `yes`.

See What are the OpenCOBOL compile time configuration files? What are the OpenCOBOL compile time con for details.

Listing 4.29: OpenCOBOL .conf

```
# 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
```

So, under GNU/Linux, bash shell

Listing 4.30: OpenCOBOL DD Name

```
$ export DD_DATAFILE='/tmp/opencobol.dat'
$ ./myprog
```

the program will find the data in `/tmp/opencobol.dat`

Listing 4.31: OpenCOBOL DD Name change

```
$ 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 enviroment variables before using a literal as the filename.

1. DD_DATAFILE
2. dd_DATAFILE
3. DATAFILE
4. and finally "DATAFILE"

where DATAFILE is the `name` used in

Listing 4.32: OpenCOBOL

```
ASSIGN TO name
```

and can be any valid COBOL identifier, or string leading to a valid operating system filename, and is not limited to *DATAFILE*.

4.1.31 AT

Controls position of ACCEPT and DISPLAY screen oriented verbs.

Listing 4.33: OpenCOBOL AT

```
*> Display at line 1, column 4 <*
 DISPLAY "Name:" AT 0104 END-DISPLAY
*> Accept starting at line 1, column 10 for length of field <*
 ACCEPT name-var AT 0110 END-ACCEPT
```

4.1.32 ATTRIBUTE

Not yet implemented, but when it is, it will allow

Listing 4.34: OpenCOBOL ATTRIBUTE

```
SET screen-name ATTRIBUTE BLINK OFF
```

4.1.33 AUTO

Automatic cursor flow to next field in screen section.

4.1.34 AUTO-SKIP

Alias for AUTO

4.1.35 AUTOMATIC

LOCK MODE IS AUTOMATIC. See MANUAL and EXCLUSIVE for more LOCK options.

4.1.36 AUTOTERMINATE

Alias for AUTO4.1.33

4.1.37 B-AND

Not yet implemented BIT4.1.52 field operation.

4.1.38 B-NOT

Not yet implemented BIT4.1.52 field operation.

4.1.39 B-OR

Not yet implemented BIT4.1.52 field operation.

4.1.40 B-XOR

Not yet implemented BIT4.1.52 field operation.

4.1.41 BACKGROUND-COLOR

Listing 4.35: OpenCOBOL BACKGROUND

```
05 BLANK SCREEN BACKGROUND-COLOR 7 FOREGROUND-COLOR 0.
```

4.1.42 BASED

Listing 4.36: OpenCOBOL BASED

```
01 based-var PIC X(80) BASED.
```

A sample posted by human [**?**]

Listing 4.37: OpenCOBOL BASED sample

```
*-----------------------------------------------------------------
 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.
*
 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)
     end-display
     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)
            end-display
         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 ---------------------------------------
```

4.1.43 BEEP

Ring the terminal bell during DISPLAY output. Alias for BELL.

Listing 4.38: OpenCOBOL BEEP

```
DISPLAY "Beeeeep" LINE 3 COLUMN 1 WITH BEEP END-DISPLAY.
```

4.1.44 BEFORE

Sets up a PERFORM loop to test the conditional BEFORE execution of the loop body. See AFTER4.6 for the alternative. BEFORE is the default.

Listing 4.39: OpenCOBOL BEFORE

```
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.

Listing 4.40: OpenCOBOL WRITE BEFORE

```
WRITE record-name
    BEFORE ADVANCING some-number LINES
```

And to control how the INSPECT verb goes about its job.

Listing 4.41: OpenCOBOL BEEP

```
INSPECT character-var TALLYING
   the-count FOR ALL "tests" BEFORE "prefix"
```

And not supported as of March 13, 2011, in the declaratives for REPORT SECTION control.

Listing 4.42: OpenCOBOL USE BEFORE

```
USE BEFORE REPORTING
 ...
```

4.1.45 BELL

Ring the terminal bell during DISPLAY output. Alias for BEEP

Listing 4.43: OpenCOBOL BELL

```
DISPLAY "Beeeeep" LINE 3 COLUMN 1 WITH BELL END-DISPLAY.
```

4.1.46 BINARY

Listing 4.44: OpenCOBOL BINARY

```
01 result PIC S9(8) USAGE BINARY
```

4.1.47 BINARY-C-LONG

With OpenCOBOL'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 CALL4.1.60 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.

4.1.48 BINARY-CHAR

Defines an 8 bit usage item.

4.1.49 BINARY-DOUBLE

Defines a 64 bit usage item.

4.1.50 BINARY-LONG

32 bit native USAGE modifier. Equivalent to S9(8).

4.1.51 BINARY-SHORT

16 bit native USAGE. Equivalent to S9(5).

4.1.52 BIT

Not yet implemented.

4.1.53 BLANK

Listing 4.45: OpenCOBOL

```
05 BLANK SCREEN BACKGROUND-COLOR 7 FOREGROUND-COLOR 0.
```

4.1.54 BLINK

Aaaaaah, my eyes!!

4.1.55 BLOCK

Listing 4.46: OpenCOBOL BLOCK

```
FD file-name
  BLOCK CONTAINS 1 TO n RECORDS
```

4.1.56 BOOLEAN

As yet unsupported modifier.

4.1.57 BOTTOM

A LINAGE setting.

Listing 4.47: OpenCOBOL BOTTOM

```
FD  mini-report
      linage is 16 lines
          with footing at 15
          lines at top 2
          lines at bottom 2.
```

4.1.58 BY

Listing 4.48: OpenCOBOL BY

```
PERFORM the-procedure
    VARYING step-counter FROM 1 BY step-size
    UNTIL step-counter > counter-limit
```

4.1.59 BYTE-LENGTH

Human inscisors average about 16mm.

More to the point, the BYTE-LENGTH returns the length, in bytes, of a data item. See FUNCTION BYTE-LENGTH.

4.1.60 CALL

The OpenCOBOL CALL verb accepts literal or identifier stored names when resolving the transfer address. The USING phrase allows argument passing and OpenCOBOL includes internal rules for the data representation of the call stack entities that depend on the COBOL PICTURE and USAGE clauses. Return values are captured with RETURNING identifier. See What STOCK CALL LIBRARY does OpenCOBOL offer? What STOCK CALL LIBRARY does OpenCOBOL offer?.

For more information see `http://www.opencobol.org/modules/bwiki/index.php?cmd=read&page=Us`

CALL is the verb that opens up access to the plethora of C based Application Binary Interface (ABI) libraries. **A plethora**.

4.1.61 CANCEL

Virtual cancel of a module is supported. Physical cancel support is on the development schedule.

4.1.62 CD

A control clause of the as yet unsupported `COMMUNICATION DIVISION`.

4.1.63 CENTER

An as yet unsupported keyword.

4.1.64 CF

Shortform for CONTROL FOOTING, a clause used in REPORT SECTION.

4.1.65 CH

Shortform for CONTROL HEADING, a clause used in PAGE descriptors in the REPORT SECTION.

4.1.66 CHAIN

Invokes a subprogram, with no return of control implied. The chained program unit virtually becomes the main program within the run unit.

4.1.67 CHAINING

Passes procedure division data through WORKING-STORAGE and can be used for shell command line arguments as well, as in `CALL "myprog" USING string END-CALL`.

from opencobol.org by human

Listing 4.49: OpenCOBOL chaining sample

```
WORKING-STORAGE SECTION.
    01 cmd-argument.
      02 some-text pic x(256).

procedure division Chaining cmd-argument.

display 'You wrote:'
        '>"' function trim(some-text) '"'
        'from shell command line'
end-display
```

4.1.68 CHARACTER

Listing 4.50: OpenCOBOL CHARACTER

```
PADDING CHARACTER IS
```

A soon to be obsolete feature.

4.1.69 CHARACTERS

A multi use keyword.

Used in SPECIAL-NAMES4.1.439

Listing 4.51: OpenCOBOL CHARACTERS

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20101031
      *> Purpose:   Try out SYMBOLIC CHARACTERS
      *> Tectonics: cobc -x figurative.cob
      *> Rave:      OpenCOBOL 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).

      *> ****************************************************************
       procedure division.
       display
           "thing" TAB "tabbed thing" LF
           "and" TAB "another tabbed thing" LF
           "other" CMA " things"
       end-display

       move a-comma to lots-of-commas
       display "MOVE a-comma : " lots-of-commas end-display

       move CMA to lots-of-commas
       display "MOVE symbolic: " lots-of-commas end-display

       goback.
       end program figurative.
```

Outputs:

```
$ cobc -x figuratives.cob
$ ./figuratives
thing   tabbed thing
and     another tabbed thing
other, things
MOVE a-comma : ,
MOVE symbolic: ,,,,,,,,,,,,,,,,,,,,
```

Used in INSPECT

Listing 4.52: OpenCOBOL

```
  INSPECT str TALLYING tal FOR CHARACTERS
```

Used in a File Description FD

Listing 4.53: OpenCOBOL

```
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.
```

4.1.70 CLASS

Used to create alphabets in SPECIAL-NAMES.

Listing 4.54: OpenCOBOL CLASS

```
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SPECIAL-NAMES.
CLASS octals IS '0' THRU '7'.

...

PROCEDURE DIVISION.
IF user-value IS NOT octals
    DISPLAY "Sorry, not a valid octal number" END-DISPLAY
ELSE
    DISPLAY user-value END-DISPLAY
END-IF
```

4.1.71 CLASS-ID

An as yet unsupported Object COBOL class identifier clause.

4.1.72 CLASSIFICATION

An as yet unsupported source code internationalization clause.

4.1.73 CLOSE

Close an open file. OpenCOBOL will implicitly close all open resources at termination of a run unit and will display a warning message stating so, and the danger of potentially unsafe termination.

Listing 4.55: OpenCOBOL

```
   CLOSE input-file
```

4.1.74 CODE

A syntactically recognized, but as yet unsupported clause of a report descriptor, RD4.1.370.

4.1.75 CODE-SET

An as yet unsupported data internationalization clause.

4.1.76 COL

Alias for COLUMNS**??**.

4.1.77 COLLATING

Allows control over alphanumeric compares within a program unit.

Listing 4.56: OpenCOBOL

```
OBJECT-COMPUTER. name.
  PROGRAM COLLATING SEQUENCE IS alphabet-1.
```

4.1.78 COLS

Alias for COLUMNS**??**.

4.1.79 COLUMN

A recognized but unsupported REPORT SECTION RD4.1.370 descriptor clause.

Also used for positional DISPLAY and ACCEPT, which implicitly uses SCREEN SECTION style ncurses screen IO.

Listing 4.57: OpenCOBOL

```
DISPLAY var-1 LINE 1 COLUMN 23 END-DISPLAY
```

4.1.80 COLUMNS

A recognized but as yet unsupported 4.1.370 clause.

4.1.81 COMMA

A SPECIAL-NAMES4.1.439 clause supporting commas in numeric values versus the default period decimal point. COBOL was way ahead of the internationization 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*.

Listing 4.58: OpenCOBOL

```
DECIMAL POINT IS COMMA
```

4.1.82 COMMAND-LINE

Provides access to command line arguments.

Listing 4.59: OpenCOBOL COMMAND-LINE

```
ACCEPT the-args FROM COMMAND-LINE END-ACCEPT
```

4.1.83 COMMIT

Flushes ALL current locks, synching file I/O buffers. OpenCOBOL supports safe transactional processing with ROLLBACK4.1.405 capabilities. *Assuming the ISAM handler configured when building the compiler can support LOCK4.1.284*

4.1.84 COMMON

Listing 4.60: OpenCOBOL COMMAND-LINE

```
PROGRAM-ID. CBL-OC-PROGRAM IS COMMON PROGRAM.
```

Ensures a nested sub-program is also available to other nested sub-programs with a program unit heirarchy.

4.1.85 COMMUNICATION

Currently March 13, 2011 unsupported DIVISION, but see Does OpenCOBOL support Message Queues? 5.10 for an alternative.

4.1.86 COMP

See COMPUTATIONAL**??**

4.1.87 COMP-1

See COMPUTATIONAL-1**??**

4.1.88 COMP-2

See COMPUTATIONAL-2**??**

4.1.89 COMP-3

See COMPUTATIONAL-3**??**

4.1.90 COMP-4

See COMPUTATIONAL-4**??**

4.1.91 COMP-5

See COMPUTATIONAL-5**??**

4.1.92 COMP-X

See COMPUTATIONAL-X**??**

4.1.93 COMPUTATIONAL

Implementors choice; OpenCOBOL is a big-endian default. With most Intel personal computers and operating systems like GNU/Linux, COMPUTATIONAL-5**??** will run faster.

4.1.94 COMPUTATIONAL-1

Single precision float. Equivalent to FLOAT-SHORT4.1.207.

4.1.95 COMPUTATIONAL-2

Double precision float. Equivalent to FLOAT-LONG4.80.

4.1.96 COMPUTATIONAL-3

Equivalent to PACKED DECIMAL. Packed decimal is two digits per byte, always sign extended and influenced by a .conf setting *binary-size* COMPUTATIONAL-6**??** is UNSIGNED PACKED.

4.1.97 COMPUTATIONAL-4

Equivalent to BINARY.

4.1.98 COMPUTATIONAL-5

Native form.

4.1.99 COMPUTATIONAL-6

Unsigned packed decimal form, see COMPUTATIONAL-3**??**.

4.1.100 COMPUTATIONAL-X

Native form.

4.1.101 COMPUTE

Computational arithmetic.

Listing 4.61: OpenCOBOL

```
COMPUTE circular-area = radius ** 2 * FUNCTION PI END-COMPUTE
```

$a = \pi r^2$

OpenCOBOL 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

`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

Listing 4.62: OpenCOBOL

```
OCOBOL*> ******************************************************************
       identification division.
       program-id. computing.

       data division.
       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 $3 * var - 1$ three times var *minus one*, OpenCOBOL will complain.

```
$ cobc -x computing.cob
computing.cob:18: Error: 'var-1' is not defined
$
```

whew, saved!

Listing 4.63: OpenCOBOL

```
OCOBOL*> ************************************************************
       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.
```

```
$ cobc -x computing.cob
$
```

OpenCOBOL will (properly, according to standard) compile this as `three times var-1`. Not saved.

OpenCOBOL programmers are strongly encouraged to use full spacing inside COMPUTE statements.

Listing 4.64: OpenCOBOL

```
OCOBOL*> ************************************************************
       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.
```

4.1.102 CONDITION

As yet unsupported USE AFTER EXCEPTION CONDITION clause.

4.1.103 CONFIGURATION

A SECTION of the `ENVIRONMENT DIVISION`. Holds paragraphs for

- SOURCE-COMPUTER
- OBJECT-COMPUTER
- REPOSITORY
- SPECIAL-NAMES

4.1.104 CONSTANT

An extension allowing constant definitions

Listing 4.65: OpenCOBOL

```
01 enumerated-value CONSTANT AS 500.
```

4.1.105 CONTAINS

An FD clause:

Listing 4.66: OpenCOBOL

```
FD a-file RECORD CONTAINS 80 CHARACTERS.
```

4.1.106 CONTENT

A CALL clause that controls how arguments are passed and expected.

Listing 4.67: OpenCOBOL

```
CALL "subprog" USING BY CONTENT alpha-var.
```

alpha-var will not be modifieable by subprog as a copy is passed.
See REFERENCE and VALUE for the other supported CALL argument control.

4.1.107 CONTINUE

A placeholder, no operation verb.

Listing 4.68: OpenCOBOL

```
if action-flag = "C" or "R" or "U" or "D"
    continue
else
    display "invalid action-code" end-display
end-if
```

4.1.108 CONTROL

4.1.109 CONTROLS

4.1.110 CONVERTING

A clause of the INSPECT verb.

Listing 4.69: OpenCOBOL

```
INSPECT X CONVERTING "012345678" TO "999999999".
```

4.1.111 COPY

The COBOL include *pre-processor* verb. Also see REPLACE and Does OpenCOBOL support COPY includes?.

4.1.112 CORR

4.1.113 CORRESPONDING

Move any and all sub fields with matching names within records.

Listing 4.70: OpenCOBOL

```
01 bin-record.
   05 first usage binary-short.
   05 second usage binary-long.
   05 this-wont-move usage binary-long.
   05 third-will usage binary-short.
01 num-record.
   05 first pic 999.
   05 second pic s9(9).
   05 third-will pic 999.
   05 this-doesnt-match pic s9(9).

move corresponding bin-record to num-record
display
    first in num-record
    second in num-record
    third-will in num-record
end-display
```

4.1.114 COUNT

4.1.115 CRT

4.1.116 CURRENCY

4.1.117 CURSOR

4.1.118 CYCLE

A clause that causes `EXIT PERFORM` to return to the top of a loop. See FOREVER for an example.

4.1.119 DATA

A magical DIVISION4.1.140.

4.1.120 DATA-POINTER

An as yet unsupported Object COBOL feature.

4.1.121 DATE

4.1.122 DAY

4.1.123 DAY-OF-WEEK

Listing 4.71: OpenCOBOL

```
accept the-day from day-of-week
```

4.1.124 DE

4.1.125 DEBUGGING

4.1.126 DECIMAL-POINT

4.1.127 DECLARATIVES

An imperative entry that can control exception handling of file operations and turn on debug entry points.

Listing 4.72: OpenCOBOL

```
procedure division.
declaratives.
handle-errors section.
    use after standard error procedure on filename-1.
handle-error.
    display "Something bad happened with " filename-1 end-display.
.
```

```
helpful-debug section.
    use for debugging on open-main-file.
help-me.
    display "About to open " filename-1 end-display.
.
end declaratives.
```

4.1.128 DEFAULT

4.1.129 DELETE

4.1.130 DELIMITED

A fairly powerful keyword used with the STRING verb. Accepts literals and the BY SIZE modifier.

Listing 4.73: OpenCOBOL

```
STRING null-terminated
    DELIMITED BY LOW-VALUE
    INTO no-zero
END-STRING
```

4.1.131 DELIMITER

4.1.132 DEPENDING

4.1.133 DESCENDING

4.1.134 DESTINATION

4.1.135 DETAIL

4.1.136 DISABLE

4.1.137 DISK

4.1.138 DISPLAY

Prints values to standard out, sets enviroment variables

Listing 4.74: OpenCOBOL

```
DISPLAY "First value: " a-variable " and another string" END-DISPLAY
```

4.1.139 DIVIDE

Highly precise arthimetic.

Listing 4.75: OpenCOBOL

```
DIVIDE dividend BY divisor GIVING answer ROUNDED REMAINDER r
```

The 20xx draft 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.

4.1.140 DIVISION

Ahh, sub-divisions. I think my favourite is the `DATA DIVISION`. It gives COBOL a distinctive and delicious flavour in a picturesque codescape.

OpenCOBOL is flexible enough to compile files with only a `PROCEDURE DIVISION`, and even then it really only needs a PROGRAM-ID. See What is the shortest OpenCOBOL program? for an example.

4.1.141 DOWN

4.1.142 DUPLICATES

4.1.143 DYNAMIC

4.1.144 EBCDIC

Extended Binary Coded Decimal Interchange Code.

A character encoding common to mainframe systems, therefore COBOL, therefore OpenCOBOL. Different than American Symbolic Code for Information Interchange (ascii) and OpenCOBOL supports both through efficient mappings. See `http://en.wikipedia.org/wiki` for more info.

ASCII to EBCDIC conversion the OpenCOBOL way

Listing 4.76: OpenCOBOL ASCII to EBCDIC with INSPECT CONVERTING

```
SPECIAL-NAMES.
ALPHABET ALPHA IS NATIVE.
ALPHABET BETA IS EBCDIC.

PROCEDURE DIVISION.
INSPECT variable CONVERTING ALPHA TO BETA
```

4.1.145 EC

4.1.146 EGI

4.1.147 ELSE

Alternate conditional branch point.

4.1.148 EMI

4.1.149 ENABLE

4.1.150 END

4.1.151 END-ACCEPT

Explicit terminator for ACCEPT.

4.1.152 END-ADD

Explicit terminator for ADD.

4.1.153 END-CALL

Explicit terminator for CALL.

4.1.154 END-COMPUTE

Explicit terminator for **??**.

4.1.155 END-DELETE

Explicit terminator for DELETE.

4.1.156 END-DISPLAY

Explicit terminator for DISPLAY.

4.1.157 END-DIVIDE

Explicit terminator for DIVIDE.

4.1.158 END-EVALUATE

Explicit terminator for EVALUATE.

4.1.159 END-IF

Explicit terminator for IF.

4.1.160 END-MULTIPLY

Explicit terminator for MULTIPLY.

4.1.161 END-OF-PAGE

4.1.162 END-PERFORM

Explicit terminator for PERFORM.

4.1.163 END-READ

Explicit terminator for READ.

4.1.164 END-RECEIVE

Explicit terminator for RECEIVE.

4.1.165 END-RETURN

Explicit terminator for RETURN.

4.1.166 END-REWRITE

Explicit terminator for REWRITE.

4.1.167 END-SEARCH

Explicit terminator for SEARCH.

4.1.168 END-START

Explicit terminator for START.

4.1.169 END-STRING

Explicit terminator for STRING.

4.1.170 END-SUBTRACT

Explicit terminator for SUBTRACT.

4.1.171 END-UNSTRING

Explicit terminator for UNSTRING.

4.1.172 END-WRITE

Explicit terminator for WRITE.

4.1.173 ENTRY

Always for CALL entry points without being fully specified sub-programs. Great for defining callbacks required by many GUI frameworks.

See Does OpenCOBOL support the GIMP ToolKit, GTK+? for an example.

4.1.174 ENTRY-CONVENTION

An as yet unsupported clause.

4.1.175 ENVIRONMENT

Divisional name. And allows access to operating system environment variables. OpenCOBOL supports

- CONFIGURATION SECTION
- INPUT-OUTPUT SECTION

within the `ENVIROMENT 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

4.1.176 ENVIRONMENT-NAME

Provides access to the running process environment variables.

4.1.177 ENVIRONMENT-VALUE

Provides access to the running process environment variables.

4.1.178 EO

4.1.179 EOL

ERASE to End Of Line.

4.1.180 EOP

4.1.181 EOS

ERASE to End Of Screen.

4.1.182 EQUAL

Conditional expression to compare two data items for equality.

4.1.183 EQUALS

Conditional expression to compare two data items for equality.

4.1.184 ERASE

A screen section data attribute clause that can control which portions of the screen are cleared during DISPLAY, and ACCEPT.

Listing 4.77: OpenCOBOL

```
01 form-record.
   02 first-field PIC xxx
      USING identifier-1
      ERASE EOL.
```

4.1.185 ERROR

A DECLARATIVES clause that can control error handling.

Listing 4.78: OpenCOBOL

```
USE AFTER STANDARD ERROR PROCEDURE ON filename-1
```

4.1.186 ESCAPE

4.1.187 ESI

4.1.188 EVALUATE

A very powerful and concise selection construct.

Listing 4.79: OpenCOBOL EVALUATE

```
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
```

4.1.189 EXCEPTION

4.1.190 EXCEPTION-OBJECT

4.1.191 EXCLUSIVE

4.1.192 EXIT

OpenCOBOL supports:

- EXIT
- EXIT PROGRAM
- EXIT PERFORM [CYCLE]
- EXIT SECTION
- EXIT PARAGRAPH

Controls flow of the program. `EXIT PERFORM CYCLE` causes an inline perform to return control to the VARYING 4.1.507, UNTIL 4.1.491 or TIMES 4.1.474 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.

4.1.193 EXPANDS

4.1.194 EXTEND

4.1.195 EXTERNAL

4.1.196 FACTORY

4.1.197 FALSE

4.1.198 FD

4.1.199 FILE

4.1.200 FILE-CONTROL

4.1.201 FILE-ID

4.1.202 FILLER

4.1.203 FINAL

4.1.204 FIRST

4.1.205 FLOAT-EXTENDED

OpenCOBOL recognizes but does not yet support `FLOAT-EXTENDED` and will abend a compile.

4.1.206 FLOAT-LONG

OpenCOBOL supports floating point long.

Listing 4.80: OpenCOBOL FLOAT-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 end-compute
display "as short " fshort end-display
compute flong = 1 / 3 end-compute
display "as long  " flong end-display
compute fpic = 1 / 6 end-compute
display "as pic   " fpic end-display
compute fpic rounded = 1 / 6 end-compute
```

```
display "rounded  " fpic end-display
goback.

end program threes.
```

```
$ ./threes
as short 0.333333343267440796
as long  0.333333333333333315
as pic   0.166666666666666666666666666666666666
rounded  0.166666666666666666666666666666666667
```

4.1.207 FLOAT-SHORT

OpenCOBOL supports short floating point.

4.1.208 FOOTING

4.1.209 FOR

4.1.210 FOREGROUND-COLOR

4.1.211 FOREVER

Provides for infinite loops. Use EXIT PERFORM or EXIT PERFORM CYCLE to control program flow.

Listing 4.81: OpenCOBOL FOREVER

```
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 end-display

    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-display
    end-perform

    display "cobol surpassed c and fortran" end-display

    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
```

4.1.212 FORMAT

4.1.213 FREE

Properly cleans up ALLOCATE4.8 alloted memory.

4.1.214 FROM

4.1.215 FULL

4.1.216 FUNCTION

Allows use of the many OpenCOBOL supported intrinsic functions.

Listing 4.82: OpenCOBOL FUNCTION

```
    DISPLAY FUNCTION TRIM("   trim off leading spaces" LEADING) END-DISPLAY.
```

4.1.217 FUNCTION-ID

Not yet implemented, but it will allow for user defined functions.

4.1.218 GENERATE

Not yet implemented beyond simple parsing REPORT writer feature.

4.1.219 GET

4.1.220 GIVING

Listing 4.83: OpenCOBOL GIVING

```
ADD 1 TO cobol GIVING OpenCOBOL.
```

4.1.221 GLOBAL

4.1.222 GO

GO TO is your friend. Edsger was wrong.

4.1.223 GOBACK

A return. This will work correctly for all cases. A return to the operating system or a return to a called program.

Listing 4.84: OpenCOBOL GOBACK

```
GOBACK.
```

4.1.224 GREATER

COBOL conditional expression.

4.1.225 GROUP

4.1.226 GROUP-USAGE

4.1.227 HEADING

4.1.228 HIGH-VALUE

The largest value by PICTURE or assumed PIC.

4.1.229 HIGH-VALUES

4.1.230 HIGHLIGHT

4.1.231 I-O

4.1.232 I-O-CONTROL

4.1.233 ID

4.1.234 IDENTIFICATION

The initial division for OpenCOBOL programs.

Listing 4.85: OpenCOBOL

```
IDENTIFICATION DIVISION.
PROGRAM-ID. sample.
```

Many historical paragraphs from the IDENTIFICATION DIVISION have been deemed obsolete. OpenCOBOL will treat these as comment paragraphs. Including

- AUTHOR
- DATE-WRITTEN
- DATE-MODIFIED
- DATE-COMPILED
- INSTALLATION
- REMARKS
- SECURITY

4.1.235 IF

Conditional branching. In COBOL, conditionals are quite powerful and there are many conditional expressions allowed with concise shortcuts.

Listing 4.86: OpenCOBOL

```
IF A = 1 OR 2
    MOVE 1 TO B
END-IF
```

4.1.236 IGNORING

4.1.237 IMPLEMENTS

4.1.238 IN

A data structure reference and name conflict resolution qualifier.

Listing 4.87: OpenCOBOL

```
MOVE "abc" TO field IN the-record IN the-structure
```

Synonym for OF

4.1.239 INDEX

4.1.240 INDEXED

4.1.241 INDICATE

4.1.242 INHERITS

4.1.243 INITIAL

4.1.244 INITIALIZE

A sample of the INITIALIZE verb posted `opencobol.org` by human [**?**]

Listing 4.88: OpenCOBOL INITIALIZE

```
OCOBOL*-------------------------------------------------------------------
       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
      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.
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
```

4.1.245 INITIALIZED

4.1.246 INITIATE

Initialize internal storage for named REPORT SECTION entries.

Not supported as of March 13, 2011.

4.1.247 INPUT

A mode of the OPEN verb for file access.

Listing 4.89: OpenCOBOL INITIALIZE

```
    OPEN INPUT file
```

4.1.248 INPUT-OUTPUT

A section in the ENVIRONMENT DIVISION of a COBOL source file containing FILE and I-O control paragraphs.

Listing 4.90: OpenCOBOL INITIALIZE

```
       environment division.
       input-output section.
       file-control.
           select htmlfile
           assign to filename
           organization is record sequential.
```

OpenCOBOL supports

- FILE-CONTROL
- I-O-CONTROL

paragraphs within the `INPUT-OUTPUT SECTION`.

4.1.249 INSPECT

Provides very powerful parsing and replacement to COBOL and OpenCOBOL supports the full gamet of options.

Listing 4.91: OpenCOBOL INITIALIZE

```
OCOBOL 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

       INSPECT DATEREC REPLACING ALL "/" BY ":" AFTER INITIAL SPACE
```

```
       display
           "Intrinsic function WHEN-COMPILED " ORIGINAL
       end-display
       display
           " after INSPECT REPLACING         " DATEREC
       end-display

       goback.
       end program inspecting.
```

Example output:

```
Intrinsic function WHEN-COMPILED 2010/03/25 23/05/0900-04/00
 after INSPECT REPLACING         2010/03/25 23:05:0900-04:00
```

4.1.250 INTERFACE

4.1.251 INTERFACE-ID

4.1.252 INTO

4.1.253 INTRINSIC

Used in REPOSITORY to allow the optional use of ”FUNCTION” keyword.

Listing 4.92: OpenCOBOL INITIALIZE

```
       environment division.
       configuration section.
       repository.
           function all intrinsic.
```

The source unit will now allow for program lines such as

Listing 4.93: OpenCOBOL INITIALIZE

```
       move trim("  abc") to dest
       move function trim("  abc") to dest
```

to compile the same code.

4.1.254 INVALID

4.1.255 INVOKE

4.1.256 IS

4.1.257 JUST

4.1.258 JUSTIFIED

4.1.259 KEY

4.1.260 KEYBOARD

A special value for Standard Input

Listing 4.94: OpenCOBOL INITIALIZE

```
    file-control.
        select cgi-in
        assign to keyboard.
```

4.1.261 LABEL

4.1.262 LAST

4.1.263 LC-ALL

4.1.264 LC-COLLATE

4.1.265 LC-CTYPE

4.1.266 LC-MESSAGES

4.1.267 LC-MONETARY

4.1.268 LC-NUMERIC

4.1.269 LC-TIME

4.1.270 LEADING

4.1.271 LEFT

4.1.272 LENGTH

4.1.273 LESS

A comparison operation.

Listing 4.95: OpenCOBOL INITIALIZE

```
IF requested LESS THAN OR EQUAL TO balance
    PERFORM transfer
ELSE
    PERFORM reject
END-IF
```

4.1.274 LIMIT

4.1.275 LIMITS

4.1.276 LINAGE

LINAGE is a *SPECIAL-REGISTER* supported by OpenCOBOL. A counter is maintained for file WRITE and can be used for paging and other control.

Listing 4.96: OpenCOBOL LINAGE

```
OCOBOL*****************************************************************
      * 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 99.
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: ".
    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"
        end-display
        perform 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
           end-display.
           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
           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
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 **??** under the FUNCTION EXCEPTION-STATUS entry.

4.1.277 LINAGE-COUNTER

An internal OpenCOBOL noun, or *Special Register*. Value is readonly and is maintained during WRITEs to files that have a LINAGE clause. Useful for quick reports and logical page layouts.

4.1.278 LINE

4.1.279 LINE-COUNTER

4.1.280 LINES

4.1.281 LINKAGE

4.1.282 LOCAL-STORAGE

4.1.283 LOCALE

4.1.284 LOCK

4.1.285 LOW-VALUE

A figurative constant for the lowest value of a COBOL field.

Listing 4.97: OpenCOBOL LOW-VALUE

```
    MOVE LOW-VALUE TO numeric-1.

    IF alphanumeric-1 EQUALS LOW-VALUE
        DISPLAY "Failed validation" END-DISPLAY
    END-IF.
```

4.1.286 LOW-VALUES

A pluralized form of LOW-VALUE 4.1.285. Equivalent.

Listing 4.98: OpenCOBOL

```
    MOVE LOW-VALUES TO alphanumeric-1.
```

4.1.287 LOWLIGHT

A screen attribute for `DISPLAY` and `SCREEN SECTION` fields.

Listing 4.99: OpenCOBOL

```
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.

4.1.288 MANUAL

4.1.289 MEMORY

4.1.290 MERGE

4.1.291 MESSAGE

4.1.292 METHOD

4.1.293 METHOD-ID

4.1.294 MINUS

4.1.295 MODE

4.1.296 MOVE

A workhorse of the COBOL paradigm. `MOVE` is highly flexible, intelligent, safe and sometimes perplexing data movement verb.

Listing 4.100: OpenCOBOL MOVE

```
01 alphanum-3               PIC XXX.
01 num2                     PIC 99.

MOVE "ABCDEFG" TO xvar3
DISPLAY xvar3 END-DISPLAY

MOVE 12345 TO num2
DISPLAY num2 END-DISPLAY
```

displays:

```
ABC
45
```

Note the 45, MOVE uses a right to left rule when moving numerics.
Groups can be moved with

Listing 4.101: OpenCOBOL MOVE CORRESPONDING

```
MOVE CORRESPONDING ident-1 TO ident-2
```

in which case only the group items of the same name will be transferred from the ident-1 group to the ident-2 fields.

4.1.297 MULTIPLE

4.1.298 MULTIPLY

A mathematic operation.

4.1.299 NATIONAL

4.1.300 NATIONAL-EDITED

4.1.301 NATIVE

4.1.302 NEGATIVE

4.1.303 NESTED

4.1.304 NEXT

4.1.305 NO

4.1.306 NONE

4.1.307 NORMAL

4.1.308 NOT

4.1.309 NULL

4.1.310 NULLS

4.1.311 NUMBER

4.1.312 NUMBERS

4.1.313 NUMERIC

4.1.314 NUMERIC-EDITED

4.1.315 OBJECT

4.1.316 OBJECT-COMPUTER

4.1.317 OBJECT-REFERENCE

4.1.318 OCCURS

Controls multiple occurances of data structures.

4.1.319 OF

A data structure reference and name conflict resolution qualifier.

Listing 4.102: OpenCOBOL OF

```
MOVE "abc" TO the-field OF the-record OF the-structure
```

Synonym for IN

4.1.320 OFF

4.1.321 OMITTED

4.1.322 ON

4.1.323 ONLY

4.1.324 OPEN

4.1.325 OPTIONAL

4.1.326 OPTIONS

4.1.327 OR

4.1.328 ORDER

4.1.329 ORGANIZATION

Defines a file's storage organization. One of INDEXED, RELATIVE, SEQUENTIAL. OpenCOBOL also supports `LINE SEQUENTIAL` file structures.

4.1.330 OTHER

4.1.331 OUTPUT

4.1.332 OVERFLOW

4.1.333 OVERLINE

4.1.334 OVERRIDE

4.1.335 PACKED-DECIMAL

4.1.336 PADDING

4.1.337 PAGE

4.1.338 PAGE-COUNTER

4.1.339 PARAGRAPH

4.1.340 PERFORM

4.1.341 PF

4.1.342 PH

4.1.343 PIC

A commonly used shortform of PICTURE 4.1.344.

4.1.344 PICTURE

The PICTURE clause 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 alphbetic 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
```

OpenCOBOL offers full standards support of all alpha, alphanumeric and numeric storage specifiers as well as full support for edit and numeric-edit clauses.

An example of some of the PICTURE options

Listing 4.103: OpenCOBOL PICTURE samples

```
       >>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.
    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 sp
    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.
          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.
      *><*
```

```
------------------------------------------------------------------------------------------
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
```

4.1.345 PLUS

4.1.346 POINTER

Listing 4.104: OpenCOBOL

```
    01  C-HANDLE        USAGE IS POINTER.

    CALL "open-lib" USING C-HANDLE
```

4.1.347 POSITION

4.1.348 POSITIVE

4.1.349 PRESENT

4.1.350 PREVIOUS

4.1.351 PRINTER

4.1.352 PRINTING

4.1.353 PROCEDURE

The COBOL DIVISION that holds the executable statements.

4.1.354 PROCEDURE-POINTER

4.1.355 PROCEDURES

4.1.356 PROCEED

4.1.357 PROGRAM

4.1.358 PROGRAM-ID

The program identifier. Case sensitive, unlike all other OpenCOBOL identifiers. OpenCOBOL 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.

4.1.359 PROGRAM-POINTER

4.1.360 PROMPT

4.1.361 PROPERTY

4.1.362 PROTOTYPE

4.1.363 PURGE

4.1.364 QUEUE

4.1.365 QUOTE

A figurative constant representing ".

Listing 4.105: OpenCOBOL

```
DISPLAY QUOTE 123 QUOTE END-DISPLAY
```

Outputs:

```
"123"
```

4.1.366 QUOTES

A figurative constant representing "s.

Listing 4.106: OpenCOBOL

```
01 var PICTURE X(4).

MOVE ALL QUOTES TO var
DISPLAY var END-DISPLAY
```

Outputs:

```
""""
```

4.1.367 RAISE

4.1.368 RAISING

4.1.369 RANDOM

A file access mode. RANDOM access allows seeks to any point in a file.

4.1.370 RD

4.1.371 READ

A staple of COBOL. Read a record.

4.1.372 RECEIVE

4.1.373 RECORD

4.1.374 RECORDING

4.1.375 RECORDS

4.1.376 RECURSIVE

4.1.377 REDEFINES

4.1.378 REEL

4.1.379 REFERENCE

4.1.380 RELATION

4.1.381 RELATIVE

4.1.382 RELEASE

4.1.383 REMAINDER

4.1.384 REMOVAL

4.1.385 RENAMES

4.1.386 REPLACE

A COBOL text preprocessing operator.

Listing 4.107: OpenCOBOL REPLACE

```
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

Listing 4.108: OpenCOBOL REPLACE

```
# 1 "replacing.cob"

 identification division.
 program-id. prog.

 procedure division.
```

```
DISPLAY "REPLACE EXAMPLE" END-DISPLAY
goback.
end program prog.
```

4.1.387 REPLACING

An INSPECT subclause.

4.1.388 REPORT

4.1.389 REPORTING

4.1.390 REPORTS

4.1.391 REPOSITORY

A paragraph of the `CONFIGURATION SECTION`. OpenCOBOL supports the `FUNCTION ALL INTRINSIC` clause of the `REPOSITORY`. Allows source code to use intrinsic functions without the FUNCTION keyword.

Listing 4.109: OpenCOBOL REPOSITORY

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20110213
      *> Purpose:   Demonstrate an intrinstric 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 end-display
       display pi space e end-display

       goback.
       end program functionall.
```

Sample output:

```
$ cobc -x functionall.cob
$ ./functionall
```

```
3.14159265358979323846264338327950292.718281828459045235360287471352662 5
3.14159265358979323846264338327950292.718281828459045235360287471352662 5
```

Without the `repository` paragraph::

```
$ cobc -x functionall.cob
functionall.cob:19: Error: 'pi' undefined
functionall.cob:19: Error: 'e' undefined
```

4.1.392 REQUIRED

4.1.393 RESERVE

4.1.394 RESET

4.1.395 RESUME

4.1.396 RETRY

4.1.397 RETURN

4.1.398 RETURNING

Specify the destination of CALL4.1.60 results.

Listing 4.110: OpenCOBOL

```
01 result PIC S9(8).

CALL "libfunc" RETURNING result END-CALL
```

4.1.399 REVERSE-VIDEO

4.1.400 REWIND

A really cool lyric in the Black Eyed Peas song, "Hey Mama".

4.1.401 REWRITE

Allow overwrite of records where primary key exists

4.1.402 RF

4.1.403 RH

4.1.404 RIGHT

4.1.405 ROLLBACK

4.1.406 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 nerds.

Listing 4.111: OpenCOBOL ROUNDED

```
COMPUTE total-value ROUNDED = 1.0 / 6.0 END-COMPUTE
```

4.1.407 RUN

4.1.408 SAME

4.1.409 SCREEN

4.1.410 SD

4.1.411 SEARCH

A powerful table and file search verb.

4.1.412 SECONDS

4.1.413 SECTION

COBOL source code is organized in DIVISIONs, `SECTION`s, paragraphs and sentences. OpenCOBOL supports user named sections and recognizes the following list of pre-defined sections.

- CONFIGURATION
- INPUT-OUTPUT
- FILE
- WORKING-STORAGE
- LOCAL-STORAGE
- LINKAGE
- REPORT (recognized but unsupported)
- SCREEN

User defined sections provide for source code organization and use of PERFORM with THROUGH for tried and true COBOL procedural programming.

4.1.414 SECURE

4.1.415 SEGMENT

4.1.416 SELECT

4.1.417 SELF

4.1.418 SEND

4.1.419 SENTENCE

4.1.420 SEPARATE

4.1.421 SEQUENCE

4.1.422 SEQUENTIAL

OpenCOBOL supports both fixed length SEQUENTIAL and newline terminated LINE SEQUENTIAL file access.

4.1.423 SET

- `SET ADDRESS OF ptr-var TO var.`
- `SET ENVIRONMENT "name" TO "value".`
- `SET cond-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 satifies the condition is true.

Listing 4.112: OpenCOBOL

```
01 field-1 pic 99.
   88 cond-1 value 42.

MOVE 0 TO field-1
DISPLAY field-1 END-DISPLAY
SET cond-1 TO TRUE
DISPLAY field-1 END-DISPLAY
```

00 and 42 are displayed.

4.1.424 SHARING

4.1.425 SIGN

4.1.426 SIGNED

4.1.427 SIGNED-INT

4.1.428 SIGNED-LONG

4.1.429 SIGNED-SHORT

4.1.430 SIZE

4.1.431 SORT

OpenCOBOL supports USING, GIVING as well as INPUT PROCEDURE and OUTPUT PROCEDURE clauses for the SORT verb.

Listing 4.113: OpenCOBOL SORT

```
OCOBOL* OpenCOBOL SORT verb example using standard in and standard out
       identification division.
       program-id. sorting.

       environment division.
       input-output section.
       file-control.
           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 and RELEASE 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).

Listing 4.114: OpenCOBOL SORT

```
OCOBOL >>SOURCE FORMAT IS FIXED
      ******************************************************************
      * Author:    Brian Tiffin
      * Date:      02-Sep-2008
      * Purpose:   An OpenCOBOL 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.
           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 9 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 end-display.
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
    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 jrls_swla[**?**]

Listing 4.115: OpenCOBOL tables

```
   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)
           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.
```

Excercise for the audience. Could the above code be simplified by using

Listing 4.116: OpenCOBOL

```
MOVE CORRESPONDING cbRecord to table-columns(tcindex)
...
MOVE CORRESPONDING table-columns(tcindex) to showdata
```

with a few judicious field name changes?

An OCSORT support tool

There is an external sort utility referenced in What is ocsort?

4.1.432 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.

4.1.433 SORT-RETURN

A *SPECIAL-REGISTER* used by the OpenCOBOL SORT routines.

- +000000000 for success
- +000000016 for failure

A programmer may set `SORT-RETURN` in an `INPUT PROCEDURE`.

4.1.434 SOURCE

4.1.435 SOURCE-COMPUTER

4.1.436 SOURCES

4.1.437 SPACE

A figurative constant representing a space character.

4.1.438 SPACES

A figurative constant representing space characters.

4.1.439 SPECIAL-NAMES

OpenCOBOL supports a fair complete set of the `SPECIAL-NAMES` in common use.

4.1.440 STANDARD

4.1.441 STANDARD-1

4.1.442 STANDARD-2

4.1.443 START

Sets a conditional that will influence sequential READ NEXT and READ PREVIOUS for INDEXED files. Can also be used to seek to the FIRST or LAST record of a file for SEQUENTIAL access modes.

Listing 4.117: OpenCOBOL START

```
start indexing
   key is less than
       keyfield of indexing-record
   invalid key
       display
           "bad start: " keyfield of indexing-record
       end-display
       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.

Listing 4.118: OpenCOBOL START conditionals

```
 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 OpenCOBOL support ISAM? for some example source code.

4.1.444 STATEMENT

4.1.445 STATUS

4.1.446 STEP

4.1.447 STOP

End a run and return control to the operating system.

Listing 4.119: OpenCOBOL

```
STOP RUN RETURNING 5.
```

4.1.448 STRING

String together a set of variables with controlled delimiters.

Listing 4.120: OpenCOBOL STRING

```
01 var PICTURE X(5).

STRING
   "abc" DELIMITED BY "b"
   "def" DELIMITED BY SIZE
   "ghi" DELIMITED BY "z"
   INTO var
   ON OVERFLOW
       DISPLAY "var is full at" SPACE LENGTH OF var END-DISPLAY
END-STRING

DISPLAY var END-DISPLAY
```

Outputs:

```
var is full at 5
adefg
```

OpenCOBOL also fully supports the WITH POINTER clause to set the initial and track the position in the output character variable.

4.1.449 STRONG

4.1.450 SUB-QUEUE-1

4.1.451 SUB-QUEUE-2

4.1.452 SUB-QUEUE-3

4.1.453 SUBTRACT

4.1.454 SUM

A REPORT SECTION control break summation field clause.

4.1.455 SUPER

4.1.456 SUPPRESS

4.1.457 SYMBOL

4.1.458 SYMBOLIC

4.1.459 SYNC

4.1.460 SYNCHRONIZED

4.1.461 SYSTEM-DEFAULT

4.1.462 TABLE

4.1.463 TALLYING

4.1.464 TAPE

4.1.465 TERMINAL

4.1.466 TERMINATE

4.1.467 TEST

4.1.468 TEXT

4.1.469 THAN

Part of the conditional clauses for readability.

Listing 4.121: OpenCOBOL THAN

```
IF A GREATER THAN 10
    DISPLAY "A > 10" END-DISPLAY
END-IF
```

4.1.470 THEN

A somewhat disdained keyword that is part of the `IF THEN ELSE` control structure.

Listing 4.122: OpenCOBOL THEN

```
IF A > 10 THEN
   DISPLAY "A GREATER THAN 10" END-DISPLAY
ELSE
   DISPLAY "A LESS THAN OR EQUAL TO 10" END-DISPLAY
END-IF
```

4.1.471 THROUGH

Used as `PERFORM paragraph-1 THROUGH paragraph-2` to provide for *source code* modularized *procedural programming* control flow.

4.1.472 THRU

A more commonly used alias for `THROUGH` 4.1.471.

4.1.473 TIME

4.1.474 TIMES

Provides for counted loops.

4.1.475 TO

4.1.476 TOP

4.1.477 TRAILING

4.1.478 TRUE

4.1.479 TYPE

4.1.480 TYPEDEF

4.1.481 UCS-4

4.1.482 UNDERLINE

4.1.483 UNIT

4.1.484 UNIVERSAL

4.1.485 UNLOCK

4.1.486 UNSIGNED

4.1.487 UNSIGNED-INT

4.1.488 UNSIGNED-LONG

4.1.489 UNSIGNED-SHORT

4.1.490 UNSTRING

4.1.491 UNTIL

4.1.492 UP

4.1.493 UPDATE

4.1.494 UPON

4.1.495 USAGE

OpenCOBOL uses standard big-endian internal storage by default. USAGE clauses influence the data representation. The INTEL® architecture uses little-endian form and OpenCOBOL programmers developing for this common chipset may need to pay heed to this for performance purposes. As per the standards, OpenCOBOL supports `COMPUTATIONAL-5` native usage.

OpenCOBOL 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 clauses both storage and display, OpenCOBOL 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

4.1.496 USE

4.1.497 USER-DEFAULT

4.1.498 USING

4.1.499 UTF-16

4.1.500 UTF-8

4.1.501 VAL-STATUS

4.1.502 VALID

4.1.503 VALIDATE

4.1.504 VALIDATE-STATUS

4.1.505 VALUE

4.1.506 VALUES

4.1.507 VARYING

4.1.508 WHEN

A very powerful keyword used in EVALUATE phrases for specifying conditional expressions.

Listing 4.123: OpenCOBOL WHEN

```
EVALUATE TRUE
    WHEN A = 10
        DISPLAY "A = 10" END-DISPLAY
    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" END-DISPLAY
    WHEN OTHER
        DISPLAY "Default imperative" END-DISPLAY
END-EVALUATE
```

4.1.509 WITH

4.1.510 WORKING-STORAGE

4.1.511 WRITE

4.1.512 YYYYDDD

4.1.513 YYYYMMDD

4.1.514 ZERO

4.1.515 ZEROES

4.1.516 ZEROS

4.2 Does OpenCOBOL implement any Intrinsic FUNCTIONs?

Yes, many. As of the Feb 2009 1.1 pre-release

ABS, ACOS, ANNUITY, ASIN, ATAN, BYTE-LENGTH, CHAR, CONCATENATE, COS, CURRENT-DATE, DATE-OF-INTEGER, DATE-TO-YYYYMMDD, DAY-OF-INTEGER, DAY-TO-YYYYDDD, E, EXCEPTION-FILE, EXCEPTION-LOCATION, EXCEPTION-STATEMENT, EXCEPTION-STATUS, EXP, EXP10, FACTORIAL, FRACTION-PART, INTEGER, INTEGER-OF-DATE, INTEGER-OF-DAY, INTEGER-PART, LENGTH, LOCALE-DATE, LOCALE-TIME, LOG, LOG10, LOWER-CASE, MAX, MEAN, MEDIAN, MIDRANGE, MIN, MOD, NUMVAL, NUMVAL-C, ORD, ORD-MAX, ORD-MIN, PI, PRESENT-VALUE, RANDOM, RANGE, REM, REVERSE, SECONDS-FROM-FORMATTED-TIME, SECONDS-PAST-MIDNIGHT, SIGN, SIN, SQRT, STANDARD-DEVIATION, STORED-CHAR-LENGTH, SUBSTITUTE, SUBSTITUTE-CASE, SUM, TAN, TEST-DATE-YYYYMMDD, TEST-DAY-YYYYDDD, TRIM, UPPER-CASE, VARIANCE, WHEN-COMPILED, YEAR-TO-YYYY

4.2.1 FUNCTION ABS

Absolute value of numeric argument

Listing 4.124: OpenCOBOL FUNCTION ABS

```
DISPLAY FUNCTION ABS(DIFFERENCE).
```

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 $[0, \pi]$.

Listing 4.125: OpenCOBOL FUNCTION ACOS

```
DISPLAY FUNCTION ACOS(-1).
```

4.2.3 FUNCTION ANNUITY

Compute the ratio of an annuity paid based on arguments of interest and number of periods.

Listing 4.126: OpenCOBOL FUNCTION ANNUITY

```
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 $[-1, 1]$. Domain errors return a result of 0. The inverse sine function returns a range of $[\frac{-\pi}{2}, \frac{\pi}{2}]$.

Listing 4.127: OpenCOBOL

```
DISPLAY FUNCTION ASIN(-1).
```

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 $[\frac{-\pi}{2}, \frac{\pi}{2}]$.

Listing 4.128: OpenCOBOL

```
DISPLAY FUNCTION ATAN(1).
```

4.2.6 FUNCTION BYTE-LENGTH

The BYTE-LENGTH function returns an integer that is the internal storage length of the given argument.

Listing 4.129: OpenCOBOL FUNCTION BYTE-LENGTH

```
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.

       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
```

4.2.7 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 or EBCDIC and details of the ALPHABET clause.

Listing 4.130: OpenCOBOL FUNCTION CHAR

```
DISPLAY FUNCTION CHAR(66).
```

Would output A in the ASCII character set. Note this may be different than what some expect. *OpenCOBOL 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. This author is often guilty of this misnomer of the use of the term ASCII. See ASCII for more accurate details.

4.2.8 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 7.5.

Listing 4.131: OpenCOBOL FUNCTION COMBINED-DATETIME

```
DISPLAY FUNCTION COMBINED-DATETIME(1; 1) END-DISPLAY
```

Outputs:

```
0000001.00001
```

4.2.9 FUNCTION CONCATENATE

Concatenate the given fields. **CONCATENATE is an OpenCOBOL extension**.

Listing 4.132: OpenCOBOL

```
MOVE "COBOL" TO stringvar
MOVE FUNCTION CONCATENATE("Open"; stringvar) TO goodsystem
DISPLAY goodsystem END-DISPLAY
```

OpenCOBOL

4.2.10 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 —PISYM— with a zero returned at —PISYM—/2. The cosine function returns a range of -1 thru +1.

Listing 4.133: OpenCOBOL

```
DISPLAY FUNCTION COS(1.5707963267949).
```

Gives:

```
-0.00000000000000304
```

4.2.11 FUNCTION CURRENT-DATE

Returns an alphanumeric field of length 21 with the current date, time and timezone information in the form YYYYMMDDhhmmsscc ± tznn

Listing 4.134: OpenCOBOL

```
DISPLAY FUNCTION CURRENT-DATE.
```

Example Output:

```
2008080921243796-0400
```

4.2.12 FUNCTION DATE-OF-INTEGER

Converts an integer date, days on the Gregorian since December 31 1600 to YYYYMMDD form

Listing 4.135: OpenCOBOL

```
DISPLAY DATE-OF-INTEGER(1)
DISPLAY DATE-OF-INTEGER(50000)
```

Outputs:

```
16010101
17371123
```

50,000 days after December 31st, 1600 being November 23rd, 1737.

4.2.13 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 OpenCOBOL 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

Listing 4.136: OpenCOBOL

```
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
```

4.2.14 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

Listing 4.137: OpenCOBOL

```
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.

4.2.15 FUNCTION DAY-TO-YYYYDDD

Converts a Julian 2 digit year and three digit dat integer to a four digit year form. See FUNCTION DATE-TO-YYYYMMDD for some of the details of the calculations involved.

4.2.16 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 properies such as:

- the derivative of e^x is e^x

- and the area below the curve of $y = \frac{1}{x} |1 <= x <= e|$

$$\sum_{x=1}^{e} \frac{1}{x}$$

  is *exactly* 1.

- making it very useful in calculations of Future Value with compound interest.

Listing 4.138: OpenCOBOL

```
DISPLAY FUNCTION E END-DISPLAY
```

outputs:

```
2.71828182845904523536028747135266 25
```

A small graph to show the magic area.

Listing 4.139: OpenCOBOL plot Euler's number

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin
      *> Date:      29-May-2009
      *> Purpose:   Plot Euler's number
      *> Tectonics: requires access to gnuplot. http://www.gnuplot.info
      *>            cobc -Wall -x ploteuler.cob
      *> OVERWRITES ocgenplot.gp and ocgpdata.txt
      *> ***************************************************************
       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 9v999.
       01 x       pic 9v999.
       01 recip   pic 9v999.

       01 gplot   pic x(80) value is 'gnuplot -persist ocgenplot.gp'.
       01 result  pic s9(9).

       procedure division.

      *><* Create the script to plot Euler's number
       open output scriptfile.
       move "set style fill solid 1.0; set grid;"
         to gnuplot-command
       write gnuplot-command end-write
       move "plot [0:3] [0:2] 'ocgpdata.txt' using 1:2" &
         " with filledcurves below x1  title '1/x'"
         to gnuplot-command
       write gnuplot-command end-write
       move "set terminal png; set output 'images/euler.png'; replot"
         to gnuplot-command
       write gnuplot-command end-write
       close scriptfile

      *><* Create the reciprocal data
       open output outfile
       move spaces to outrec
       compute xstep = function e / 100 end-compute
       perform varying x from 1 by xstep
           until x > function e
               move x to x-value
               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 end-display
           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.*

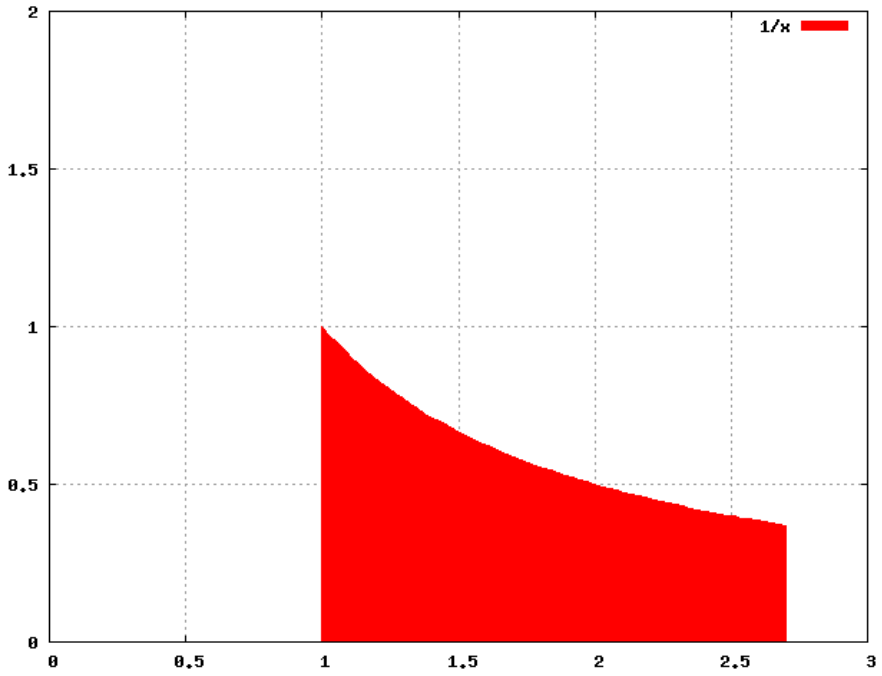


Figure 4.1: e, Euler's number

See Can OpenCOBOL be used for plotting? for some details on plotting.

4.2.17 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 for an example.

4.2.18 FUNCTION EXCEPTION-LOCATION

This special-register can be queried for the location of the last exception. See FUNCTION EXCEPTION-STATUS 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.

4.2.19 FUNCTION EXCEPTION-STATEMENT

This special-register holds the statement that was executing when the latest exception was raised. See FUNCTION EXCEPTION-STATUS for an example. Note: This fea-

ture requires compilation with `-fsource-location` compiler switch. This option is also turned on with `-g` debugging info compiles.

4.2.20 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`

Listing 4.140: OpenCOBOL

```
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 run-time exceptions supported by OpenCOBOL.

4.2.21 FUNCTION EXP

Returns an approximation of Euler's number (see FUNCTION E) raised to the power of the numeric argument.

Listing 4.141: OpenCOBOL FUNCTION EXP

```
DISPLAY FUNCTION EXP(1) END-DISPLAY
```

outputs:

```
2.718281828459045091
```

> 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.

4.2.22 FUNCTION EXP10

Returns an approximation of the value 10 raised to the power of the numeric argument.

Listing 4.142: OpenCOBOL

```
DISPLAY FUNCTION EXP10(1.0) END-DISPLAY
DISPLAY FUNCTION EXP10(1.2) END-DISPLAY
DISPLAY FUNCTION EXP10(10) END-DISPLAY
```

Outputs:

```
10.000000000000000000
15.848931924611132871
10000000000.000000000000000000
```

4.2.23 FUNCTION FACTORIAL

Computes the factorial of the integral argument. Valid Range of $[0, 19]$ with a domain of $[1, 121645100408832000]$.

Listing 4.143: OpenCOBOL FUNCTION FACTORIAL

```
OCOBOL*> ************************************************************
      *> Program to find range and domain of FUNCTION FACTORIAL
       identification division.
       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-display
               end-add
               display ind " = " function factorial(ind) end-display
       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
```

4.2.24 FUNCTION FRACTION-PART

Returns a numeric value that is the fraction part of the argument. Keeping the sign.

Listing 4.144: OpenCOBOL

```
DISPLAY FUNCTION FRACTION-PART(FUNCTION E) END-DISPLAY
DISPLAY FUNCTION FRACTION-PART(-1.5) END-DISPLAY
DISPLAY FUNCTION FRACTION-PART(-1.0) END-DISPLAY
DISPLAY FUNCTION FRACTION-PART(1) END-DISPLAY
```

Outputs:

```
+.718281828459045235
-.500000000000000000
+.000000000000000000
+.000000000000000000
```

4.2.25 FUNCTION INTEGER

Returns the greatest integer less than or equal to the numeric argument.

Listing 4.145: OpenCOBOL

```
DISPLAY
    FUNCTION INTEGER (-3)      SPACE
    FUNCTION INTEGER (-3.141)
END-DISPLAY
DISPLAY
    FUNCTION INTEGER (3)       SPACE
    FUNCTION INTEGER (3.141)
END-DISPLAY
DISPLAY
    FUNCTION INTEGER (-0.3141) SPACE
    FUNCTION INTEGER (0.3141)  SPACE
    FUNCTION INTEGER (0)
END-DISPLAY
```

Outputs:

```
-000000000000000003 -000000000000000004
+000000000000000003 +000000000000000003
-000000000000000001 +000000000000000000 +000000000000000000
```

Note the -4, *greatest integer* ***less than or equal*** *to the argument*.

4.2.26 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 valud for the specified month and year. Invalid input returns unpredictable results and sets the exception EC-ARGUMENT-FUNCTION to exist. See **??** for the converse function.

4.2.27 FUNCTION INTEGER-OF-DAY

Converts a Julian date of YYYYDDD to integer date form. See FUNCTION DAY-OF-INTEGER for the converse intrinsic function. Invalid arguments return an undefined result and set the exception `EC-ARGUMENT-FUNCTION` to exist.

4.2.28 FUNCTION INTEGER-PART

Returns the integer part of the numeric argument. Similar to FUNCTION INTEGER but returns different values for negative arguments.

Listing 4.146: OpenCOBOL FUNCTION INTEGER-PART

```
DISPLAY
    FUNCTION INTEGER-PART (-3)      SPACE
    FUNCTION INTEGER-PART (-3.141)
END-DISPLAY
DISPLAY
    FUNCTION INTEGER-PART (3)       SPACE
    FUNCTION INTEGER-PART (3.141)
END-DISPLAY
DISPLAY
    FUNCTION INTEGER-PART (-0.3141) SPACE
    FUNCTION INTEGER-PART (0.3141)  SPACE
    FUNCTION INTEGER-PART (0)
END-DISPLAY
```

Outputs:

```
-000000000000000003 -000000000000000003
+000000000000000003 +000000000000000003
+000000000000000000 +000000000000000000 +000000000000000000
```

4.2.29 FUNCTION LENGTH

Returns an integer that is the length in character positions of the given argument.

Listing 4.147: OpenCOBOL FUNCTION LENGTH

```
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
```

4.2.30 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 associted with a locale in the SPECIAL-NAMES paragraph. See http://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.

4.2.31 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 associted with a locale in the SPECIAL-NAMES paragraph. See http://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.

4.2.32 FUNCTION LOCALE-TIME-FROM-SECONDS

Returns a culturally appropriate date given an alphanumeric number of seconds and an optional locale name that has been associted with a locale in the SPECIAL-NAMES paragraph. See http://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.

4.2.33 FUNCTION LOG

Returns an approximation of the natural logarithmic value of the given numeric argument. Uses a base of FUNCTION E.

4.2.34 FUNCTION LOG10

Returns an approximation of the base-10 logarithmic value of the given numeric argument.

4.2.35 FUNCTION LOWER-CASE

Convert any uppercase character values (A-Z) in the argument to lowercase (a-z).

4.2.36 FUNCTION MAX

Returns the maximum value from the list of arguments.

Listing 4.148: OpenCOBOL

```
DISPLAY FUNCTION MAX("def"; "abc";) END-DISPLAY
DISPLAY FUNCTION MAX(123.1; 123.11; 123) END-DISPLAY
```

Outputs:

```
def
123.11
```

4.2.37 FUNCTION MEAN

Returns the arithmetic mean (average) of the list of numeric arguments.

Listing 4.149: OpenCOBOL

```
DISPLAY FUNCTION MEAN(1; 2; 3; 4; 5; 6; 7; 8; 9) END-DISPLAY
```

Outputs:

```
+5.00000000000000000
```

4.2.38 FUNCTION MEDIAN

Returns the middle value of the arguments formed by arranging the list in sorted order.

Listing 4.150: OpenCOBOL

```
DISPLAY FUNCTION MEDIAN(1; 2; 3; 4; 5; 6; 7; 8; 9) END-DISPLAY
```

Outputs:

```
5
```

4.2.39 FUNCTION MIDRANGE

Returns the arithmetic mean (average) of the minimum and maximum argument from the list of numeric arguments.

Listing 4.151: OpenCOBOL

```
DISPLAY FUNCTION MIDRANGE(1; 2; 3; 4; 5; 6; 7; 8; 9) END-DISPLAY
```

Outputs:

```
5.000000000000000000
```

4.2.40 FUNCTION MIN

Returns the minimum value from the list of arguments.

Listing 4.152: OpenCOBOL FUNCTION MIN

```
DISPLAY FUNCTION MIN ( "def"; "abc"; ) END-DISPLAY
DISPLAY FUNCTION MIN ( 123.1; 123.11; 123 ) END-DISPLAY
```

Outputs:

```
abc
123
```

4.2.41 FUNCTION MOD

Returns an integer value of that is the first-argument modulo second-argument.

Listing 4.153: OpenCOBOL

```
DISPLAY FUNCTION MOD(123; 23) END-DISPLAY
```

Outputs:

```
+000000000000000008
```

4.2.42 FUNCTION NUMVAL

Returns the numeric value represented by the character string argument.

4.2.43 FUNCTION NUMVAL-C

Returns the numeric value represented by the culturally appropriate currency specification argument.

4.2.44 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.

Listing 4.154: OpenCOBOL

```
DISPLAY FUNCTION ORD("J") END-DISPLAY
```

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".

4.2.45 FUNCTION ORD-MAX

Returns the integer that is the ordinal position of the maximum value of the given argument list.

Listing 4.155: OpenCOBOL

```
DISPLAY ORD-MAX(9; 8; 7; 6; 5; 4; 3; 2; 1) END-DISPLAY
DISPLAY ORD-MAX('abc'; 'def'; 'ghi') END-DISPLAY
```

Outputs:

```
00000001
00000003
```

4.2.46 FUNCTION ORD-MIN

Returns the integer that is the ordinal position of the minimum value from the argument list.

Listing 4.156: OpenCOBOL

```
OCOBOL >>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 end-display
       move ord-min ("abc"; "def"; "000"; "def"; "abc") to posmin
       display posmin end-display
       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.

4.2.47 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.

Listing 4.157: OpenCOBOL

```
OCOBOL >>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.
       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 end-display

       compute circumference = function pi * diameter end-compute
       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
       end-display

       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.
```

4.2.48 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.

Listing 4.158: OpenCOBOL

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ****************************************************************
      *> Author:    Brian Tiffin
      *> 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"
       end-display

       compute the-value rounded =
           function present-value(rate; 1000, 1000, 1000, 1000)
       end-compute
       display
            "A discount rate of " rate " gives a PRESENT-VALUE of "
            the-value " given" newline
            "end-amounts of 1000, 1000, 1000 and 1000"
       end-display

       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 OpenCOBOL emits before compiling. **rant over** *By the way, don't ask me to tell you what is going on with financials. I give free advice.*

4.2.49 FUNCTION FUNCTION RANDOM

Returns a pseudo-random number given a numeric seed value as argument.

Listing 4.159: OpenCOBOL

```
DISPLAY FUNCTION RANDOM(1) END-DISPLAY
DISPLAY FUNCTION RANDOM(1) END-DISPLAY
DISPLAY FUNCTION RANDOM() END-DISPLAY
```

Outputs:

```
+00000000.1804289383
+00000000.1804289383
+000000000.846930886
```

4.2.50 FUNCTION RANGE

Returns the value of the minimum argument subtracted from the maximum argument from the list of numeric arguments.

Listing 4.160: OpenCOBOL FUNCTION RANGE

```
DISPLAY FUNCTION RANGE(1; 2; 3; 4; 5; 6; 7; 8; 9) END-DISPLAY
```

Outputs:

```
+000000000000000008
```

4.2.51 FUNCTION REM

Returns the numeric remainder of the first argument divided by the second.

Listing 4.161: OpenCOBOL

```
DISPLAY FUNCTION REM(123; 23) END-DISPLAY
```

Outputs:

```
+000000000000000008
```

4.2.52 FUNCTION REVERSE

Returns the reverse of the given character string.

Listing 4.162: OpenCOBOL FUNCTION REVERSE

```
DISPLAY FUNCTION REVERSE("abc") END-DISPLAY
```

Outputs:

```
cba
```

4.2.53 FUNCTION SECONDS-FROM-FORMATTED-TIME

4.2.54 FUNCTION SECONDS-PAST-MIDNIGHT

Returns the seconds past midnight from the current system time.

4.2.55 FUNCTION SIGN

Returns +1 for positive, 0 for zero and -1 for a negative numeric argument.

4.2.56 FUNCTION SIN

Returns an approximation for the trigonometric sine of the given numeric angle (expressed in radians) argument. See Can OpenCOBOL be used for plotting? for a sample graph using gnuplot.

4.2.57 FUNCTION SQRT

Returns an approximation of the square root of the given numeric argument.

Listing 4.163: OpenCOBOL FUNCTION SQRT

```
DISPLAY FUNCTION SQRT(-1) END-DISPLAY
CALL "perror" USING NULL END-CALL
DISPLAY FUNCTION SQRT(2) END-DISPLAY
```

Outputs: *also demonstrates how OpenCOBOL can access 's*

```
0.000000000000000000
Numerical argument out of domain
1.414213562373095145
```

> Note: `CALL "perror"` reveals a bug in OpenCOBOL versions packaged before June 2009 where the stack will evetually underflow due to improper handling of the `void` return specification. Versions supporting `RETURNING NULLi` fix this problem. An actual application that needed to verify the results of square roots or other numerical function may be better off placing a small C wrapper to set and get the global errno.

4.2.58 FUNCTION STANDARD-DEVIATION

Returns an approximation of the standard deviation from the given list of numeric arguments.

Listing 4.164: OpenCOBOL FUNCTION STANDARD-DEVIATION

```
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)
END-DISPLAY
```

Outputs:

```
2.872281323269014308 28.605069480775604518
```

4.2.59 FUNCTION STORED-CHAR-LENGTH

Returns the numeric value of the internal storage length of the given argument in bytes, not counting spaces.

4.2.60 FUNCTION SUBSTITUTE

FUNCTION SUBSTITUTE is an OpenCOBOL extension to the suite of intrinsic functions.

Listing 4.165: OpenCOBOL FUNCTION SUBSTITUTE

```
DISPLAY
    FUNCTION SUBSTITUTE("this is a test",
        "this", "that",
        "is a", "was",
        "test", "very cool!")
END-DISPLAY
```

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

Listing 4.166: OpenCOBOL ref mod SUBSTITUTE

```
MOVE FUNCTION SUBSTITUTE(subject, pat, repl)(2:4) TO xvar4
```

to result in 4 characters starting at the second position after the substitution.

4.2.61 FUNCTION SUBSTITUTE-CASE

Similar to **??**, but ignores upper and lower case of subject when matching patterns.

4.2.62 FUNCTION SUM

Returns the numeric value that is the sum of the given list of numeric arguments.

4.2.63 FUNCTION TAN

Returns an approximation for the trigonometric tangent of the given numeric angle (expressed in radians) argument. Returns ZERO if the argument would cause an infinity or other size error.

4.2.64 FUNCTION TEST-DATE-YYYYMMDD

Test for valid date in numeric yyyymmdd form.

4.2.65 FUNCTION TEST-DAY-YYYYDDD

Test for valid date in numeric yyyyddd form.

4.2.66 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.

Listing 4.167: OpenCOBOL FUNCTION TRIM

```
DISPLAY '"' FUNCTION TRIM("   abc   ") '"' END-DISPLAY
DISPLAY '"' FUNCTION TRIM("   abc   " LEADING) '"' END-DISPLAY
DISPLAY '"' FUNCTION TRIM("   abc   " TRAILING) '"' END-DISPLAY
```

Outputs:

```
"abc"
"abc   "
"   abc"
```

4.2.67 FUNCTION UPPER-CASE

Returns a copy of the alphanumeric argument with any lower case letters replaced by upper case letters.

Listing 4.168: OpenCOBOL FUNCTION UPPER-CASE

```
DISPLAY FUNCTION UPPER-CASE("# 123 abc DEF #") END-DISPLAY
```

Outputs:

```
# 123 ABC DEF #
```

4.2.68 FUNCTION VARIANCE

Returns the variance of a series of numbers. The variance is defined as the square of the FUNCTION STANDARD-DEVIATION4.2.58

Listing 4.169: OpenCOBOL

```
DISPLAY FUNCTION VARIANCE(1 2 3 4 5 6 7 8 9 100) END-DISPLAY.
```

```
+818.250000000000000
```

4.2.69 FUNCTION WHEN-COMPILED

Returns a 21 character alphanumeric field of the form YYYYMMDDhhmmsscc —plus-minus— zzzz e.g. 2008070505152000-0400 representing when a module or executable is compiled. The WHEN-COMPILED special register reflects when an object module was compiled

Listing 4.170: OpenCOBOL

```
program-id. whenpart1. procedure division.
display "First part :" FUNCTION WHEN-COMPILED end-display.

program-id. whenpart2. procedure division.
display "Second part:" FUNCTION WHEN-COMPILED end-display.

program-id. whenshow. procedure division.
call "whenpart1" end-call.
call "whenpart2" end-call.
display "Main part  :" FUNCTION WHEN-COMPILED end-display.
```

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
```

4.2.70 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.

4.3 Can you clarify the use of FUNCTION in OpenCOBOL?

Yes. This information is from Roger [8], posted to the `http://opencobol.org` 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 [8]:

```
The standard only defines FUNCTION LENGTH.
The LENGTH OF phrase is an extension (from MF)
```

4.5 What STOCK CALL LIBRARY does OpenCOBOL offer?

OpenCOBOL 1.0 ships with quite a few callable features. See CALL. Looking through the source code, you'll find the current list of service calls in:

```
libcob/system.def
```

With the 1.1 pre-release of July 2008, that list included

Listing 4.171: OpenCOBOL Stock Library

```
/* COB_SYSTEM_GEN (external name, number of parameters, internal name) */

COB_SYSTEM_GEN ("SYSTEM", 1, SYSTEM)
COB_SYSTEM_GEN ("CBL_ERROR_PROC", 2, CBL_ERROR_PROC)
COB_SYSTEM_GEN ("CBL_EXIT_PROC", 2, CBL_EXIT_PROC)
COB_SYSTEM_GEN ("CBL_OPEN_FILE", 5, CBL_OPEN_FILE)
COB_SYSTEM_GEN ("CBL_CREATE_FILE", 5, CBL_CREATE_FILE)
```

```
COB_SYSTEM_GEN ("CBL_READ_FILE", 5, CBL_READ_FILE)
COB_SYSTEM_GEN ("CBL_WRITE_FILE", 5, CBL_WRITE_FILE)
COB_SYSTEM_GEN ("CBL_CLOSE_FILE", 1, CBL_CLOSE_FILE)
COB_SYSTEM_GEN ("CBL_FLUSH_FILE", 1, CBL_FLUSH_FILE)
COB_SYSTEM_GEN ("CBL_DELETE_FILE", 1, CBL_DELETE_FILE)
COB_SYSTEM_GEN ("CBL_COPY_FILE", 2, CBL_COPY_FILE)
COB_SYSTEM_GEN ("CBL_CHECK_FILE_EXIST", 2, CBL_CHECK_FILE_EXIST)
COB_SYSTEM_GEN ("CBL_RENAME_FILE", 2, CBL_RENAME_FILE)
COB_SYSTEM_GEN ("CBL_GET_CURRENT_DIR", 3, CBL_GET_CURRENT_DIR)
COB_SYSTEM_GEN ("CBL_CHANGE_DIR", 1, CBL_CHANGE_DIR)
COB_SYSTEM_GEN ("CBL_CREATE_DIR", 1, CBL_CREATE_DIR)
COB_SYSTEM_GEN ("CBL_DELETE_DIR", 1, CBL_DELETE_DIR)
COB_SYSTEM_GEN ("CBL_AND", 3, CBL_AND)
COB_SYSTEM_GEN ("CBL_OR", 3, CBL_OR)
COB_SYSTEM_GEN ("CBL_NOR", 3, CBL_NOR)
COB_SYSTEM_GEN ("CBL_XOR", 3, CBL_XOR)
COB_SYSTEM_GEN ("CBL_IMP", 3, CBL_IMP)
COB_SYSTEM_GEN ("CBL_NIMP", 3, CBL_NIMP)
COB_SYSTEM_GEN ("CBL_EQ", 3, CBL_EQ)
COB_SYSTEM_GEN ("CBL_NOT", 2, CBL_NOT)
COB_SYSTEM_GEN ("CBL_TOUPPER", 2, CBL_TOUPPER)
COB_SYSTEM_GEN ("CBL_TOLOWER", 2, CBL_TOLOWER)
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$TOUPPER", 2, CBL_TOUPPER)
COB_SYSTEM_GEN ("C$TOLOWER", 2, CBL_TOLOWER)
COB_SYSTEM_GEN ("C$JUSTIFY", 1, cob_acuw_justify)
COB_SYSTEM_GEN ("CBL_OC_NANOSLEEP", 1, cob_oc_nanosleep)
```

Note the `"SYSTEM"`. 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"` call. While shell access opens yet another powerful door for the OpenCOBOL programmer, diligent developers will need to pay heed to cross platform issues when calling the operating system.

4.5.1 A CBL-ERROR-PROC example

Listing 4.172: OpenCOBOL CBL-ERROR-PROC

```
OCOBOL >>SOURCE FORMAT IS FIXED
      ************************************************************
      * OpenCOBOL 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
      *     now obsolete 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
* By definition, error messages are 325 alphanumeric
 linkage section.
 01  err-msg           pic x(325).

* example of OpenCOBOL 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-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
     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.
******************************************************************

******************************************************************
* 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 OpenCOBOL'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**" 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 OpenCOBOL 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.
```

with tectonics A.16:

```
$ 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)**
```

4.5.2 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 cotain 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 posative
                                       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
```

Listing 4.173: OpenCOBOL

```
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.
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
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.
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
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).
377800 zz600-Exit.
377900     exit.
```

4.6 What are the XF4, XF5, and X91 routines?

From `http://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

Listing 4.174: OpenCOBOL

```
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.

Listing 4.175: OpenCOBOL

```
ALL X"91" USING
              RESULT-VAR
              FUNCTION-NUM
              PARAMETER-VAR
          RETURNING STATUS-VAR
```

As mentioned by Roger, OpenCOBOL supports FUNCTION-NUM of 11, 12 and 16.

11 and 12 get and set the on off status of the 8 (eight) run-time OpenCOBOL switches definable in the SPECIAL-NAMES paragraph. 16 returns the number of call parameters given to the current module.

4.7 What is CBL-OC-NANOSLEEP OpenCOBOL library routine?

CBL_OC_NANOSLEEP allows (upto) nanosecond sleep timing. It accepts a 64 bit integer value which may be in character or numeric data forms.

Listing 4.176: OpenCOBOL

```
    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.*

4.8 How do you use C-JUSTIFY?

The C-JUSTIFY sub program can centre, or justify strings left or right.

Listing 4.177: OpenCOBOL

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      01-Jul-2008
      *> Purpose:   Demonstrate the usage of OpenCOBOL 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.
       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 end-display
           stop run
       end-if
       perform show-justification
       .

      *> ****************************************************************
       show-justification.
       evaluate justification
           when "L"   display "Left justify" end-display
           when "C"   display "Centred (in UPPERCASE)" end-display
           when other display "Right justify" end-display
       end-evaluate
       display "Source:    |" source-str "|" end-display
       display "Justified: |" just-str "|" end-display
       display space end-display
       .
```

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
```

Chapter 5

Features and extensions

5.1 How do I use OpenCOBOL for CGI?

OpenCOBOL 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.

Listing 5.1: OpenCOBOL CGI handling

```
OCOBOL >>SOURCE FORMAT IS FIXED
      ******************************************************************
      * Author:    Brian Tiffin, Francois Hiniger
      * Date:      30-Aug-2008
      * Purpose:   Display the CGI environment space
      * Tectonics: cobc -x cgienv.cob
      *   Move cgienv to the cgi-bin directory as cgienv.cgi
      *   browse http://localhost/cgi-bin/cgienv.cgi or cgienvform.html
      ******************************************************************
       identification division.
       program-id. cgienv.

       environment division.
       input-output section.
       file-control.
           select webinput assign to KEYBOARD.

       data division.
       file section.
       fd webinput.
          01 postchunk       pic x(1024).

       working-storage section.
       78 name-count      value 34.
       01 newline         pic x   value x'0a'.
       01 name-index      pic 99 usage comp-5.
```

```
01 value-string    pic x(256).
01 environment-names.
   02 name-strings.
      03 filler    pic x(20) value 'AUTH_TYPE'.
      03 filler    pic x(20) value 'CONTENT_LENGTH'.
      03 filler    pic x(20) value 'CONTENT_TYPE'.
      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_COOKIE'.
      03 filler    pic x(20) value 'HTTP_CONNECTION'.
      03 filler    pic x(20) value 'HTTP_HOST'.
      03 filler    pic x(20) value 'HTTP_REFERER'.
      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 'PATH_INFO'.
      03 filler    pic x(20) value 'PATH_TRANSLATED'.
      03 filler    pic x(20) value 'QUERY_STRING'.
      03 filler    pic x(20) value 'REMOTE_ADDR'.
      03 filler    pic x(20) value 'REMOTE_HOST'.
      03 filler    pic x(20) value 'REMOTE_IDENT'.
      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.

procedure division.

* Always send out the Content-type before any other IO

display
    "Content-type: text/html"
    newline
end-display.
display
    "<html><body>"
```

```
       end-display.
       display
           "<h3>CGI environment with OpenCOBOL</h3>"
       end-display.
       display
           '<a href="/cgienvform.html">To cgienvform.html</a>'
           "<p><table>"
       end-display.
      * Accept and 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
               display
                   "<tr><td>"
                   name-string(name-index)
                   ": </td><td>"
                   function trim (value-string trailing)
                   "</td></tr>"
               end-display
               if (name-string(name-index) = "REQUEST_METHOD")
                  and (value-string = "POST")
                   open input webinput
                   read webinput
                       at end move spaces to postchunk
                   end-read
                   close webinput
                   display
                       '<tr><td align="right">'
                       "First chunk of POST:</td><td>"
                       postchunk(1:72)
                       "</td></tr>"
                   end-display
               end-if
       end-perform.
       display "</table></p></body></html>" end-display.
COOL   goback.
```

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`

Listing 5.2: OpenCOBOL cgienv form

```
<html><head><title>OpenCOBOL sample CGI form</title></head>
<body>
<h3>OpenCOBOL sample CGI form</h3>
<form action="http://localhost/cgi-bin/cgienv.cgi" method="post">
    <p>
    Text: <input type="text" name="text"><br>
```

```
    Password: <input type="password" name="password"><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>
</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
    You need not change anything with the cobol code.

   ajax.html
```

Listing 5.3: OpenCOBOL cgienv form

```
<html>
<head>
<title>Simple Ajax Example</title>
<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-urlenco
    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 = 'w=' + escape(word);  // NOTE: no '?' before querystring
```

```
    return qstr;
}

function updatepage(str){
    document.getElementById("result").innerHTML = str;
}
</script>
</head>
<body>
<form name="f1">
  <p>word: <input name="word" type="text">
  <input value="Go" type="button" onclick='javascript:xmlhttpPost("/cgi-bin/cgienv.cgi")'></p>
  <div id="result"></div>
</form>
</body>
</html>
```

A quick screenshot from the OpenCOBOL called Vala WebKit sample. **Sometimes, just wow**.

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.

Listing 5.4: OpenCOBOL ocdoc.cob

```
OCOBOL >>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 OpenCOBOL 1.1pr.  OpenCOBOL is tasty.
      *><* :Tectonics: cobc -x ocdoc.cob
      *><* :Docgen:    $ ./ocdoc ocdoc.cob ocdoc.rst ocdoc.html skin.css
      *> ***************************************************************
      *><*
      *><* ------------
      *><* Command line
      *><* ------------
```

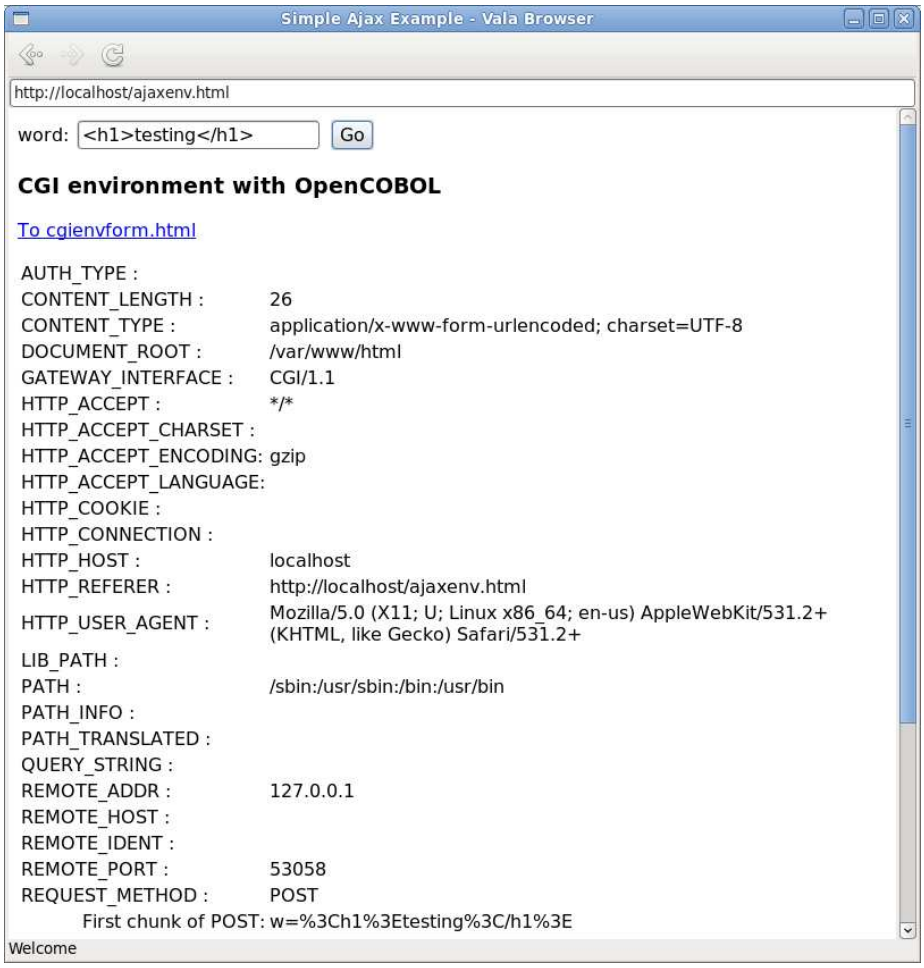


Figure 5.1: OpenCOBOL linked through Vala to WebKit browsing OpenCOBOL responding to CGI/AJAX

```
      *><* *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
*><+  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
*><* -------------
*><*
*><* ::
*><*
*><[
 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.
           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
      *><+  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
*><+  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
*><*
*><* ::
*><*
*><[
     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
      *><*
      *><* ::
      *><*
      *><[
                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

*><]
*><*
*><* 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 OpenCOBOL 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
             " " 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
```

See ocdoc.html for the output from processing *ocdoc.cob* with **ocdoc**.

5.3 What is CBL_OC_DUMP?

CBL_OC_DUMP is somewhat of a community challenge application to allow for run-time data dumps. Multiple postings to `http://opencobol.org` has refined the hex display callable to:

Listing 5.5: OpenCOBOL CBL-OC-DUMP

```
OCOBOL >>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'.
*
 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
      *
           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
           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.
        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

Offs  HEX-- -- -- 5- -- -- -- -- 10 -- -- -- -- 15 -- CHARS----1----5-

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-
```

5.3.1 Update to OC_CBL_DUMP

human posted a new version that displays the dump upon SYSERR. Goes to

Edit 19-Oct-2010: Put all dump-outputs to syserr. Removed unused paragraphs and minor beauty changes.

Listing 5.6: OpenCOBOL

```
OCOBOL >>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 '?'.
 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
            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
              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
        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 OpenCOBOL support any SQL databases?

Yes. There is no embedded SQL in OpenCOBOL in terms of `EXEC` but there are *at least* two usable CALL extensions, the EXEC potential of the Firebird `gpre` and the tried and successful use of Oracle's `procob`. There are as of March 13, 2011 quite a few active developments for easing SQL engine access.

- as reported on `http://opencobol.org` the `procob 10.2 Oracle` preprocessor produces code that compiles and executes just fine with OpenCOBOL 1.1 See note about data sizes and the `binary-size:` configuration below.
- A `libdbi` *generic database access* extension is also available. See cobdbi for full details.
- Efforts toward providing a preprocessor for EXEC are underway.
- Jim Currey's team [1] has kindly posted an ease-of-use MySQL preprocessing layer. http://svn.wp0.org/add1/libraries/mysql4Windows4OpenCobol/
- Rumours of a potential Postgres layer have also been heard.
  - Not a rumour anymore. Work on a nicely complete PostgreSQL binding was posted by gchudyk to opencobol.org
- **AND** as a *thing to watch for*, one of the good people of the OpenCOBOL community is writing a layer that converts READ and WRITE verbage to SQL calls `at run time`. More on this as it progresses.

5.4.1 SQLite

There are workable prototypes for access to the SQLite3 shell 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

5.4.2 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 Microfocus / Oracle, and microfocus 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
```

5.4.3 Sybase ASE

Another post from http://opencobol.org

```
Preliminary work with Sybase ASE 15 indicates that the output of the Sybase
precompiler cobpre64 and cobpre_r64) is compatible with OpenCOBOL.

Some fiddling with COB_LIBRARY_PATH and COB_LIBS was necessary to get ld (on
AIX 6.1) to see and resolve the externals in the generated code. It's also
important to get the "bitness" of the various pieces in agreement, in the UNIX
case, 64-bit.

Works with UNIX (AIX), also Windows XP and 7 in 32-bit mode.

I'll put together a writeup on the process when time permits.

Jim
```

5.4.4 DB2

Another post from http://opencobol.org

```
Re: AN IDEA FOR SQL SUPPORT IN OPENCOBOL
Embedded SQL with DB2 and the DB2 preprocessor (db2 prep)works fine with OpenCobol, too.

Cheers,
Juergen
```

5.4.5 PostgreSQL Sample

Nowhere near as complete as the binding that Gerald posted to opencobol.org the example below was a starting point.

Note that the PostgreSQL runtime library is `libpq`, *ending in q not g*.

Listing 5.7: OpenCOBOL PostgreSQL connection test

```
OCOBOL*> *************************************************************
      *> 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
           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 null 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  <*
       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.

5.5 Does OpenCOBOL 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 OpenCOBOL?3.2 for more details about these options. The rest of this entry assumes the default Berkeley database.

ISAM is an acronymn for Indexed Sequential Access Method.

OpenCOBOL has fairly full support of all standard specified ISAM compile and runtime semantics.

For example:

Listing 5.8: OpenCOBOL ISAM sample

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *><* ================
      *><* indexing example
      *><* ================
      *><* :Author:    Brian Tiffin
      *><* :Date:      17-Feb-2009
      *><* :Purpose:   Fun with Indexed IO routines
      *><* :Tectonics: cobc -x indexing.cob
      *> ************************************************************
       identification division.
       program-id. indexing.

       environment division.
       configuration section.

       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
          .

      *> ** OpenCOBOL does not yet support split keys **
      *>  alternate record key is newkey
      *>      source is first-part of indexing-record
      *>                last-part of indexing-record
      *>      with duplicates

       data division.
       file section.
       fd indexing.
       01 indexing-record.
          03 keyfield          pic x(8).
          03 splitkey.
             05 first-part     pic 99.
             05 middle-part    pic x.
             05 last-part      pic 99.
          03 data-part         pic x(54).

       working-storage section.
       01 display-record.
          03 filler            pic x(4)  value spaces.
          03 keyfield          pic x(8).
          03 filler            pic xx    value spaces.
          03 splitkey.
             05 first-part     pic z9.
             05 filler         pic x     value space.
             05 middle-part    pic x.
             05 filler         pic xx    value all "+".
             05 last-part      pic z9.
          03 filler            pic x(4)  value all "-".
          03 data-part         pic x(54).

      *> control break
       01 oldkey               pic 99x99.

      *> In a real app this should well be two separate flags
       01 control-flag         pic x.
          88 no-more-duplicates          value high-value
             when set to false is              low-value.
          88 no-more-records             value high-value
             when set to false is              low-value.
```

```
*> ************************************************************
 procedure division.

*> Open optional index file for read write
 open i-o indexing

*> populate a sample database
 move "1234567800a01some 12345678 data here" to indexing-record
 perform write-indexing-record
 move "8765432100a01some 87654321 data here" to indexing-record
 perform write-indexing-record
 move "1234876500a01some 12348765 data here" to indexing-record
 perform write-indexing-record
 move "8765123400a01some 87651234 data here" to indexing-record
 perform write-indexing-record

 move "1234567900b02some 12345679 data here" to indexing-record
 perform write-indexing-record
 move "9765432100b02some 97654321 data here" to indexing-record
 perform write-indexing-record
 move "1234976500b02some 12349765 data here" to indexing-record
 perform write-indexing-record
 move "9765123400b02some 97651234 data here" to indexing-record
 perform write-indexing-record

 move "1234568900c13some 12345689 data here" to indexing-record
 perform write-indexing-record
 move "9865432100c13some 98654321 data here" to indexing-record
 perform write-indexing-record
 move "1234986500c13some 12349865 data here" to indexing-record
 perform write-indexing-record
 move "9865123400c13some 98651234 data here" to indexing-record
 perform write-indexing-record

*> close it ... not necessary, but for the example
 close indexing

*> clear the record space for this example
 move spaces to indexing-record

*> open the data file again
 open i-o indexing

*> 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
           perform read-indexing-record
           perform read-next-record
               until no-more-duplicates

      *> 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

      *> using start and read next
           set no-more-records to false
           perform start-at-key
           perform read-next-by-key
               until no-more-records

      *> read by primary key of reference
           move "87654321" to keyfield of indexing-record

      *>
           set no-more-records to false
           perform start-prime-key
           perform read-previous-by-key
               until no-more-records

      *> and with that we are done with indexing sample
           close indexing

           goback.
      *> ****************************************************************

      *><* Write paragraph
           write-indexing-record.
               write indexing-record
                   invalid key
                       display
                           "rewrite key: " keyfield of indexing-record
                       end-display
                       rewrite indexing-record
                           invalid key
                               display
                                   "really bad key: "
                                   keyfield of indexing-record
                               end-display
                       end-rewrite
               end-write
           .

      *><* read by alternate key paragraph
           read-indexing-record.
```

```
           display "Reading: " splitkey of indexing-record end-display
           read indexing key is splitkey of indexing-record
               invalid key
                   display
                        "bad read key: " splitkey of indexing-record
                   end-display
                   set no-more-duplicates to true
           end-read
       .

      *><* read next sequential paragraph
       read-next-record.
           move corresponding indexing-record to display-record
           display display-record end-display
           move splitkey of indexing-record to oldkey

           read indexing next record
               at end set no-more-duplicates to true
               not at end
                   if oldkey not equal splitkey of indexing-record
                       set no-more-duplicates to true
                   end-if
           end-read
       .

      *><* start primary key of reference paragraph
       start-prime-key.
           display "Prime < " keyfield of indexing-record end-display
           start indexing
              key is less than
                  keyfield of indexing-record
              invalid key
                  display
                      "bad start: " keyfield of indexing-record
                  end-display
                  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
       .

      *><* read previous by key of reference paragraph
       read-previous-by-key.
           move corresponding indexing-record to display-record
           display display-record end-display

           read indexing previous record
               at end set no-more-records to true
```

```
           end-read
       .
      *><* start alternate key of reference paragraph
       start-at-key.
           display "Seeking >= " splitkey of indexing-record end-display
           start indexing
              key is greater than or equal to
                  splitkey of indexing-record
              invalid key
                  display
                      "bad start: " splitkey of indexing-record
                  end-display
                  set no-more-records to true
              not invalid key
                  read indexing next record
                      at end set no-more-records to true
                  end-read
           end-start
       .

      *><* read next by key of reference paragraph
       read-next-by-key.
           move corresponding indexing-record to display-record
           display display-record end-display

           read indexing next record
               at end set no-more-records to true
           end-read
       .
       end program indexing.
      *><*
      *><* Last Update: 20090220
```

which outputs:

```
Reading: 00b02
    12345679   0 b++ 2----some 12345679 data here
    97654321   0 b++ 2----some 97654321 data here
    12349765   0 b++ 2----some 12349765 data here
    97651234   0 b++ 2----some 97651234 data here
    12345679   0 b++ 2----some 12345679 data here
    97654321   0 b++ 2----some 97654321 data here
    12349765   0 b++ 2----some 12349765 data here
    97651234   0 b++ 2----some 97651234 data here
    12345679   0 b++ 2----some 12345679 data here
    97654321   0 b++ 2----some 97654321 data here
    12349765   0 b++ 2----some 12349765 data here
    97651234   0 b++ 2----some 97651234 data here
Seeking >= 00a02
```

```
    12345679   0 b++ 2----some 12345679 data here
    97654321   0 b++ 2----some 97654321 data here
    12349765   0 b++ 2----some 12349765 data here
    97651234   0 b++ 2----some 97651234 data here
    12345679   0 b++ 2----some 12345679 data here
    97654321   0 b++ 2----some 97654321 data here
    12349765   0 b++ 2----some 12349765 data here
    97651234   0 b++ 2----some 97651234 data here
    12345679   0 b++ 2----some 12345679 data here
    97654321   0 b++ 2----some 97654321 data here
    12349765   0 b++ 2----some 12349765 data here
    97651234   0 b++ 2----some 97651234 data here
    12345689   0 c++13----some 12345689 data here
    98654321   0 c++13----some 98654321 data here
    12349865   0 c++13----some 12349865 data here
    98651234   0 c++13----some 98651234 data here
    12345689   0 c++13----some 12345689 data here
    98654321   0 c++13----some 98654321 data here
    12349865   0 c++13----some 12349865 data here
    98651234   0 c++13----some 98651234 data here
    12345689   0 c++13----some 12345689 data here
    98654321   0 c++13----some 98654321 data here
    12349865   0 c++13----some 12349865 data here
    98651234   0 c++13----some 98651234 data here
Prime < 87654321
    87651234   0 a++ 1----some 87651234 data here
    12349865   0 c++13----some 12349865 data here
    12349765   0 b++ 2----some 12349765 data here
    12348765   0 a++ 1----some 12348765 data here
    12345689   0 c++13----some 12345689 data here
    12345679   0 b++ 2----some 12345679 data here
    12345678   0 a++ 1----some 12345678 data here
```

on any first runs, where **indexing.dat** does not exist. Subsequent runs have the same output with::

```
rewrite key: 12345678
rewrite key: 87654321
rewrite key: 12348765
rewrite key: 87651234
rewrite key: 12345679
rewrite key: 97654321
rewrite key: 12349765
rewrite key: 97651234
rewrite key: 12345689
rewrite key: 98654321
```

```
rewrite key: 12349865
rewrite key: 98651234
```

prepended, as the WRITE INVALID KEY clause triggers a REWRITE to allow overwriting key and data.

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 OpenCOBOL FILE STATUS codes See ISAM for the details.

5.6 Does OpenCOBOL support modules?

Yes. Quite nicely in fact. Dynamically! COBOL modules, and object files of many other languages are linkable. As OpenCOBOL uses intermediate C, linkage to other languages is well supported across many platforms. The OpenCOBOL CALL instruction maps COBOL USAGE to many common C stack frame data representations.

Multipart, complex system development is well integrated in the OpenCOBOL 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, OpenCOBOL has access to most shared libraries supported on it's platforms.

```
$ cobc -x -lcurl showcurl.cob
```

Will link the `/usr/lib/libcurl.so` from the cURL project to `showcurl`. The OpenCOBOL CALL verb will use this linked library to resolve calls at runtime.

Large scale systems are at the heart of COBOL development and OpenCOBOL is no exception.

For more information, see What is COB-PRE-LOAD?.

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:

Listing 5.9: OpenCOBOL ISAM sample

```
$ cobc occurl.c
$ cobc occgi.c
```

```
$ cobc -x myprog.cob
$ export COB_PRE_LOAD=occurl:occgi
$ ./myprog
```

That will allow the OpenCOBOL 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. OpenCOBOL will do the right thing on the various platforms.

If the DSO 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? **??** for information on setting the module search path.

5.8 What is the OpenCOBOL 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 for more details.

5.9 What does the -fstatic-linkage OpenCOBOL 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 [8]

```
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 it's 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 OpenCOBOL, and the *-fstatic-linkage* option may be deprecated.

5.10 Does OpenCOBOL support Message Queues?

Yes, but not out of the box. A linkable POSIX message queue layer is available.

Listing 5.10: OpenCOBOL POSIX message queues

```
/* OpenCOBOL 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;
}

/* 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 *)olda
    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,
```

```
    mqd_t mqres;
    struct timespec mqtimer;
    struct timeval curtime;

    /* Expect seconds and nanos to wait, not absolute.  Add the OpenCOBOL 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;
}

/* 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 OpenCOBOL 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;

    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 OpenCOBOL 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.

Listing 5.11: OpenCOBOL mq

```
OCOBOL >>SOURCE FORMAT IS FIXED
      ******************************************************************
      * Author:    Brian Tiffin
      * Date:      August 2008
      * Purpose:   Demonstration of OpenCOBOL 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 'OpenCOBOL is awesome'.
 01 user-message         pic x(80).
 01 send-length          usage binary-long.

 01 urgent-message       pic x(20) value 'Urgent OpenCOBOL 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
 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.
* 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
               "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
                              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
 .

* 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 OpenCOBOL 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
           if mqres > 0
               display
                   "priority 31 message: " msgbuf(1:mqres)
               end-display
           end-if
       end-perform.

       goback.
       end program MQSIGNAL.
```

5.11 Can OpenCOBOL interface with Lua?

Yes. Lua can be embedded in OpenCOBOL applications.

Listing 5.12: OpenCOBOL Lua interface

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *><* ======================
      *><* OpenCOBOL Lua Interface
      *><* ======================
      *><*
      *><* .. sidebar:: Contents
      *><*
      *><*     .. contents::
      *><*         :local:
      *><*         :depth: 2
      *><*         :backlinks: entry
      *><*
      *><* :Author:    Brian Tiffin
      *><* :Date:      28-Oct-2008
```

```
*><* :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 "OpenCOBOL " .. 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
```

```
    "OpenCOBOL 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
    "OpenCOBOL 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
    "OpenCOBOL 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
            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 OpenCOBOL 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 an OpenCOBOL 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
*><*
*><* +++++++++++++++++
*><* OpenCOBOL Lua API
*><* +++++++++++++++++
*><* ----------
*><* OCLUA_OPEN
*><* ----------
*><* Initialize the Lua engine.
*><*
*><* ::
*><*
*><*   01 luastate USAGE POINTER.
*><*
*><*   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 "OpenCOBOL " .. 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
      *><*       "OpenCOBOL displays: " depth " |" luaresult "|"
      *><*   end-display
      *><*
      *><* Outputs::
      *><*
      *><*   OpenCOBOL displays: +0000000001 |OpenCOBOL 1.1
||
      *><*
      *><* ------------
      *><* 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
      *><*       "OpenCOBOL displays: " depth " |" luaresult "|"
      *><*   end-display
      *><*
      *><* Given oclua.lua::
      *><*
      *><*   -- Start
      *><*   -- Script: oclua.lua
      *><*   print("Lua prints hello")
      *><*
      *><*   hello = "Hello OpenCOBOL from Lua"
      *><*   return math.pi, hello
      *><*   -- End
      *><*
      *><* Outputs::
      *><*
      *><*   Lua prints hello
      *><*   OpenCOBOL displays: +0000000002 |Hello OpenCOBOL 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"
      *><*       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 an OpenCOBOL 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: OpenCOBOL 1.1
*><*   Item 2: 3.1415926535898
*><*   Item 3: Hello OpenCOBOL from Lua
*><*   Item 4: 3.1415926535898
*><*   Item 5: Hello OpenCOBOL from Lua
*><*
*><* ---------
*><* OCLUA_POP
*><* ---------
*><* Pops the given number of elements off of the Lua stack
*><* returning the depth of the stack after the pop.
*><*
*><* 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

Listing 5.13: OpenCOBOL Lua C glue

```
/* OpenCOBOL 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, in
    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) {
  /* 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);
  }

  /* close the engine */
  void OCLUA_CLOSE(lua_State *L) {
      lua_close(L);
  }

  /**/
```

and this sample Lua script **oclua.lua**

Listing 5.14: Lua script

```
  -- Start
  -- Script: oclua.lua
  print("Lua prints hello")

  hello = "Hello OpenCOBOL from Lua"
  return math.pi, hello
  -- End
```

5.12 Can OpenCOBOL use ECMAScript?

Yes. Using the SpiderMonkey **??** engine. See Can OpenCOBOL use JavaScript?

5.13 Can OpenCOBOL use JavaScript?

Yes. A wrapper for the SpiderMonkey engine allows OpenCOBOL access to core JavaScript.

Listing 5.15: OpenCOBOL with SpiderMonkey ECMAScript

```
/* OpenCOBOL 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
#define OCJS_ERROR_STANDARD -4
#define OCJS_ERROR_EVALUATE -5

/* OpenCOBOL 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 */
    memset(result, ' ', length);

    /* Evaluate javascript */
    ok = JS_EvaluateScript(cx, global, script, strlen(script), filename, lineno, &rv

    /* 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 OpenCOBOL application:

Listing 5.16: OpenCOBOL embedding SpiderMonkey

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *>*****************************************************************
      *>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 "OpenCOBOL result-field: " result-field end-display
 display "OpenCOBOL 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
     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 "OpenCOBOL result-field: " result-field end-display
 display "OpenCOBOL 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 "OpenCOBOL result-field: " result-field end-display
       display "OpenCOBOL 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)
           returning result
       end-call
       if result equal ocjs-error-evaluate
           display " *** script problem ***" end-display
       end-if
       display "OpenCOBOL result-field: " result-field end-display
       display "OpenCOBOL 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 "OpenCOBOL result-field: " result-field end-display
       display "OpenCOBOL 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 "OpenCOBOL result-field: " result-field end-display
       display "OpenCOBOL 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 "OpenCOBOL result-field: " result-field end-display
    display "OpenCOBOL 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 "OpenCOBOL result-field: " result-field end-display
    display "OpenCOBOL received    : " result end-display

    goback.
    end program jscaller.
```

And with a sample script:
`ocjsscript.js`

Listing 5.17: javascript

```
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
OpenCOBOL result-field: 56877
OpenCOBOL received    : +000000005

Script: pat = /\$\d+\.\d+\s\d+/; a = "----+----1----+-$56.78 90----3----+---
OpenCOBOL result-field: 16
OpenCOBOL received    : +000000002

Script: a;
OpenCOBOL result-field: ----+----1----+-$56.78 90----3----+----4
OpenCOBOL received    : +000000040

Script: an error of some kind;
 *** script problem ***
OpenCOBOL result-field:
OpenCOBOL received    : -000000005

Script: re = /(\w+)\s(\w+)/; str = "John Smith"; newstr = str.replace(re, "$
OpenCOBOL result-field: Smith, John
OpenCOBOL received    : +000000011

Script: myString = "Hello 1 word. Sentence number 2."; splits = myString.spl
OpenCOBOL result-field: Hello ,1, word. Sentence number ,2,.
OpenCOBOL received    : +000000036

Script: new Date()
OpenCOBOL result-field: Mon Sep 15 2008 04:16:06 GMT-0400 (EDT)
OpenCOBOL received    : +000000039
```

5.14 Can OpenCOBOL interface with Scheme?

Yes, directly embedded with Guile**??** and libguile.

callguile.cob

Listing 5.18: OpenCOBOL

```
OCOBOL >>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).
       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
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

Listing 5.19: Guile script

```
(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

      ;; 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 an OpenCOBOL application would not be a smart usage. This is just a working sample.

5.15 Can OpenCOBOL interface with Tcl/Tk?

Yes. OpenCOBOL supports the Tcl/Tk embedding engine developed by Rildo Pragana [7] as part of the TinyCOBOL project. We have been given permission by Rildo to embed his engine in OpenCOBOL.

See `http://ww1.pragana.net/cobol.html` for sources.

Rildo's working sample

Listing 5.20: TinyCOBOL tclgui

```
TCOBOL 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
 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

Listing 5.21: TCL in OpenCOBOL, by Rildo Pragana for TinyCOBOL

```
#!/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
  }
  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} }
    }
}
###############################################################################
## 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
        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 $w
        }
        "endmodal" {
            ## ends modal dialog started with startmodal, argument is var name
            set ::${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::$base.cpd45 {
    array set save {-disabledforeground 1 -font 1 -text 1}
}
namespace eval ::widgets::$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::$base.ent48 {
    array set save {-background 1 -disabledforeground 1 -insertbackground 1 -textvariable
}
namespace eval ::widgets::$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
        }
        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} {

}

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"
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 $top.cpd45 \
    -disabledforeground #a1a4a1 -font {helvetica 18 bold} -text Endereço:
vTcl:DefineAlias "$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 \
        -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 $top.but50 \
        -command {MinhaJanela hide} -disabledforeground #a1a4a1 -text fechar
    vTcl:DefineAlias "$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

Listing 5.22: TCL in OpenCOBOL, by Rildo Pragana for TinyCOBOL

```
#!/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 \
  "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 OpenCOBOL interface with Falcon PL?

Not yet, but work with Giancarlo to allow embedding of Falcon scripts is in progress.
Update on December 31st, 2010

`http://en.wikipedia.org/wiki/Falcon_(programming_language)`

Yes, yes it can.

This is from the linked post ... but the Falcon programming language embeds in OpenCOBOL just fine.

`falconscript.fal`

Listing 5.23: Giancarlo Niccolai Falcon, list comprehension

```
> "Falcon list comprehension called from OpenCOBOL"
sums = [].mfcomp( {x,y=> x+y}, .[1 2 3], .[4 5 6] )
return sums.describe()
```

it goes

```
$ ./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]
```

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.

See `http://www.opencobol.org/modules/newbb/viewtopic.php?topic_id=1221&forum=1&post_` for details.

FalconPL has some nice features.

Listing 5.24: Giancarlo Niccolai's Falcon

```
saying = List("Have", "a", "nice", "day")

for elem in saying
   >> elem
   formiddle: >> " "
   forlast: > "!"
end
```

giving:

Have a nice day!

Source files can be found in http://fossile.plpwebs.com/ocsamples.cgi/dir?ci=tip

5.17 Can OpenCOBOL interface with Ada?

Yes. The freely available **gnat** system can be used and will create object files that can be included in an OpenCOBOL project.

This example compiles an gnat package that includes *hello* and *ingress* PROCEDURE and a *echo* FUNCTION. These will be called from an OpenCOBOL **adacaller.cob** program.

The gnat specification file

Listing 5.25: GNAT Ada

```
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

Listing 5.26: GNAT Ada

```
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 OpenCOBOL");
   New_Line;
end hello;

procedure ingress(value : in integer) is
begin
   Put_Line("Passing integer to Ada from OpenCOBOL");
   Put("OpenCOBOL 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

Listing 5.27: OpenCOBOL interfacing to Ada

```
OCOBOL****************** adacaller.cob ********************************
       >>SOURCE FORMAT IS FIXED
      ******************************************************************
      * Author:    Brian Tiffin
      * Date:      08-Sep-2008
      * Purpose:   Demonstrate using Ada sub-programs
      * 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

       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*

Listing 5.28: OpenCOBOL interfacing to Ada

```
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 OpenCOBOL executable.

Sample run using `./adacaller`:

```
Hello from Ada and OpenCOBOL

Passing integer to Ada from OpenCOBOL
OpenCOBOL passed:          42

Ada echo
Ada return: +000000009
```

See Can the GNAT Programming Studio be used with OpenCOBOL?5.20 for more.

5.18 Can OpenCOBOL interface with Vala?

Yes. Very easily. The Vala design philosophy of producing C application binary interface code means that Vala is directly usable with OpenCOBOL's CALL statement.

See `http://live.gnome.org/Vala` for some details on this emerging programming enviroment.

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 OpenCOBOL programs from Vala

Using a few simple tricks, Vala can easily call OpenCOBOL 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`.

Listing 5.29: Vala call OpenCOBOL

```
/* Call OpenCOBOL 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`.

Listing 5.30: OpenCOBOL interfacing to Vala

```
OCOBOL >>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 OpenCOBOL'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 OpenCOBOL 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 OpenCOBOL from a Vala GTK gui application

And another experiment, with a gui button and repeated timer calls.

`callhellogui.vala`

Listing 5.31: Vala GTK call OpenCOBOL

```
// Call OpenCOBOL 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];

    public static int main (string[] args) {

        Gtk.init (ref args);
        var time = new TimeoutSource(50);

        var window = new Window (WindowType.TOPLEVEL);
        window.title = "Invoke OpenCOBOL 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`.

Listing 5.32: OpenCOBOL call ochellogui from.Vala

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20101017
      *> Purpose:   Call ochello from Vala in a from.vala Class
      *> 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 OpenCOBOL'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 OpenCOBOL *unsafely, mind you*. If you push button ”42”, a message is printed to standard out.

Figure 5.2: Call OpenCOBOL GUI

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 OpenCOBOL

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 OpenCOBOL.

Listing 5.33: Genie piping

```
 Tectonics: valac -c piping.gs
ndent=4]
ass 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
      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,o
      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`

Listing 5.34: OpenCOBOL call Genie

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *><* =========
      *><* 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 for *hellogenie* 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

Listing 5.35: Genie regex

```
// Tectonics: valac -c genieregex.gs
[indent=4]
class cbl.oc.genie : Object
    def static regexing(pattern : string, subject : string, out value : string, out
        print " "
        print "Pattern: %s", pattern
        print "Subject: %s", subject
        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

Listing 5.36: OpenCOBOL call Genie Regex

```
 OCOBOL >>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
            "OpenCOBOL, 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

 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

$ 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
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: OpenCOBOL, Fortran, Vala, Genie, Python, C, APL
Result from Genie: +0000000000
replacement now: OpenCOBOL, 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 withi
Result from Genie: +0000000001
replacement now: The Regex fails
```

5.19 Can OpenCOBOL interface with S-Lang?

Yes. The *S-Lang engine* can be used with OpenCOBOL 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 OpenCOBOL defined storage members.

5.19.1 Setup

You will need the S-Lang library for this interface. Under Debian3.1.2 that is simply

```
$ apt-get install libslang2
```

See `http://www.s-lang.org/` 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.

Listing 5.37: OpenCOBOL

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      20090503
      *> Purpose:   Experimental S-Lang interface
      *> Tectonics: cobc -x slangkey.cob -lslang
      *> ************************************************************
       identification division.
       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 OpenCOBOL 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
           "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.


      *> ****************************************************************
      *> Exit procedure to ensure terminal properly reset
      *> ****************************************************************
       entry "tty-reset".
       call "SLang_reset_tty" end-call
       display "exit proc reset the tty" end-display
       goback.

       end program slangkey.
```

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.

Listing 5.38: OpenCOBOL call S-Lang

```
OCOBOL >>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.
       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
       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 OpenCOBOL?

Yes. Extensions to smooth the integration of OpenCOBOL development in gnat-gps is posted at `http://svn.wp0.org/ocdocs/brian/opencobol.xml`

Listing 5.39: GNAT Programming Studio

```
<?xml version="1.0"?>
<Custom>
  <Language>
    <Name>OpenCOBOL</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>

    <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.
       repository.
       special-names.
       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; **************************************************************

        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|unichar|void|</Key
    <Keywords>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|volatile|weak|</Keywor
    <Keywords>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</titl
   <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" />
      <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="tr
          tip="Generate a listing file to given filename" />
   <field label="Save Generated files to " switch="-save-temps" separator="=
          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="-fmfcomm
          tip="Allow * or / in column 1 as FIXED format line comment" />
   <check label="FUNCTION implied" switch="-ffunctions-all" line="2" column=
          tip="Allow use of intrinsic functions without FUNCTION keyword" />
   <check label="Fold Copy LOWER" switch="-ffold-copy-lower" line="2" column
          tip="Fold COPY subject to lower case" />
   <check label="Fold Copy UPPER" switch="-ffold-copy-upper" line="2" column
          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"
             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 that you do not go beyond the boundary of the s
   <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 D (FIXED FORMAT) debug lines and &gt;&gt;D inline compi
   <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"
```

```
                tip="Enable output of trace statements for SECTION, PARAGRAPH and
        <check label="Source locations" switch="-fsource-location" line="2" colum
                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 compatibilit
    </switches>
</tool>

<action name="make">
  <external>make</external>
</action>

<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">
        <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?*

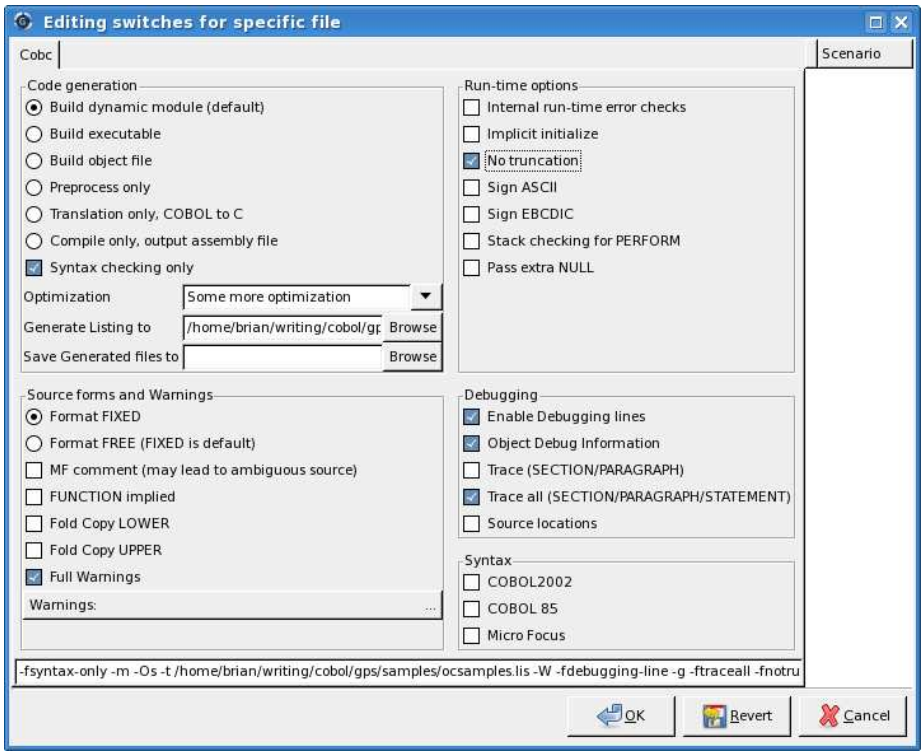


Figure 5.3: GNAT Programming Studio

5.21 Does OpenCOBOL support SCREEN SECTION?

Yes. The OpenCOBOL 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 20xx 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.

See Does OpenCOBOL support CRT STATUS? 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 [2] and `opencobol.org`.

```
  In order to detect the PgUp, PgDn or PrtSc (screen print) keys, you must f
```

```
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 OpenCOBOL program, as long
as they're done before the ACCEPT.
```

Listing 5.40: OpenCOBOL set SCREEN EXCEPTIONS at runtime

```
SET ENVIRONMENT 'COB_SCREEN_EXCEPTIONS' TO 'Y'
SET ENVIRONMENT 'COB_SCREEN_ESC'        TO 'Y'
```

5.22 What are the OpenCOBOL SCREEN SECTION colour values?

The FOREGROUND-COLOR and BACKGROUND-COLOR clauses will accept

Listing 5.41: OpenCOBOL SCREEN SECTION color values

```
78  black                   value 0.
78  blue                    value 1.
78  green                   value 2.
78  cyan                    value 3.
78  red                     value 4.
78  magenta                 value 5.
78  brown                   value 6.
78  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.

5.23 Does OpenCOBOL support CRT STATUS?

Yes.

Listing 5.42: OpenCOBOL SCREEN SECTION color values

```
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.
IF screen-status = COB-SCR-F1
    ...
```

There is also a special OpenCOBOL variable, **COB-CRT-STATUS** which can be used instead of the CRT STATUS special name.

There is also a COPY text that ships with OpenCOBOL, copy/screenio.cpy that can be included in the DATA DIVISION and provides 78 level constants for supported key status codes. Some values include:

* COB-SCR-F1 thru * COB-SCR-F64 * COB-SCR-ESC

examine the file to see the other values.

5.24 What is CobCurses?

CobCurses is an optional package designed to work with OpenCOBOL 1.0, before OpenCOBOL 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.

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.

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 OpenCOBOL 1.1.

Current source code is available at http://svn.wp0.org/add1/tools/cobxref or http://sourceforge.net/projects/cobx and is, as of March 13, 2011, in active development.

The system ships with full documentation and information for building from source is included in the *readme* file.

Fetching the utility

Listing 5.43: cobxref

```
$ svn checkout http://svn.wp0.org/add1/tools/cobxref
```

Example **truncated** to 72 and using the ocdoc.cob OpenCOBOL program for source code:

```
$ cobc -save-temps ocdoc.cob
$ cobxref ocdoc.i -L
$ cut -c1-72 ocdoc.lst

ACS Cobol Cross Reference Xref v0.95.27 (04/01/2009@11:27) Dictionary Fi

Symbols of Module: ocdoc (ocdoc)
--------------------------------

Data Section (FILE)               Defn    Locations
----------------------------------+---------------------------------------

doc-output                       000124F  000252 000499
doc-record                       000125F  000269 000381 000387 000390 00
                                          000478 000482 000485
```

```
source-input                    000122F  000251 000287 000458 000500
source-record                   000123F  000285 000288 000300 000316 00
                                         000324 000355 000456 000459
standard-input                  000117F  000256 000282 000453 000497
standard-output                 000119F  000257 000496
stdin-record                    000118F  000283 000285 000454 000456
stdout-record                   000120F  000387 000388 000475 000476

ACS Cobol Cross Reference Xref v0.95.27 (04/01/2009@11:27) Dictionary Fi

Symbols of Module: ocdoc (ocdoc)
--------------------------------

Data Section (WORKING-STORAGE)    Defn    Locations
---------------------------------+-------------------------------------

arguments                       000128W  000219 000221 000244 000245
autoappend                      000187W  000380
autodoc                         000186W  000385
buffer-empty                    000178W  000267 000380 000398 000472
buffer-flag                     000177W
buffer-offset                   000176W  000268 000382 000399 000433 00
buffered-output                 000179W  000385 000441 000471
counter                         000181W  000369 000410 000412 000416
data-field1                     000193W
data-field2                     000194W
data-field3                     000197W
data-record                     000192W
data-subfield1                  000195W
data-subfield2                  000196W  000218
doc-buffer                      000175W  000417 000419 000430
doc-name                        000130W  000246 000505 000522 000532
filter-flag                     000138W
filtering                       000139W  000254 000281 000386 000452 00
first-part                      000184W  000368
helping                         000137W  000222
here-data                       000169W  000355
here-record                     000167W  000356
heredoc                         000156W  000315 000337 000354
hereend                         000153W  000340 000353
hereflag                        000155W
herenone                        000157W  000341
herestart                       000152W  000336 000353
len-of-comment                  000182W  000411 000415 000416
line-count                      000141W  000270 000301 000435
line-display                    000142W  000435 000438
```

```
result                          000190W  000548 000551 000552
result-name                     000131W  000247 000518 000524 000534
rst-command                     000189W  000517 000525 000535 000542 00
seq-data                        000173W  000317
seq-record                      000171W  000318
skipseqnum                      000135W  000314
source-name                     000129W  000246 000504
special                         000185W  000379
style-name                      000132W  000247 000519 000530
trimmed                         000151W  000316 000321 000324 000356 00
usagehelp                       000136W  000221
verbose                         000134W  000392 000480 000503 000539
verbosity                       000133W  000248

ACS Cobol Cross Reference Xref v0.95.27 (04/01/2009@11:27) Dictionary Fi

Variable Tested [S]             Symbol (88-Conditions)
----------------------------------------------------------------

buffer-flag                     buffer-empty
buffer-flag                     buffered-output
filter-flag                     filtering
first-part                      special
first-part                      autodoc
first-part                      autoappend
hereflag                        heredoc
hereflag                        herenone
trimmed                         herestart
trimmed                         hereend
usagehelp                       helping
verbosity                       verbose
verbosity                       skipseqnum

ACS Cobol Cross Reference Xref v0.95.27 (04/01/2009@11:27) Dictionary Fi

Variable Tested                 Symbol (88-Conditions) [S]
----------------------------------------------------------------

first-part                      autoappend
first-part                      autodoc
buffer-flag                     buffer-empty
buffer-flag                     buffered-output
filter-flag                     filtering
usagehelp                       helping
hereflag                        heredoc
trimmed                         hereend
```

```
    hereflag                        herenone
    trimmed                         herestart
    verbosity                       skipseqnum
    first-part                      special
    verbosity                       verbose

    ACS Cobol Cross Reference Xref v0.95.27 (04/01/2009@11:27) Dictionary Fi

    Procedure                         Defn    Locations
    --------------------------------+-------------------------------------

    trim                             000324P  000394 000430 000482 000504 00

    ACS Cobol Cross Reference Xref v0.95.27 (04/01/2009@11:27) Dictionary Fi

    Unreferenced Working Storage Symbols

    buffer-flag                      000177W
    data-field1                      000193W
    data-field2                      000194W
    data-field3                      000197W
    data-record                      000192W
    data-subfield1                   000195W
    filter-flag                      000138W
    hereflag                         000155W

    ACS Cobol Cross Reference Xref v0.95.27 (04/01/2009@11:27) Dictionary Fi

    Unreferenced Procedures

    None
```

CobXRef produces 132 column output by default and the commands used here limit the width to 72 characters in order to fit the FAQ file.

5.26 Does OpenCOBOL implement Report Writer?

Not at this time. *July, 2008*, or later March 13, 2011.

But it does support LINAGE. See Does OpenCOBOL implement LINAGE?Does OpenCOBOL implement LINAGE?

5.27 Does OpenCOBOL implement LINAGE?

Yes. LINAGE sets up logical pages inside file descriptors enhancing the WRITE operations and enabling the END-OF-PAGE clause.

Listing 5.44: OpenCOBOL LINAGE

```
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-COUNTER4.1.277 noun is maintained during writes to LINAGE output files.

See LINAGE4.1.276 for a sample program.

5.28 Can I use ctags with OpenCOBOL?

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

Listing 5.45: vi with ctags

```
$ 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.

5.29 What about debugging OpenCOBOL programs?

OpenCOBOL 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. Does OpenCOBOL support D indicator debug lines?.

`-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 gdbA.7 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 PARAGR
(gdb) cont
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

Listing 5.46: OpenCOBOL debug tips

```
OCOBOL
      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

Listing 5.47: OpenCOBOL debug tips

```
OCOBOL
       01  debugmode pic x.
           88  debugmode-on values 'O', 'Y', 'J', 'o', 'y', 'j', '1'.
```

put an

Listing 5.48: OpenCOBOL debug tips

```
OCOBOL
           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

Listing 5.49: OpenCOBOL debug tips

```
OCOBOL
           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

Listing 5.50: OpenCOBOL debug tips

```
OCOBOL
      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

      ...

      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 `http://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 OpenCOBOL inserting animator source code that at runtime provides a pretty slick stepper with WORKING-STORAGE display.

This open source bundle is OpenCOBOL. 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.

5.30 Is there a C interface to OpenCOBOL?

Most definitely. See C interface for details.

As a short example, showing off a little of cobc's ease of use when it comes to C source code.

Listing 5.51: hello cobc and cobcrun sample

```
#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-cha
                -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
```

5.31 What are some idioms for dealing with C char * data from OpenCOBOL?

Thanks to Frank Swarbrick for pointing these idioms out

To add or remove a null terminator, use the STRING verb. For example

Listing 5.52: OpenCOBOL

```
OCOBOL
      * Add a null for calling C
       STRING current-url
           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

Listing 5.53: OpenCOBOL

```
OCOBOL
      * Change nulls to spaces
       INSPECT current-url
           REPLACING ALL X"00" WITH SPACE.
```

Or there is also modified references in OpenCOBOL

Listing 5.54: OpenCOBOL

```
OCOBOL
      * Assume IND is the first trailing space (or picture limit).
      * Note: OpenCOBOL 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 OpenCOBOL CONCATENATE intrinsic

Listing 5.55: OpenCOBOL

```
OCOBOL
       MOVE FUNCTION CONCATENATE(filename; X"00") TO c-field.
```

Roger [8] 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”*.

.. Note to maintainers. The section below is just wrong. BASED is a different thing altogether and simply means the item does not have any permanent storage area. Entry commented out until corrected.

.. When a parameter needs to be passed between C and OpenCOBOL, you can use .. the BASED optional clause in WORKING-STORAGE:: .. .. * Create a BASED allocation .. WORKING-STORAGE SECTION. .. 01 current-url PIC X(80) BASED. .. .. This may be a cleaner solution than:: .. .. LINKAGE SECTION. .. 01 current-url PIC X(80). .. .. And a SET ADDRESS OF CARG ... sequence.

With the CALL verb, use ADDRESS OF and/or BY REFERENCE

Listing 5.56: OpenCOBOL

```
    CALL "CFUNCTION" USING BY REFERENCE ADDRESS OF current-url.
```

The above being equivalent to char** in C.

COBOL, by it’s nature, passes all arguments by reference. That can be overridden with the **BY VALUE** clause and the **BY CONTENT** clause.

5.32 Does OpenCOBOL support COPY includes?

Yes. COPY is fully supported, all variations from the standards up to and including the proposed 20xx 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 OpenCOBOL support WHEN-COMPILED?

Both as a noun and as an intrinsic function.

Listing 5.57: OpenCOBOL

```
DISPLAY WHEN-COMPILED.
DISPLAY FUNCTION WHEN-COMPILED.
```

07/05/0805.15.20 2008070505152000-0400

Note: The noun WHEN-COMPILED is non-standard and was deemed obsolete in the pre 85 standard.

5.34 What is PI in OpenCOBOL?

With OpenCOBOL 1.1

Listing 5.58: OpenCOBOL

```
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 GMPA.8.

5.35 Does OpenCOBOL support the Object features of the 2002 standard?

Not yet. *July 2008*

5.36 Does OpenCOBOL implement PICTURE 78?

Yes. PICTURE 78 clauses can be used for constants, translated at compile time. This common non-standard extension is supported in OpenCOBOL.

5.37 Does OpenCOBOL implement CONSTANT?

Current OC 1.1 has preliminary support for a subset of the standard conforming ”CONSTANT” phrase. eg

Listing 5.59: OpenCOBOL

```
01 MYCONST CONSTANT AS 1.
```

Note: there is a syntax difference between 78 and CONSTANT.

5.38 What source formats are accepted by OpenCOBOL?

Both FIXED and FREE COBOL source formats are supported. FIXED format follows the 1-6, 7, 8-72 special columns of the COBOL standards. The compiler directives:

```
Column
12345678901234567890
       >>SOURCE FORMAT IS FREE
       >>SOURCE FORMAT IS FIXED
```

can be used. The directive must occur at column 8 or beyond if the ACTIVE scan format is FIXED. As per the 2002 standard this directive can be used to switch formats multiple times within a compilation unit.

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.

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.

.. Note to readers. The comment operator is *¿ the backslash is for ReST

The **-free** and **-fixed** options to **cobc** also influence the expected source formats, with the default being mandated by the standards as FIXED.

5.39 Does OpenCOBOL 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 *column 7* in FREE form source.

Note that in this example there is no terminating quote on the string continuations, but there is an extra starting quote following the dash

Listing 5.60: OpenCOBOL

```
12345678901234567890123456789012345678901234567890123456789012345678901234567890123456789012
       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
      -"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 OpenCOBOL programmers are urged to read through the standards documents for full details.

5.40 Does OpenCOBOL support string concatenation?

Absolutely. Sources that need long strings, or those wishing to enhance source code readability, can use the & operator

Listing 5.61: OpenCOBOL

```
      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

Listing 5.62: OpenCOBOL

```
$ 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 OpenCOBOL, see FUNCTION CONCATENATE4.2.9.

5.41 Does OpenCOBOL 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).
```

OpenCOBOL 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 OpenCOBOL programs?5.29

5.42 Does OpenCOBOL support mixed case source code?

Absolutely, kind of. Mixed case and mixed format, ASCIIA.3 and EBCDIC4.1.144. Most COBOL compilers have not required uppercase only source code for quite a few

years now. Still, most COBOL compilers including OpenCOBOL folds parts of the source to uppercase *with certain rules* before translating.

The compiler is case insensitive to names

Listing 5.63: OpenCOBOL

```
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).
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:

Listing 5.64: OpenCOBOL

```
$ cobc -x mixcase.cob
```

produces::

Listing 5.65: OpenCOBOL

```
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, OpenCOBOL's dynamic link loader is case sensitive.

Listing 5.66: OpenCOBOL

```
CALL "C$JUSTIFY" USING center-string "C" END-CALL.
```

is not the same as

Listing 5.67: OpenCOBOL

```
CALL "c$justify" USING center-string "C" END-CALL.
```

In support of case folding and COPY libraries, OpenCOBOL supports `-ffold-copy-lower` and `-ffold-copy-upper`. For mixing and matching legacy sources.

Trivia The expressions *uppercase* and *lowercase* date back to early moveable 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 shelf; the lower case letters.

5.43 What is the shortest OpenCOBOL program?

All that is needed is a program-id. Doesn't do much.

Listing 5.68: OpenCOBOL shortest

```
program-id. a.
```

5.44 What is the shortest Hello World program in OpenCOBOL?

A short version of OpenCOBOL hello world, compiled -free

Listing 5.69: OpenCOBOL short Hello

```
program-id.h.procedure division.display "Hello World!".
```

Thanks to human and the `http://opencobol.org` forums.

Please note: This is *not good* COBOL form, and is only shown as an example of the possibilities.

5.45 How do I get those nifty sequential sequence numbers in a source file?

?? 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

Listing 5.70: OpenCOBOL sequence numbers

```
000005* HELLO.COB OpenCOBOL FAQ example
000010 IDENTIFICATION DIVISION.
000020 PROGRAM-ID. hello.
000030 PROCEDURE DIVISION.
```

```
000040 DISPLAY "Hello World!".
000100 STOP RUN.
```

Running the following `ex perl` filter

Listing 5.71: vi perl numbers

```
perl -ne 'printf("\%06d\%s\n", $. * 100, substr($_, 6, -1));'
```

```
.. Note to readers of the plain text of this FAQ. ReStructuredText uses
   backslash to escape certain features.  That line is actually
   :%!perl -ne 'printf("\%06d\%s\n", $. * 100, substr($_, 6, -1));'
```

produces a nicely resequenced source file.

Listing 5.72: OpenCOBOL sequence numbers

```
000100* HELLO.COB OpenCOBOL 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.

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 OpenCOBOL?

Yes. Quite a few. But instead of resorting to a PERFORM VARYING sequence try

Listing 5.73: OpenCOBOL

```
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
    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 `http:\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

Listing 5.74: OpenCOBOL

```
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 OpenCOBOL, the intrinsic

```
FUNCTION TRIM(myedit LEADING)
```

will trim leading whitespace. The LEADING is not really necessary as TRIM removes both leading and trailing whitespace.

OpenCOBOL 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

Listing 5.75: OpenCOBOL

```
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
```

Listing 5.76: OpenCOBOL

```
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.

5.48 Is there a way to detemermine when OpenCOBOL is running ASCII or EBCDIC?

OpenCOBOL supports both ASCII and EBCDIC character encodings. A simple test such as

Listing 5.77: OpenCOBOL

```
01  MYSPACE   PIC X VALUE X"20".
    88 MYISASCII   VALUE SPACE.

IF MYISASCII
    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 OpenCOBOL is running on 32 or 64 bits?

OpenCOBOL builds and supports both 32 and 64 bit architectures. A simple test such as

Listing 5.78: OpenCOBOL

```
01  MYPOINTER    USAGE POINTER.

IF FUNCTION LENGTH(MYPOINTER) EQUALS 8
    DISPLAY "This is a 64 bit machine" END-DISPLAY
END-IF
```

can be used to determine the native bit size at run-time.

5.50 Does OpenCOBOL support recursion?

Yes. Not completely to standard, but as of March 13, 2011, as there are no restrictions on calling programs in a recursive manner, but yes.

A made up example using a factorial called program

Listing 5.79: OpenCOBOL recurvise factorial

```
OCOBOL*> ************************************************************
      *> 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
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 OpenCOBOL capture arithmetic overflow?

Yes. Here is one sample using ADD with `ON SIZE ERROR`.

Listing 5.80: OpenCOBOL overflow

```
OCOBOL*> ***************************************************************
      *> 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.
```

```
         end program overflowing.
        *> ************************************************************
```

which outputs:

```
+0000000001: +00000000000000000001
+0000000002: +00000000000000000002
+0000000003: +00000000000000000006
+0000000004: +00000000000000000024
+0000000005: +00000000000000000120
+0000000006: +00000000000000000720
+0000000007: +00000000000000005040
+0000000008: +00000000000000040320
+0000000009: +00000000000000362880
+0000000010: +00000000000003628800
+0000000011: +00000000000039916800
+0000000012: +00000000000479001600
+0000000013: +00000000006227020800
+0000000014: +00000000087178291200
+0000000015: +00000001307674368000
+0000000016: +00000020922789888000
+0000000017: +00000355687428096000
+0000000018: +00006402373705728000
+0000000019: +00121645100408832000
overflow at: +0000000020 is +00121645100408832000 without test 432902008
overflow at: +0000000021 is +00121645100408832000 without test 19745402
```

5.52 Can OpenCOBOL be used for plotting?

Yes? One way is with an external call to `gnuplot`.

Listing 5.81: Plot SIN/COS and Networth

```
OCOBOL >>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.

        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
       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.

      * 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:

5.53 Does OpenCOBOL support the GIMP ToolKit, GTK+?

Yes. A binding for GTK+ is in the works. Early samples have proven workable and screenshots of OpenCOBOL 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
Text entry widget
Sample OpenCOBOL that generated the above

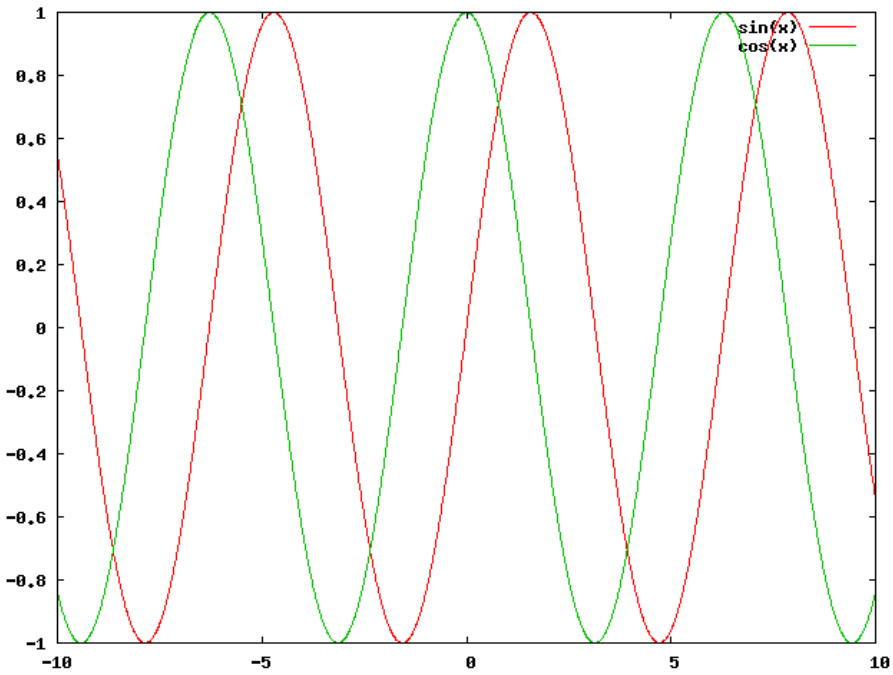


Figure 5.4: Plot of FUNCTION SIN, FUNCTION COS

Listing 5.82: Hello from GTK+

```
OCOBOL >>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.

       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.
```

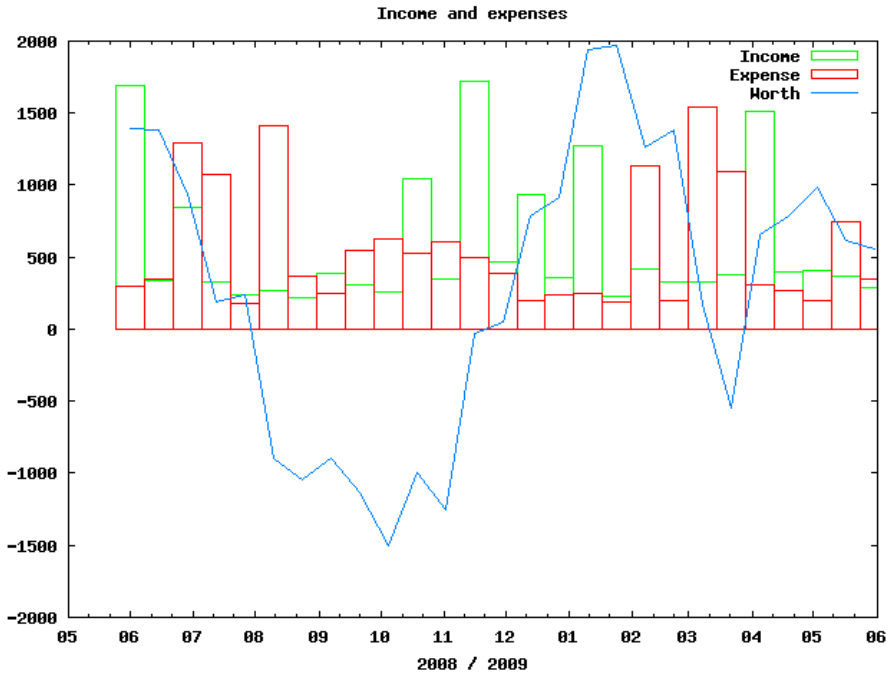


Figure 5.5: Plot of Income, Expenses, Networth

```
Hello from GTK in OpenCOBOL at 2008120111495787-0500
Hello from GTK in OpenCOBOL at 2008120111500044-0500
```

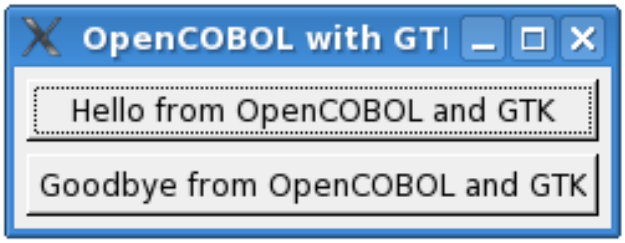


Figure 5.6: OpenCOBOL Hello from GTK+

```
       01 gtk-goodbye          usage pointer.

       01 callback             usage procedure-pointer.
       01 params               usage pointer.

      *> ***************************************************************
       procedure division.
```

```
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
```

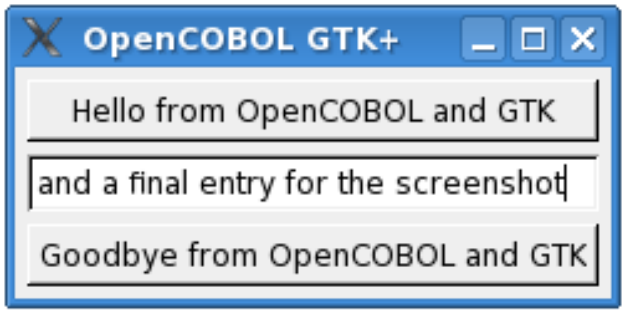


Figure 5.7: OpenCOBOL text entry with GTK+

```
      *> 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 "OpenCOBOL 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"
              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 OpenCOBOL 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

      *> 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 OpenCOBOL 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 ********************************
       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 OpenCOBOL 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+

Listing 5.83: OpenCOBOL GTK+ wrapper

```
/* OpenCOBOL 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 */
void
CBL_OC_GTK_INIT(int argc, char *argv[])
{
    gtk_init(&argc, &argv);
}

/* 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 */
void
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; }

    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[1];
    if (!title_field) { return; }

    cstr = (char *)malloc(title_field->size + 1);
    if (!cstr) { return; }

    memcpy(cstr, title_field->data, title_field->size);
```

```
    cstr[title_field->size] = '\0';

    gtk_window_set_title(GTK_WINDOW(window), cstr);

    free(cstr);
}

/* Widget sizing */
void
CBL_OC_GTK_WIDGET_SET_SIZE_REQUEST(void *widget, int x, int y)
{
    gtk_widget_set_size_request(GTK_WIDGET(widget), x, y);
}

/* Set border width */
void
CBL_OC_GTK_CONTAINER_SET_BORDER_WIDTH(void *window, int pixels)
{
    gtk_container_set_border_width(GTK_CONTAINER(window), pixels);
}

/* 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 */
void
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, (guin
}

/* 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)
{
    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; }

    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; }

    cstr = (char *)malloc(title_field->size + 1);
    if (!cstr) { return; }

    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;
}

void
CBL_OC_GTK_MENU_ITEM_SET_SUBMENU(void *item, void *menu)
{
    gtk_menu_item_set_submenu(GTK_MENU_ITEM(item), menu);
    return;
}

void
CBL_OC_GTK_MENU_SHELL_APPEND(void *menu, void *item)
{
    gtk_menu_shell_append(GTK_MENU_SHELL(menu), item);
```

```
    return;
}

/* 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 */
void
CBL_OC_GTK_ENTRY_SET_TEXT(void *entry, char *text)
{
    gtk_entry_set_text(GTK_ENTRY(entry), text);
    return;
}

/* 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 */
void
CBL_OC_G_SIGNAL_CONNECT(void *gobj, char *sgn, void (cb)(void *, void *), void *parm)
{
    g_signal_connect(G_OBJECT(gobj), sgn, G_CALLBACK(cb), parm);
}

/* add object to container */
void
CBL_OC_GTK_CONTAINER_ADD(void *window, void *gobj)
{
    gtk_container_add(GTK_CONTAINER(window), gobj);
}

/* tell gtk that object is now ready */
void
CBL_OC_GTK_WIDGET_SHOW(void *gobj)
{
    gtk_widget_show(gobj);
}

/* tell gtk to ready all the wdigets */
void
CBL_OC_GTK_WIDGET_SHOW_ALL(void *window)
{
    gtk_widget_show_all(window);
}

/* Some dialogs */
GtkWidget*
CBL_OC_GTK_FILE_SELECTION_NEW(char *title)
{
    return gtk_file_selection_new(title);
}

/* the event loop */
void
CBL_OC_GTK_MAIN()
{
    gtk_main();
}

/* stop the gui */
void
CBL_OC_GTK_MAIN_QUIT()
{
    gtk_main_quit();
}
```

A screenshot with added menu and file dialog after hitting File -¿ Open

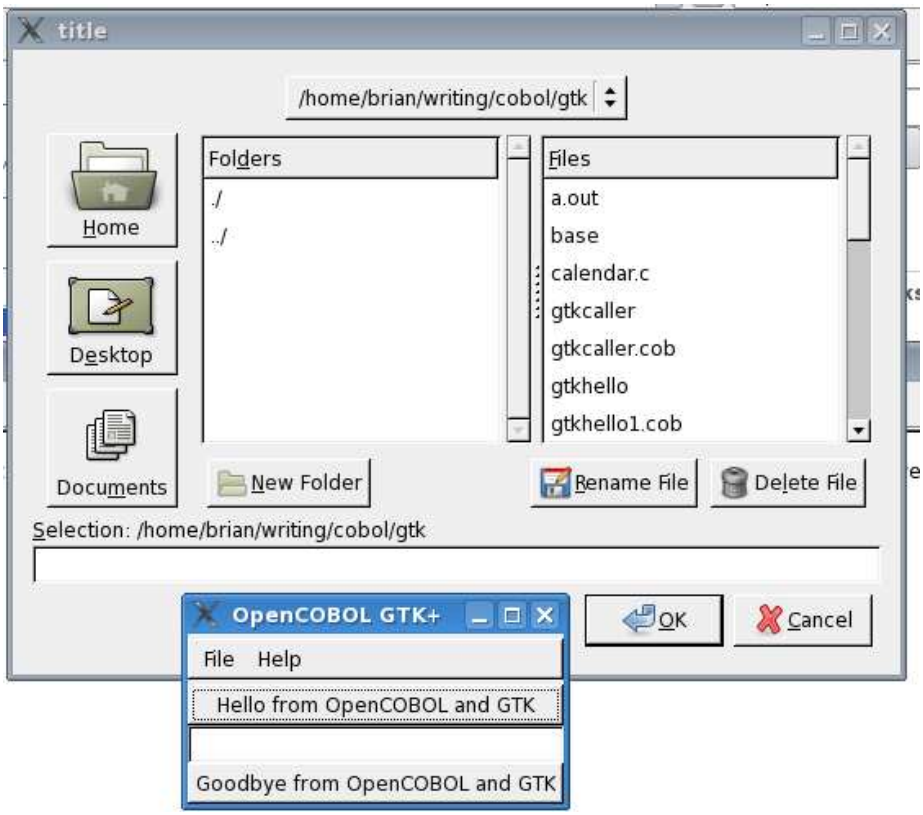


Figure 5.8: OpenCOBOL with GTK+ file menu

5.53.1 A web browsing widget embedded in OpenCOBOL?

Yep.

A short sample, made for OpenCOBOL 1.0's first birthday, Dec 27th, 2008.

Listing 5.84: OpenCOBOL GTK+ HTML rendering

```
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;
}
```

Figure 5.9: Happy Birthday 1.0 OpenCOBOL 1.0

And the COBOL:

Listing 5.85: OpenCOBOL GTK+ HTML rendering

```
*> ************************************************************
*> Author:    Brian Tiffin
*> Date:      27-Dec-2008
*> Purpose:   Happy Birthday OpenCOBOL
*> 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.
```

5.54 What is ocsort?

Proof of concept release *as of February 2010*

A powerful external sort utility using OpenCOBOL for the sort engine.

A preliminary version can be referenced through `http://www.opencobol.org/modules/newbb/vi` or directly from `http://oldsite.add1tocobol.com/tiki-download_file.php?fileId=74`

ocsort supports a variety of sorting options, for example::

```
ocsort sort fields"(1,5,CH,A,11,4,CH,A)" use inputfile record f,391 org sq give out
```

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...)
```

The sources include the parser for the ocsort command language.

5.55 When is Easter?

A short program to display the day of Easter for a given year.

Listing 5.86: Display the date of Easter

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ************************************************************
      *> Author:    Brian Tiffin
      *> Date:      17-Nov-2008
      *> Purpose:   Display Easter Day for any given year, 1580 - 2050xx
      *> 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
 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
```

5.56 Does Vim support OpenCOBOL?

Very well. See cobol.vimA.13 for a syntax highlighter tuned for OpenCOBOL.

Vim's Visual Block mode can be very handy at reforming COBOL source code.

Author's choice. `ocfaq.rst` is edited using Vim, Bram Moolenaar's [**?**] `vi` enhancement. See below for some settings that can make OpenCOBOL 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
```

5.57 What is w3m?

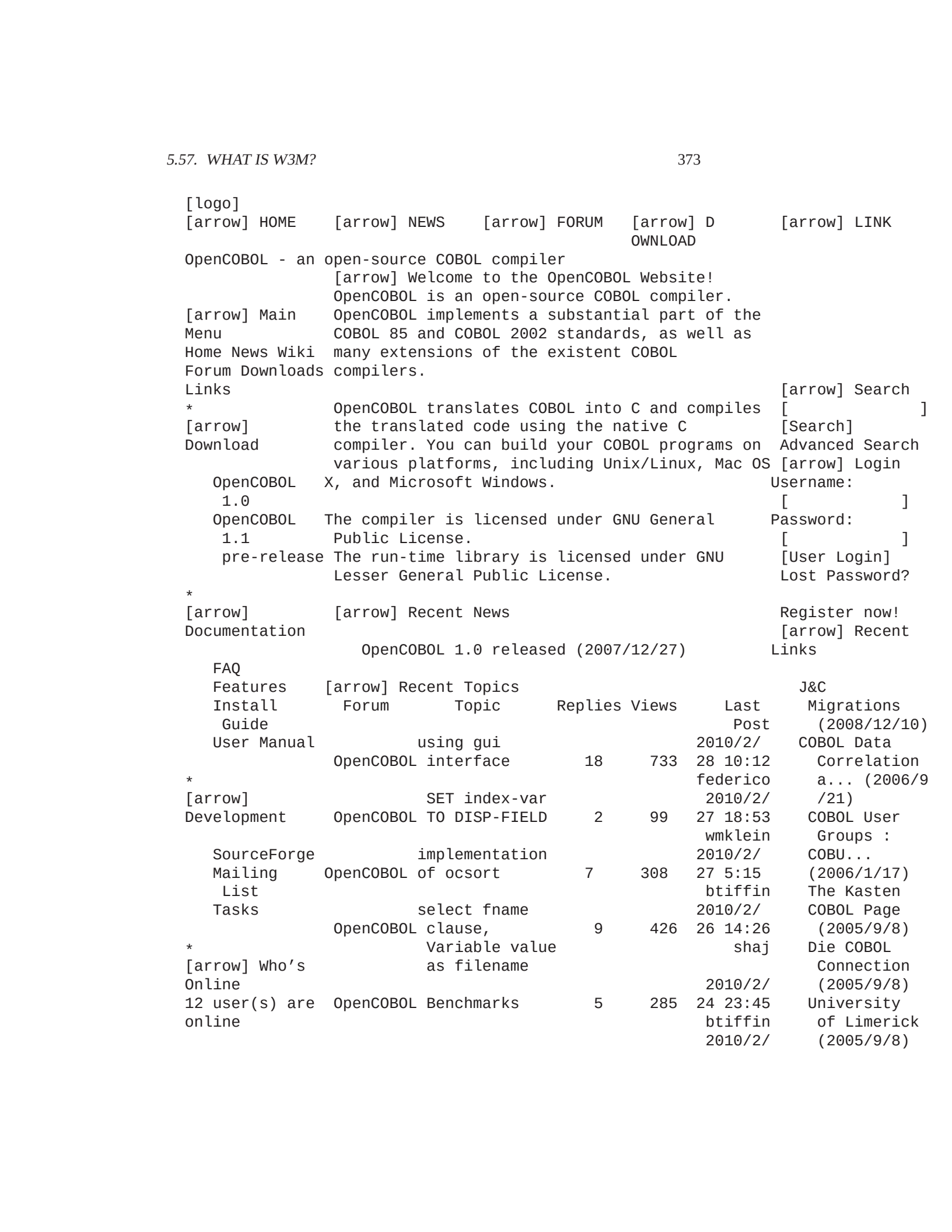
`w3m` is a text based web browser. OpenCOBOL can leverage some of the power of this application by directly calling it with `SYSTEM`.

Listing 5.87: Call w3m and get a web page

```
OCOBOL >>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] DOWNLOAD [arrow] LINK
OpenCOBOL - an open-source COBOL compiler
[arrow] Welcome to the OpenCOBOL Website!
OpenCOBOL is an open-source COBOL compiler.
[arrow] Main Menu
OpenCOBOL implements a substantial part of the COBOL 85 and COBOL 2002 standards, as well as many extensions of the existent COBOL compilers.
Home News Wiki Forum Downloads Links
[arrow] Search
[ ]
[arrow] Download
OpenCOBOL translates COBOL into C and compiles the translated code using the native C compiler. You can build your COBOL programs on various platforms, including Unix/Linux, Mac OS X, and Microsoft Windows.
[Search]
Advanced Search
[arrow] Login
Username:
[ ]
Password:
[ ]
[User Login]
Lost Password?
OpenCOBOL 1.0
OpenCOBOL 1.1 pre-release
The compiler is licensed under GNU General Public License.
The run-time library is licensed under GNU Lesser General Public License.
[arrow] Main Menu
[arrow] Documentation
[arrow] Development
[arrow] Who’s Online
Register now!
[arrow] Recent Links
OpenCOBOL 1.0 released (2007/12/27)
FAQ
Features
Install Guide
User Manual
SourceForge Mailing List
Tasks
[arrow] Recent Topics
Forum
Topic
Replies
Views
Last Post
OpenCOBOL
using gui interface
18
733
2010/2/28 10:12
federico
OpenCOBOL
SET index-var TO DISP-FIELD
2
99
2010/2/27 18:53
wmklein
OpenCOBOL
implementation of ocsort
7
308
2010/2/27 5:15
btiffin
OpenCOBOL
select fname clause, Variable value as filename
9
426
2010/2/26 14:26
shaj
OpenCOBOL
Benchmarks
5
285
2010/2/24 23:45
btiffin
2010/2/
12 user(s) are online
J&C Migrations (2008/12/10)
COBOL Data Correlation a... (2006/9/21)
COBOL User Groups : COBU... (2006/1/17)
The Kasten COBOL Page (2005/9/8)
Die COBOL Connection (2005/9/8)
University of Limerick (2005/9/8)

```
  Members: 1      OpenCOBOL Default Colour    7     327  21 15:32    Stefans
  Guests: 11                                                jgt      kleine
                            OpenCOBOL 1.1                2010/2/     COBOL
  clemcoll,       OpenCOBOL compiler          8     451  20 21:52    (2005/
  more...                   listing                      btiffin    COBOL W
  *                         MOVE loops                   2010/2/     Develo
  [arrow] Powered OpenCOBOL when operands     9     443  20 20:39    (2005/
  by                        are overlaying                 human    Kobol
    SourceForge             [solved]                                 Kompar
                            0MQ (zeromq),                2010/2/     (2005/
       Xoops      OpenCOBOL network           3     223  20 15:12    CoCoLab
                            messaging and                btiffin     (2005/
     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 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 link libraries `ocnewstuff` then `ocstuff`, giving your testing versions priority during development.

5.59 Can OpenCOBOL interface with Rexx?

Yes, ooRexx linkage is commented on at `http://www.opencobol.org/modules/newbb/viewtopic.`

A Regina Rexx layer can be as simple as

Listing 5.88: Embed Regina Rexx in OpenCOBOL

```
/* OpenCOBOL 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;
    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 OpenCOBOL */
    memset(resfield, ' ', reslen);
    if (rexxapiret == 0) {
        memcpy(resfield, retstr.strptr, (retstr.strlength > reslen) ? reslen : retstr.strlengt
        *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, "C
        RXCOMMAND, NULL, &rexxret, &retstr);

    /* set result back to OpenCOBOL */
    memset(resfield, ' ', reslen);
    if (rexxapiret == 0) {
        memcpy(resfield, retstr.strptr, (retstr.strlength > reslen) ? reslen : retst
        *result = rexxret;
    }

    /* 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

Listing 5.89: Call Regina Rexx from OpenCOBOL

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *><* *****************
      *><* Rexx in OpenCOBOL
      *><* *****************
      *><*
      *><* :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 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
*><* ===
*><*
*><* ------
*><* 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
     apicode = function length(function trim(scriptname))
 end-compute
 display
     "CALL Rexx with |" scriptname(1:apicode - 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
     apicode = function length(function trim(cmds))
 end-compute
 display newline
     "CALL Rexx command with |" cmds(1:apicode - 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
     apicode = function length(function trim(cmds))
 end-compute
 display newline
     "CALL Rexx command with |" cmds(1:apicode - 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

Listing 5.90: sample Rexx script

```
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  re
|+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|

CALL Rexx command with |parse arg argument; say '##' || argument || '##';
capture = '';
address system 'cat tectonic && cat verrexx.cmd && ls -l && w3m rexxcaller.html' wi
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 OpenCOBOL 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 OpenCOBOL

 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 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
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
    apicode = function length(function trim(cmds))
end-compute
display newline
    "CALL Rexx command with |" cmds(1:apicode - 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
    apicode = function length(function trim(cmds))
end-compute
display newline
    "CALL Rexx command with |" cmds(1:apicode - 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

|
```

and the ocdoc output at rexxcaller.html

5.60 Does OpenCOBOL 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

Listing 5.91: Demonstrate linear SEARCH

```
OCOBOL >>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 tabler; not really, only a couple
*> populate Ontario and then PEI using different field loaders
 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

Listing 5.92: Demonstrate binary SEARCH ALL

```
OCOBOL >>SOURCE FORMAT IS FIXED
      *> ***************************************************************
      *> Author:    Brian Tiffin, with some suggestions from human
      *> Date:      30-Nov-2008, 02-Dec-2008
      *> 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 100000.
       01 wordlist             based.
          05 word-table occurs 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

 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

       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/
$ ./searchbinary
word to find: abacus
abacus               sorted to +000080466, originally +0000018104 of /usr/
```

See SORT4.1.431 for other examples.

5.61 Can OpenCOBOL handle named pipes?

Yes. Here is a sample, using a tongue-in-cheek `corncob` filename.

Listing 5.93: Demonstrate mkfifo named pipes

```
OCOBOL >>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 atmost times depending on liner
              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
                "OpenCOBOL: " 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
OpenCOBOL: nums.cob
OpenCOBOL: nums
OpenCOBOL: network
[1]+  Done                    ls -d n* > corncob
$ ls -d n*
network  nums  nums.cob
$ date >corncob & ./popcorn
[1] 5037
OpenCOBOL: Sun Apr 11 08:04:48 EDT 2010
[1]+  Done                    date > corncob
```

5.62 Can OpenCOBOL interface with ROOT/CINT?

Yes. The Feburary 2009 pre-release generates acC code that can be loaded by the ROOT/CINT framework. acROOT is a high energy physics data analysis framework released by acCERN. acROOT/CINT embeds the acCINT C/C++ interactive interpreter.

See `http://root.cern.ch/drupal/content/cint` for details.

OpenCOBOL programmers can use ROOT/CINT for interactive testing of COBOL subprograms.

Given:

Listing 5.94: pass arguments to ROOT/CINT

```
OCOBOL >>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. LHC LCG ROOT/Framework (ROOT) preloads the runtime libcob.so. Then it's .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 OpenCOBOL to have an unsigned char pointer as it's 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 OpenCOBOL's RETURN-CODE.

5.62.1 Graphing sample

ROOT/CINT is built for analysis. So, plotting and graphing are built-in.
Given:

```
OCOBOL*>>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.

*> ****************************************************************
*> ****************************************************************
 identification division.
 program-id. cobalpha.

 data division.
 working-storage section.
 01 incobol  pic x(80).
 linkage section.
 01 fromroot pic x(81).

*> ****************************************************************
 procedure division using by reference fromroot.
 display "fromroot: |" fromroot "|" end-display
 move spaces to incobol
 string fromroot delimited by low-value into incobol end-string
```

```
    display "incobol:    |" incobol "|" end-display
    move function ord(fromroot(1:1)) to return-code
    goback.
    end program cobalpha.

*> ****************************************************************
*> ****************************************************************

    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.

*> ****************************************************************
*> ****************************************************************

    identification division.
    program-id. cobmachine.
```

```
data division.
working-storage section.
01 time-field pic 999999.
01 job-field  pic x(4).

*> ****************************************************************
procedure division.
perform 10 times
   display
     "DEBUG: Your time and job " with no advancing
   end-display
   accept time-field end-accept
   accept job-field end-accept
   evaluate time-field also job-field
      when 0800 also 'Army' perform a-late
      when 1200 also 'Army' perform a-lunch
      when 2300 also 'Army' perform a-lights
      when 0800 also 'Baby' perform b-cryandpee
      when 1200 also 'Baby' perform b-cryandpee
      when 2300 also 'Baby' perform b-finally
   end-evaluate
end-perform
goback.

a-late.
   display "You're late! I'm docking 2 hours pay!" end-display
.

a-lunch.
   display "Eats!" end-display
.

a-lights.
   display "Can I sleep yet?" end-display
.

b-cryandpee.
   display "Whaaaa... psssssss" end-display
.

b-finally.
   display "Zzzzzz..." end-display
.
end program cobmachine.
```

which, with `cobc -C`, produces:

```
/* Generated by          cobc 1.1.0 */
/* Generated from        cobparams.cob */
/* Generated at          Mar 06 2011 22:15:57 EST */
/* OpenCOBOL build date    Jan 04 2011 21:39:38 */
/* OpenCOBOL package date  Feb 06 2009 10:30:55 CET */
/* Compile command       cobc -C cobparams.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          "cobparams.cob"
#define COB_PACKAGE_VERSION      "1.1"
#define COB_PATCH_LEVEL          0

/* Global variables */
#include "cobparams.c.h"

static void
cob_decimal_set_uint (cob_decimal *d, const unsigned int n)
{
      mpz_set_ui (d->value, n);
      d->scale = 0;
}

/* Function prototypes */

int cobparams (unsigned char *);
static int cobparams_ (const int, unsigned char *);
int cobalpha (unsigned char *);
static int cobalpha_ (const int, unsigned char *);
int cobfloats (unsigned char *, unsigned char *);
static int cobfloats_ (const int, unsigned char *, unsigned char *);
int cobmachine (void);
static int cobmachine_ (const int);

/* Functions */

int
cobparams (unsigned char *b_5)
{
```

```
 return cobparams_ (0, b_5);
}

static int
cobparams_ (const int entry, unsigned char *b_5)
{
 /* Local variables */
 #include "cobparams.c.l1.h"

 static int initialized = 0;
 static cob_field *cob_user_parameters[COB_MAX_FIELD_PARAMS];
 static struct cob_module module = { NULL, NULL, NULL, NULL, cob_user_parameters,
0, '.', '$', ',', 1, 1, 1, 0 };

 /* Start of function code */

 /* CANCEL callback handling */
 if (unlikely(entry < 0)) {
        if (!initialized) {
              return 0;
        }
        initialized = 0;
        return 0;
 }

 /* Initialize frame stack */
 frame_ptr = &frame_stack[0];
 frame_ptr->perform_through = 0;

 /* Push module stack */
 module.next = cob_current_module;
 cob_current_module = &module;

 /* Initialize program */
 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 *)"cobparams", (void *)cobparams, (void *)cobparams_);
    (*(int *) (b_1)) = 0;
    initialized = 1;
   }
```

```
 cob_save_call_params = cob_call_params;

 /* Entry dispatch */
 goto l_2;

 /* PROCEDURE DIVISION */

 /* Entry cobparams */

 l_2:;

 /* MAIN SECTION */

 /* MAIN PARAGRAPH */

 /* cobparams.cob:17: DISPLAY */
 {
  cob_display (0, 1, 1, (f_5.data = b_5, &f_5));
 }
 /* cobparams.cob:18: MOVE */
 {
  (*(int *) (b_1)) = (*(int *)(b_5));
 }
 /* cobparams.cob:19: GOBACK */
 {
  goto exit_program;
 }

 /* Program exit */

 exit_program:

 /* Pop module stack */
 cob_current_module = cob_current_module->next;

 /* Program return */
 return (*(int *) (b_1));
}

int
cobfloats (unsigned char *b_24, unsigned char *b_26)
{
 return cobfloats_ (0, b_24, b_26);
}

static int
```

```
cobfloats_ (const int entry, unsigned char *b_24, unsigned char *b_26)
{
 /* Local variables */
 #include "cobparams.c.l3.h"

 static int initialized = 0;
 static cob_field *cob_user_parameters[COB_MAX_FIELD_PARAMS];
 static struct cob_module module = { NULL, NULL, NULL, NULL, cob_user_parameters,
0, '.', '$', ',', 1, 1, 1, 0 };

 /* Start of function code */

 /* CANCEL callback handling */
 if (unlikely(entry < 0)) {
       if (!initialized) {
             return 0;
       }
       mpz_clear (d0.value);
       d0.scale = 0;
       mpz_clear (d1.value);
       d1.scale = 0;
       initialized = 0;
       return 0;
 }

 /* Initialize frame stack */
 frame_ptr = &frame_stack[0];
 frame_ptr->perform_through = 0;

 /* Push module stack */
 module.next = cob_current_module;
 cob_current_module = &module;

 /* Initialize program */
 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 *)"cobfloats", (void *)cobfloats, (void *)cobfloats_);
    /* Initialize decimal numbers */
    cob_decimal_init (&d0);
    cob_decimal_init (&d1);
```

```
    (*(int *) (b_14)) = 0;
    memset (b_18, 48, 3);
    {double temp = 0.0; memcpy (b_19, (char *)&temp, sizeof(temp));}
    for (i1 = 1; i1 <= 450; i1++)
      {
      {double temp = 0.0; memcpy (b_20 + 8 * (i1 - 1), (char *)&temp, sizeof(temp));}
      }
    for (i1 = 1; i1 <= 450; i1++)
      {
      {double temp = 0.0; memcpy (b_22 + 8 * (i1 - 1), (char *)&temp, sizeof(temp));}
      }
    initialized = 1;
  }

 cob_save_call_params = cob_call_params;

/* Entry dispatch */
goto l_8;

/* PROCEDURE DIVISION */

/* Entry cobfloats */

l_8:;

/* MAIN SECTION */

/* MAIN PARAGRAPH */

/* cobparams.cob:68: PERFORM */
{
 memcpy (b_18, "001", 3);
 while (1)
   {
    if (((int)cob_cmp_numdisp (b_18, 3, 450) >= 0))
      break;
    {
     /* cobparams.cob:69: COMPUTE */
     {
       {
         {
           cob_decimal_set_uint (&d0, cob_get_numdisp (b_18, 3));
           cob_decimal_set_field (&d1, cob_intr_random (0));
           cob_decimal_mul (&d0, &d1);
           cob_decimal_get_field (&d0, &f_19, 2);
         }
```

```
        }
       }
       /* cobparams.cob:70: MOVE */
       {
        cob_move (&f_18, (f0.size = 8, f0.data = b_20 + 8 * (cob_get_numdisp (b_18,
3) - 1), f0.attr = &a_3, &f0));
       }
       /* cobparams.cob:71: MOVE */
       {
        memcpy (b_22 + 8 * (cob_get_numdisp (b_18, 3) - 1), b_19, 8);
       }
      }
      cob_add_int (&f_18, 1);
     }
  }
  /* cobparams.cob:73: MOVE */
  {
   memcpy (b_24, b_20, 3600);
  }
  /* cobparams.cob:74: MOVE */
  {
   memcpy (b_26, b_22, 3600);
  }
  /* cobparams.cob:75: MOVE */
  {
   (*(int *) (b_14)) = cob_get_numdisp (b_18, 3);
  }
  /* cobparams.cob:76: GOBACK */
  {
   goto exit_program;
  }

  /* Program exit */

  exit_program:

  /* Pop module stack */
  cob_current_module = cob_current_module->next;

  /* Program return */
  return (*(int *) (b_14));
}
/* End functions */
```

Listing 5.95: pass WORKING-STORAGE data structure to ROOT/CINT

```
OCOBOL >>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*.

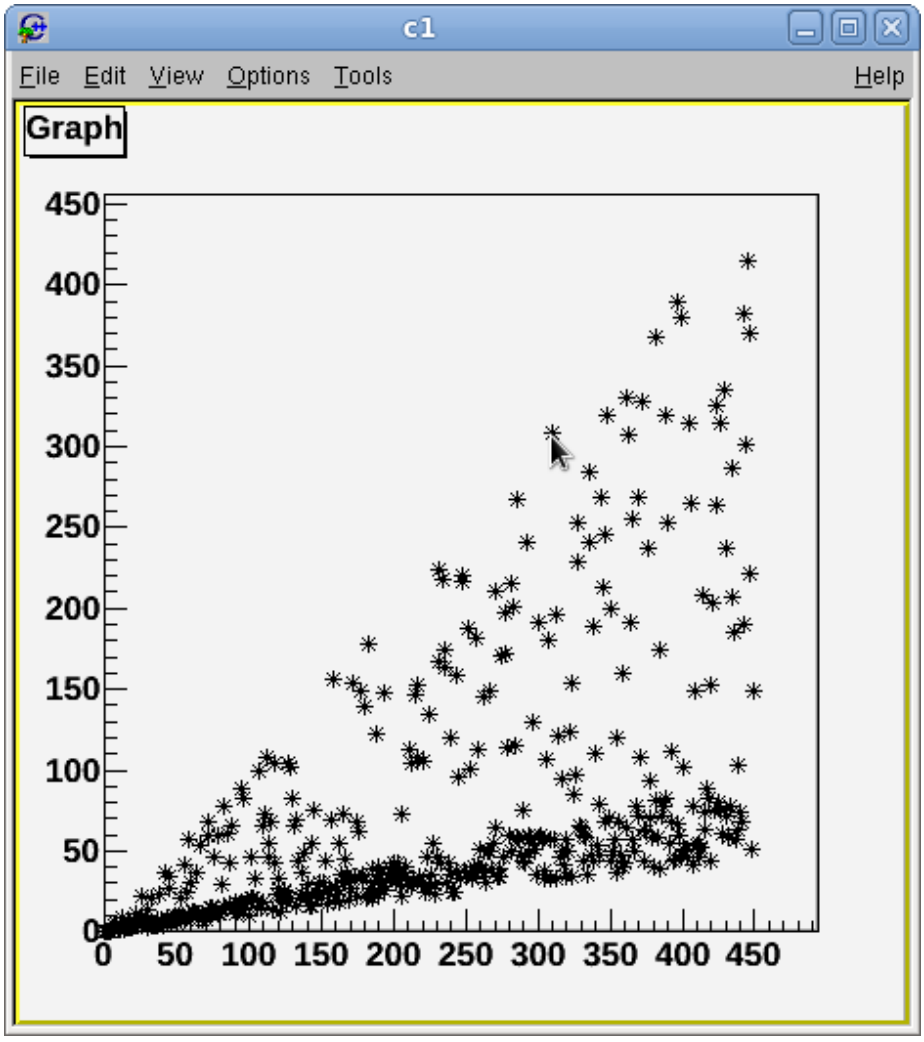


Figure 5.10: constrained random numbers

A trials and tribulations thread can be read at `http://www.opencobol.org/modules/newbb/viewt`

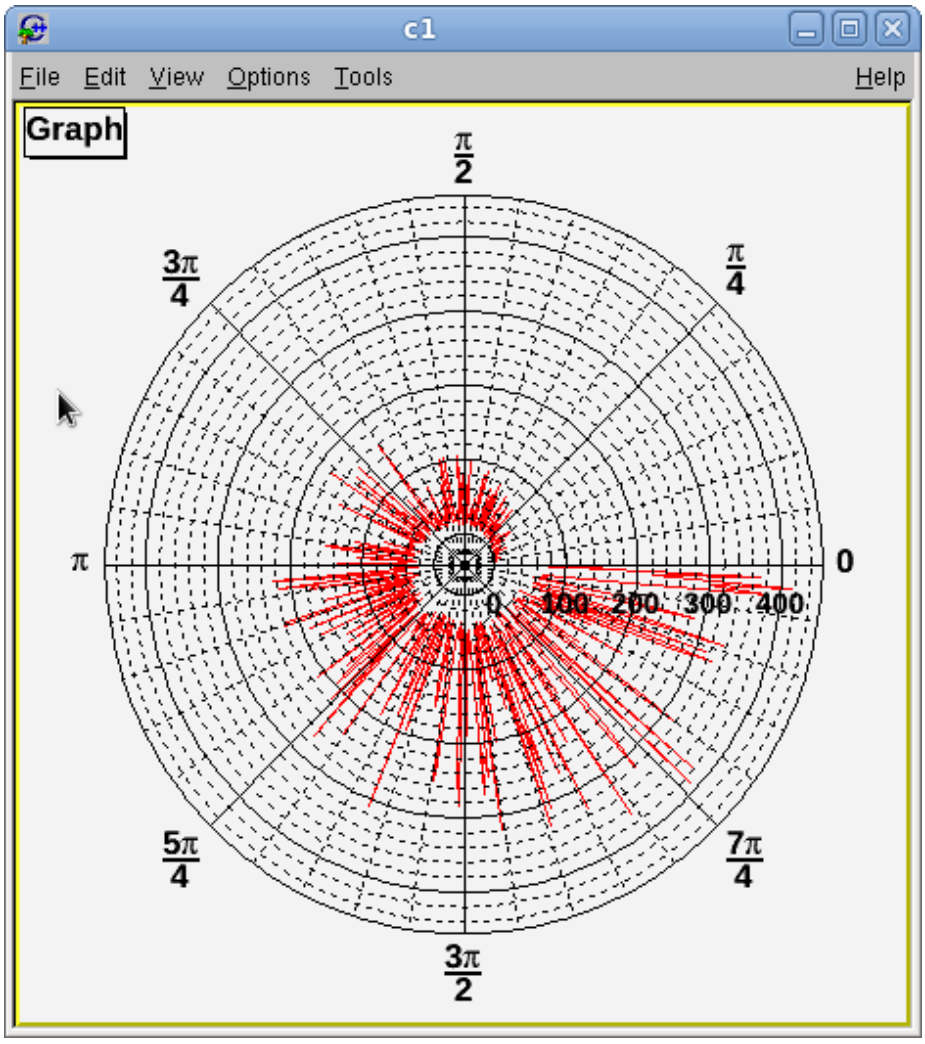


Figure 5.11: polar graph of the same contrained random numbers

5.63 Can OpenCOBOL be used to serve HTTP?

Not directly, COBOL preceding the World Wide Web by some 35 years, but yes.

5.63.1 libsoup HTTP server

Vala and libsoup is one way.

Given `soupserver.vala`

Listing 5.96: Vala libSoup

```
// 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);
}

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;
}
```

Listing 5.97: Demonstrate a libsoup sever

```
OCOBOL >>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
            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
```

You get RESTful screen shots like…

Figure 5.12: ocsouphome

The next steps are getting the `add_handler` callbacks into COBOL, and then play with the template and replace model.

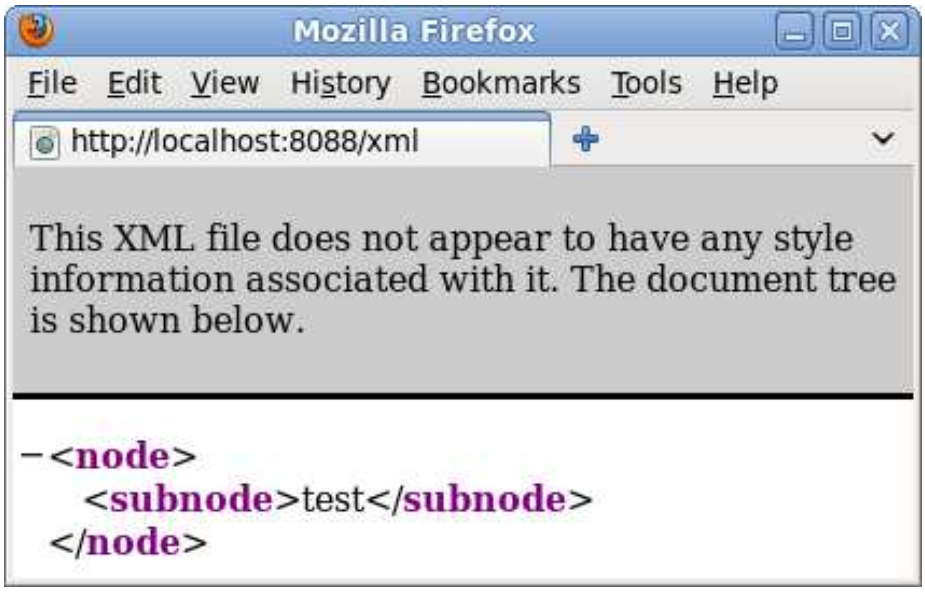


Figure 5.13: ocsoupxml

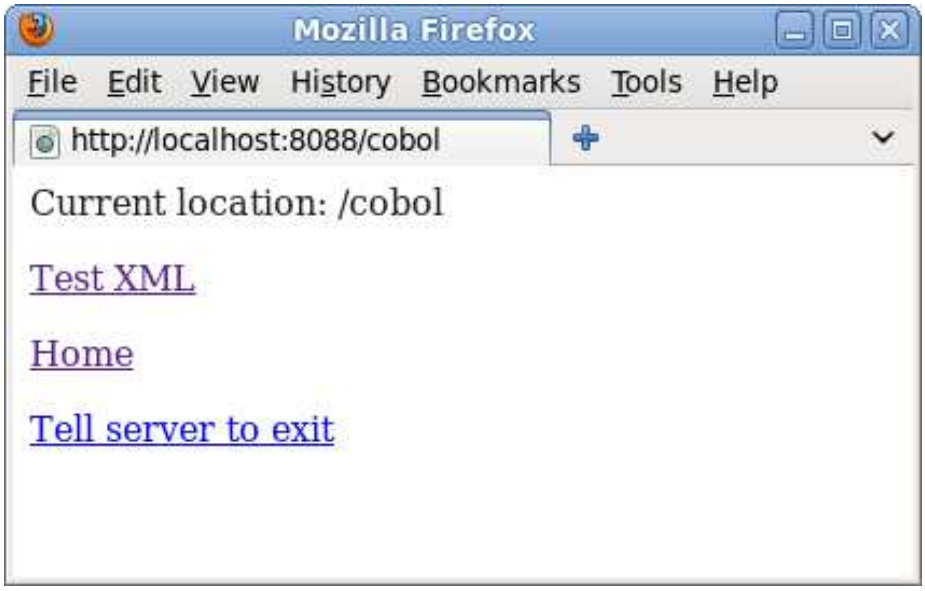
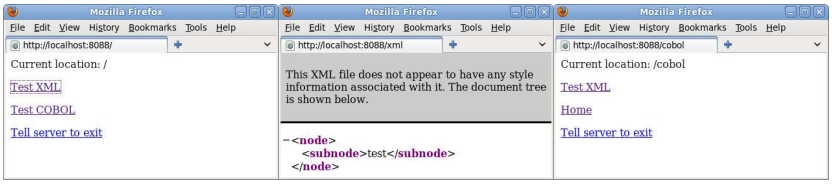


Figure 5.14: ocsoupcobol



(a) ocsouphome (b) ocsoupxml (c) ocsoupcobol

Figure 5.15: ocsoup

5.64 Is there a good SCM tool for OpenCOBOL?

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 OpenCOBOL 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.

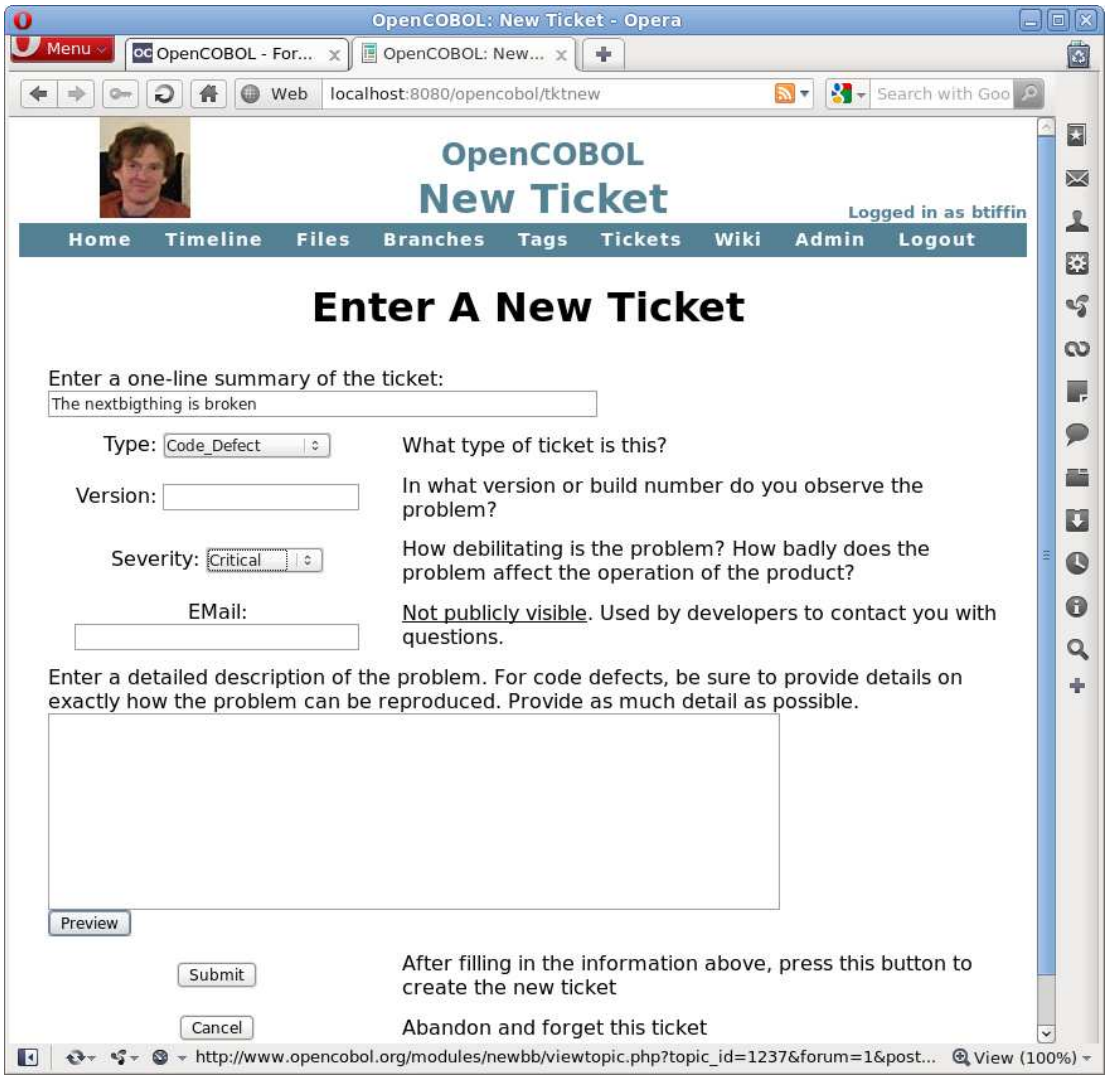


Figure 5.16: Fossil Ticket New

Appendix A

Notes

A.1 big-endian

Binary values stored with the most significant byte at the lowest memory address.

Big End First.

See `http://en.wikipedia.org/wiki/Endianness` for more details.

The OpenCOBOL compiler *default* storage format for USAGE 4.1.495 BINARY 4.1.46 and COMP **??**.

A.2 little-endian

Binary values stored with the most significant byte at the highest memory address.

Little End First.

See `http://en.wikipedia.org/wiki/Endianness` for more details.

This is the common Intel architecture form, and USAGE 4.1.495 clauses of COMPUTATIONAL-5 **??**, BINARY-CHAR 4.1.48, BINARY-SHORT 4.1.51, BINARY-LONG 4.1.50, BINARY-DOUBLE 4.1.49 are a true performance boost on this hardware. See `http://www.opencobol.org/modules/bwiki/i` for some details.

A.3 ASCII

ascii.

The character encoding common to personal computers and the early Internet Age, therefore OpenCOBOL. OpenCOBOL also supports the EBCDIC 4.1.144 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 OpenCOBOL operates using an intelligent choice of encoding for each platform build.

See `http://en.wikipedia.org/wiki/American_Standard_Code_for_Information_Interchange` for more info.

Unicode? OpenCOBOL supports PIC N, a two-byte character field.

A.4 currency symbol

COBOL allows a SPECIAL-NAMES clause that determines the currency symbol. This effects both source codes and input/output PICTURE 4.1.344 definitions.

Listing A.1: SPECIAL-NAMES currency symbol

```
CONFIGURATION SECTION.
SPECIAL-NAMES.
CURRENCY SIGN IS "#".
```

A.5 DSO

Dynamic Shared Object (DSO)
: Similar to but subtly different from *share libraries*.

A.6 errno

OpenCOBOL and C are fairly closely related as OpenCOBOL 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 OpenCOBOL, but a small wrapper along the lines of

Listing A.2: access errno

```
/* set/get errno */

#include <errno.h>

int reset_errno() {
    errno = 0;
    return errno;
}

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

Listing A.3: access errno from OpenCOBOL

```
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 END-CALL
END-IF
```

Outputs::
Numerical argument out of domain

A.7 gdb

The GNU symbolic debugger. Big, deep, wide.

```
$ info gdb for the details.
```

or visit `http://www.gnu.org/software/gdb/documentation/`

A.8 GMP

GMP. GNU Library for decimal arithmetic. See `http://gmplib.org/` for complete details on the library advertised as *Arithmetic without limitations*.

A.9 ISAM

ISAM. A system to allow a variety of access methods for data records in file storage.
See `http://en.wikipedia.org/wiki/ISAM` for more details.

A.9.1 OpenCOBOL FILE STATUS codes

From `http://oldsite.add1tocobol.com/tiki-list_file_gallery.php?galleryId=1` `statcodes.cpy` courtesy of John Ellis.

Listing A.4: File operations Status Codes

```
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'.
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".`

A.10 line sequential

An access method for newline terminated files. OpenCOBOL reads each line and strips off carriage returns and line feeds. Filling the record buffer with the current line and padding with spaces.

A.11 APT

Advanced Package Tool (apt). One of the strengths of the Debian GNU/Linux system. Allows for dependency checked binary packages.

A.12 ROBODoc Support

Below is a sample of a configuration file for using ROBODoc with OpenCOBOL programs.

```
# robodoc.rc for OpenCOBOL
#
items:
    NAME
```

```
    AUTHOR
    DATE
    PURPOSE
    TECTONICS
    SYNOPSIS
    INPUTS
    OUTPUTS
    SIDE EFFECTS
    HISTORY
    BUGS
    EXAMPLE
    SOURCE
ignore items:
    HISTORY
    BUGS
item order:
    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:
    *>
# OpenCOBOL keywords *><*
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
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
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
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
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
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
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
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
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
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.

A.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 ALPHABET ALPH
syn keyword cobolReserved contained ALPHABETIC-LOWER ALPHABETIC-UPPER ALPHANUMERIC ALPHANUM
syn keyword cobolReserved contained ALTERNATE AND ANY ARE AREA AREAS ASCENDING ASSIGN AT AU
syn keyword cobolReserved contained BLANK BLOCK BOTTOM BY CANCEL CBLL CD CF CH CHARACTER CH
syn keyword cobolReserved contained CLOCK-UNITS CLOSE COBOL CODE CODE-SET COLLATING COLUMN
syn keyword cobolReserved contained COMMUNICATIONS COMPUTATIONAL COMPUTE CONFIGURATION CONT
syn keyword cobolReserved contained CONTROL CONVERTING CORR CORRESPONDING COUNT CURRENCY DA
syn keyword cobolReserved contained DATE-WRITTEN DAY DAY-OF-WEEK DE DEBUG-CONTENTS DEBUG-IT
syn keyword cobolReserved contained DEBUG-NAME DEBUG-SUB-1 DEBUG-SUB-2 DEBUG-SUB-3 DEBUGGIN
syn keyword cobolReserved contained DELARATIVES DELETE DELIMITED DELIMITER DEPENDING DESCEN
syn keyword cobolReserved contained DETAIL DISABLE DISPLAY DIVIDE DIVISION DOWN DUPLICATES
syn keyword cobolReserved contained ENABLE END-ADD END-COMPUTE END-DELETE END-DIVIDE END-EV
syn keyword cobolReserved contained END-MULTIPLY END-OF-PAGE END-PERFORM END-READ END-RECEI
syn keyword cobolReserved contained END-REWRITE END-SEARCH END-START END-STRING END-SUBTRAC
syn keyword cobolReserved contained END-WRITE ENVIRONMENT EQUAL ERROR ESI EVALUATE EVERY EX
syn keyword cobolReserved contained EXTEND EXTERNAL FALSE FD FILE FILE-CONTROL FILLER FINAL
syn keyword cobolReserved contained GENERATE GIVING GLOBAL GREATER GROUP HEADING HIGH-VALUE
syn keyword cobolReserved contained I-O-CONTROL IDENTIFICATION IN INDEX INDEXED INDICATE IN
syn keyword cobolReserved contained INITIATE INPUT INPUT-OUTPUT INSPECT INSTALLATION INTO I
syn keyword cobolReserved contained JUSTIFIED KEY LABEL LAST LEADING LEFT LENGTH LOCK MEMOR
syn keyword cobolReserved contained MERGE MESSAGE MODE MODULES MOVE MULTIPLE MULTIPLY NATIV
syn keyword cobolReserved contained NUMBER NUMERIC NUMERIC-EDITED OBJECT-COMPUTER OCCURS OF
syn keyword cobolReserved contained OPTIONAL OR ORDER ORGANIZATION OTHER OUTPUT OVERFLOW PA
syn keyword cobolReserved contained PAGE PAGE-COUNTER PERFORM PF PH PIC PICTURE PLUS POSITI
syn keyword cobolReserved contained PRINTING PROCEDURE PROCEDURES PROCEDD PROGRAM PROGRAM-I
syn keyword cobolReserved contained RANDOM RD READ RECEIVE RECORD RECORDS REDEFINES REEL RE
syn keyword cobolReserved contained RELATIVE RELEASE REMAINDER REMOVAL REPLACE REPLACING RE
syn keyword cobolReserved contained REPORTS RERUN RESERVE RESET RETURN RETURNING REVERSED R
syn keyword cobolReserved contained RIGHT ROUNDED SAME SD SEARCH SECTION SECURITY SEGMENT S
syn keyword cobolReserved contained SELECT SEND SENTENCE SEPARATE SEQUENCE SEQUENTIAL SET S
syn keyword cobolReserved contained SORT-MERGE SOURCE SOURCE-COMPUTER SPECIAL-NAMES STANDAR
syn keyword cobolReserved contained STANDARD-1 STANDARD-2 START STATUS STRING SUB-QUEUE-1 S
syn keyword cobolReserved contained SUB-QUEUE-3 SUBTRACT SUM SUPPRESS SYMBOLIC SYNC SYNCHRO
syn keyword cobolReserved contained TAPE TERMINAL TERMINATE TEST TEXT THAN THEN THROUGH THR
syn keyword cobolReserved contained TRAILING TRUE TYPE UNIT UNSTRING UNTIL UP UPON USAGE US
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 method object static
syn keyword cobolReserved contained class-id class-control private 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

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
  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["']/
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
  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
```

A.14 make check listing

A `make check` from February 2009:

```
## ------------------------------------- ##
## OpenCOBOL 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
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
## ----------------------------------- ##
## OpenCOBOL 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
 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: Alphanumeric and binary numeric              ok
48: Dynamic call with static linking             ok
49: CALL m1. CALL m2. CALL m1.                   ok
50: CALL binary literal parameter/LENGTH OF      ok
51: INSPECT REPLACING LEADING ZEROS BY SPACES    ok
52: INSPECT: No repeat conversion check          ok
53: INSPECT: REPLACING figurative constant       ok
54: INSPECT: TALLYING BEFORE                     ok
55: INSPECT: TALLYING AFTER                      ok
56: INSPECT REPLACING TRAILING ZEROS BY SPACES   ok
57: INSPECT REPLACING complex                    ok
58: SWITCHES                                     ok
59: Nested PERFORM                               ok
60: EXIT PERFORM                                 ok
61: EXIT PERFORM CYCLE                           ok
62: EXIT PARAGRAPH                               ok
63: EXIT SECTION                                 ok
64: 88 with FILLER                               ok
65: Non-overflow after overflow                  ok
66: PERFORM ... CONTINUE                         ok
67: STRING with subscript reference              ok
68: UNSTRING DELIMITED ALL LOW-VALUE             ok
69: READ INTO AT-END sequence                    ok
70: First READ on empty SEQUENTIAL INDEXED file  ok
71: REWRITE a RELATIVE file with RANDOM access   ok
72: SORT: table sort                             ok
73: SORT: EBCDIC table sort                      ok
74: SORT nonexistent file                        ok
75: PIC ZZZ-, ZZZ+                               ok
76: Larger REDEFINES lengths                     ok
77: PERFORM type OSVS                            ok
78: Sticky LINKAGE                               ok
79: COB_PRE_LOAD test                            ok
80: COB_LOAD_CASE=UPPER test                     ok
81: 88 level with FALSE IS clause                ok
82: ALLOCATE/FREE with BASED item                ok
83: INITIZIALIZE with reference modification     ok
84: CALL with OMITTED parameter                  ok
85: ANY LENGTH                                   ok
86: BASED item non-ALLOCATED (debug)             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
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

## ------------- ##
## Test results. ##
## ------------- ##

All 194 tests were successful.
PASS: ./run
```

```
## Run time tests with -O option ##

## ---------------------------------- ##
## OpenCOBOL 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
 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: Alphanumeric and binary numeric                 ok
 48: Dynamic call with static linking                ok
 49: CALL m1. CALL m2. CALL m1.                      ok
 50: CALL binary literal parameter/LENGTH OF         ok
 51: INSPECT REPLACING LEADING ZEROS BY SPACES       ok
```

```
 52: INSPECT: No repeat conversion check          ok
 53: INSPECT: REPLACING figurative constant       ok
 54: INSPECT: TALLYING BEFORE                     ok
 55: INSPECT: TALLYING AFTER                      ok
 56: INSPECT REPLACING TRAILING ZEROS BY SPACES   ok
 57: INSPECT REPLACING complex                    ok
 58: SWITCHES                                     ok
 59: Nested PERFORM                               ok
 60: EXIT PERFORM                                 ok
 61: EXIT PERFORM CYCLE                           ok
 62: EXIT PARAGRAPH                               ok
 63: EXIT SECTION                                 ok
 64: 88 with FILLER                               ok
 65: Non-overflow after overflow                  ok
 66: PERFORM ... CONTINUE                         ok
 67: STRING with subscript reference              ok
 68: UNSTRING DELIMITED ALL LOW-VALUE             ok
 69: READ INTO AT-END sequence                    ok
 70: First READ on empty SEQUENTIAL INDEXED file  ok
 71: REWRITE a RELATIVE file with RANDOM access   ok
 72: SORT: table sort                             ok
 73: SORT: EBCDIC table sort                      ok
 74: SORT nonexistent file                        ok
 75: PIC ZZZ-, ZZZ+                               ok
 76: Larger REDEFINES lengths                     ok
 77: PERFORM type OSVS                            ok
 78: Sticky LINKAGE                               ok
 79: COB_PRE_LOAD test                            ok
 80: COB_LOAD_CASE=UPPER test                     ok
 81: 88 level with FALSE IS clause                ok
 82: ALLOCATE/FREE with BASED item                ok
 83: INITIZIALIZE with reference modification     ok
 84: CALL with OMITTED parameter                  ok
 85: ANY LENGTH                                   ok
 86: BASED item non-ALLOCATED (debug)             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
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

## ------------- ##
## Test results. ##
## ------------- ##

All 194 tests were successful.
PASS: ./run-O
## ---------------------------------------------- ##
## OpenCOBOL 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 ##

## ------------------------------------------- ##
## OpenCOBOL 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-O
==================
All 5 tests passed
==================
```

A.15 ABI

Application Binary Interface (ABI). An acronym that covers the way object code is managed and the expectations of the run-time system. OpenCOBOL 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 OpenCOBOL to link with many existant libraries, more than enough, but does mean that small wrapper access code may be required for access to C++ runtimes.

A.16 Tectonics

I use the expression `tectonics`, *using a definition in the 1913 Webster dictionary* as a basis for the slang describing the code building process. Originally found 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 OpenCOBOL is rock solid and artistically pleasing. Ok fine, I mean **wicked cool**!.

Appendix B

Authors

B.1 Lead Development

Keisuke Nishida
Initial developer and creator of OpenCOBOL. From the 1990's through 2004 Keisuke was the primary developer and OpenCOBOL project lead. His efforts are greatly appreciated by the userbase of OpenCOBOL.

Roger While
OpenCOBOL 1.1 is as of March 13, 2011 in active development, and Roger is the lead programmer. From early 2004, Roger has been very active on the `http://opencobol.org` website, and is open to feature requests and clarifications to the implementation. Roger has, since January 2008, actively monitored an OpenCOBOL 1.1 wishlist on the `opencobol.org` OpenCOBOL forum. OpenCOBOL 2.0 will likely be a Roger creation.

B.2 Maintainers and Contributors

btiffn
Brian Tiffin, this FAQ and sample programs for OpenCOBOL 1.1.

aoirthoir
Joseph James Frantz. Hosting, support and herding the clowder.

jrls_swla
John Ellis. Samples and how-to's and ...

human human. Samples and style, technical assistance.

wmklein
Bill Klein, Keeper of the COBOL FAQ and all round COBOL myth buster.

```
.. These are the external link substitutions.
.. _OpenCOBOL: http://opencobol.org/
.. _opencobol.org: http://opencobol.org/
.. _‘OpenCOBOL 1.0‘: http://opencobol.org/modules/mydownloads/singlefile.php
.. _‘OpenCOBOL 1.1‘: http://www.opencobol.org/modules/mydownloads/singlefile
.. _COBOL: http://en.wikipedia.org/wiki/COBOL
.. _‘COBOL 85‘: http://www.cobolstandards.com/
.. _‘COBOL 2002‘: http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogu
.. _‘COBOL FAQ‘: http://home.comcast.net/~wmklein/FAQ/COBOLFAQ.htm
.. _COBUG: http://www.cobug.com/
.. _OpenCOBOL Install‘: http://www.opencobol.org/modules/bwiki/index.php?Ins
.. _‘OpenCOBOL Wiki‘: http://www.opencobol.org/modules/bwiki/
.. _‘OpenCOBOL Forum‘: http://www.opencobol.org/modules/newbb/
.. _‘OpenCOBOL News‘: http://www.opencobol.org/modules/news/

.. _‘OpenCOBOL Programmers Guide‘: http://opencobol.add1tocobol.com/OpenCOBO

.. _kiska.net: http://www.kiska.net/opencobol/1.1/

.. _ReStructuredText: http://docutils.sourceforge.net/rst.html
.. _Pygments: http://pygments.org/
.. _add1tocobol.com: http://add1tocobol.com
.. _ocfaq.rst: http://opencobol.add1tocobol.com/ocfaq.rst
.. _ocfaq.pdf: http://opencobol.add1tocobol.com/ocfaq.pdf

.. _GIMP: http://www.gimp.org
.. _GTK: http://www.gtk.org
.. _ROBODoc: http://www.xs4all.nl/~rfsber/Robo/robodoc.html
.. _ocrobo: http://opencobol.add1tocobol.com/docs/cobc.html

.. _CUPS: http://www.cups.org

.. _SpiderMonkey: http://www.mozilla.org/js/spidermonkey/
.. _guile: http://www.gnu.org/software/guile/guile.html

.. _‘GNU General Public License‘: http://www.gnu.org/licenses/gpl.html
.. _‘GNU Lesser General Public License‘: http://www.gnu.org/licenses/lgpl.ht

.. _TinyCOBOL: http://tiny-cobol.sourceforge.net/index.php

.. _‘Admiral Grace Hopper‘: http://en.wikipedia.org/wiki/Grace_Hopper

.. _SCM: http://en.wikipedia.org/wiki/Software_configuration_management
.. _Fossil: http://www.fossil-scm.org

.. This section holds replacements and special symbols.
```

```
.. |copysym| unicode:: 0xA9
.. |copyright| replace:: Copyright |copysym|
.. |copyleft| replace:: Copyright |copysym| 2008 Brian Tiffin

.. |PISYM| unicode:: 0x03C0
.. |plusminus| unicode:: 0xB1

.. |currently| replace:: currently *(February 2010)*
.. |KeisukeActive| replace:: From the 1990s through 2004
.. |RogerActive| replace:: From early 2004 up till today, and tomorrow
```

Appendix C

ChangeLog

02-Jul-2008, 06-Jul-2008, 07-Jul-2008, 11-Jul-2008, 13-Jul-2008
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.

17-Jul-2008, 20-Jul-2008, 24-Jul-2008, 28-Jul-2008
Last-last-last 0.0 pre-alpha. Second DIFF. Corrections pass. Expanded the SCREEN SECTION questions. Another correction pass, with clarifications from Roger While

10-Aug-2008, 21-Aug-2008, 28-Aug-2008, 29-Aug-2008, 30-Aug-2008
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

23-Sep-2008
Adds and a trial skin

13-Oct-2008, 15-Oct-2008,19-Oct-2008, 22-Oct-2008, 29-Oct-2008
Added a few samples. Added TABLE SORT sample. Added configure script information. Added dialect configuration information.

28-Nov-2008
OpenCOBOL passes the NIST test suite.

12-Dec-2008, 16-Dec-2008, 21-Dec-2008
Added new links to OpenCOBOL 1.1 binary builds by Sergey. Updated header templates. Added a few keywords.

28-Dec-2008, 29-Dec-2008, 30-Dec-2008
Added info on CobXRef, some debugging tricks and an entry on recursion.

01-Jan-2009, 10-Jan-2009, 12-Jan-2009, 22-Jan-2009
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.

02-Feb-2009, 06-Feb-2009, 09-Feb-2009, 11-Feb-2009
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.

16-Feb-2009, 18-Feb-2009
Added JavaScript, Lua, Guile embedding samples and mention Tcl/Tk, GTK. Added CBL_OC_DUMP sample by Asger Kjelstrup and human

09-Mar-2009, 31-Mar-2009
Added Vala and a few more RESERVED word entries. Added -ext clarification.

17-Apr-2009, 18-Apr-2009, 19-Apr-2009
Clarified -fsource-location option. Added a production use posting. Added START and ISAM sample.

01-May-2009, 09-May-2009, 28-May-2009, 31-May-2009
Started a structural and TOC reorg. Mention S-Lang. Continue re-org. Added some FUNCTION samples. Getting close to a complete Intrinsic list.

01-Jun-2009, 03-Jun-2009, 05-Jun-2009, 28-Jun-2009
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.

29-Jul-2009
more human assisted corrections.

13-Sep-2009
Some printing information.

12-Oct-2009
Added some links, credits.

15-Feb-2010, 20-Feb-2010, 25-Feb-2010, 27-Feb-2010, 28-Feb-2010
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.

01-Mar-2010, 28-Mar-2010
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

04-Apr-2010, 05-Apr-2010, 11-Apr-2010, 15-Apr-2010
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.

05-May-2010, 06-May-2010
Added the SEARCH and SORT sample. Updated Rexx. Image for GNAT GPS.

13-Jun-2010
Reorganized table of contents boxes. Split SEARCH sample source code.

18-Oct-2010, 19-Oct-2010, 24-Oct-2010, 30-Oct-2010, 31-Oct-2010
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.

01-Nov-2010, 06-Nov-2010, 18-Nov-2010, 20-Nov-2010, 27-Nov-2010
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.

12-Dec-2010, 31-Dec-2010
Added libsoup HTTP server sample. Changed EOP file status 52 copy sample. Updated Falcon entry.

02-Jan-2011, 23-Jan-2011
Added errorproc.cob sample. Added some vim and Fossil info.

13-Feb-2011
Fixed an unnecessary css import, small corrections. Added REPOSITORY, CYCLE and FOREVER entries.

06-Mar-2011
LaTeX markup begins.

Figure C.1: rennab QAF LOBOCnepO

Appendix D

Acronyms

COBOL COmmon Business Oriented Language

CERN European Organization for Nuclear Research

C/Int C Interpretter

ROOT LHC LCG ROOT/Framework

COBOL COmmon Business Oriented Language

C C programming language

apt Advanced Package Tool

rpm RedHat Package Manager

FLOW-MATIC FLOW-MATIC programming language

ABI Application Binary Interface

ascii American Symbolic Code for Information Interchange

DSO Dynamic Shared Object

ISAM Indexed Sequential Access Methods

GMP GNU Multi Precision math library, libgmp

ABI Application Binary Interface

Index

Bibliography

[1] Jim Currey. add1tocobol. Technical Advisor, 2009.

[2] Gary Cutler. *OpenCOBOL Programmer's Guide*. 2010.

[3] Joseph Franz. Add 1 to cobol. GPL and LGPL source code, 2010.

[4] Admiral Grace Hopper. Cobol. Standards, 1959.

[5] William Klein. Cobol. FAQ, 2002.

[6] Keisuke Nishida. Opencobol. GPL and LGPL source code, 2002.

[7] Rildo Pragana. Tinycobol. GNU GPL COBOL Compiler for IA32, 2003.

[8] Roger While. Opencobol. GPL and LGPL source code, 2007.