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VOLUME 1, NUMBER 4

DECEMBER 1984

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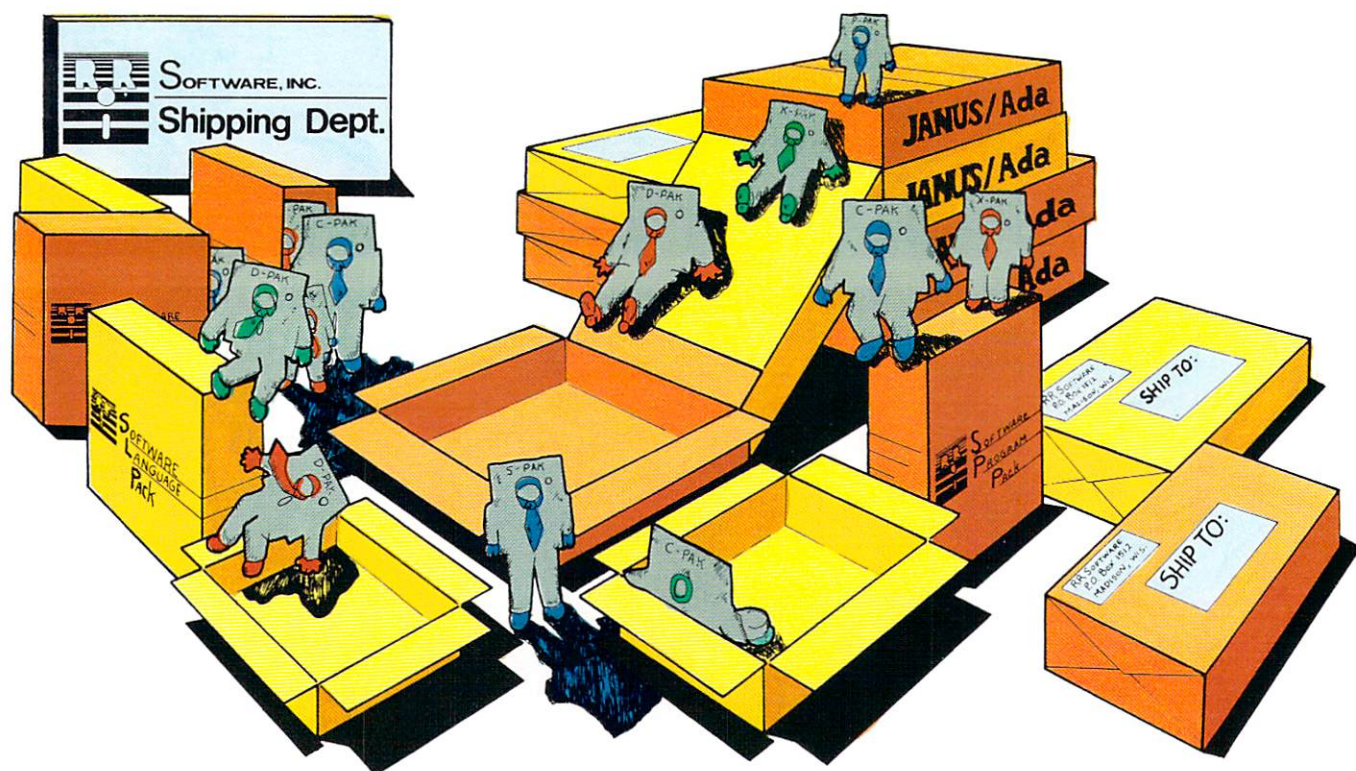
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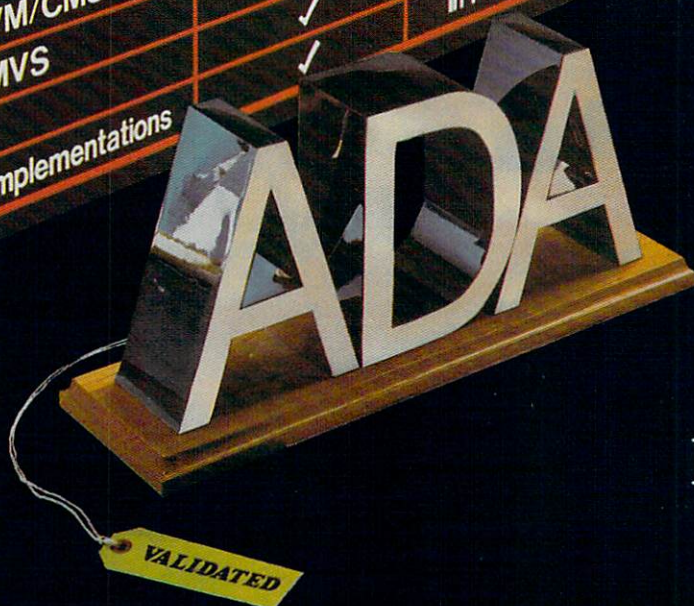
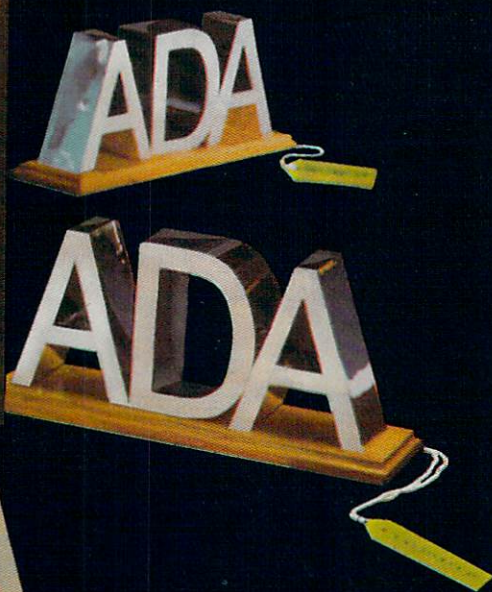
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CIRCLE 74 ON READER SERVICE CARD

COMPUTER LANGUAGE

ARTICLES

Exploratory Programming

by Michael Ham

Coding style is greatly influenced by the syntax and tools provided by the available programming language. As an extensible language, Forth promotes a kind of "revise as you go" coding style that can help programmers discover how to progressively improve the speed and efficiency of their programs.

27

Fred—More than just a macro facility within Framework

by Darryl Rubin

Within Framework, a new integrated software package from Ashton-Tate, exists a programming language named Fred that has many of the powerful features of LISP, Smalltalk, BASIC, and C. Here we discover how to write and run Fred programs and how to develop some useful, undocumented Fred routines.

33

Enhancing Source Code Control under UNIX, Part II

by Luke C. Dion and Alan Filipski

Last month we described how a front-end interface to the standard UNIX SCCS utility set could solve the problem posed when many people are trying to store and access their files simultaneously. In this issue, Dion and Filipski discuss the tools necessary to design and implement such an interface.

41

What Day is It, Exactly?

by Joe Celko

The format for writing dates on a computer is by no means standard. Using Julianized dates, this author provides the various algorithms necessary to establish an accurate, consistent calendar program based on the U.S. military's format for calendar dates.

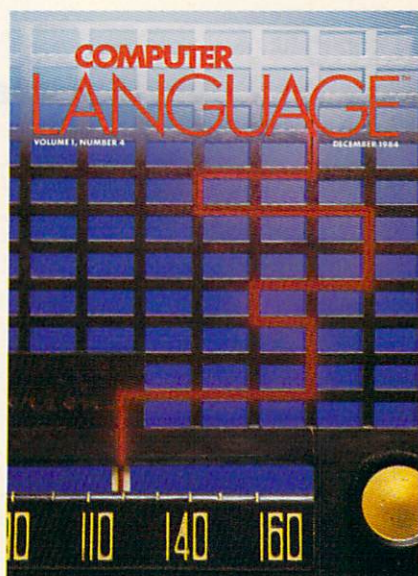
47

Customize your High-Level Language

by Charles K. Ballinger

Assembly subroutines are often designed to interface with high-level programs in order to execute a specific task when called. This author shows how easily such an interface can be achieved by describing how he married Microsoft's COBOL-80 language with assembler to control his printer.

51



DEPARTMENTS

| | |
|--|----|
| Editor's Notes | 5 |
| Feedback | 9 |
| Back to the Drawing Board | 15 |
| Designers Debate | 21 |
| The art of hacking | |
| Public Domain Software Review | 55 |
| Exotic Language of the Month Club | 58 |
| OMNI: One person's language | |
| ComputerVisions | 63 |
| Bill Godbout, chairman and CEO of CompuPro | |
| Software Reviews | 69 |
| A comparison of six Pascal compilers | |
| Advertiser Index | 80 |

WHY DEBUG YOUR PROGRAM IN ASSEMBLY LANGUAGE WHEN YOU WROTE IT IN ONE OF THESE...

ATRON Announces Source Level Software Debugging

Without source level debugging, the programmer must spend time mentally making translations between assembly language and the C, PASCAL, or FORTRAN source code in which the program was written. These tedious translations burn up valuable time which should be spent making critical product schedules. The low level hex and symbolic debuggers available today are superseded by ATRON'S solution — Source Probe.

HOW TO SINGLE STEP YOUR SOURCE CODE AND KEEP CRITICAL DATA IN VIEW

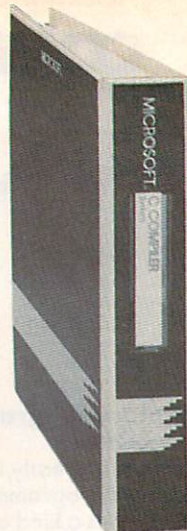
With Source Probe, you can step your program by source code statements. While stepping, a window which you define can display critical high level data structures in your program. The next several source code statements are also displayed to give you a preview of what the program will do

HOW TO DISPLAY DATA IN MEANINGFUL FORMATS

Why look at program data in hex when you defined it to be another data type in your program. Source Probe provides a formatted print statement to make the display of your variables look like something you would recognize. You can specify data symbolically too.

FIND A BUG — FIX IT RIGHT NOW

Source Probe provides an on-line text editor to allow you to log program corrections as you find them while debugging. With on-line display and editing of source files, the time lost printing and looking through program listings can be eliminated.



A SNAP SHOT OF REAL TIME PROGRAM EXECUTION — BY SOURCE CODE !

When Source Probe is running on ATRON'S PC PROBE hardware, the real time execution of the program is saved. You can then view your source code as it executed in real time — including all the changes the program made to your data variables.

HOW TO FIND A BUG WHICH OVERWRITES MEMORY

When running on PC PROBE, the Source Probe can trap a bug which overwrites a memory location. Because complex pointers are normally used in high level language programming, this bug occurs frequently and is very difficult to find.

A BULLET PROOF DEBUGGER

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CIRCLE 4 ON READER SERVICE CARD

Editor's Notes

Today a growing number of people are becoming involved in the art and science of programming. Many of the new entrants to our industry are unaware of the time when hobbyists would wire wrap their own printed circuit boards on workbenches in their garages to produce homemade, single-board systems that had a only few kilobytes of memory to play with.

Back in 1975, mainframe programming was for the privileged few who had the clearance badges to those sacred, sterile computer rooms in large corporations and government facilities.

The microcomputer world has taken a few quantum leaps since then, and many people today feel that small systems programming issues have become even more complex than mainframe issues. The technical hurdles that now face programmers challenge intellectual and creative abilities to an extreme.

For example, in the programming world of the 1980s, debates are fierce on whether the C programming language is only good for systems programming jobs and whether "big" languages like Ada and COBOL can ever be successfully implemented in their standard forms on a microcomputer.

COMPUTER LANGUAGE will continue to be a forum for the discussion of issues like these and other subjects that are important to today's programmer.

On that point, this month I'd like to announce our plans to begin publishing theme issues on an planned basis. We are now in the process of designing a 1985 editorial calendar that will map out our future coverage of subjects judged to be of current interest to people in our industry.

Next February we will begin with our first theme issue, which will be devoted to C. We have tentative plans for theme

issues on BASIC, Modula-2, artificial intelligence, COBOL, and exotic languages in the following months.

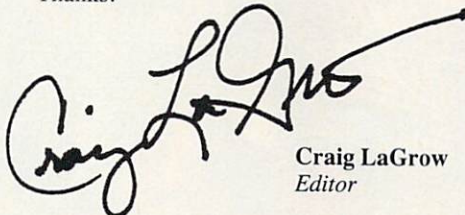
Each theme issue will also include a product wrap-up table that will analyze all the important products in the field being covered (e.g., compilers/interpreters for all language-oriented issues). In the Software Reviews department this month, we begin this product analysis strategy with our review of six Pascal compilers.

Also in the works for next year will be our first East Coast **COMPUTER LANGUAGE** technical seminar on C. Geared primarily toward experienced C programming professionals, this seminar will feature lectures and workshops led by well-known figures in the C world.

We are also considering sponsoring other technical speaking events in major cities around the country. What would you like to see covered in such a seminar if you were to attend? Who do you think would be the speakers most qualified to lead technical workshops?

I encourage you to write in with your ideas on the subjects you think we should be considering for our upcoming technical seminar and also for future theme issues. Tell us how we might also improve the criteria by which products are compared in our Pascal wrap-up table.

And, in general, now that you've had a chance to see how we've covered programming subjects in the past three issues, I hope you'll continue to write in with your thoughts on how we can better improve our editorial coverage, style, or anything else you might have in mind. Thanks!



Craig LaGrow
Editor

COMPUTER LANGUAGE

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COMPUTER LANGUAGE BBS: (415) 957-9370, 7 bit, even parity, 300/1200 baud. CompuServe account: "GO CLM".

COMPUTER LANGUAGE is published monthly by COMPUTER LANGUAGE Publishing Ltd., 131 Townsend St., San Francisco, CA 94107. (415) 957-9353.

Advertising: For information on ad rates, deadlines, and placement, contact Carl Landau or Jan Dente at (415) 957-9353, or write to: COMPUTER LANGUAGE, 131 Townsend St., San Francisco, CA 94107.

Editorial: Please address all letters and inquiries to: Craig LaGrow, Editor, COMPUTER LANGUAGE, 131 Townsend St., San Francisco, CA 94107.

Subscriptions: Contact COMPUTER LANGUAGE, Subscriptions Dept., 2443 Fillmore St., Suite 346, San Francisco, CA 94115. Single copy price: \$2.95. Subscription prices: \$24.00 per year (U.S.); \$30.00 per year (Canada and Mexico). Subscription prices for outside the U.S., Canada, and Mexico: \$36.00 (surface mail), \$54.00 (air mail)—U.S. currency only. Please allow six weeks for new subscription service to begin.

Postal information: Second-class postage rate is pending at San Francisco, CA and additional mailing offices.

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Jerry Pournelle,
Byte, July 1984

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Bruce Webster,
Softalk IBM: March 1984



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CIRCLE 77 ON READER SERVICE CARD

FEEDBACK

NSWEEP defended

Dear Editor:

I disagree with Tim Parker's comment about front-end programs for CP/M 80.

He apparently hasn't seen NSWEEP (NewSWEEP), a 12K bundle of dynamite that not only replaces REN, TYPE, PIP, and ERA, but also has such features as squeeze and unsqueeze, sets file status, and more.

Let's see how fast brute force can move half a dozen files to another disk if the names are unrelated so wild cards can't do it with PIP, then erase all of them. Try squeezing three of the six at the same time while unsqueezing the other three! With NSWEEP205 you hit "t" to tag the files you want to move as you space through the alphabetical list of files, "Q" to indicate the squeeze routine, "R" to indicate "reverse", (squeeze the unsqueezed files and unsqueeze the squeezed ones), a drive and user specification for the destination, and NSWEEP does the work. When it's done, hit "a" for retag, "e" to erase, "t" to indicate the tagged files are the ones to erase, and "n" to indicate no prompting before erasing.

Now I'll grant that you could write a submit file to do it, or with ZCPR or some other program you could use multiple commands on a single line, but you'll spend a lot more time doing it and if you misspell one of the names of the files you'll be done in. NSWEEP lets you view or print out squeezed files without having a separate program for that function or unsqueezing the files first.

SWEEP version 4.0 ran about 28K and had fewer features than NSWEEP at 12K. DISK and WASH are primitive by comparison.

By the way, NSWEEP told me how many K bytes the programs to be copied were (cumulatively) and a simple mash on two keys would tell me whether there was space enough on the destination drive, though I wouldn't have the size of files before/after squeezing if I were doing that at the same time. If true programmers eschew these easy features, it's no wonder so many programs are lousy.

Benjamin H. Cohen
Chicago, Ill.

Oooops

Editor's Note: To err is human, right? In our November issue we published a letter from Gary Nemeth of Cleveland, Ohio, that was supposed to include a Forth version of the Quicksort algorithm. Instead, we re-published the Fortran version of an issue earlier. Our humble apologies.

Will the real Forth Quicksort please stand up? Presented in Listing 1 is Nemeth's Forth Quicksort, which was converted to IBM PC display management. In this version, the data-dependent words COMPARE and EXCHANGE are factored. The first line is the machine-dependent part and thus must be ported (debugged first). The rest of the program will run on any Forth computer.

Promotional cover

Dear Editor:

I was getting a little worried about your monthly publication after three months had gone by. Recently, however, I have begun to receive *COMPUTER LANGUAGE*.

I was a little upset at first because the first issue I received was the premier issue (the one I had purchased at the book store). But I reread it and passed it on to a friend. Soon my second issue came. And then there were two, and they were both good.

```
( ECHO RCV>PAD RCVBLOCKS ) ( 8/03/84 GSN)
NEED PRINT2 ( 5/31/84 GSN)
: FRAME BEGIN AKEY ASCII * = UNTIL ;
  VARIABLE PAD 1K ALLOT
: RCV>PAD FRAME 1K 0 DO AKEY PAD I + C! LOOP ;
: .PAD 16 0 DO CR I 3 .R SPACE PAD I 64 * + 64 TYPE LOOP ;
: STASH PAD SWAP BLOCK 1K CMOVE UPDATE FLUSH ;

: RBLOCK RCV>PAD .PAD DUP STASH LIST ;
: RBLOCKS 1+ SWAP DO I RBLOCK LOOP ;
: XBLOCK PRINT2 ." *" BLOCK 1K TYPE ME ;
: XBLOCKS 1+ SWAP DO I XBLOCK 4 DELAYS LOOP ;

: =BLOCK RCV>PAD DUP . BLOCK 1K PAD -TEXT ABORT" !@# " ;
: =BLOCKS 1+ SWAP DO I =BLOCK LOOP ;
;S

: QUICKSORT ; ( from Forth Dimensions V5#5 7/26/84 GSN)
NEED FORTH79 NEED RECURSE
: K@ 2* CRTSEG LC@ ; : K! 2* CRTSEG LC! ; VARIABLE MIDDLE
: MIDDLE@ ( a a -- ) OVER - 2/ + K@ MIDDLE ! ;
: COMPARE ( a -- ) K@ MIDDLE @ - ;
: EXCHANGE ( a a -- ) 2DUP K@ SWAP K@ ROT K! SWAP K! ;
: SORT ( a low a high -- ) 2DUP > IF 2DROP ELSE
  2DUP 2DUP MIDDLE@ ( -- 1 h 1 h )
  BEGIN SWAP BEGIN DUP COMPARE 0< WHILE 1+ REPEAT
    SWAP BEGIN DUP COMPARE 0> WHILE 1- REPEAT
    2DUP > NOT IF 2DUP EXCHANGE 1 -1 D+ THEN
    2DUP > UNTIL SWAP ROT ( -- start sl+ el- end )
  2OVER 2OVER - ROT ROT - < IF 2SWAP THEN ( smallest first )
  RECURSE RECURSE THEN ;
: SS ( Sort Screen ) 0 1359 SORT ; ALIAS QSS SS
```

Listing 1.



I have one question: on page 8 of both issues appears an ad for *COMPUTER LANGUAGE*. The ad shows a picture of the premier issue which looks a lot like my premier issue, except its cover is a little different (read totally different). I'm not complaining, it's just those articles in the ad interest me a great deal. I was wondering where I could get that issue (or an explanation). Thank you.

Dan Efron
St. Louis Park, Minn.

Editor's Note: Before we began making preparations to publish the first issue of COMPUTER LANGUAGE, we needed to test the waters with a hypothetical promotional issue. At that point the publisher, Carl Landau, and I were not even sure COMPUTER LANGUAGE would ever come to be.

Since that early time we have published four real issues, yet many readers are also interested in those article subjects which appeared on the promotional cover.

So, in the interests of those who have written in so far with this concern, I have consigned for future publication each and every one of the article subjects referred to on the promotional cover.

In the November issue you may have noticed our natural language processing article, and soon to come will be articles on C screen editors and macro libraries.

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CIRCLE 5 ON READER SERVICE CARD

CL for professionals

Dear Editor:

I have almost finished reading the premier issue of *COMPUTER LANGUAGE* and am surprised and extremely delighted with it. This is the only publication I have read that is targeted to the professional software designer.

The article on True BASIC was quite an eye catcher as I have been using a language almost exactly like it for several years. BASIC09 (Microware Systems, Des Moines, Iowa) contains the constructs for structured programming, the ability to create library functions and link to them at run time, and most of the other desirable features in True BASIC. In addition, BASIC09 has an interactive editor to catch the simple mismatched quotes or misused keyword, as well as a compiling debugger to pick up the likes of unterminated structures and other logical errors. BASIC09 produces a compiled "I code" upon exiting the editor and need not be compiled each time the program is run.

Don Loughlin
Hauppauge, N. Y.



More on mainframes

Dear Editor:

Before I say anything negative, I want to say quickly that I think *COMPUTER LANGUAGE* is very successful, and the proof of my high opinion of your work is that I am willing to spend the time to write this letter.

If I have any overall reservations with *COMPUTER LANGUAGE* it is that the premier issue is too oriented toward microcomputers. The old world of mainframes and so on may be duller but it remains and will probably always be the place where most of the computing (and programming) is done.

Your layout is attractive and intelligent; I like it. Your articles are so-so. One bad sign is a tendency toward quick superficial articles. I would say that there is a minimal market for a popular magazine on computer languages and *COMPUTER LANGUAGE* must be at least as technically tough as the *Scientific American* (more would be better).

David Kleinecke
Santa Barbara, Calif.



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*Times courtesy of Dr. David Clark
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SNOBOL, LISP, and OASIS

Dear Editor:

This is my second time on your BBS (first time was some months ago). I am very impressed with the first two issues of your magazine—keep up the good work.

I am also impressed with the concept of and the services available on your BBS. I would enjoy seeing some articles in *COMPUTER LANGUAGE* on SNOBOL replacements (ICON and SL-5) and on the new implementation of LISP, Common LISP. Also, I would very much like to see some coverage of the OASIS operating system from Phase One Systems and OASIS Technology. I use OASIS regularly, and I feel it is one of the best (albeit poorly known) operating system available for Z-80 micros.

Larry A. Schrupp
Colstrip, Mont.

He'll pay the bill

Dear Editor:

I ordered your magazine with the intention of taking the first issue and cancelling. Your ad plan worked; I am hooked. *COMPUTER LANGUAGE* has a "feel" unlike any other computer maga-

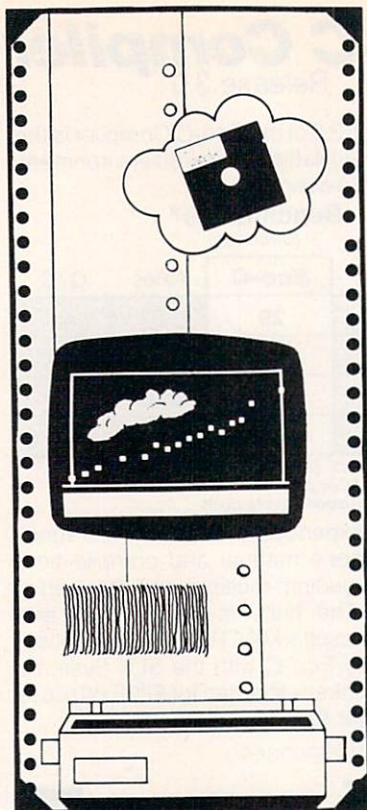


Illustration: Anne Doering

zine I've read. I'll still take *BYTE*, but I'm going to pay your bill when it comes.

Thanks for a good magazine and the Bulletin Board Service. Both are valuable to me. Your setting up this board is part of the philosophy that gives you that different feel.

Lance Reichert
Dayton, Ohio

Suggestions for the future

Dear Editor:

Thanks for an excellent magazine and for your progressive use of bulletin boards. I have a couple of suggestions for future issues:

- An EDITORS section. This could compare editors (vi, emacs, teco . . .) in the same manner in which you compared C and Forth in the first issue.
- A TOOLS section to look at things like Smart-C for automating programming tasks.
- A CODE LIBRARIES section that discusses things like the Greenleaf C library (not just public domain stuff).
- There are a lot of us Macintosh programmers out here looking for development support tools and information . . . domain stuff.

Ric Ford

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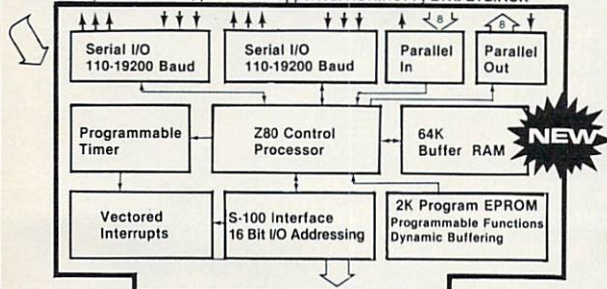
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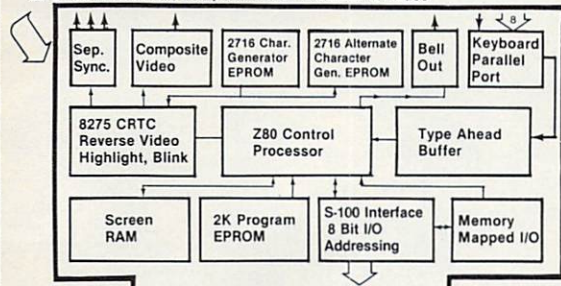
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CIRCLE 41 ON READER SERVICE CARD

BACK TO THE DRAWING BOARD

 **G**reat news! Within just a short time, *COMPUTER LANGUAGE* has become one of the most active SIGs on CompuServe. (You can access *COMPUTER LANGUAGE*'s SIG by typing "GO CLM".)

Now we have an "electronic soapbox" via CompuServe. You can hold forth (pardon the pun) on any subject you want and get immediate reaction. Although Back to the Drawing Board is concerned with problems and solutions, sometimes the black and white distinctions between what's called a problem and what's called an opinion gets a little gray. Let's look at some examples . . .

Jim Kyle, Tim Parker, Ron Bernstein, Barry Boland, John McNamee, Greg Law and I were part of the following conversation on CompuServe under the subject heading Language Wars.

Jim: C should be duck soup for any Pascal programmer! The structure is nearly identical. The major difference, as I keep telling my Pascal buddies, is the lack of strong typing—which is the feature that has kept me, as a systems-level programmer, away from Pascal.

Ron: With so many programmers writing COBOL code eight hours a day, one ought to think twice before PICing on its reputation.

Tim: If I get a few COBOL programmers insulted . . . great! We may get a little heat in the SIG after all. I still would like anyone to defend COBOL as a useful language!

Barry: Give COBOL credit where credit is due. There has to be something for everything else to be better than!

Greg: COBOL, the only program to require 300 lines of initialization per line of code. I programmed in COBOL once and found it a big mistake. I keep the card deck to remind me of that mistake! 800 cards to test memory. Redid it in assembly in about 75 cards. Talk about hassles.

 **N**ext is a thread of messages about a problem every programmer faces: how best to handle documenting right there in the source

code. Parties involved here are Pete Holsberg and Jeff Young.

Pete: It depends on the language. A self-documenting language like Pascal needs (my opinion) only an intro for the whole schmeer, for each procedure, and for each function. You know, "Converts the string in NAME to a . . ." kind of thing.

In assembly language, I like intro comments and lots of in-line comments. The trouble with assembly language is that most mnemonics aren't. One must work with a mnemonic set day in and day out to remember them well enough to figure out what the program is doing. I like the documentation that Intel has on the SDK-85 monitor program.

Now, if you always write in only one or two languages, and you do that constantly, then you will be able to read your own code in your sleep. I'm talking about non-programmer programming: the engineer who wants to write her own application program because there isn't any commercial program available. That person needs great documentation so she can debug the d---d thing!

Jeff: As a professional programmer/analyst, I frequently run across the question, "How much in-line documentation is enough?" The general approach that I and most of the programmers I work with have taken is to insert comments in front of each major section identifying the general function and then further define comments within the section as needed. For a non-programming type person, I would tend to agree with the concept that the program should be documented down to the detail code line. This type of person has a very limited knowledge of programming and could easily get confused as to the actual function of the code.


There is no real way to ensure that the comments have been updated, but if a program change alters the function of a section of code, most programmers will document it with some comment. Any changes that don't alter the function performed should not have to be documented in comments as the code itself would be sufficient.

Pete: But that's exactly the point! It just ain't good enough that "most programmers will document . . . with some comment." It is a fact that maintaining docu-

Electronic soapboxes

By Burton Bhavisyat

mentation is not enforceable; a program that works will work with (a) no comments, (b) good comments, (c) poor comments, and (d) wrong comments!

 **B**y the way, Dennis Sarris of A-FuturDat tells me that he runs a service of writing documentation (in either English or Spanish!) for anyone's programs. He takes your source code, studies it, and comes up with manuals. If you think that concept can release you from some struggling, contact me here at *COMPUTER LANGUAGE*, and I'll line you up with his address.

Getting back to the documentation in source code issue, here's a conversation held recently between programmers John McNamee, Jim Kyle, David Zook, Tim Smith, Pete Holsberg, and Cheyenne Wills.

John: Have you ever seen the source code to the UNIX shell? The guy does lots of things like . . .

```
#define FOREVER for (;;)
#define IF if (
#define THEN ) {
#define ELSE } else {
#define FI }
```

You get the idea. That program doesn't look at all like C, and it is impossible to read. I'm not sure advocating defining FOREVER is such a good idea. The all caps looks terrible in a sea of lower case, and any good C programmer should be able to see *for (;;)* and know what it means (if they can't handle that, they shouldn't be using C).

Jim: Gotta disagree with that last statement, John. It's like saying that anybody who can't drift through a 90-degree bend at 95 mph shouldn't try to learn to drive! The all upper-case #defines are recommended by Kernighan (in *Software Tools* and also in *K&R*) specifically to indicate that what you see is not what the compiler will get, and FOREVER indicates what you were trying to do, while *for(;;)* looks

like you left something out, unless you already know why it's being done.

I have learned the hard way to comment my code extensively and make maximum use of mnemonic variables and defines. When I have to come back next year and maintain it, I'm not the same person I was when I wrote it and need all the help I can get in remembering why I wrote it the way I did. As Kernighan (or maybe Plauger) wrote in *The Elements of Programming Style*, "If you're as clever as you can be when you write the code, how are you

ever going to be able to debug it?"

John: My point is that a program full of upper-case defines can end up looking ugly. The worst case of this is the UNIX shell. Only S.R. Bourne, the author, likes the way it looks. It's a mess for the rest of us who have to maintain it.

Jim: In which case, why not take a good editor to your own copy and sweep through, replacing the *IF*, *THEN*, *ELSE*, etc., references with what they stand for? I agree with you so far as overusing the *define* capability to make C look like some

other language goes, but if it's not made meaningless by overuse, the special-definition technique can add a whole new dimension of readability to a program.

David: I agree with using *FOREVER* and other things to make your intent clear. The more I have to mentally combine several lines of code into one comment that tells what the code does, the worse the language (or the programmer) is. An ideal language can be read top-down, without bottom-up reconstruction of the programmer's intent (as is necessary with *while(1)* or *for(;;)*). C is a long way from being an ideal language, but *define* lets you make it more palatable.

Pete: I agree with you 100%!

Jim: The UNIX shell was written by Steve Bourne, who is (was) quite an ALGOL fan. As a C programmer, I find it very hard to read.

Tim: *for(;;)* is such a common C idiom that there is no reason to rename it.

Pete: But that's just the point: it's idiomatic, therefore less than obvious.

John: But *for(;;)* is so common that any good C programmer should know it. Use *#define* on the hard stuff and leave the basic idioms to the mind of the programmer (any C programmer who can't see *for(;;)* and know what it means probably doesn't have a mind). You have to have seen a program full of new syntax for basic things before you can appreciate how much it gets in the way of understanding the program.

Cheyenne: Just to put my two cents in. When using *defines* and such you are actually redefining the language. That may be fine for you, but think of the person who must then maintain that program. He may know C inside and out, but now he has to learn a new "language." Having been a systems type for some time, working mostly with assembly language, I've come across "assembly" programs that could have been compiled by a PL/I compiler. The number of macros that were used made the program much harder to maintain. Plus, think of it the other way around.

If you have been redefining the language and you have someone learning from that code, that person will be hindered later when he must maintain other code. Not that I'm against using macros—they have their place.

John: That's what I've been trying to say, but very few people seem to agree.

Tim: Pete—All human languages are irregular and complex to some degree. But let's define terms here. An idiom is a phrase whose meaning cannot be directly determined from its constituent words.

In English, the phrase "kick the

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bucket" meaning to die is idiomatic. So *for(;;)* in C is idiomatic only in a weak sense. You can figure out what it means from the language definition, but its meaning is not immediately obvious. I don't think a computer language with a lot of idioms would be very useful, but most computer languages have constructions that are idiomatic in this weak sense, and we just have to learn them to be effective users of the language. Alas, nothing is perfect.

If you've been wondering how to get at all the wonderful data bases full of languages and utilities as mentioned all over the SIG, here's your answer in an exchange between Dan Martin and Tim Parker and a little goodie from Eli Willner.

Dan: So far I've spent about 30 min (\$\$\$) trying to actually find the data bases that are so freely referenced. What menu path do I take to get into them and look at their contents?

Tim: This version of the SIG program doesn't have the menu selection for the data bases, which has led to a bit (!) of confusion. To enter the data bases, type XA # where # is 0 to 10. Then menus appear. Subject headings can be seen by typing "SN" at the main menu.

Eli: This information may help you in your quest for public domain languages.

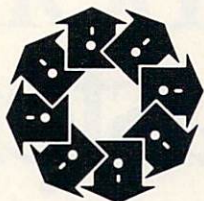
A good source of information is the Digital Equipment Computer User Society (DECUS). This user group is partially sponsored by DEC and has a large software library, all of which is public domain. The library has compilers for Pascal, APL, ALGOL, RATFOR, LISP, C all available in source form. Some are specific to DEC machines, of course, and are written in DEC assembler language. But many are written in high-level languages and can be adapted to other environments.

The UCSD Pascal Users Society (USUS) maintains a library of software which is not public domain but is available to members for non commercial use for a nominal fee (usually on the order of \$5 to \$10 per diskette). This library contains an Ada syntax checker, a LISP interpreter, and an APL interpreter, among many other useful programs. These are written in Pascal.

Membership in DECUS is free; membership in USUS costs \$25 per year. Those interested in joining USUS can check out MUSUS, our SIG here on CompuServe (R SIGUSC from this SIG).

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functional but lacks the enhancements of the current version (separate compilation, concurrency, etc.), was developed under a government grant and is also public domain. This compiler generates p-code but can be adapted without much difficulty to generate native code instead (in fact, many current commercial Pascal compilers used this implementation as their base).

This compiler (which is in Pascal) is available on the PDP-11 SIG on CompuServe (R SIGM11 from this SIG). Membership in the PDP-11 SIG is free;

just leave a message to Sysop with your full name, asking for membership. You will then have access to the on-line software library.

I'm most familiar with the DEC and p-system worlds. I'm sure there are plenty of other PD languages floating around for other machines and OSs as well.



Looking through my mailbox this month, I came across an item of great interest to developers of software for the MAC. The Pro-

grammer's Shop, Hanover, Mass., has installed a bulletin board system (similar to the one here at *COMPUTER LANGUAGE*) at (617) 826-4086 to be used as a forum for discussion related to MAC development.

Among topics being discussed are development software (for the MAC) running on an IBM XT (really, it says that right here), a newsletter, a BASIC compiler, several C compilers, a Modula-2 compiler and miscellaneous utilities. There is no charge for participation in this exchange.

If you've been following the action here on Back to the Drawing Board and on the *COMPUTER LANGUAGE* BBS, you know that we've assembled a group of experts who've volunteered to answer your questions. Every so often, I'll do a little profile on one or two of our volunteer experts.

Dr. Timothy C. Prince, Marblehead, Mass., says, "I would like to volunteer for your list of 'experts.' I have a lot of experience with FORTRAN, medieval and modern, and RATFOR preprocessors on a variety of machines from IBM 7090 to Z80 to 68000 to Floating Point Systems 164.

"I have done quite a bit of patching Z80 code over 8080 code in WordStar and the CP/M BDOS and have developed BIOS code for CP/M 2.2 as well as patches to make non-2.2 .COM files run.

"I've been doing work on FORTRAN to C conversion in order to take advantage of matrix analysis software. Good Luck with your project!"

And from Art Winston, Fort Lauderdale, Fla., comes, "my high touch contribution is knowledge about commercial stock market and commodity data bases such as Quicktrieve and Dow Jones and how to get at them using BASIC, FORTH, and SAS."

Thanks go to Winston and Prince and all our volunteer experts for helping to make the *COMPUTER LANGUAGE* expert forum a success. **i**

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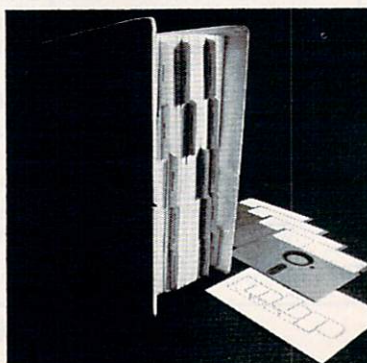
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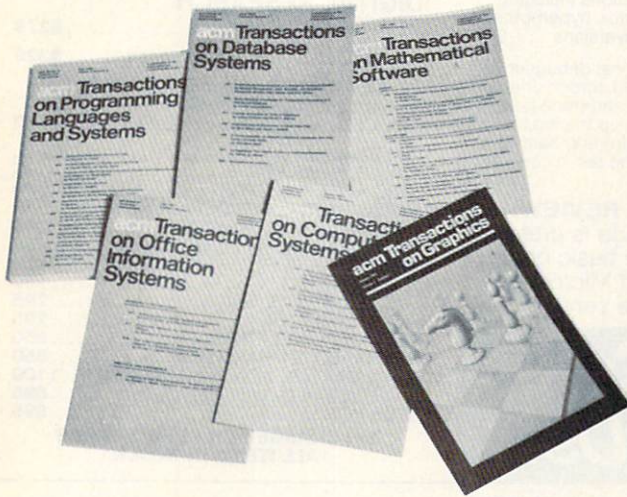
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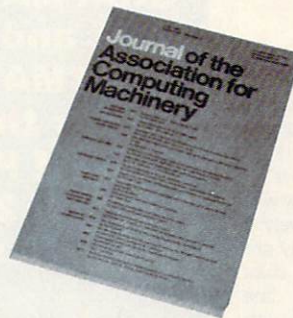
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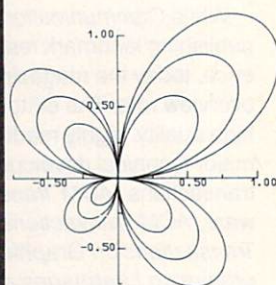
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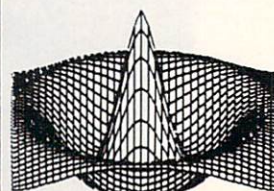
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The art of hacking

By Ken Takara

In the October 1984 issue of *COMPUTER LANGUAGE*, we presented the formal approach to software design. This time, let's look at the other side—the world of the software hacker.

To some, a hacker is merely a sloppy and disorganized programmer. To others, they are highly skilled craftsmen. The general public often associates the term with computer vandals.

This month, dedicated hackers Dale Carlson, Chris Wiley and Dave Pifer describe their techniques and philosophies, providing some insight into that much maligned practice of hacking.

Carlson is a professional engineer who works with real-time processes such as motor controls. Among the projects he has done is the firmware for a microprocessor-driven burglar alarm system.

Wiley prefers to program non-professionally after dark. He is the author of *PC Musician*, a user-supported program for the IBM PC. He considers hacking a high art not found in the production environment.

Pifer's programs are generally written for personal use first and then often published in magazines. He is the founder of Computer Hobbyists Against Raiders and Thieves (CHART), a section of the Writer's and Editor's Special Interest Group on CompuServe. This organization is dedicated to regaining the dignity that hackers have lost due to the media's misuse of the term.

First off, what is hacking? Or, perhaps, what is the difference between a designer and a hacker?

Carlson: A designer makes plans while a hacker makes programs. A designer will lay out the entire project before doing anything else, trying to anticipate everything before it ever comes up. A designer will produce reams of paper, specifications, designs, and so on, describing the project in intimate detail without ever producing anything solid.

A hacker also will try to get a handle on the problem as a whole, but will build a

core upon which the rest of the program can be built. Rather than try to anticipate it all, a hacker will tackle the problems as they arise.

I like to think of hacking as interactive programming—you build the program, interacting with it a lot.

Wiley: For me the important feature is that hacking is an individual thing. It's not a suitable approach for a group project.

But I think it's the most efficient way for a single person to program. This individuality makes hackers difficult to manage. They don't usually fit into a group project too well.

Hacking is highly creative programming, something like writing a novel. I don't think you can truly hack an assigned project because you lose the essence of the creative part: dreaming it up in the first place.

This business of calling computer vandals or burglars hackers is truly appalling. There is a romance to hacking, just as there is to writing novels. But I prefer to emphasize the positive, creative aspects.

Pifer: Hackers are designers. It's just the actual design technique that differs. Typically, a hacker will have spent countless hours going over a project before the first line of code is hacked. However, the hacker's planning usually takes place away from the computer. And almost never will the hacker's planning involve note taking.

True designers sit down for design sessions. They set aside time to think about the design and nothing else. Copious notes will be made and, more importantly, actually referred to while writing the program. I doubt seriously that a designer spends any more time in designing a program than does a hacker. It's just a more conscious effort.

As for preserving the reputation of the true hacker, I can't say enough against the misuse of the term. CHART has been very active in correcting the media when it uses hacker to describe computer criminals.

How do you approach a project?

Wiley: When I program something, I first of formulate at least a set of core

requirements of what I want the program to do. Then I see if I can get it to do that much. I generally use the first algorithm that comes to mind and see where it leads.

Once I get it to do the basic function I've visualized, I can stop and see what further functions or stylistic changes are suggested by using it. So the planning for me very rarely takes place on paper at all. It usually is a matter of thinking about what I want it to do and how I want it to interact in a general way. After that, it's a matter of picking the core functions and constructing a skeleton, then hanging the embellishments onto it.

I don't do any diagramming. Sometimes I'll use a little bit of pseudocode. Generally I can work just as fast by coding directly in C.

Carlson: Usually someone comes to me with a request for a program but doesn't really know what he wants. He'll give me some loose specs and say, "Give me something like this."

If I ask, "How do you want it done?" he'll say, "Do whatever you want to, as long as it works."

So then I have to figure out as closely as possible what he's after. I have to ask questions to get as much information as I can. Then I build a simple prototype that I can show him. It usually helps people to see something. Then he can say, "Oh, change this, add that." And so on.

Once I have an idea of what someone wants, I try to look at the program in its entirety. It's kind of a Gestalt approach to programming. You look at the big picture, then try to break it down into smaller blocks—usually the functional units. Finally I select a block and start coding.

Pifer: All of my projects fall into one of two categories. Either they are short-term, immediate-need programs or long-term, procrastination prone pet projects. Short-term projects involve peeling concepts from my long-term mental log and applying them to the problem at hand. Basically, if you keep enough long-term projects in mind you can build a powerful library of program modules.

The pet projects get a lot more planning put into them. They are nice because they give you something to do while driving to work, or while on hold, or during long meetings. Pet projects are almost always written in my mind before I start them. All that remains is to add bells and whistles and, of course, debugging.

Wiley: Hacking is characterized by its interactive nature. You try something, see if it works, and fix it till it does. I code the main module first, with a few of the core functions, testing them one at a time to see how they work together. Then I either optimize them to work together better or I add other functions.

The danger of coding the way that I do is that you can come up with unforeseen side effects. This is particularly true if you use a lot of global variables. Having been a BASIC programmer, I probably use more global variables in C than I ought to, leading to some bugs to squash.

Carlson: It's important to know how to modularize the program since you obviously can't take the whole thing on at one time.

The most important thing, though, is to select the right block to start with. You want to start with a block that is central to

the program. It will become the core upon which you will add everything else.

Pifer: The true beauty of hacking is that there is no such thing as wasted time or energy. Even if you've written half the program and have to scrap it for a new approach, you know that you will always use the scrap code somewhere down the road.

 **W**hat kind of language do you feel is conducive to hacking?

Carlson: The way I work, it helps to be able to test the core as you build on it. I build, then I like to test before adding more. I can hack in assembler, but it's not easy. I have to write extra code to test the routines.

A language like Forth is a hacker's paradise. You can build a small amount then test it without putting in a whole lot of effort.

Wiley: I used to hack in BASIC on an Apple II. There I ran into the phenomenon that I couldn't read my own code after a while.

Once I moved into the IBM PC world and got a C compiler, I suddenly found that I could hack and get away with it.


The reason is that the modularity of C

imposed a structure itself such that I could break my program down into functions and subroutines that were relatively small and easy to understand.

I've used Pascal. I'm inherently on the lazy side, I guess. I found all the declarations and rigamarole at the beginning of a procedure to be very tedious. With C, I can dive in with the function, then later go back and declare variables that I've used.

Forth is totally incomprehensible, and I've never owned a reverse polish calculator.

Pifer: Of course, BASIC is the ultimate hacking language. You have to respect a language that allows you GOTO GOSUBs and get away with it. But languages such as Pascal and C are also ideal. It goes back to my scrap theory. It is much easier to build a collection of blocks and then read them in as needed for any given project. Someday this collection of program blocks may make my mental notebook obsolete.

 **S**o in hacking you tend to use the build-as-you-go approach rather than the well laid out design-first approach?

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Carlson: Well, you need some sort of design. If you were to really hack without any plan at all, you wouldn't get anywhere. I don't think any hacker is that disorganized. Actually, it's a matter of degree.

I suppose there are some things you can do without any plan, while other things require a great deal of planning.

Wiley: In my experience, my approach of building a skeleton, then hanging the flesh and organs from it, hasn't resulted in my needing to rebuild the whole thing. It's a matter of letting the program evolve, rather than having the perspicacity to sit down and imagine in detail what it will end up as.

I started one program with a general idea of what it should do, then I planned the user interfaces. After that, I had to set up the data structures so that they could be manipulated the way I wanted. That was the extent of my design. Then it was a matter of sitting down at the keyboard and coding.

A lot of designing takes place at the subconscious level, in a dream-like state. I generally keep it in my head. I might draw a rough diagram of the way the screen looks, or I might make a list of

commands just to see that they make sense.

I generally design with my eyes closed, reclining in a chair just thinking about it.

Pifer: As I said before, I believe the hacker is always very well prepared when he sets out to write the program. Personally, I am most careful with the data structures within my programs. My reasoning for this is that as long as I know where and what the data is, there are 1,001 ways to go about getting to it.

Carlson: One problem with designers is the tendency to over-design.

Sometimes a designer will try to anticipate absolutely everything, and that's just impossible. Sometimes it turns out the world doesn't turn the way you thought it did when you laid out the design.

In real-time applications, many things don't show up until you're actually running the program. There are all sorts of hardware dependencies that you may or may not have anticipated.

Depending on how detailed your design is, you may have to go back and change the whole thing. You can end up with twice as much work. Or worse yet, you decide to skimp on the documentation and work on the code, and it all becomes outdated.

Pifer: An important difference between the designer and the hacker is

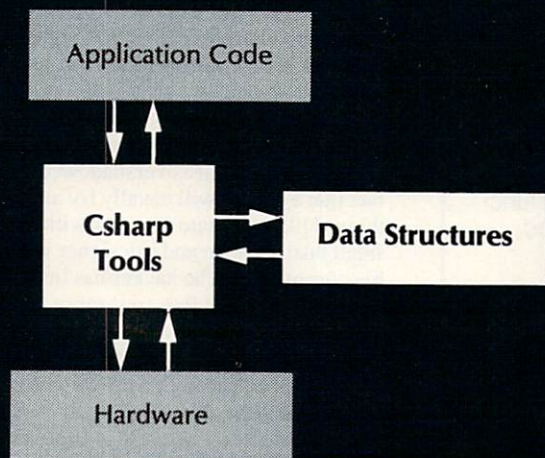
that once the designer attains the design, the program is complete. A hacker's program is never complete. Even when the program is finally debugged and running flawlessly, the hacker will always find a reason to go back in and change or enhance something.

I think this is the primary reason hackers tend to not document or to poorly document their programs. Only lately have I started to fully document my works. I always knew that I should but always postponed it until after the next version. Proper documentation is something that even the commercial developers have not caught on to yet, so how can we expect it of a hacker?

Wiley: I don't document my code. I find if names are long and descriptive enough, just looking at the code is sufficient to remind me of what it does. I find C is very friendly for that.

I think it would be impossible to figure out what was happening in Forth after putting it down for a day. I looked over some code once that was designed and well-commented. I did not find what it was doing immediately obvious. I still had

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to go over it a few times before I could understand it.

Carlson: I prefer to document what I have now, rather than what I think I'll have. There is a need for documentation, of course, but there's no point in making extra work for yourself.

A set of notes to remind yourself of what you're doing is useful. A whole book describing code you haven't even written yet is unnecessary.

Of course, I have to write some sort of manual for the user.

Wiley: If it's a general purpose routine that I'll be using in the future, then I do document it. But that's probably the only time. I don't write many general sub-routines, though. Most of my code is specific to the context of the application. If I need to write general utilities, it's because of a deficiency in the C library.

I have written manuals for the user. My personal feeling is that a program that leads you too much with many menus and prompts slows you down once you understand how to use it. Since I prefer a com-

mand driven program, user documentation is required.

Do you find any limitations to hacking?

Carlson: There is a limit to the size of the project you can take on by hacking. The bigger or more complex it is, the more planning you have to do.

You have to plan more carefully as more people are involved also. It's difficult for two or more people to hack a program together.

When you have a very complex program or a large team, you need to have someone to break the thing down into reasonable blocks or tasks. This person should also design the task interfaces so that everyone involved can talk to everyone else.

But you know, once the designer has done the task specs and designed the task interfaces, someone has got to build it. And that's probably a hacker.

Wiley: My own philosophy of software is of the school that favors small, tight, well-crafted tools rather than the big blunderbuss, do-everything programs. I doubt that I would ever tackle anything too big to think about or keep in my head.

I think this approach results in programs that are more clearly focused and ultimately more useful.

I think a lot of the truly great breakthrough programs are hacked. They may be eventually torn down and redone by committee for a finished version, but I'm sure that something like the first version of VisiCalc was hacked.

It's very hard to imagine any committee coming up with something new and original. That always springs from one creative individual.

Pifer: There are a number of limitations to what can be hacked. But all of these restrictions are overshadowed by the fact that a hacker will usually try anything. I like to equate a hacker with a small businessman and a designer with a big corporation. The hacker has little to lose if an idea falls flat, so is more likely to ignore the fact that what he wants to do can't be done. Fortunately for all of us, there have been enough hackers to keep this industry moving.

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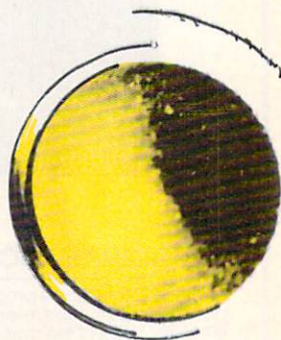
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Exploratory Programming

By Michael Ham

Few computer languages offer a suitable environment for exploratory programming, which follows a winding path through idea and experience, hypothesis and experiment, and definition and test to arrive finally at solid and often serendipitous solutions.

To find the best solution, you must know the problem well. Such knowledge comes only from grappling with the problem and trying various holds. Once you truly understand the problem, through having tried a variety of approaches and solutions, you are able to step back, see the pattern of your experience with the problem, and watch the problem open to reveal its constituent sub-problems, from whose separate simple solutions the final program is quickly constructed.

Many of us are inclined to postpone the awkward first encounters with a new problem, a new situation in which we feel ignorant and vulnerable. Young children lack this fear: they are fascinated by something new and immediately set to work to find out what it can do—they hold it, taste it, shake it, listen to it, throw it, and in general develop a rich set of experience with it so that they can understand it. Somewhere along the way we abandon this method, productive as it is; we put our faith in analysis and acquire a fear of feeling ignorant.

Most computer languages pander to our disinclination to work directly with the problem. They encourage us to spend

time playing with paper—doing specifications, PERT charts, system designs, flow charts, and the like—and only at the very end actually to try to write the program code.

Logo and Forth, on the other hand, were designed to provide an environment that encourages exploratory programming. Logo's designers well understood the mechanisms of learning and were deliberately trying to mold the language to match the exploratory nature of children. Forth's designer was a practicing programmer who was deliberately trying to create a language to maximize his productivity in creating programs.

In Forth, for example, programmers normally begin the design process by writing and trying out various procedures, revising and refining them based on their effects and flaws until they begin to see through these prototypes what the problem truly requires. Only then do they attempt a final implementation, designed in the light of what they have learned. In Forth jargon this is called iterative development. How does Forth encourage this approach?

Exploratory programming is possible only under certain conditions. If the language implementation makes it difficult or tedious to define, compile, and test procedures, then the programmer will avoid writing short procedures because of the overhead effort. Putting more lines of code into a single procedure makes the overhead more tolerable.

Exploratory programming requires the define-compile-run cycle to be easy and quick, with minimal overhead, for only then will programmers write short procedures. It is only when the procedures

are short that they can be immediately and directly grasped by the mind. When the procedures are simple and elemental, they are easily combined with other such procedures to create more complex structures, which themselves are combined into bigger units that fit together ultimately to form the program itself.

Exploratory programming works best when procedures are named and called simply by name. In this way irrelevant mechanisms do not impede or interrupt the dialogue of thought and effect—the interplay between the idea as conceived and as realized. The name becomes (in our mind) the entity, and uttering the name invokes the action. We feel as if we are in immediate and direct contact with our thoughts as they take form in program code, and we watch them grow and evolve in a tiny Darwinian struggle with the problem.

The power of this exploratory approach can be seen in contexts other than programming, of course. Many of us have at some time or another helped in a mass mailing—a newsletter, for example. It obviously doesn't take high-level skills to design a work procedure to fold the letters, address the envelopes, insert the letters into the envelopes, seal the envelopes, and stamp them.

But if you've done this sort of thing, you inevitably find that soon one person is waiting while another struggles to keep up. The optimal solution is most quickly reached simply by setting to work,

observing the bottlenecks, and changing the procedures until things go smoothly. It usually takes three or four attempts before the procedure is completely polished, whereas a priori analysis and design would be more difficult, take longer, and probably produce a less efficient solution.

It is worth noting that the solution arrived at by experiment is optimal in part because it is not overgeneralized—it fits the specific requirements of *this* mailing and the skills and abilities of *these* people. It is important not to try to do too much; in programming as in art, less is often more.

Another example can be seen in forms design. No matter how careful the analysis and how considered the design, the first version of a new form is never right. The form inevitably fails to collect some needed information, a space is too small or too large for what people need to write in it, the layout is confusing, instructions are ambiguous, and so on.

Experienced forms designers quickly learn two lessons. First, when revising a form, they look at completed examples of the current version to discover how the form is actually filled out. Second, they print only a few copies of any new form, knowing the need for some revisions will immediately become obvious when the form is put to actual use. In other words, the designers build into their design cycle early and frequent interaction with the implementation of their ideas.

Yes-or-no Forth example

To look at an example of the exploratory approach in programming, let's examine the development of a new Forth command. Forth is an extensible language, and Forth programs are written by creating new commands and combining them to make new, higher-level commands until the final command is the program. Forth programmers find some commands generally useful in their applications, and they add these commands permanently to their Forth systems. The example given here is a command that would probably be wanted as a permanent addition.

A common exchange in interactive programs is for the program to ask a yes-or-no question and the user to respond. Thus it is convenient to have a yes-or-no com-

mand to collect and edit such a response. Our exploration will follow the evolution of a yes-or-no command in Forth.

The basic yes-or-no (*Y/N*) command is simply an indefinite loop that insists on getting a Y or an N and presents the result to the program:

```
: Y/N (-- n) 0 BEGIN DROP KEY
  DUP 78 = OVER 89 = OR UNTIL;
```

This works well enough. The phrase *0 BEGIN DROP* is a trick that gives a cheap way of setting up for repetitions of the loop. If the loop is repeated, *DROP* gets rid of any invalid input—input not equal to the ASCII values of N (78) or Y (89). The 0 preceding the *BEGIN* gives *DROP* something to work on the first time through the loop. An on-the-spot test (the word is compiled immediately upon the carriage return following the semicolon) shows that the word works as expected: it awaits a keystroke and leaves on the stack the ASCII value of the Y or N that was pressed, ignoring all other keys.

The definition can, however, be improved in several ways. First, the values 78 and 89 seem a bit stark by themselves. A reader of the program may not immediately realize their significance. And, of course, they depend on the base being decimal at the time the block is loaded from disk. Most Forths include the word *ASCII*, which accepts the next character and converts it to its ASCII value. The first enhancement is to replace 78 with *ASCII N* and 89 with *ASCII Y* to improve readability.

Often the output of *Y/N* is used by an *IF ELSE THEN* to pick the appropriate choice of action. In the preceding version of *Y/N*, however, both outputs, being non-zero, signify "true" to an *IF*. Thus the first functional refinement is to follow *UNTIL* with

```
ASCII Y =
```

This phrase makes the final output a true flag (if the input was Y) or a false flag (if the input was an N).

This change makes life easier for the programmer, but the focus of the programmer's attention should be the user. *Y/N* churlishly insists that the input be upper case. It will ignore a lower-case y

or n, even though either makes the user's intention perfectly clear. Programs should be written to respect the clear intention of the user.

One way to do this is to include two additional phrases in *Y/N*'s string of comparisons. These phrases would be placed between the *OR* and the *UNTIL*. The two phrases are:

```
OVER ASCII y = OR    OVER ASCII
n = OR
```

When you have a language such as Forth, however, in which you are defining new commands, a new measure of good design emerges. One must consider which functions should be embedded in the fabric of a given definition and which should be factored out for separate definition, with only their name included in the original definition. Generally speaking, a function that would make a good, elemental, general-purpose command should be given its own identity so that it can be used in any definition as needed.

In this case a better factoring is to isolate the function of capitalization to create a command that will capitalize any alphabetic input. *CAP* can be defined to do the job cheaply through a trick:

```
: CAP ( n -- n ) 95 AND ;
```

You can insert *CAP* into the original definition immediately following *KEY*. Then a lower case y or n will be capitalized before the comparisons with the ASCII values are made. (You should think about why *CAP* works and what it does to non-alphabetic characters.) Now *Y/N* begins to resemble a usable word. What more can it do?

Without going into the details of development (these are left as an exercise for the reader), playing with the command leads to an evolution of refinement, with some subspecies created along the way.

For example, sometimes one wants the flags reversed so that a "no" response leaves a true flag and a "yes" a false flag. An example is the question "Do you want

to try again (Y/N)?" just before the *UNTIL* in a *BEGIN UNTIL* loop. (Of course, you could simply rephrase the question to "Do you want to stop now (Y/N)?" but never mind that.) A command *NO?* is created that accepts only yes or no answers but leaves reversed flags:

```
: NO? ( -- flag ) Y/N NOT ;
```

The definition of *NO?* is simple because we are able to use one of our earlier commands—already developed, tested, and at hand. This is an example of the advantage of an extensible language. Creating the foundation may require some pains, though it is made easier by tackling it in small chunks. As we work our way upward, the tools we command become more and more powerful.

Because *Y/N* will almost certainly be used after a question, its definition next is modified so that it displayed (once only!) the phrase "(Y/N)?" before attempting to collect the user's response. We do this by including the phrase, "(Y/N)?" in front of the *BEGIN*.

If the user will not be working in a situation in which noise is a problem, you might want to signal that an answer is sought by sounding a brief beep. It is easy to add a beep to the word by using your Forth command to sound a bell.

The beep could be made to sound once only (to notify the user an input is requested), even though several invalid inputs are received. Or the beep could sound at each request for input so that if several invalid inputs are received, the user will hear several beeps, one for each new input request. (The "(Y/N)?" display should, of course, occur only once.) In one case the beep is placed with the "(Y/N)?" before the loop, in the other just before *KEY* within the loop.

Sometimes it helps to show the user the response received so that she or he can tell that something has happened. *Y/N* is easily modified so that the response is displayed and then, if it is invalid, the cursor backs up and waits in the original position

for another attempt. (Note that the displayed phrase "(Y/N)?" must then be followed by a blank so the response is not jammed against the question mark.) A useful little word to echo input is easily defined:

```
: ECHO ( n -- n ) DUP EMIT ;
```

This command can follow *KEY* and will echo to the screen the character collected by *KEY*. The program must then backspace the cursor in the event of an error so that the new input will overwrite the old. At this point, the little trick of *O BEGIN DROP* reveals its inherent limitations: it inadequately separates the functions within the loop.

Y/N now has two distinct parts: the normal procedure and the setup for a repeat if the loop has to be retried. For this situation Forth provides the *BEGIN WHILE REPEAT* loop, in which the words between *WHILE* and *REPEAT* are executed only if the *WHILE* received a true flag ("execute the following while true"), and *REPEAT* always returns to *BEGIN*. If *WHILE* gets a false flag, the loop is escaped by execution proceeding immediately to the first word after *REPEAT*. Thus the *WHILE* clause functions naturally as the setup for a repeat of the loop. The definition can then be constructed (Listing 1).

Bells tend to annoy users—no one likes to be beeped at. The preceding word beeps only once, but it can be modified so that a beep occurs only when the input is invalid. If the user makes a valid response the first time, all is blessed silence. We simply move the *BEEP* from its position before *BEGIN* to within the *WHILE* clause—which in effect is before the *KEY* on attempts after the first one.

This latest version might be improved by displaying a message "Invalid

response" when the bell sounds for any invalid response. Note that the message must be blanked out when a valid response is received.

Because Forth, as a compiled language, is fast, it is probably simplest to include a *ZAP* word that prints 16 spaces (enough to wipe out the message) after the *ECHO*—the message can then be redisplayed by a word in the *WHILE* clause if the response is invalid. To the user's eye, the message will barely flicker.

Sometimes a program can help the user by offering a default answer that the user can accept by entering a carriage return. A version of *Y/N* can be written to display a default *Y* and a version to display default *N*, each accepting a carriage return character as being the same as the default answer. (Obviously, if the default is a *Y*, for example, the user must still be able to enter a *Y* with no problem.)

Good factoring suggests that only one version of *Y/N* is needed to offer either default (*Y* or *N*). This is easily done by having *Y/N* expect a logical value that determines the default (for example, true = default *Y*, false = default *N*). The question using *Y/N* can then pass the appropriate value to *Y/N*. The new *Y/N* is defined as seen in Listing 2.

In this transfiguration, *Y/N* accepts a logical flag and then, after printing the question prompt, puts the ASCII value for *Y* or *N* on the stack (*Y* if the flag were true, *N* if false). That value is displayed to the user (with *ECHO*, note how our earlier extensions become generally useful), the cursor is backspaced to rest on the default answer, and *KEY* awaits the user's input.

This time we don't enter the indefinite loop until after we check to see whether the default answer was taken. If the keyed

```
: Y/N ( -- flag ) ." (Y/N)? " BEEP .BEGIN KEY ECHO CAP
  DUP ASCII N = OVER ASCII Y = OR NOT
  WHILE DROP BACKSPACE REPEAT ASCII Y = ;
```

Listing 1.

value was 13 (the ASCII for carriage return, factored out for separate definition as a documentation aid), then there is no need to go through the indefinite loop. The 13 is dropped (to expose the Y or N placed on the stack by the program), we ECHO the Y or N that the carriage return erased on the screen, and then we skip directly to the word that converts the Y or N to a logical flag.

On the other hand, if the user keyed some other value, we don't need our original Y or N. That value is swapped to the top of the stack and then dropped. We enter the indefinite loop, not to exit until a valid response is received. The loop itself has been factored out for separate definition because short definitions are easier to write and offer bugs fewer places to hide. Exploratory programming encourages us to write short definitions and compile and test them immediately—play with them to see what they do—and then use them with confidence.

VERIFY checks the value the user entered and, if it was invalid, continues to collect and edit responses until a valid response is received. Notice that KEY DUP has now migrated inside the WHILE clause (because in this version a KEY has already been done before the loop was entered, so within the loop KEY becomes

```
: CR? ( n -- flag ) 13 = ;
: VERIFY ( n -- n ) BEGIN ECHO CAP DUP ASCII N = OVER
  ASCII Y = OR NOT WHILE BEEP DROP BACKSPACE KEY REPEAT ;
: Y/N ( flag -- flag ) ." (Y/N)? " IF ASCII Y ELSE ASCII N THEN
  ECHO BACKSPACE KEY DUP CR? IF DROP ECHO ELSE SWAP DROP VERIFY
  THEN ASCII Y = ;
```

Listing 2.

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|--|---|---|---|---|
| TEXTFILES (100 Sectors) (791 Strings, 32 chars ea) | TSAVE TLOAD WRITE READ PRINT/READ APPEND | 8.0 6.2 29.3 24.3 44.2 142.3 | NO NO 28.0 16.3 45.9 142.9 | NO NO 88.4 83.8 117.1 1231.2 |
| APPLESOFT (100 Sectors) | *SAVE LOAD | 6.4 5.0 | 16.4 4.0 | 33.1 23.5 |
| INTEGER (100 Sectors) | *SAVE LOAD | 6.6 4.9 | NO NO | 33.4 23.4 |
| BINARY (100 Sectors) | *BSAVE BLOAD | 7.3 5.8 | 18.4 4.8 | 28.7 24.5 |
| 48K PROGRAM SPACE (With 3 Bufs avail) | APPLESOFT INTEGER BINARY | 36.352 36.352 36.352 | NO NO 34.816 | 36.352 36.352 36.352 |
| 64K PROGRAM SPACE (With 4 Bufs avail) | APPLESOFT INTEGER BINARY | 46.592 46.592 46.592 | 32.256 NO 41.728 | 35.756 35.756 35.756 |

*Add 5 seconds for Verify. Apple II, Applesoft & ProDOS are trademarks of Apple.

Ten New DOS Commands

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2. FRE makes ultra-fast garbage collection.
3. DATE stamp files. Clock or manual dating.
4. TLOAD speed loads all Text Files to mem.
5. TSAVE speed saves Text Files from memory.
6. TLIST lists all Text Files to screen/printer.
7. DUMP Binary/Ascii to screen or printer.
8. DISA disassembles Binary to screen/printer.
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a part of the setup for a repetition rather than the normal routine). Note also that in this version the beep is sounded only for invalid input.

Playing with this most recent definition shows that the *CAP* and *ECHO* in *VERIFY* should be interchanged so the user will see a capitalized Y or N (as is shown for the default) even if lowercase were entered. But in that case numeric entries give odd responses until *CAP* is redefined to replace its little trick with a more explicit test. (Note how tricks often fail to hold up as you play and experiment with them; cheap tricks, like cheap toys, are frequently frail.) The new definition for *CAP* is seen in Listing 3.


The user, with this latest definition of Y/N, cannot accept the default value after once attempting some other answer. This is a matter of the programmer's choice, of course, but since we elected to display the invalid response and thus overwrite the default answer, it seems best that the default answer should vanish internally as well so that the program will be consistent with the screen display. It is good practice to match the user's mental model of what is happening. If the value is displaced on the screen, it should no longer exist in the program.

An even better default situation would be for the question to remember the last answer it got and pass that value to Y/N as the default value. Each question could have its own variable in which the last answer is stored. The question passes its variable's address to Y/N, which fetches the value that determines the default and then, after completing its input, stores a copy of the new answer for the next time the question is asked.

A little experience shows that Y/N should be written so that one value of the variable indicates no default is presumed. This value would be the variable's initial value for the first time the question is asked.

The article ends here, but the evolution of the word can continue. Take a moment to reflect, however, that it is unlikely the

programmer would have arrived at this last embodiment of Y/N if he or she had taken the initial specification and immediately designed the word, without playing with the idea and letting it develop and grow.

Exploratory programming allows the programmer to have much experience within the writing of a single program. Hindsight is one of our most powerful tools; exploratory programming allows you to use it early and often. 

Michael Ham has worked in program and systems design, development, and documentation for many years. He currently works in software development at the Scotts Valley, Calif., office of Dysan Corp.

```
: CAP ( n -- n ) DUP ASCII a < NOT OVER ASCII z > NOT AND
IF 32 - THEN ;
```

Listing 3.

(LISP) FOR A.I.

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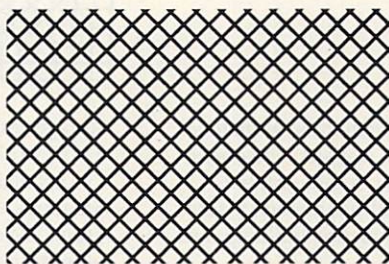
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U N I X S O F T W A R E

Fred

More than just a macro facility
within Framework



By Darryl Rubin

What would you call a language that combines some of the best features of LISP, Smalltalk, BASIC, and C? The developers of just such a language at Forefront Corp. have chosen to call it Fred.

Fred is the programming language component of Framework, the integrated software package distributed by Ashton-Tate for the IBM PC. But Fred is much more than the mere macro facility you might expect from a package rooted in the world of multifunction spreadsheets.

Despite its unassuming name, Fred is a full-featured programming language that lets you manipulate text, numbers, and graphics on the same screen in exciting new ways. Fred puts all of Framework and its flashy multi-windowed environment at your command. The only trick in using it is divining what is missing from its skimpy documentation.

Well sit back and discover.

In this article we'll tour the Fred language, learn exactly how to write and run Fred programs, and develop some useful routines that will make Framework work better for you. We'll even trip across one of Fred's useful but undocumented features.

You can get your own copy of the programs presented in this article by calling the *COMPUTER LANGUAGE* Bulletin Board Service at (415) 957-9370 and downloading the file FRED.FW. If you don't have Framework, download the file FRED.LST instead.

The anatomy of Fred

In the true spirit of integration, Fred pulls together features from several of today's most influential programming languages.

Like Smalltalk, Fred operates in a multi-windowed environment that encapsulates programs and data in displayable objects—frames—that can communicate with each other and be nested hierarchically. For example, you can send data to, display, and then hide a frame as easily as this:

```
@SET(FRAME1,DATA),  
@DISPLAY(FRAME1),  
@HIDE(FRAME1).
```

Like LISP, Fred has a recursive, function-oriented syntax with flexible type binding and the ability to pass a variable number of arguments to a function. Programs are stored and treated like data, so programs can modify and create other programs. Do you recognize this famous function as written in Fred?

```
F(n): @if( @or(n=0,n=1), 1, @F(n-1))
```

Like C, Fred is a free-formatted, block-structured language in which spaces, tabs, and comments are insignificant, as are—believe it or not—character fonts and enhancements (yes, you can italicize and embolden your source text!). Fred's other C-like features are its local and external variables, *if/then/else* and *while* statements, and value-returning assignment operator.

There's even a clever way to write *#DEFINE* macros in Fred, as we'll see. A C programmer should feel right at home with the following Fred statement:

```
@while ;Open a while block  
( ;Condition clause:  
(c := @get(Table)) < > #N/A!,  
; statement:  
total := total + c,  
)
```

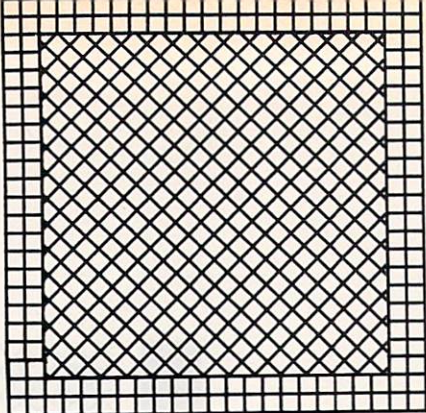
Like BASIC, Fred is an interpretive language with interactive editing and diagnostics features. When an error occurs, Fred shows you the location of the error in the source program and tells you in plain English what went wrong. A *@TRACE* function acts like a super-charged version of the *TRON* and *TROFF* statements of many BASICs. With this and Framework's full-powered word processing at your disposal, you can usually correct and rerun your program in seconds.

Like any full language, Fred has an extensive set of data types, operators, and built-in functions. This is the meat-and-potatoes part of the language, and Fred will leave you, if anything, stuffed.

Framework's manual tells you about Fred's numeric and string data types, but you'll have to read very, very carefully to realize that Fred has arrays and structures, too. (Figuring this out qualifies you to join Mensa.)

Operators include everything you'd expect plus some you don't always get: exponentiator (^), string concatenator (&), range operator (:), and a unique postfix operator, percent (%).

The set of built-in functions defines



description, other than to say it includes functions for math, statistics, business, string manipulation, logic, graphics, sound, print formatting, menus, macros, program control, function building, and frame navigation.

Surely, you say, a language of so many parts must be the Edsel of the eighties, the PL/I of the PC generation. Not at all. Fred is surprisingly clean and straightforward. I would almost call it elegant because many of its features are rooted in a single, underlying construct.

And that is the frame.

What's in a frame

The frame is the unifying construct of Framework. It is at once the basic unit of

storage, execution, and display within the Framework environment.

This makes frames much like objects in Smalltalk. Frames can hold data and programs, be executed, communicate with other frames, and display themselves in overlapping windows. Frames can also be nested hierarchically, inheriting programs and data from their containing, parent frames. This gives Fred a powerful block structuring capability.

A frame is like a two-sided sheet of paper. Side one is the value area that holds whatever data is associated with the frame. This can be a number, string, graphics, spreadsheet tables, data base records, or other (nested) frames.

Side two of the frame is the formula area. It holds the program by which the value part of the frame is calculated or processed. Framework normally doesn't

display this side of a frame, but it is where Fred lives and works.

Any frame can have a formula and be nested inside other frames. You can also associate formulas with spreadsheet cells and data base fields because Framework treats these as frames, too—nested frames to be exact.

Figure 1 shows a Framework desktop with text, spreadsheet, data base, and nested frames. What you're seeing here is the value area of each of the frames. Notice that each frame has a label in its top-left corner. As we'll see later, this is the name by which a Fred program can reference the frame's value area or execute (call) the frame's formula.

The frames labeled UTILS (OUTLINE VIEW) and FRAME VIEW in Figure 1 are examples of frames that contain other frames. In fact, these are two different views of the very same frame. Where UTILS displays its nested frames in outline form (labels only), FRAME VIEW shows the frames themselves. Look carefully—you're getting a sneak preview of the programs we'll be presenting shortly.

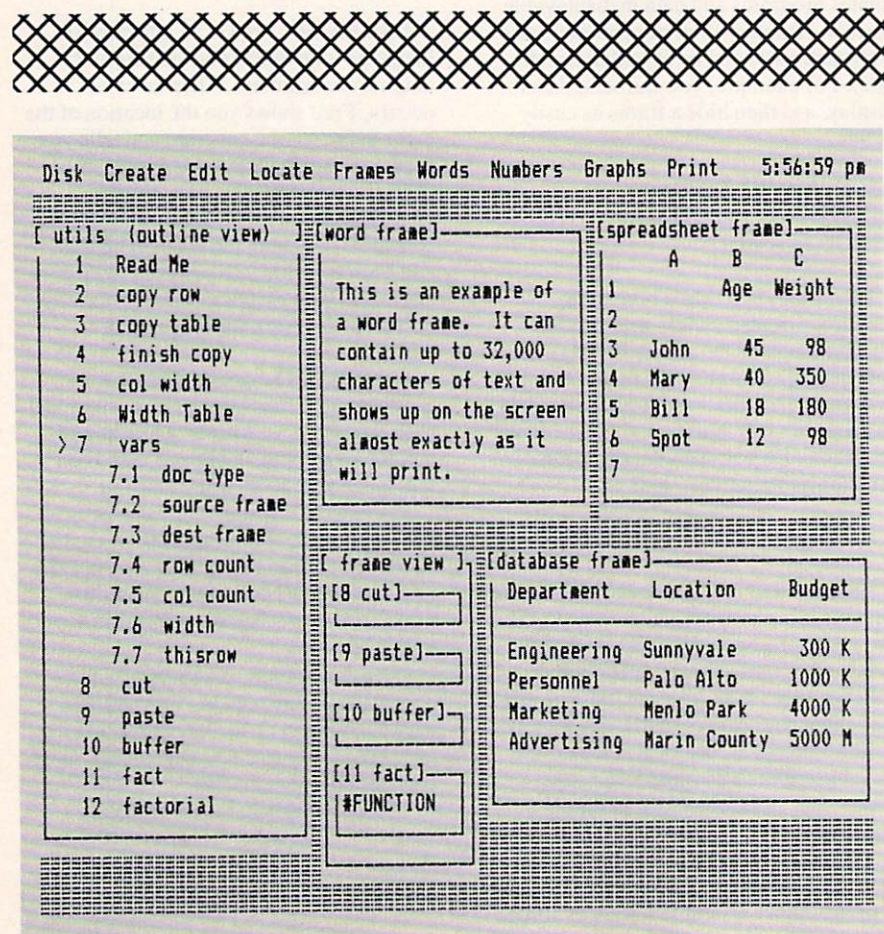


Figure 1.

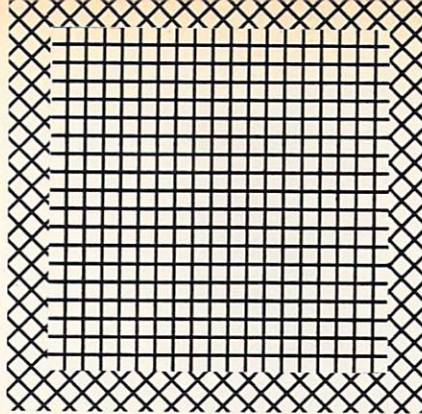
Freedom of expression

A Fred program probably resembles a LISP program more than anything else because it is simply an expression or a sequence of expressions. As such, a Fred program always returns a value, which is the value of the last evaluated expression. For example, here is a program called Factorial whose value is the factorial of a number entered by the user:

```
@prompt(@integer(@fact(
@value(@inputline(
"Type a number")))))
```

To decipher this program you have to read it inside out because that is the order in which the functions are evaluated. The @INPUTLINE function prompts the user and returns keyboard input as a string. @VALUE converts this to a number and @FACT evaluates the factorial of that number. @INTEGER converts the result to a string and @PROMPT displays it.

@INPUTLINE is one of Fred's snazziest functions because it lets the user zoom into a full-screen editing mode if he or she needs to submit more than one line of text. All of Framework's word processing fea-



tures are then available for editing the input, including text formatting and display enhancements.

The preceding *@FACT* function is one that I wrote. It does the dirty work of calculating factorials in true recursive style:

```
@if( ;condition:
    @item1 = 1, @item1 = 0),
    1, ;then
    @item1 * @fact(@item1-1)) ;else
```

These lines illustrate Fred's *@IF* statement, which is simply a list of three expressions: a condition, a *then* (true) clause, and an *else* (false) clause. Sounds mighty like the LISP *COND* function, doesn't it?

Each clause of the *@IF* statement can only be a single expression. If one just won't do, you can turn a list of expressions into a single one by using the form *@LIST(EXPR1, EXPR2, . . . , EXPRN)*. Like Lisp's *PROGN* function, *@LIST* sequentially evaluates each of its arguments and returns the value of the last one.

Notice *@FACT*'s use of the *@ITEM1* function, which returns the value of the first argument passed to a Fred program. Other arguments, if supplied, could be referenced using *@ITEM2* through *@ITEM16* or by the expression *@ITEM(NUMBER)*. You can use *@ITEMCOUNT* to find out how many arguments were actually passed.

See Fred run

Fine, you say, but how can you enter and execute programs like *@FACTORIAL* and *@FACT*? The Framework documentation probably left you a little bewildered. Here's all there is to it:

1. Create a frame of the desired type or highlight the border of an existing one.
2. Press F2 (Formula Edit) followed by F9 (Zoom).
3. Enter your program. All of Framework's word processing features are available to you.

4. When you're done, hit escape and label your frame if you haven't already done so. The frame's label serves as the name for your program.

Because Fred treats spreadsheet cells and data base fields like frames, you can associate programs with them, too. Just highlight the desired cell or field and proceed from step 2. You won't have to individually label the cell or field because cells are named by their coordinates (e.g., B3 or, equivalently, Age.John in Figure 1), while fields are named by the first row of the data base (e.g., Budget in Figure 1).

Framework offers you several ways to run your program. One is to highlight the cell, field, or frame containing the program and press F5 (Recalculate). Another is to bind the program to an Alt key. To do this you'll need to put a call to *@SETMACRO* into an empty frame and execute it via F5. For example, executing *@SETMACRO({ALT-F}, UTILS.FACTORIAL)* will bind the factorial program to Alt-F.

The third way to execute a program is to call it as a procedure from another program. Look back at the *@FACTORIAL* program presented in the last section. Did you notice how this program called *@FACT*?

You might be wondering why procedure calls require that you preface the called frame's name with an at sign (@). For the answer, let us proceed to the reference section.

Fred's references

The C language lets you refer to programs and data using symbolic identifiers. Fred has identifiers too, but in Fred they are called references.

Using references, you can execute another frame's formula, retrieve or change that frame's value, or perform an operation on a range of adjacent frames. Corresponding to each of these respective purposes, Fred has formula references, value references, and region references.

A formula reference is the name of a frame preceded by an at sign (@) and optionally followed by a parameter list in parentheses. This is just like a function call in C. For example, *@FACT(2)* calls *@FACT* to evaluate the factorial of 2. More in the LISP style, parameters are

passed by value and can be of any type. You can even pass different numbers of parameters on each call to the same frame.

A value reference is just the name of a frame. Like an identifier in C, a value reference can be the source or target of an assignment or a term in an expression. For example, the UTILS frame in Figure 1 has within it a frame called BUFFER. Valid references to this frame's value include *BUFFER := "THIS IS A STRING"*, *BUFFER := 2*, *BUFFER := BUFFER + 1*, and *BUFFER := VARS.DOC TYPE*. You see, the value area of a frame is just like a C external variable except it is untyped.

A region reference is a pair of value references separated by a colon. For example, *UTILS.CUT:UTILS.BUFFER* refers to the frames UTILS.CUT, UTILS.PASTE, and UTILS.BUFFER in Figure 1. Similarly, *C3:C6* and *WEIGHT.JOHN:WEIGHT.SPOT* each refer to the weight column of the spreadsheet frame.

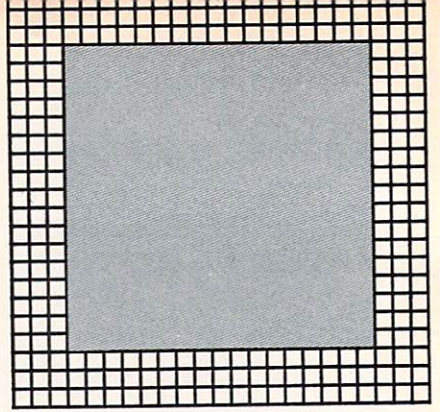
Given Framework's ability to have multiple frames on the desktop and to nest frames, you might be wondering what happens if you have two frames, say X and Y, each of which contains a frame called Z. No problem, because references can use a path-naming syntax, as in *X.Z* and *Y.Z*. In fact, when a program in one frame refers to another frame, it must use the full path name of the target frame unless that frame is the parent (containing frame) or a brother of the referencing frame.

Some examples of path names in Figure 1 are *UTILS.VARS.WIDTH*, *SPREADSHEET FRAME.B3*, *SPREADSHEET FRAME.AGE.JOHN*, and *DATABASE FRAME.BUDGET*.

Kinder cuts

Now that we're getting familiar with Fred, let's put the language through its paces.

In its utility library, Framework includes two programs, CUT and PASTE, that let you cut text from a word frame and later paste it back. But these programs are *s . . . l . . . o . . . w* and can only handle one cut at a time.



Listing 1 shows revved up versions of CUT and PASTE that not only work almost instantly but also let you stack multiple cuts and recall them in reverse order.

These programs introduce a few of Fred's most useful functions: @TEXTSELECTION, @PERFORMKEYS, and @SETSELECTION.

@TEXTSELECTION returns as a string the currently highlighted text in the currently selected frame; this is how CUT fetches the text to be cut.

@PERFORMKEYS is a keyboard function that passes Framework a string of keystrokes as if the user had typed them.

CUT uses this to activate the move function (F7) in preparation for moving the highlighted text to the cut buffer (UTILS.BUFFER).

@SETSELECTION navigates to the specified frame and returns the name of the currently selected frame as a string. CUT uses this function to navigate from the user's word frame to UTILS.BUFFER, which is the destination of the move operation.

Also notice the @LOCAL function. This function declares a local variable for use by a frame's formula. Local variables can hold any value that a frame can, even a text string up to 32,000 characters long. In fact, the name of a local variable can be used in value and formula references just like frame names can.

You can do interesting things with this capability, as we'll see next.

Can do

You've already seen Fred's @IF and @WHILE statements, but what about the good old "do" loop? Fred doesn't have one, but we can write one, as Listing 2 proves.

DO's most interesting feature is how it assigns its first parameter (a text string) to a local variable (REF) and executes that string as a formula (via @REF).

This is a powerful capability. As in LISP, your programs can synthesize and execute other programs. You can also use this feature to implement C-like #DEFINE macros. For example, the following macro substitutes "This is a bother to type" wherever you type @ABBREV:

```
abbrev := "@list('"'This is a bother to
type'"")"
```

A more useful macro is @DIALOG:

```
dialog := "@eraseprompt," &
"@prompt('"'Enter your
choice'"')," &
"k:=@nextkey"
```

You can assign formulas to frames as well as to local variables. Fred provides a function called @SETFORMULA for this purpose. There is also a function called @GETFORMULA, which returns a frame's formula as a string that you can manipulate.

Frame work

Now let's really put Fred to work. Have you ever tried to copy a table from a spreadsheet or data base to a word frame? If so, you've seen Framework politely tell you that it can't be done. Well it can be done if you're familiar with Fred, as the @COPY TABLE program in Listing 3 demonstrates.

This program actually consists of several subroutine and data storage frames, numbered 2 through 7.7 in the UTILS frame (Figure 1). The whole thing is too long to list or explain here, so let's just hit the highlights.

@COPY TABLE, the main routine, is invoked when you hit Alt-T. It prompts

```
UTILS.DO:

; Do -- Repeated do loop.

; Syntax: @do(expression,count)
;
; Result: Executes the passed expression "count" times.
;
; Note: The expression must be passed as a string value. For
;       example, to sound 3 beeps: @do("@beep(880,100)",3)

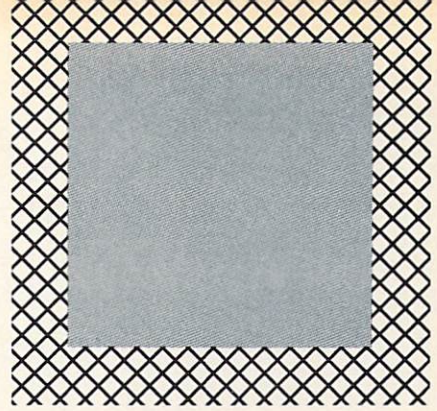
@local(i,ref),
ref := @item1,
i := @item2,
@while(i > 0,
  @ref,
  i := i - 1)

UTILS.DOLOOP:

; Doloop -- demo driver for Do routine. Prompts user for a Fred
; expression and a count, then calls Do execute the
; expression the specified number of times.

@do(@inputline("Type a Fred expression"),
  @value(@inputline("Type a repeat count")))
```

Listing 1.



you for information about the table to be copied and the name of the frame you want it copied to. It then makes multiple calls to `@COPY ROW`, which does the dirty work.

The secret of `@COPY ROW` is its use of the `@TEXTSELECTION` function to retrieve the contents of spreadsheet cells and data base fields as screen formatted strings. Wait, you say, the Framework documentation says that `@TEXT SELECTION` only works in word frames. Surprise—here is one of Fred's undocumented and quite useful features. `@COPY TABLE` shows off some other

nifty features of Fred. For example, it lets you specify whether the table should have fixed or varying column widths. If the latter, it presents you with a data base frame, `WIDTH TABLE`, into which you enter the desired column widths. Constructing a fancy user interface was never so easy.

Another neat thing `@COPY TABLE` does is use `@SETFORMULA` to create a function, `@COL WIDTH`, that returns the width of the current column to `@COPY ROW`. This way, `@COPY ROW` doesn't have to know whether you specified fixed or varying column widths. If you specified a fixed width, `@COL WIDTH` is assigned a formula that returns a constant value. Otherwise it gets a formula that looks up values in the `WIDTH TABLE`.

Does it strike you that the `WIDTH TABLE` serves as an array for `@COL WIDTH`? Indeed it does—you've found Fred's "missing" array and structure construct: the data base frame. (Welcome to Mensa!) If you like, you can also use spreadsheet frames to store arrays and structures.

Frame play

After all the features we've seen so far, could Fred possibly have more to offer? The answer is a resounding yes! Fred also

UTILS.CUT:

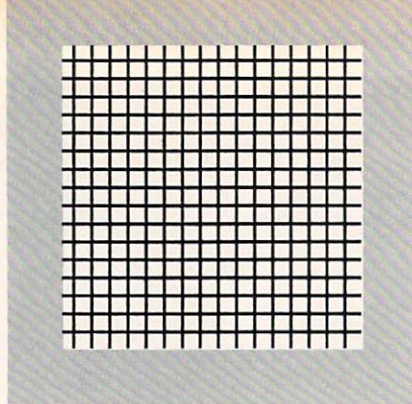
```
; Cut -- Cut text to a cut buffer. Uses the global variable "buffer".
```

```
@echo(#OFF),                                ;Keep the display quiet
@local(src),                                ;Start the move sequence
@performkeys("{f7}"),                        ;Go to the cut buffer
src := @setselection("utils.buffer"),        ;Finish the move sequence,
@performkeys(                                ; stacking the moved
    "{dnlevel}{ctrl-home}{return}{ctrl-home}{return}"), ; text LIFO
@setselection(src),                          ;Return to the source frame
@performkeys("{dnlevel}"),
@echo(#ON)                                   ;Reenable display
```

UTILS.PASTE:

```
; Paste -- Paste text from cut buffer. The last stacked entry in the
; buffer is the one pasted.
```

```
@echo(#OFF),                                ;Keep display quiet
@local(dest),                                ;Go to the cut buffer
dest := @setselection("utils.buffer"),        ;Select the topmost buffer
@performkeys(                                ; entry and start the move
    "{dnlevel}{ctrl-home}{ctrl-pgdn}{f7}"), ;Go to the dest frame
@setselection(dest),                          ;Finish the move and
@performkeys("{dnlevel}{return}{backspace}"), ; delete the terminating
@echo(#ON)                                   ; paragraph marker
```

does menus, graphics, print formatting, DOS environment control, and external program calling.

With all these capabilities at your command, you can do more than make frames work—you can positively make them sing. I'm serious, because Framework comes with a sample program, MUSIC-

MAC, that lets you write and play music.

Considering its ability to manipulate text, numbers, and graphics on the same screen and its combination of features from Smalltalk, LISP, C, and BASIC, will Fred make obsolete other languages? Is it the programmer's be all and end all? Is it the only programming language you'll ever need?

Probably not. Fred doesn't have everything for everybody.

It just has a little bit of something for everybody. **i**

Darryl Rubin is section manager for network products at ROLM Corp.

UTILS.COPY TABLE:

```
;Copy Table -- Copies a selected table from a spreadsheet
;               or database to a word frame.

;Local variables --
; rows:  Number of rows to copy
; cols:  Number of columns to copy
; src:   Source frame (spreadsheet or database)
; dest:  Dest frame (word frame)

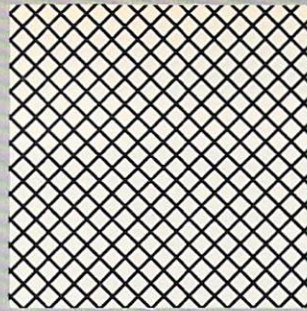
;Global variables (contained in Vars frame) --
; doc type: Source frame type (s => spreadsheet, d => database)
; width:    Column width of table or "p" to flag use of per-column widths
; thisrow:  Number of current row being processed
; row count: Total number of rows to copy
; col count: Total number of columns to copy

;User defined functions --
; @Copy Row(cols,dest frame): Copies the specified number of columns
;                             to the specified destination frame.
;
;
; @Col Width(column number): A function created by Copy Table based
;                             on whether the user specified a fixed
;                             column width or per-column widths.
;                             @Col Width is used by @Copy Row.
;

@local(rows,cols,src,dest),
vars.doc type := "",
vars.thisrow := 0,

@while(
    @and(vars.doc type <> "s",
        vars.doc type <> "d"),
    vars.doc type := @inputline(
        ;current row being copied
        ;ask whether source frame
        ; is spreadsheet
        ; or database
        ; and store user response
```

Listing 3. (Continued on following page).



```

    "Is the source frame a spreadsheet or database?" &
    " (type s or d)")),

rows := @value(@inputline(
    "Enter number of rows to copy")),
;ask for number of rows
; to copy

cols := @value(@inputline(
    "Enter number of columns to copy")),
;ask for number of columns
; to copy

dest := @inputline(
    "Enter name of word frame to copy table to"),
;ask for name of dest
; word frame

vars.width := @inputline(
    "Enter column width or type 'p' to specify per-column widths"),
;ask for column width

;initialize @col width
; function, assuming
; user picked a fixed width
;Return fixed column width
@setformula(utils.col width,
    @value(vars.width)),

@if(@iserr(@value(vars.width)),
;but if user didn't type
; a number, he wants per-
; column widths, so
; copy local vars to globals
; for use by @finish copy
; routine
@list(@performkeys("{uplevel}"),
    utils.vars.source frame := @setselection(),
    utils.vars.dest frame := dest,
    utils.vars.row count := rows,
    utils.vars.col count := cols,

;then set @col width function
; to use per-column width

@setformula(utils.col width,
    @list(@local(w,i),
    i := @item1,
    w := @get(utils.Width Table.Width),
    @while(i>0,@list(
        i := i-1,
        w := @next(utils.Width Table.Width))),
    w)
),
; get passed column number
; get width of 1st column
; step through Width Table
; to get width of
; desired column
; and return that width
@setselection("utils.Width Table.width"),
@performkeys("{f9}"),
;all set, now take user
; to Width Table
; and let him edit column
@eraseprompt,
@prompt("Edit width values, press Alt-U when done")), ;width values

```



```

;If user is specifying per-column widths, this function now returns.
;The user must edit the width values in the Width Table and then press
;Alt-U to invoke @finish copy, which will complete the copy process.
;If the user specified a single column width for the whole table,
;processing continues with the @list block below.

@list(
  @while(rows > 0,@list(
    @copy row(cols,dest),
    @performkeys("{dnarrow}"),
    src := @setselection(dest),
    @performkeys("{dnlevel}{end}{return}"),
    @setselection(src),
    vars.thisrow := vars.thisrow + 1,

    @if(vars.doc type = "d",@performkeys(
      @rept("{dnarrow}",vars.thisrow))),

    rows := rows-1)),

  @setselection(dest),
  @performkeys("{dnlevel}"))))

;do for each row
;copy this row to dest
;advance to next row
;go to dest frame
;and insert a line break
;return to source frame
;bump row counter

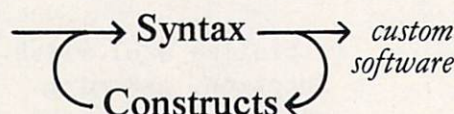
;if source is a database,
; return to current record

;downcount row processed

;go to dest word frame
;leave user at end of
;table copied

```

Listing 3. (Continued from preceding page).



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Enhancing Source Code Control under UNIX

PART II

By Luke C. Dion and Alan Filipski

Last month we briefly described the Source Code Control System (SCCS) utilities *admin*, *get*, and *delta* provided with the UNIX operating system and described how a simple front-end interface could greatly enhance the usefulness of these utilities for a software project. This article provides some technical detail on how to actually implement such an interface.

The implementation described here, the Project Source Code Control System (PSCCS), was used by Motorola Microsystems Inc. during a UNIX System V port involving about 6,000 files and 15 people.

Such an interface is not difficult to build; ours consisted of only 600 lines of C code and was tailored to the requirements of our project. The information presented here should enable a programmer to write such a package for any particular project environment with any enhancements required.

Anyone doing this should, of course, become thoroughly familiar with the UNIX documentation on the utilities *admin*, *get*, and *delta*, as well as the less frequently used *prs*, *crc* and *rmdel*. Part I of this article, which appeared in the November issue of *COMPUTER LANGUAGE*, described their basic function but was by no means a tutorial on their use.

argc, argv, and env

First, a brief description of *argc*, *argv*, and *env* is in order, since knowledge of these UNIX operating system features is fundamental to an understanding of the

PSCCS interface.

In the C language under UNIX System V, every procedure *main* has three arguments available to it when it begins executing. If we want to use these arguments, we start the definition of our procedure *main* as follows:

```
main(argc, argv, env)
int argc;
char *argv[];
char *env[]; {
```

argc is a count of how many arguments were given on the command line that invoked the process containing *main*. For example, if the invocation line is "pget -e cat", then *argc* would be 3. *argv* is a pointer to an array of strings that correspond to these arguments. In the example, *argv[0]* would be "pget", *argv[1]* would be "-e" and *argv[2]* would be "cat". Figure 1 illustrates this arrangement. In this way a program can know by what name it

was invoked and with what arguments.

This fact is important to PSCCS since it is necessary for a program like *pget* to modify its command line arguments and pass them on to the utility *get*. The third string, *env*, is analogous to *argv* but instead of command-line arguments, it contains "environmental variables" and their values. These are shell variables known and exported by the shell from which the program was invoked. For example, if we type (in Bourne shell notation):

```
DBFILE=util
DBDIR=/port/db
export DBFILE DBDIR
```

and then

```
pget -e cat
```

env[0] would be the string "DBFILE=util" and *env[1]* would be the string

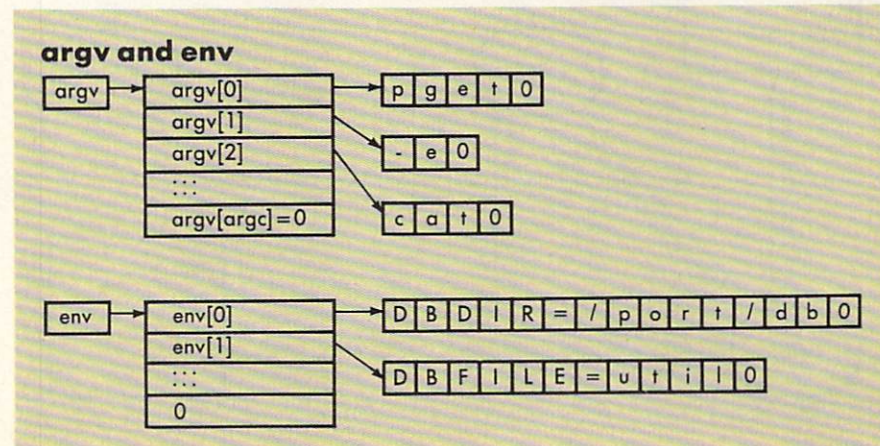


Figure 1.

"DBDIR=/port/db". (There is no count analogous to *argc* supplied for environmental variables.) This setup is also depicted in Figure 1. In this way a program can also know something about the environment from which it was executed.

PSCCS also uses this capability. For example, a user might have

```
DBDIR=/port/db
export DBDIR
```

in his or her .profile file (analogous to the Berkeley .login). Then a *pget* executed later in the session would know that the project data base file is /port/db. A C library routine called *getenv()* is supplied in System V to search the *env* array for a particular environmental variable.

Data flow in the PSCCS system

Figure 2 shows the data flow resulting from the user typing the command *pget -e cat*. Recall that the intention of this command is to find some SCCS file in the project administration area with the string

"cat" as part of its name and return the top-level version of that file to the user's current directory.

In this example we are assuming the file we want to find is /port/src/cmd/s.cat.c, and there are no other path names of files under PSCCS control with "cat" as a substring. (We will see later exactly what happens if more than one file has the given substring.)

The arrows in Figure 2 represent data flow, the oval boxes represent processes, the rectangular boxes represent files, and the numbers represent the chronological sequence of the data transfers. The files shown on the left side of Figure 2 constitute a simple data base of PSCCS path names. We will call these files the data base files. Each file is simply a list of path names, one per line, in arbitrary order, of SCCS files that the programmer may want to *get*.

The data base files are all in the same directory, in this case the directory /port/db. Although not essential, it is a good idea to group the path names into files on some basis, such as one file for

utility path names, another for path names of kernel-related files, one for game source files, etc. The reason for grouping the path names into multiple data base files will be explained later.

The two files at the right of Figure 2 are the SCCS file /port/src/cmd/s.cat.c containing the record of source code changes to cat.c and the source file cat.c obtained from this SCCS file.

Here is a step-by-step description of the data movements that occur when the user types *pget -e cat*:

- Typing the command *pget -e cat* at the terminal causes the shell to invoke the executable PSCCS utility *pget* and pass it the strings "-e" and "cat" as command line arguments.

- Something else also happens during this step, which is not shown in the diagram; as described before, *pget* checks its *env* strings for the value of the environmental variable *DBDIR*. This is the name of the PSCCS data base directory containing one or more files that together contain a simple list of path names of all files under PSCCS control. In this case *DBDIR* is equal to /port/db. There is also an optional *DBFILE* environmental variable, but we will ignore it for this first pass description.

- The program *pget* uses the UNIX library routine *popen* to invoke the utility *grep* to search for the string "cat" somewhere within the ASCII files in the directory /port/db and to return to *pget* via a pipe any lines in those files that contain that string. This is equivalent to invoking the command *grep cat /port/db/**.

- As *grep* executes the search, the line "/port/src/cmd/s.cat.c" is found in the PSCCS path name file /port/db/util.

- This path name, /port/src/cmd/s.cat.c, is returned to *pget* via a pipe.

- Now that *pget* knows the full path name of the file it is looking for, it executes — via the system call *exec()* — the command *get -e /port/src/cmd/s.cat.c*.

- The SCCS utility *get* processes the file /port/src/cmd/s.cat.c to extract its top-level version for editing.

- The utility *get* writes this top-level version to the current directory as file cat.c. This should be what the user wants.

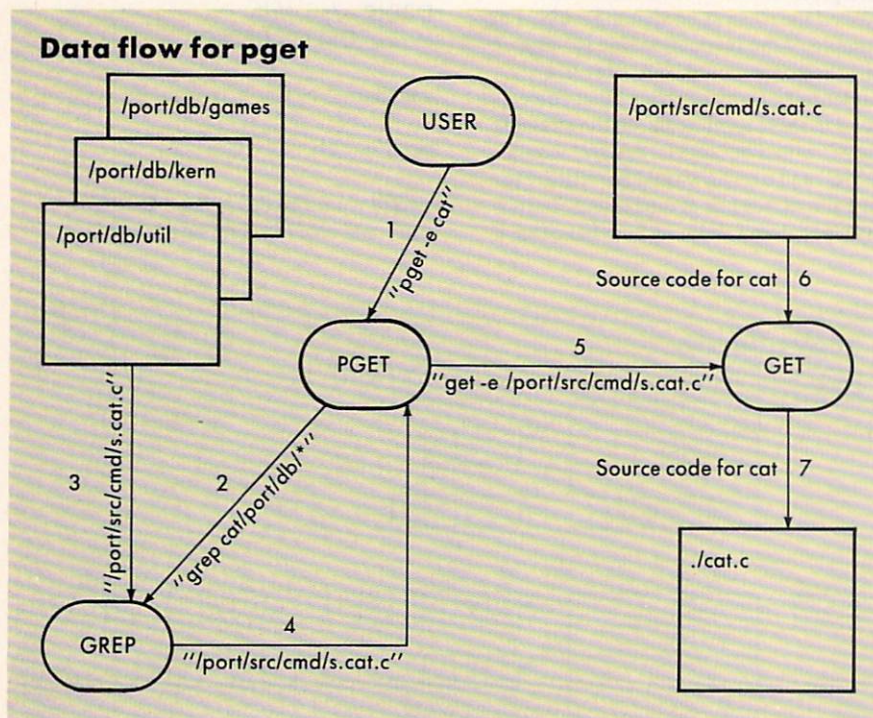


Figure 2.

The PSCCS code

Procedure *main* of the compilation unit *pget.c* is shown in Listing 1. As you can see, it is fairly trivial. Most of the real work is done in procedure *expandargs* which modify the *argv* array by expanding each substring of an SCCS file into a complete appropriate path name. For example, if the *argv* array is originally

```
pget
-e
cat
venture
```

then after calling *expandargs* it will become

```
pget
-e
/port/src/cmd/s.cat.c
/port/src/games/s.adventure.c
```

Exactly how *expandargs* does this will be discussed later. In the next statement the 0th argument is changed to *get*. Finally */usr/bin/get* is executed via an *execv()* system call with the new set of arguments. This process is exactly equivalent to executing the command

```
get -e /port/src/cmd/s.cat.c /port/
src/games/s.adventure.c
```

by typing it in at the terminal. Since *execv* transforms the old process into the new one, it should not be possible to get to the next instruction of the old process, hence the error message on the next line.

pcdc, *pdelta*, *pprs*, *prmdel* all work in the same way as *pget*. It is even possible (and would save space) to make them all exactly identical by setting up a single program that acts differently depending upon the name it is called. This is left as an exercise for the reader. But be careful. In some cases it may not be a good idea to combine some of the utilities. For example, it may be permissible to *pget* version 1.4 of a file but not permissible to remove that version via *prmdel*. This example illustrates that the PSCCS utilities can be used to inhibit (or automatically add) certain command line options to the underlying SCCS tools. This capability is important to the *padmin* utility as we will explain below.

Listing 2 gives a pseudo-C code

description of the operation of procedure *expandargs()* along with the procedure *expand1()*, which it uses. The following is a narrative description of the operation of that code.

The first thing that procedure *expandargs* does is to check the environment string array *env* to see if a value has been assigned to the variable *DBDIR*. The data base files reside in this file. If *DBDIR* is missing, then an error exit is taken, but that is not shown in the code. Each argument in the *argv* array except for *argv[0]* and the option arguments (those whose first character is a minus sign) is then processed in turn.

Here the optional *DBFILE* environment variable comes into play. If the user has set, say "*DBFILE=util*", this says that the user is primarily interested in retrieving utility code rather than kernel or compiler code and that therefore the data base file *util* in the *DBDIR* directory should be searched first. If a suitable path name is not found there, then the rest of the *DBDIR* directory is searched. The routine *expand1* does these searches.

expand1 invokes the *grep* utility to search the specified file or files for occurrences of the string given by *arg*. If exactly one path name is found which contains *arg* as a substring, *arg* is expanded into that path name. If more than one such path name exists, the user is asked which one is wanted.

All of these operations are fairly straightforward in C. One warning, however—don't try to expand *argv[i]* by copying the new path name character-by-character into the place pointed at by

argv[i]. The original *argv* is on the stack and there is not enough room there. Just put the path name string into some static array and redirect *argv[i]* to point there.

This completes the discussion of the code for all of the PSCCS utilities except *padmin*. The *padmin* command is significantly different from the others since it needs to update the data base files. When invoked, *padmin* must process its arguments. Like *pget*, it must call *expandargs* on all arguments except command options (arguments beginning with a "-"). In addition, *padmin* must review these command options to guarantee that the SCCS administrative parameters are set correctly.

For example, an SCCS file contains information that describes which users are permitted to access that file. The SCCS *admin* command permits the user to change this information. If unrestricted, the *padmin* command could let a user add another (unauthorized) name to the permission list. Since the integrity of the project SCCS files in part rests on restricted access to them, then that access must be protected. Hence, *padmin* must guarantee that certain options to *admin* are prohibited. Currently we prohibit the following *admin* options:

| | | |
|-----|-----|----|
| -fb | -dj | -r |
| -fi | -df | -a |
| -ff | -di | -z |
| -fi | -dq | -h |
| -fq | -e | |

Since the SCCS *admin* command can be

```
main( argc,
      argv, env )
int    argc;
char   **argv;
{
    expandargs( argc, argv );
    argv[0] = "get";
    execv( "/usr/bin/get", argv );
    fprintf( stderr, "exec failure" );
}
```

Listing 1.

used to create new SCCS files (the "-i" and "-n" options) and change the administrative options of existing files, then *padmin* must handle both cases. When simply changing the parameters for existing SCCS files, *padmin* works like *pget*. However, when creating new files, *padmin* has much more work to do.

The first step that *padmin* must take when creating a new SCCS file is to sup-

ply the *admin* command with the default creation options. We currently supply the following default options:

- **-rR** where R is a revision level. This option sets the current revision of the new file to the same level as other files under PSCCS control. Controlling the revision level is important since reproducing earlier versions of a product will be based on these levels. If, for example, a new file is

created at revision level 1.1, it will confuse anyone attempting to rebuild revision 1 of the system.

- **-fi**. This option requires that every PSCCS file have at least one ID keyword sequence. The "%W%Q%" sequence discussed in our first article is an example of an ID keyword sequence. With this option we guarantee that every version of an SCCS file will be generated with ver-

```
expandargs ( argc ,argv ) {
  get DBDIR from environment
  for i = 1 to argc-1 {
    if first char of arg[i] is not a minus sign {
      if there is a DBFILE environment variable {
        expandl( arg[i], DBDIR/DBFILE)
      }
      if expandl failed to expand arg {
        expandl( arg[i], DBDIR)
      }
    }
  }
}

expandl ( arg ,filenam ) {
  if filenam is a directory {
    grep for arg in filenam/*
  }else{ /* filenam must be a file*/
    grep for arg in file filenam
  }
  if exactly one pathname is found by grep {
    set current arg string to that pathname
    return success
  }else if more than one pathname is found {
    for each pathname found {
      display pathname at terminal followed by question mark
      accept answer from user (yes or no)
      if answer is yes {
        set current arg string to current pathname
        return success
      }
    }
  }
  return failure
}
```

Listing 2.

sion identification information. Knowledgeable programmers could devise a way to circumvent this guarantee, but we can't think of any reason for doing this.

■ **-fb**. This option permits creation of branches on the PSCCS file. It is included in the default options so that a later *padmin* call will not be needed.

■ **-aG** where G is a UNIX group number. This option sets up the SCCS file so that anyone in the users group can access the PSCCS file.

Once these default options are set, *padmin* will create the new SCCS file by calling *admin*. However, unlike *pget*, *padmin* must wait around until *admin* completes. (Remember, *pget* uses the *exec* system call to overlay itself with *get*.) If the *admin* command succeeds, then *padmin* must add the name of the newly created SCCS file to the project file name data base. In our current implementation, *padmin* simply appends the name to the appropriate data base file(s) in DBDIR.

To execute *admin*, *padmin* must call the *fork()* system call to create a new process. The new process (the child process) will execute the *admin* command by overlaying itself via an *exec()* system call. The original process (the parent process) will wait for the child to complete by making a *wait()* system call. This system call returns the child process's return status that will indicate whether the command succeeded or not.

As you may guess, the *padmin* command is the most complicated of the PSCCS commands. In it resides the real integrity of the files under PSCCS control. It controls the creation and administrative updating of all PSCCS files. The discussion on *padmin* has been somewhat simplified for this article. For a more in-depth discussion, a firm understanding of *admin* and the UNIX operating system are needed.

The setuid feature

Under the UNIX operating system, each file (including directories) has three levels of permissions associated with it. We are concerned with two here: owner permissions and other permissions. The owner permissions specify those operations the

owner of the file may perform on it. The other permissions specify which operations other users may perform on the file.

Several kinds of operations on the file may be permitted or denied at several levels. We are interested in permission to write to the file. Note that even if you do not have permission to write to a file, it still may be possible to delete it and then to replace it with something else. To do this, it is only necessary to have write permission to the directory containing the file. The ordinary SCCS uses this trick.

The other security feature of the UNIX operating system we need be concerned with here is that every executing process has both a real user ID and an effective user ID that are set equal to some (not necessarily the same) valid login ID of the system. The real user ID of a process is always the user ID of whomever executed the program. Usually the effective user ID is the same. However, if an executable file has its setuid bit on, then, whenever it is run, the effective user ID of the process is that of the owner of the file, not the one who executes it.

The PSCCS utilities are all setuid utilities owned by some administrator, such as "port". (Of course port must be a valid login name. In our system, port was the login name for the project administrator for the M68000 port of UNIX System V.) The PSCCS files and the directories that contain them deny write permission to everyone except port. Therefore the only way a user can modify the PSCCS files is through the PSCCS utilities.

This protection greatly reduces the likelihood of the files being inadvertently destroyed or corrupted. We have seen too many cases where an engineer has accidentally removed vital files. Under UNIX the only effective way to restore these files is to retrieve them from backups, but then you will lose any changes between the time that backups were made and the time the file was lost.

Enhancements and variations

As we have seen, the PSCCS tools have been built out of standard UNIX System V utilities and a little glue. The glue consists of approximately 600 lines of C code in a few SCCS preprocessors. This approach, while being exceptionally effective, is

very primitive. In principle, the underlying data base is really just a collection of regular UNIX files. The first obvious enhancement of these tools would be the use of a more powerful data base management scheme.

We hesitate to mention a full blown data base management system since its capabilities far exceed the requirements of the PSCCS utilities. (On the other hand, if you are currently running on one of the UNIX based DBMSs, you can and should take advantage of it.) Some simple extensions to the current approach would probably be more appropriate.

For example, one simple approach would be to maintain separate data base files where inclusion of a particular SCCS file into a particular data base file would be based on the name of the SCCS file (the SCCS files beginning with "a" in data base file "dba", files beginning with "b" in "dbb", etc.). This very simple method will significantly improve PSCCS throughput by permitting the search to begin by indexing to the correct data base file.

Another area of overall improvement in the PSCCS package is the increase in the access speed to files based on external information. For example, in the UNIX System V shell, the environment variable *CDPATH* is used to determine which directory will be used when changing directories. When using *CDPATH*, directories in non-local file systems can be accessed as if they were in the current directory. That is, if *CDPATH* is defined as

```
CDPATH=: $HOME
```

when a change directory command is issued, if the target directory is in the current directory or in the home directory, the change directory will succeed. In this same manner we can define a *SCCSPATH* that will tell the PSCCS commands to search some set of directories first before looking into the data base. For example, if *SCCSPATH* is defined as

```
SCCSPATH=dir1:dir2:dir3
```


if we execute `pget s.cat.c` while `s.cat.c` is in one of `dir1`, `dir2`, or `dir3`, then `pget` can retrieve the file without ever reading the file data base.

The `expandargs` procedure can be modified to look in the directories specified by `SCCSPATH` to see if the requested SCCS file is present. Note that this improved accessing efficiency in no way bypasses the built-in protection of the PSCCS tools.

Another interesting extension to the PSCCS tools would be to "associate" groups of PSCCS tools. Once a file in an association group is updated, the PSCCS command `pdelta` could send out electronic messages to all pertinent users that the file has been changed. This message could also contain reminders to review all associated files as well.

This feature could be best used as a way to insure that the various representations of a program are all kept in synchronization. For example, the functional specification, design specification, pseudocode design, and end product implementation can be placed into an association. If the implementation is changed, then the project administrator can be notified. If the associated specifications

and design documents are not also changed within some predetermined time frame (say one or two days), the programmer can be reminded to do so. Having this capability will greatly help project librarians keep design documents and implementations synchronized.

Other enhancements or improvements are possible. However, keeping the PSCCS tools relatively simple will take careful planning and implementation. The greatest danger of these utilities is that programmers and project administrators alike may view them as a substitute for a well-designed DBMS. They aren't. What they do provide is an economical method of insuring that project SCCS files are safe.

Benefits

We have presented an outline of the design of a simple user interface to the UNIX SCCS. The interface has been set up to enhance the security, convenience, and control features of the ordinary SCCS. It greatly facilitated our execution of a UNIX System V port, a project involving 15 people and 6,000 files.

With the information we have presented it should be possible for a knowledgeable C programmer familiar with UNIX to set up such a system in a week or so, incorpo-

rating additional features as appropriate for a particular project management environment. ■

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```
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ed newdoc
kwic newdoc | sortmrng | uniq | unrot >index
make -f makdoc ndx
```

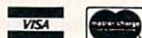
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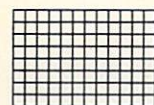
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| 9 | 10 | 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 | 21 | 22 |
| 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | | | | | | |

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| 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | 31 | | | | | |

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| 24 | 25 | 26 | 27 | 28 | 29 |
| 30 | 31 | | | | |

Programming a calendar using the military format and Julianized dates

By Joe Celko



Almost any system needs to use dates. But the trouble is that our calendar is not a regular, orderly measurement of time. A week is seven days, but seven is a prime number. The months do not all have the same number of days—they average 30.4375 days or 4.33 weeks. A year is not really 365 days long, it's 365 and about one-quarter days. We use years marked B.C. and A.D., but this scheme has no zero year.

These irregularities are the reason that the only unit of time defined in the metric system is the second. All other time units are considered common units, but they have no formal definition. Computer people are used to units of time smaller than a second—millisecond, microsecond, nanosecond, etc. Technically, we can use kiloseconds and gigaseconds for longer units. But nobody does, of course, because weeks and days are so much more natural.

Converting dates

Algorithms have been developed to convert dates into numbers for ease of use by the machine. This procedure is called Julianizing a date. Most of the time the numbers fall between 1 and 366, but it is just as easy to assign numbers over a range of many years as it is over one year. If you look on the bottom of many desk calendar pads, you will see the number of days past and remaining in the current year. This is one way of doing the job in the 1 to 366 range.

Computer people often confuse a Julianized date with the Julian date. The Julian date is a number well over 2 billion used by astronomers for calculations. The

algorithm for calculating it is available but useless to most programmers because of the large numbers involved.

The format for writing dates on a computer is defined in the ANSI X3.30-1971 standard. This standard allows you to use the year or the year-in-century. The year is the full four digits (such as 1984) and the year-in-century is the last two digits (84). All fields are numerics—you use leading zeros and not blanks. Months are numbered from 01 for January to 12 for December. The days are numbered in the usual fashion starting with 1 and going to 28, 29, 30 or 31 depending on the month in which they fall. The order of the fields is year, month, and day and no separators are used, which lets you sort dates as if they were one long number.

While it is not required by the standard, you should use the full year and not the year-in-century. There is no longer a great need to save computer storage space by cutting off characters, and the year 2000 is not that far away. If you use the year-in-century, you set in motion systems that will collapse in the future. Imagine the fun of having a program that computes interest based on negative time intervals.

Leap year calculations are generally a little messier than people think. Most people know that every year divisible by four

is a leap year. But most forget that there is also a 400-year cycle. Since the year 2000 is coming up shortly, it is a good idea to consider it. The four-year cycle exists because the number of days in a year is 365 and almost one-quarter. Leap year takes care of the one-quarter day, and the 400-year rule takes care of the "almost." It is a very fine adjustment.

Listing 1 presents a simple algorithm in an ALGOL-like pseudocode for testing a leap year. It is not very confusing, and the cost of the extra Boolean expression to compute the 400-year cycle is tiny. Although few people work with time that goes over centuries, I like to get the accuracy when it is so cheap.

Error checking is always a problem, and you should always try to catch errors as soon as possible in a system. Since dates are messy things, they will need to pass through an edit procedure before they get to the data base. It is worth the effort to have reasonableness edits at places in the program.

The terms reasonable lower limit and reasonable upper limit have to be user defined. If the system does not allow front dating, then today's date is a good value for the reasonable upper limit. If the sys-

```
BOOLEAN PROCEDURE Leapyear (INTEGER year);
/* year is four digits, not year-in-century */
Leapyear:=
((year MOD 4 = 0) AND (year MOD 400 <> 0))
OR (year MOD 400 = 0);
```

Listing 1.

| S | M | T | W | T | F | S |
|----|----|----|----|----|----|----|
| | | | | 1 | 2 | 3 |
| 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 18 | 19 | 20 | 21 | 22 | 23 | 24 |
| 25 | 26 | 27 | 28 | 29 | 30 | 31 |

I strongly recommend the current military format. It is much easier for a human being to read correctly. It takes no trouble at all to convert between ANSI and this display format. All you need is a little string handling and a table of the three-letter codes.

It is also possible to write an input procedure that will accept a wide range of date formats and convert them into "yyyymmdd". This will allow the user to type in the date in almost any format. But the procedure should immediately overwrite the input with the converted date so that the user can see how the machine interpreted what was typed in. Remember, there is no way to tell if the U.S. "mm/dd/yy" or the U.K. "dd/mm/yy" format was meant, so you have to make an assumption based on your geography.

Examples

Now we are ready to Julianize a date with the procedure presented in Listing 3.

This approach can be extended over a wider range by adding a year total table, which would be indexed by the year minus a constant. The tables are fairly small and represent a good trade-off with approaches that would use floating point

calculations. This algorithm allows you to generate ANSI ordinal format dates by attaching the year-in-century to the high order digits of the result.


But algorithms do not have to be unique. Just take a look in any textbook at all the ways to sort an array. Another algorithm that can perform this same function is shown in Listing 4. It is based on smoothing out the distribution of days in the year (365.25 days per year) and then using a set of *IF-THEN-ELSE* statements to put the irregularities back into the calculation to adjust the date.

For most people, there is no way to look at a day and tell what day of the week it fell upon. The algorithm in Listing 5 computes the day of the week from a date given in the format that we have been using for the Julianization algorithms.

In Listing 6, pseudocode for computing the number of days between two dates is presented. It depends on an encoding algorithm that returns a pseudo-Julianized date. The pseudo-Julianized date is a real number that represents the position of the day within the year if all months and days were spread uniformly over a year. It is not a completely accurate Julian calculation because of these assumptions, but the differences are accurate enough for computing interest to a few places and other financial applications.

Commercial users often write programs under the assumption that the year has 360 days and all months have 30 days. This algorithm is an improvement over the common practice.

If you ever get a chance to vote for calendar reform in your lifetime, please do so. Several schemes have been proposed, all superior to the present system. I favor the Edwards calendar, which has four three-month quarters. The months are 30, 30 and 31 days long in each quarter. This scheme splits New Year's Day away from any month and uses a zero to represent it. Leap year day appears every four years in the middle of the year and is also shown with a zero day at the start of the third quarter.

It is left as an exercise for the reader to design programs for the Edwards calendar. But they are very easy. 

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```

INTEGER PROCEDURE Jul2 (INTEGER year, INTEGER month, INTEGER day);
/* This is Julianized day within year, not an astronomer's Julian day *

BEGIN EXTERNAL BOOLEAN PROCEDURE ValidDate,
LeapYear;
If ValidDate (year, month, day)
THEN BEGIN
    Jul2:= Truncate ((30.475 * (month-1)) + day);
    IF (month > 2) THEN Jul2:= Jul2 + 2 ELSE NULL;
    IF (month > 5) THEN Jul2:= Jul2 + 1 ELSE NULL;
    IF (month > 6) THEN Jul2:= Jul2 - 1 ELSE NULL;
    IF (month > 7) THEN Jul2:= Jul2 - 1 ELSE NULL;
    IF (LeapYear(year) AND (month > 1))
    THEN Jul2:= Jul2 + 1 ELSE NULL;
    END
ELSE Fault ("This is a bad Date");
END of Jul2;

```



```

STRING PROCEDURE DayOfWeek (INTEGER year, INTEGER month, INTEGER day);
/* returns the three-letter day of week */

BEGIN EXTERNAL BOOLEAN PROCEDURE ValidDate, LeapYear;
STRING ARRAY DayName [0:6]
    INIT ("SUN", "MON", "TUE", "WED", "THU", "FRI", "SAT");
INTEGER ARRAY DayTable[1:12]
    INIT (0, 3, 3, 6, 1, 4, 6, 2, 5, 0, 3, 5);
INTEGER ARRAY CenturyTable[1:12]
    INIT (1,2,0,6,4);
INTEGER Century, YearInCentury, Result;
IF ValidDate (year, month, day)
THEN BEGIN
    IF (LeapYear(year)
    THEN BEGIN
        DayTable[1] := 6;
        DayTable[2] := 2;
        END
    ELSE NULL;
    Century:= Year DIV 100;
    YearInCentury:= year - (Century * 100);
    Result:= CenturyTable[Century] +
        YearInCentury +
        (YearInCentury DIV 4) +
        DayTable[month] +
        Day;
    DayOfWeek:= DayName [Result MOD 7];
    END
ELSE Fault ("This is a bad Date");
END of DayOfWeek;

```

Listing 5.

```

INTEGER PROCEDURE DateDiff (INTEGER year1, INTEGER month1, INTEGER day
    INTEGER year2, INTEGER month2, INTEGER day2);
BEGIN
REAL PROCEDURE Pseudo-jul (INTEGER year, INTEGER month, INTEGER day);
/* this will give a Pseudo-Julianized date */
BEGIN EXTERNAL BOOLEAN PROCEDURE ValidDate;
IF ValidDate (year, month, day)
THEN Pseudo-jul :=
    ((365.25 * year) + (30.475 * month) + day)
ELSE Fault ("This is a bad Date");
END of Pseudo-julian;

EF ValidDate (year1, month1, day1)
THEN IF ValidDate (year2, month2, day2)
    THEN DateDiff:=
        Truncate (Pseudo-jul (year2, month2, day2)
            - Pseudo-jul (year1, month1, day1)
            + 0.05)
        ELSE fault ("Second date is bad");
    ELSE fault ("First date is bad");
END DateDiff;


```

Listing 6.

Customize Your High-Level Language

A COBOL-assembly example

By Charles Ballinger

 Although this article deals with the specifics of interfacing Microsoft's COBOL-80 language with assembler subroutines, the concepts and requirements are applicable to a wide range of other high-level languages.

The programs discussed were written and tested using Microsoft's COBOL-80 compiler version 4.60 and 4.65. The assembler used was Microsoft's M80, which is included with the COBOL compiler, but any assembler capable of producing an .REL file can be used (i.e., RMAC, etc.).

Why would you want a high-level language to interface to an assembler module? I realized I wanted such a high-level language interface when I was writing an application program in COBOL and needed to control special printer functions such as spacing and font size.

Although COBOL is an excellent business language, it has several shortcomings. One of them is its inability to easily pass embedded control codes to the printer.

At this point I set out to find the information necessary to write an assembler subroutine that my COBOL program could call to handle these special printer functions. Although the assembler subroutine deals with an Okidata 83A printer, it can be easily changed to support whatever printer you are using.

The Microsoft COBOL-80 manual is very skimpy in the areas of sample programs. Only a mention is made of the

method that must be employed when attempting to call an assembler subroutine.

Most of my discoveries involved nothing more than trial-and-error attempts to discover what the magical linkage should be. This article can be a road map that takes you on a much shorter journey than the one I took. By the end of the article you should be able to see just how easy the interface is and how easily the assembler program could be modified to support a similar function you have always wanted.

You will undoubtedly see areas in the assembler source that can be shortened or eliminated entirely. The assembler program is heavily commented so that the COBOL programmer who knows a little assembler can readily modify the code to suit his or her needs. I will not attempt to teach you either COBOL or 8080 code in this article but instead will show you the things I uncovered that do not appear in any Microsoft sample program and are only hinted at in its documentation.

Microsoft's mention

To start off, let's review just what Microsoft's reference manual has to say about calling an assembler program. Everything the manual contains on this subject can be found in Appendix B of the COBOL-80 reference manual.

This appendix briefly describes the interface calling mechanism used when COBOL calls an assembler subroutine. The COBOL run-time system transfers control to the subroutine by means of the machine language *CALL* instruction. The subroutine must return control to COBOL by issuing a machine language *RET* instruction.

Parameters are passed from the high-level language down to assembler by reference—by passing the address of the data and not the data itself. The method of passing these parameters depends on the number of parameters you are attempting to pass. If there are from one to three parameters to be passed they are passed in the following manner:

Parameter 1 in register pair HL
Parameter 2 in register pair DE
Parameter 3 in register pair BC

If you are passing more than three parameters, parameters 1 and 2 are still passed in HL and DE, but register pair BC now points to a contiguous data block of memory that holds the list of parameter addresses. Remember, if you pass more than three parameters, this contiguous block of memory contains the addresses of the additional parameters in byte-reversed order.

Also note that neither the compiler nor the run-time system checks to ensure that the correct number of parameters or their sequence has been passed. You are responsible for the integrity of the parameters as well as matching up the sequence in both the calling and the called program. If you get weird results, this should be the first thing you check.

Since the stack space used by COBOL is contained within the program boundaries, the assembler program must not


```

IDENTIFICATION DIVISION.
PROGRAM-ID. TEST.
AUTHOR. CHUCK BALLINGER.
DATE-WRITTEN. 04/10/84.
*
* THIS PROGRAM IS A DEMO PROGRAM TO SHOW YOU HOW THE
* CALL TO "PRSET" PROGRAM WORKS. THE USE OF ASSEMBLER
* SUBROUTINES ARE ONLY LIMITED BY YOUR IMAGINATION.
*
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE-COMPUTER.
OBJECT-COMPUTER.
INPUT-OUTPUT SECTION.
FILE-CONTROL.
    SELECT PRINTL ASSIGN TO PRINTER.
DATA DIVISION.
FILE SECTION.
FD PRINTL
    LABEL RECORDS ARE OMITTED
    RECORD CONTAINS 132 CHARACTERS
    DATA RECORD IS PRINTLN.
01 PRINTLN.
    02 FILLER PIC X(132).
WORKING-STORAGE SECTION.
77 FUNCTION-CODE PIC X VALUE SPACE.
77 RETURN-CODE PIC X VALUE SPACE.
01 TESTLN-1.
    02 PART1 PIC X(10).
    02 PART2 PIC X(10).
    02 PART3 PIC X(10).
    02 PART4 PIC X(10).
    02 PART5 PIC X(10).
    02 FILLER PIC X(82) VALUE SPACES.
PROCEDURE DIVISION.
START-OF-PROGRAM.
    OPEN OUTPUT PRINTL.
*
* SET PRINTER TO 8/LINES INCH AND PRINT DEMO
*
    MOVE "8" TO FUNCTION-CODE.
    MOVE " " TO RETURN-CODE.
    CALL 'PRSET' USING FUNCTION-CODE, RETURN-CODE.
    IF RETURN-CODE = " " NEXT SENTENCE ELSE
        GO TO ERROR-OUT.
    MOVE SPACES TO PRINTLN.
    MOVE "THESE LINES PRINTED AT 8 LINES PER INCH" TO PRINTLN.
    WRITE PRINTLN AFTER ADVANCING 1 LINES.
    WRITE PRINTLN AFTER ADVANCING 1 LINES.
    WRITE PRINTLN AFTER ADVANCING 1 LINES.
    WRITE PRINTLN AFTER ADVANCING 1 LINES.
*
* SET PRINTER BACK TO 6 LINES/INCH
*
    MOVE "6" TO FUNCTION-CODE.

```

overflow or underflow the stack. To be sure this doesn't happen, the assembler program, upon entry, should save the COBOL stack and then set up its own stack pointer.

The preceding information brings to a close what the COBOL-80 manual says about calling an assembler subroutine. You probably noticed that no samples or clues are given as to just what registers are affected.

A working version

At this point frustration set in. So I called the Microsoft technical support line only to be told, "Nobody here has ever tried that." About all the Microsoft people were sure of was that you had better save every register upon entry into your assembler program because they didn't have any information about what, if any, registers were affected. With this lack of information I then proceeded through the trial-and-error sessions necessary to get a working version of the assembler subroutine.

As you can see in Listing 1, the COBOL code necessary to *CALL* an assembler subroutine is very straightforward. The calling sequence is:

CALL 'PRSET' USING FUNCTION-CODE, RETURN-CODE.

Only two parameters are used. The first, FUNCTION-CODE, is passed in the HL register pair, while the second, RETURN-CODE, is passed using the DE register pair. The program does not make use of a third parameter, so registers BC are left in an unknown state but are saved anyway once inside the subroutine.

Up to now we have just covered the basics of the linkage required. I have written a printer setup program (PRSET), which can be used to set special printer modes. (Unfortunately it is too long to be printed here, but it can be accessed by calling the *COMPUTER LANGUAGE* Bulletin Board Service or CompuServe.)

The PRSET assembler program can be refined and reduced in size if you wish to experiment. My goal in writing the program was to make it easy for a non-8080 programmer to modify. I'm no 8080

giant, but the code works, is easy to follow, and lends itself to whatever modifications you may wish to implement.

The subroutine only has a few areas you must watch for. If you are writing your own routine, be sure that at the beginning of the program you have an *ENTRY* statement program to name the module. At link time this is required to name the module so the COBOL linker can find and link it to the main COBOL program. This program uses the standard entry points for CP/M 2.2+ for both BDOS and LIST devices. If your particular version of CP/M uses an entry of other than 05H (5 Hex), then change the equates in the PRSET program.

The first thing the program does is save the HL register pair. Then it swaps HL and DE and finally saves HL again. The first *SHLD* saves parameter 1's address. The registers are then swapped and the second *SHLD* saves parameter 2's address. The program then saves register pair BC even though they are not used.

Here's the tricky part. You must clear the HL register pair and then do a *DAD SP* instruction to load the value of the COBOL stack pointer. Now the program saves the COBOL stack pointer in a field called COBSTK and proceeds to establish its own stack area. Register pair HL is then loaded with the address of parameter 1, and the program checks to see what, if any, option was requested.

If no valid option was found, then the code falls through to the error routine. At the error routine the program gets addressability to the return code field (parm 2) and moves an X into the return code field to indicate it found an error. The registers are then restored, and the COBOL stack pointer is restored to the same value it had upon entry. A machine language *RET* instruction is then executed, which returns control back to the COBOL program.

The normal exit point in the program (0210H) does the same thing with the exception that the return code field is set to a blank prior to returning.

The individual routines within the sub-

```

MOVE " " TO RETURN-CODE.
CALL 'PRSET' USING FUNCTION-CODE, RETURN-CODE.
IF RETURN-CODE = " " NEXT SENTENCE ELSE
    GO TO ERROR-OUT.
MOVE SPACES TO PRINTLN.
MOVE "THESE LINES ARE AT 6/LINES PER INCH" TO PRINTLN.
WRITE PRINTLN AFTER ADVANCING 2 LINES.
WRITE PRINTLN AFTER ADVANCING 1 LINES.
WRITE PRINTLN AFTER ADVANCING 1 LINES.
WRITE PRINTLN AFTER ADVANCING 1 LINES.
*
* PRINT AT VARYING FONTS SIZES ON SAME LINE
*
MOVE "C" TO FUNCTION-CODE.
MOVE " " TO RETURN-CODE.
CALL 'PRSET' USING FUNCTION-CODE, RETURN-CODE.
MOVE SPACES TO PRINTLN, TESTLN-1.
MOVE "16.5 CPI" TO PART1.
WRITE PRINTLN FROM TESTLN-1 AFTER ADVANCING 3 LINES.
MOVE SPACES TO PART1.
MOVE "B" TO FUNCTION-CODE.
MOVE " " TO RETURN-CODE.
CALL 'PRSET' USING FUNCTION-CODE, RETURN-CODE.
MOVE "8.3 CPI" TO PART2.
WRITE PRINTLN FROM TESTLN-1 AFTER ADVANCING 0 LINES.
MOVE SPACES TO PART2.
MOVE "W" TO FUNCTION-CODE.
MOVE " " TO RETURN-CODE.
CALL 'PRSET' USING FUNCTION-CODE, RETURN-CODE.
MOVE "5 CPI" TO PART3.
WRITE PRINTLN FROM TESTLN-1 AFTER ADVANCING 0 LINES.
MOVE SPACES TO PART3.
MOVE "R" TO FUNCTION-CODE.
MOVE " " TO RETURN-CODE.
CALL 'PRSET' USING FUNCTION-CODE, RETURN-CODE.
MOVE "10 CPI" TO PART4.
WRITE PRINTLN FROM TESTLN-1 AFTER ADVANCING 0 LINES.
END-THE-PROGRAM.
DISPLAY (24, 1), "RETURNING TO CP/M - PLEASE STANDBY" ERASE.
CLOSE PRINTL.
STOP RUN.
*
* DISPLAY ERROR IF INVALID RETURN CODE WAS FOUND
* YOU DECIDE HOW YOU WANT TO HANDLE IT. ONCES TESTED
* YOU MAY WANT TO IGNORE THE RETURN CODE FIELD
*
ERROR-OUT.
DISPLAY (24, 1) ERASE
"YOU WERE PASSED A RETURN INDICATING AN ERROR OCCURED"
GO TO END-THE-PROGRAM.

```

Listing 1. (Continued from preceding page).

routine can be expanded or combined if you wish. The program currently accepts any number of characters to pass to the list device, so you are not limited as to how many control functions you can do within one *CALL*. The program will terminate when a byte containing zero hex (00H) is encountered. As long as you terminate each table entry with this value you can set multiple conditions in each routine.

Now that I had finally succeeded in getting COBOL and assembler to talk to each other, the program didn't seem that hard. As long as you save all your registers

upon entry and restore them before you leave, you can use this subroutine to do many things besides control your printer. Perhaps you wanted to do special screen graphics to produce a form but didn't like the idea of trying that in a high-level language. With this subroutine you can now do it easier and faster.

Figure 1 shows the link statement necessary to link the TEST program with the printer setup program (PRSET). Figure 2 illustrates the assembler instructions necessary to assemble the PRSET.MAC program into a .REL file that is ready to be linked to the main COBOL program.

As you can see from this article and listings, the task really wasn't that hard. The only major drawback was the lack of truly

technical information of any kind.

I am releasing these programs into the public domain, and it is my hope that you can make use of the information presented here. ■

Charles Ballinger is a systems analyst and has been involved in computers and programming for a little over 10 years. He has been actively involved in microcomputers since 1978.

```
LD80 TEST/N,TEST,PRSET/E
```

Subroutine name followed by /E to indicate that this is the end of the load and to return to operating system when finished with link.

The first module to be linked, this MUST be the main COBOL program or you will get link errors.

This specifies the name under which this program is to be stored. The /N indicates this is what you want the program named to the linker.

If you have more than one assembler subroutine that you wish to call from COBOL then you would list them like this:

```
LD80 TEST/N,TEST,SUB1,SUB2,PRSET/E
```

This would link the program TEST with the subroutines named SUB1, SUB2, and PRSET. You may specify the subroutines in any order and the linker will resolve the necessary addresses.

Figure 1.

```
M80 PRSET,LST:=PRSET
```

Name of source file, this file must have an extension of .MAC to be recognized by the M80 assembler.

Name of printer output file or device to receive the printed output. Can specify CON: if you want to display the output.

Name of .REL module that will be generated by the M80 assembler. This is the name of the module that you would use within the COBOL link statement.

Figure 2.



PUBLIC DOMAIN SOFTWARE REVIEW



We've been having a terrific debate on the

COMPUTER LANGUAGE section of CompuServe over the "best" programming language.

For those who haven't yet tried our CompuServe section, the conclusion to be drawn from the debate is that there is no best language. Each language has its own merits and drawbacks for any given situation, although probably two or three would do equally well for the job.

Naturally, personal biases come in to play, and those who program in only one or two languages have as their own favorites the languages they are most familiar with. Among the multi-language people there is about an even split between C, FORTH, Pascal (Modula-2), and number crunchers like FORTRAN and APL. (The latter's proponents tend to be engineers or scientists.)

It becomes very obvious to any programmer who can write code in several languages that some are general purpose by design, such as Pascal and BASIC, while others are not—APL, for example, cannot possibly be mistaken for anything else but a number cruncher at heart. So the unsolvable debate will continue to the amusement of all (and probably to the education of all, too).

What is the best language? The one *you* like the best.



With so many languages available to a

programmer, it is no surprise at all that each has a growing number of support organizations. These users groups devote themselves to distribution of information or programs about a specific language, or more usually, a specific implementation of that language. Therefore, any public domain columnist must address these groups as well as the generally targeted users groups such as CP/MUG and SIG/M.

Leor Zolman's BDS C has been through many revisions over the past few years and continues to be one of the most popular C implementations available. As the

number of users of BDS C expanded, a nucleus appeared that took the form of the BDS C Users Group. The group began collating material for inclusion on its disk volumes and very quickly grew to a respectable number.

While the BDS C compiler is emphatically not public domain, the associated software from the users group is. And while the BDS C compiler is intended as the compilation system, there is no major obstacle (except some syntax and lesser known functions) to using either the public domain Small-C or another commercial C compiler on the source codes. Most of the group's disks include source code as well as compiled code.

The BDS C Users Group has not assigned a cataloging system like SIG/M and CP/MUG uses, so the contents of each disk are sometimes hard to decipher. A master catalog (which looks very much like it was done on Ward Christensen's XCAT/NCAT system) is available that lists file names with their associated disk but has no descriptions at all. (At least not in the releases I have seen—such a thing may exist now if someone has taken the time to compile it.)

Regardless, several dozen disks are available either from the users group directly (address at the end of this column along with all other mentioned organizations) or through some of the clearing houses that specialize in distribution of public domain material, such as Elliam Associates.

As BDS C Users Group disks have no accurate numbering system, an arbitrary system has been adapted by several sources. Currently 44 disks have contents varying from the ubiquitous games to software tools, utilities, functions, and other material. One of the disks even has the Small-C (public domain) compiler on it.

Notable disks have the ROFF4 text formatter, a 6800-1802 cross assembler, Ed Ream's screen editor (both BDS C and Small-C versions), video terminal libraries, 6809 software tools, and PISTOL (see last month's column). Five disks contain utility programs, and three have functions. The complete software tools are available.

Pascal/Z has also developed a users group with a similar series of disks avail-

By Tim Parker

able. Again, most of the programs are available in source code form, so any Pascal will work after suitable modification where necessary. Most of the Pascal/Z Users Group's disks have been released on SIG/M disks, so two sources exist.

One volume that always seems to raise an eyebrow is Pascal/Z vol. 14, SIG/M vol. 71, which includes among the bit manipulator, statistical package (worth the look) and randomizer, a LISP written entirely in Pascal! While it is quite a subset, the novelty alone of looking at the code (all 26K worth) is instructive to LISPers and Pascal users alike. (Now I'd like to see a Pascal written in LISP.)

Another useful volume from a machine language programmer's point of view is Pascal/Z vol. 22, SIG/M vol. 97. This has an updated COMBINE (discussed in the first Public Domain Software Review column—it combines a number of small assembler files into one larger one) and a program called CROSS, which allows indentation, annotation, and cross-referencing of Pascal code. The Pascal source code is supplied as are compiled versions.

Finally, Pascal/Z vol. 25, SIG/M vol. 133, has a metric conversion program and a balanced cattle feed ration design program. (Luckily, those aren't the best things on the disk.) An extended precision floating point routine, which has worked well in testing, is also included.

The (unfortunately) defunct JRT Systems' JRT Pascal (which pioneered the low-cost CP/M software idea) is available on Pascal/Z vol. 18, SIG/M vol. 82. This is version 2 of the compiler. JRT Pascal 3.0 is also available, but the disk numbers have not yet been announced.

Despite a lot of criticism, JRT Pascal has been the Pascal entry vehicle for thousands of programmers, and its inclusion in the public domain is bound to allow many more people to access Pascal. (JRT



Pascal 3.0 is available on CompuServe's *COMPUTER LANGUAGE* data base section along with complete documentation. An extended precision package allowing 502 digit manipulation is also there. It is not yet available through any public domain source as it is a user-supported program.)

A company called Elliam Associates has a catalog of all current CP/MUG and SIG/M disks and abbreviated descriptions available. Elliam supplies the disks in many formats and over the past few months has proven itself to be extremely

reliable and cooperative. The company is very highly recommended from personal experience and will be mentioned here quite often in the future in connection with some of its releases. Elliam's catalog costs \$7.50.

Elliams collects material of similar types on several disks. For example, Elliam has a disk of SUBMIT facilities that will collate the best (and most recent versions) of the submit programs from the disks in the library and present them on one collection. While it may be argued that getting a mass of submit programs at once is not that beneficial because so many won't be used, it must also be considered that this allows a user who wishes to use a submit program to find the one that best suits the requirements.

Elliam offers collections with several themes, including copy programs, disk utilities, directory and catalog routines, and others. Two I have found of value as a programmer deal with assemblers and disassemblers and Z80 programs (for the ol' 8-bit machines).

The assemblers and disassemblers disk contains 49 files in 420K and is available for \$22.00 in most formats (obviously on multiple disks for some). While some of the programs are of limited use to most people unless they happen to own specific systems, there is enough good material to make the collection a worthwhile addition to a CP/M-80 programmer's library.

A sampling of the included programs shows several straight assemblers. ASM-X allows cross-reference maps to be generated and recognizes Z80 mnemonics. A file includes the index register op code syntax that ASM-X handles. ASM-X isn't perfect (what program is) in that the disk buffer is a paltry 128 bytes needing many disk accesses, and it requires all labels to be in column one (instructions cannot be there!), but a label can be the same as a valid op code, if required. Six additional op codes can be handled by ASM-X to allow listings to be turned on and off, paging, conditional paging, and changes of listings from hex to octal. ASM-X doesn't handle macros, which is not too bad a problem as MACASM on the same disk does.

LINKASM is compatible with ASM from Digital Research and allows a series of files to be linked together during assembly. LINKASM seems to run faster than ASM under all conditions and allows the construction of a symbol table that can be used with SID.

Disassemblers on the disk include the previously discussed RESOURCE (see the premier issue) by Ward Christensen modified to handle Z80 mnemonics; the Intel Users Group's DISASM, which has been severely overhauled to handle Z80 mnemonics and disassemble better; and DISSAMBR, an 8080 BASIC program.

Of those mentioned, RESOURCE and its derivatives for Z80s have performed flawlessly in countless attempts to dis-

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semble and understand programs. RESOURCE has a well-written document file and allows the programmer (or in this case "unprogrammer"?) enough flexibility to create the source code in whatever is best for the situation.

The disk also has a number of programs designed to make a programmer's life much easier. NOTATE and COMBINE have been previously mentioned in this column, but for those who missed it, NOTATE allows comments to be added to a source program. It displays each uncommented line with the cursor positioned at the comment location and allows the programmer to add a comment if required or to simply skip over the line. The original file is saved as a .BAK file, while the new version takes the .ASM file type.


COMBINE concatenates a number of source codes into one larger program and allows comments to be stripped at the same time. When a large program is designed in modules, this program proves itself very worthy.

Included is a structured assembler "programming language" called ML80, which seems ideal for those who want to program in machine language but can't get a grip on the mnemonics. It allows 8080 code to be written in a preprocessor style that prevents memorization of all the functions available. As an example, to increment the accumulator the line "A=A+1" can be used instead of the standard "INR A". (That doesn't particularly excite me, but there must have been some need for the program. It does have a good macro facility.)

Finally, XREF is the source for a cross-reference generator that has been modified over previous versions to accept lower case and add extra error messages. PAGE and ELSE pseudo-ops are ignored.

Some of the other Elliam collection disks will be examined in upcoming columns, but that's enough for now. In the next column, you'll see more for Big Blue and maybe even a look at some Apple stuff. (There were a lot of Apples sold . . . they must be out there somewhere!)

Some of the programs mentioned here are available with a tub-load of languages on either the *COMPUTER LANGUAGE* Bulletin Board Service or on CompuServe. So, till next we meet, ciao!

Useful addresses: SIG/M is at P.O. Box 2085, Clifton, N.J. 07015-2085. CP/MUG is at 1651 Third Ave., New York, N.Y. 10028. PC-SIG is at 1556 Halford Ave., Suite 130, Santa Clara, Calif. 95051, (408) 730-9291. Elliam Associates is at 24000 Bessemer St., Woodland Hills, Calif. 91367, (818) 348-4278. Pascal/Z Users Group is at 7962 Center Parkway, Sacramento, Calif. 95823, and the BDS/C Users Group is at Box 287, Yates Center, Kan. 66783. 

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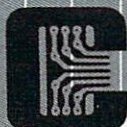
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EXOTIC LANGUAGE OF THE MONTH CLUB

OMNI: One person's language

By Steve Heller

In 1979, after I had spent two years writing a general data base program in a version of Microsoft BASIC, with ad hoc extensions in Z80 assembly language, I decided that no programmer should ever have to go through the same ordeal. OMNI is the result of that determination. OMNI's purpose is to provide the professional programmer with the tools needed to write commercial programs quickly and easily. These tools include powerful and flexible data types, including variable-length virtual memory string arrays; a uniform and simple syntax—reverse polish notation with no hierarchy of operators to remember; and a highly interactive environment, including a word-processor-type program editor and an exceptionally rapid compiler.

It has taken me the equivalent of more than two years of full-time work to create the prototype of the OMNI system. Table 1 compares in detail the features of OMNI with other currently available languages.

Since I perceive the greatest market for microcomputer programming to be in commercial data processing, OMNI's design was heavily influenced by the requirements of such programming. However, other types of programming, such as scientific programming, should also benefit from the highly interactive nature of the programming process in OMNI.

Some of the major design criteria (and their solutions) are:

- Extremely rapid compilation to make testing and debugging an interactive task. This relies heavily on three concepts: hash coding of the symbol table; segregating special compiling functions into the operators that need them, thus reducing the checking that must be done in the compiler proper; and using reverse polish notation to reduce the compiler's job essentially to looking up the indexes of the operations whose names are listed in a definition.
- Compact object code to allow more room for data in memory and to reduce virtual memory overhead for code swapping. In order to achieve this, I allow for

two different sized operators: 1 byte for primitives, which are defined in assembly language, and 2 bytes for secondaries, which are defined as a sequence of primitives and/or other secondaries. Since the most common operations are primitives, this reduces the average object code size to less than 2 bytes per operator.

- Good execution speed for real world programs to promote commercial acceptance of programs produced. This was accomplished by coding the most commonly used functions in assembler rather than attempting to increase the portability of the language itself by coding as much as possible in higher-level code as is done in Fig-Forth, for example.

- Excellent debugging facilities at a high level so that machine language debugging is not necessary.

- Excellent run-time error checking. For example, all array subscripts should be checked for out-of-bounds conditions. No special techniques were needed to implement this.

- Ability to handle necessary data types as an intrinsic part of the language, e.g., variable-length virtual memory string arrays and variable-length random access data files. The method of implementation of this feature is described later in this article.

- Ease of entering and changing programs by using a built-in word-processing-type editor.

- Portability of source code so that the same program will not have to be written over again for each type of computer.

- Ability to handle large memory configurations efficiently, without requiring the programmer to be concerned with memory allocation schemes.

- Encouragement of structured programming to reduce the likelihood of errors in the control flow.

- Support for long, mnemonic variable and subroutine names to improve readability.

- Support of BCD arithmetic to allow correct addition of totals in accounting reports. The OMNI commercial arithmetic package provides BCD add, subtract, multiply and divide in 16-digit accuracy.

- Support of slide-rule accuracy arithmetic having very high performance and great dynamic range.

It was necessary to write OMNI in assembly language to achieve maximum performance, which is especially important for providing a highly interactive environment as well as the computing resources necessary to support the language's other characteristics.

This may seem to contradict the ideal of portability, one of the characteristics of OMNI. Why didn't I write OMNI in C to gain portability?

The question has two answers. The first is that the user of a language is interested in the portability of the programs written in the language or those acquired from others. The user doesn't care how much work it is to transport the language from one machine to another since he or she doesn't have to do that.

The second reason is that no compiler in the world can generate code as well as an expert assembly language programmer. If OMNI were written in C, the OMNI compiler would probably run at one-tenth the speed it does now. Execution time efficiency would also be impaired.

The most difficult problem I had while writing OMNI was the implementation of the virtual memory. It had to be able to manage the storage and retrieval of strings and records, which could vary in length dynamically.

The design solution was to divide the mass storage into blocks of 1KB each, numbered from 1 to the maximum capacity of the system (limited to either 65,535 or approximately 2 billion blocks, depending on the processor). Each block is divided into up to 63 variable-length items, which are referred to by their relative item number. Therefore, each item in the virtual storage may be accessed by its block number and relative item number. Each block has a directory at its end, organized as shown in Table 2.

After the last item pointer and type, a dummy points to the free space in the block, which is always kept in a single segment. This allows the system to calculate the length of any item by subtracting its starting address from the starting address of the next item, with the free

Comparison of BASIC, COBOL, Forth, and OMNI

| | Microsoft MBASIC | | Microsoft COBOL v. 2.2 | | fig- Forth | | OMNI | |
|--|---------------------|-------------|------------------------------|-------------------|---------------|---------------|-------------|--------------------|
| | Rating | Value | Rating | Value | Rating | Value | Rating | Value |
| Compilation speed (Sieve, in sec) | 4 | <<1 | 0 | 146 | 3 | 2 | 4 | <<1 |
| Size of object code (Sieve, in bytes) | 3 | 300 | 1 | 786 | 3 | 260 | 4 | 177 |
| Execution speed (Sieve, in sec) | 1 | 1,920 | 0 | 5,115 | 4 | 85 | 2 | 310 |
| Variable name length | 1 | 2 chars | 4 | 31 chars | 4 | 31 chars | 4 | 31 chars |
| Local variables | 0 | none | 0 | none | 0 | none | 3 | scalars |
| Subroutine names | 1 | line ^ | 4 | 31 chars | 4 | 31 chars | 4 | 31 chars |
| Variable length strings | 2 | mem only | 1 | fixed | 0 | none | 4 | virtual |
| Variable length random- access records | 0 | none | 2 | incon- venient | 0 | none | 4 | virtual |
| Ease of extending language | 1 | assembly | 1 | assembly | 4 | high level | 3 | high level |
| BCD arithmetic | 0 | none | 4 | user- specific | 0 | none | 3 | fixed point |
| Engineering arithmetic (floating point) | 3 | accuracy | 0 | none | 0 | none | 3 | speed |
| Simple syntax | 3 | few rules | 1 | many rules | 3 | few rules | 3 | few rules |
| Meaningful error messages | 3 | in English | 2 | codes | 1 | often none | 3 | English |
| Interactive debugging | 2 | trace | 0 | batch | 2 | write own | 4 | single step |
| Run-time error checking | 3 | error msg | 2 | code | 1 | bomb | 3 | error msg |
| Source editor | 1 | line editor | 2 | screen | 2 | screen | 4 | word processing |
| Total | 28 | | 24 | | 31 | | 55 | |
| Average | 1.75 | | 1.5 | | 1.94 | | 3.44 | |

0 is lowest, 4 is highest rating.

Sources: Gilbreath, John. "A High-Level Language Benchmark." Byte Sept. (1981): 180 and the author's experiments.

Table 1.

| Byte Number | Size | Name in block |
|-------------|------|---|
| 0 | 1 | Block item count—tells how many variable length items this block currently contains |
| 3,4 | 2 | Same as above, but for second item in block |
| etc. | | |

Table 2.

space pointer serving this purpose for the last item in the block.

Retrieving the value of an item in the virtual memory was not particularly difficult to implement. For example, suppose that you ask for the value of the 300th element of string array #12. Of course, in a real program the array would have a name, but I am simplifying for purposes of discussion.

First OMNI looks up the pointer block number of array #12 in the master object table. Suppose the entry says "block 97, relative item #1". Block 97 is read into memory if it is not already there, and the

address of the first item in the block is looked up. Since string pointers are 3 bytes long, 300 is multiplied by 3 to yield an offset into the pointer array of 900.

At offset 900 in the array, a 3-byte string pointer is read. It says "block 102, item 27". So block 102 is read into memory, if necessary, and its item count is checked to see whether item 27 exists. If not, an error results. Assuming it does exist, its length will be calculated by subtracting its starting address from the starting address of the next item in the block, and it will be pushed onto the string stack.

This may seem like a lot of work just to retrieve the value of a variable-length string array element. But the reward is that the programmer no longer has to

worry about running out of RAM for such arrays. In OMNI you can create dozens or hundreds of arrays of thousands of variable-length string elements each, as long as your disk storage holds out.

The other unique problem that I encountered while writing OMNI was the requirement that definitions of operators be able to be removed from memory when no longer needed and their space reclaimed. This meant that all references to the address of an operator must be known to the system so that they could all be adjusted if a definition was removed or changed in length.

I wrote a subroutine called *MOVER*, which moved all definitions above the one deleted or changed and updated all entries in the definition address table and on the return stack, which was used to store return addresses during subroutine calls. This also meant that there must be no addresses in the OMNI object code, whether primitive or secondary. All primitives must use only position-independent addressing modes when referring to code or data contained in them, and all branches in secondaries must use relative addressing so that all operators will function correctly even if they are moved to different memory addresses.

As mentioned before, the OMNI compiler is fast for three main reasons. First, since the language uses reverse polish notation, the compiler doesn't have much work to do compared to the code needed to unravel complicated hierarchical expressions. Also, parameter passing is done mainly on the stack, which reduces subroutine linkage complexity.

Second, the look-up of indexes of operations, given their names, is speeded up immensely (a factor of 10 or more, depending on the number of operations currently defined) by using hash coding.

Third, the code necessary to handle compilation of such things as loops, conditional execution, and variable definitions is distributed to the operators responsible for those specialized tasks and not centralized in the compiler. This allows extensions to the language without continually increasing the size and complexity of the main compiler, which handles only operator name look-up and conversion of numeric constants from ASCII to internal format.

The main tool for debugging OMNI programs is the tracing inner interpreter (II). The II controls the execution of applications programs in OMNI and can be switched from one mode to another by changing one pointer.

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I wrote a specialized II that displays the name of the next operation to be performed (if it has one) and the current contents of the stacks before it executes each operation. It then waits for a keystroke, after which the II accepts a line of code that can contain almost any legal OMNI code.

This same code will then be compiled and executed. This allows you to watch the execution of an operator and interrupt it at any point, change the stack contents, or display or modify the value of a variable, and then continue where you left off. Since a large percentage of program errors in a reverse polish notation language are caused by incorrect stack usage, the constant display of the stacks is very useful in debugging.

The word processor can be run in "hot" mode, which allows immediate compilation of a section of the source program currently being edited and the testing of it, without ever leaving the word processor. This allows even greater interactivity than would be assumed from the rating of compiler speed in Table 1 since it takes only a fraction of a second to recompile a section of program of 20 lines or so, which covers the vast majority of operators.

OMNI attempts to give as much protection against programming errors as possible. Because you cannot address memory directly, but only through carefully controlled and monitored access operators, it is essentially impossible to corrupt the object code of your program in memory or store into a data area that is not appropriate.

Memory is viewed only in the guise of variables and arrays. Subscripts are checked at run time since one of the most common programming errors is to violate the boundaries of an array and destroy something else in memory. If a subscript error is detected, an error is raised. This also applies to BCD overflow, which is generally a fatal error anyway.

When an error occurs, the compiler or interpreter indicates what the subroutines were that were suspended at the time of the error in an upward order from the lowest one.

Because the edit/compile/test cycle is so rapid, I have not felt it necessary for compilation to continue after the first error is detected and announced. This may be changed in the future.

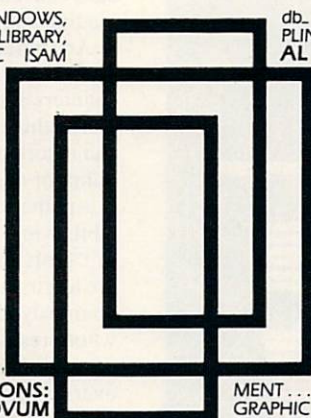
Portability to me means that the same program should produce the same results on any machine on which it will run at all, and it will run on more than one machine of differing architecture. This is a major goal of OMNI.

Portability affects the implementation of OMNI in a variety of ways, which can be summarized as follows:

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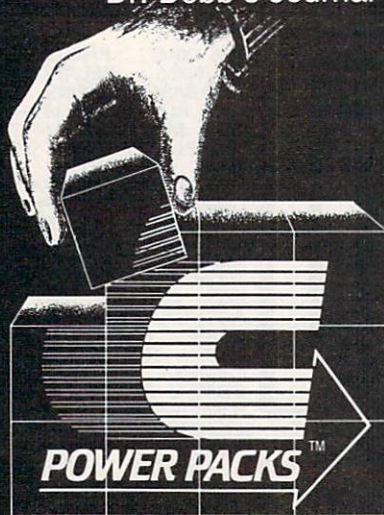
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■ **Memory and I/O control.** No application program may access memory or I/O devices except through the intermediary of OMNI primitives. Memory may be viewed only as variables and arrays, and I/O devices are treated as files, with standard conventions for opening, closing, reading and writing.

■ **Arithmetic operations.** All OMNI systems use 16-bit integer arithmetic for counters and similar uses, 16-digit decimal arithmetic for commercial arithmetic and record numbers, and 16-bit floating point for engineering applications.

Another of the great drawbacks to portability in C is the fact that the precisions of "short" and "long" integers and reals are left to the implementor to decide. This obviously allows the writing of programs whose results depend on the actual length of such numbers, especially if arithmetic overflow is not detected at run time.

■ **File access.** OMNI files can have up to about 2 billion records, each of which can have up to approximately 32,000 fields. The total mass storage supported as one virtual address space varies from system to system since 32-bit arithmetic is unreasonably slow and large on some 8-bit computers, such as the Z80. On those machines, the virtual address space is limited to approximately 65MB. On other machines, such as in the 68000 or 8086 families, the limit is approximately 2 trillion bytes!

In any discussion of software portability, someone will express the opinion that portability is unnecessary because all the software developer needs to do is be IBM PC compatible. This is an attractive notion as there are always trade-offs in attempting to write portable code.

However, I believe this idea to be erroneous for the following reason: IBM compatibility cannot be attained because even the various models of the IBM PC line are not hardware compatible. Leaving aside the PCjr, which is not a business-oriented machine, and the PC 370XT, which is designed to run IBM System 370 software, the new PC AT is different architecturally from the PC and PC XT as it uses an 80286 processor rather than the 8088 that the other two use.

Since memory segmentation works differently on the 80286 than it does on the 8088, programs that modify the segmentation registers are not transferable between these processors without major changes. This includes all major business programs for the IBM PC line, such as Lotus 1-2-3. Even worse, IBM appears to have deliberately prevented the "compatible" machines from running IBM's new software.

The only solution to this problem is for

developers to use a virtual machine such as OMNI. Then a new machine will necessitate the rewriting of only one program, the OMNI system. The developers will be able to go on to write new programs rather than struggle to keep up with IBM.

As previously mentioned, the size of OMNI object code is extremely small—less than 2 bytes per use of each operator on average. Overhead for definitions of operators is also small—it amounts to 5 bytes plus the name of the operator.

The names of any or all operators can be removed from the object code at any time and the space thus saved reclaimed. This adds to program security since an operator whose name has been removed can no longer be compiled into a new definition and further reduces space requirements. (For example, source code for the Sieve of Eratosthenes, excluding comments, is 487 bytes and the object code is 177 bytes.)

A final point I'd like to make is that a great deal of room exists for disagreement on the readability of various programming languages. It is as easy to write unreadable programs in OMNI as it is in APL and Forth.

However, it is also easy to write readable ones. You must make liberal use of variables and restrict to the minimum your use of the stacks. In fact, it is not necessary to use the stacks explicitly at all (although performance may be improved if you do use them). Take the following examples of what to do and what not to do:

(bad) $ABC \text{ over over } + * \text{ swap } -$
 $+ - > D$
(good) $CC * BC * + B - A +$
 $- > D$
(The BASIC equivalent would be: $D = C * C + B * C - B + A$)

If you'd like to learn more about OMNI, leave me a message on the Bulletin Board Service or send me a note c/o *COMPUTER LANGUAGE*, 131 Townsend St., San Francisco, Calif. 94107. Tell me what you think about the design features I developed with OMNI and ways you think it might be improved. ■

Steve Heller graduated from Shimer College around 1970 and became a programmer more or less by accident. He has been programming for the past 15 years.

A conversation with CompuPro's Bill Godbout

By Regina Starr Ridley

"How're you doing, Bill!" a young

CompuPro employee greets Bill Godbout as he walks through a large warehouse room where 20 or so employees are eating lunch, playing ping pong, or working amid an amazing jumble of hardware.

Godbout, chairman and CEO of CompuPro, responds warmly. He wears a blue plastic name tag that says Bill Godbout, probably put on absentmindedly, out of habit. Everyone here knows who Bill is. And you get the feeling everyone likes this big, friendly man who looks like he'd make an excellent Santa Claus.

Godbout is an entrepreneur—a very successful one whose 25 years or so in business appear unblemished with failure. But he's no cutthroat business man. He talks about CompuPro as a family and his life seems to have been filled with varied, unusual experiences, many of which Godbout is pleased to share. He loves to tell a good anecdote, joke, or bit of trivia. And he knows plenty of them.

Originally from the East Coast, Godbout came west to California's Bay Area after being on active duty in the military for most of the 1960s. He had been involuntarily recalled to active duty in 1961—the Berlin Wall period—while working for IBM.

Godbout put in for duty in the Far East hoping to go to Korea, which he heard was the best kept secret in the army, or Japan, with its geisha houses and the Aki Habara, an electronics trade zone. Shortly before Christmas of 1961 he got orders to prepare for a transfer and, as he puts it, he thought "ah! I've made it! Geisha houses, the Aki Habara . . ."

"I went to bed that night happy as a little tick," Godbout says smiling, shaking his head. "Little did I know . . ."

Godbout was discharged in 1968. Although he held IBM in esteem, he decided he would not to work for a big government or a big company again. But, he said, "If I were to work for a big company I sure as hell would consider IBM right up at the top of the list."

Godbout moved to the Bay Area because someone he knew was putting together a crisis management team to help save a company in deep financial trouble

and asked him to join. The team had 18 months to turn the company around—they did it in 13.

The team members figured they had done so well they might as well start their own company. But they quickly found out that knowing how to save a foundering company is not the same as making a success of a new one. "We did all the same wrong things that those guys had done to get into trouble except for one thing," said Godbout. "Once we really got into difficulties we knew what to do. We could work our way out."

"It was a very, very low profile company," said Godbout, dropping his voice to a conspiratorial whisper and declining to reveal the company's products. The kicker was that the company was located in Oakland, the town right next to Berkeley—not exactly a peaceful area during the late sixties and early seventies.

"We had visions of people burning cars in the parking lot," said Godbout. But the low profile was mostly successful except for one frustration.

"It wasn't like James Bond and that was a big disappointment," Godbout said. "Never once in all those years did a gorgeous anything—blonde, redhead, or brunette—ever try to seduce me. I could have been had too! I should have been in the FBI. I guess that's the way to get the action."

Godbout sold the business and went into a period of semi-retirement, "retirement on the installment plan." It was a time, he said, of bumming around, fondling airplanes, playing at the airport, drinking a lot, and "doing the good old boy thing till I was bored to death."

Then came the beginnings of CompuPro.

A good friend of Godbout's, Mike Quinn, had a place at the Oakland airport where he sold surplus semiconductors and miscellaneous electronic spare parts. Godbout was fascinated.

But maybe the true start of CompuPro was when Godbout was a little boy. "To drop back many years, I guess really all my life I've been a dump picker at heart. As a kid with a paper route I used to pass a dump behind a GE plant. There were lots of wonderful and useful things back there,



like meters. It might have a bent needle but you could straighten it out."

"When I look back at the amount of time it took to take the thing apart and then really get the damn thing working, considering the time factor, it would cost a technician twice as much. But at that time, from my point of view, I thought, 'Oh God, what's the matter with these people?' I would drag these things home, much to the chagrin of my mother."

Godbout's friend was buying electronic parts that semiconductor firms couldn't economically deal with and were selling at upset prices. Parts also came from companies going out of business. The real job was redistributing the parts into markets which had been unreachable. This too reminded Godbout of his boyhood.

"I recall the first transistor I got when I was a kid. It was treated like a crown jewel," said Godbout. It was called a CK722 and was the first commercially made transistor.

"God I don't recall how much paper route money it took to obtain that damned thing but I managed to get one. I got it from a wholesaler who I think took pity on me. He sold me just one unit at the one-thousand-piece price because this kid showed up with money clutched in hand to see if he could get a transistor."

"I could see people like me of all ages who were interested in electronics. And you would see these neat projects in *Popular Electronics* and *Radio Electronics* magazines, and you'd have to scrounge like mad to find the parts to build the damn things."

First Godbout became interested in the acquisition of surplus parts and spent

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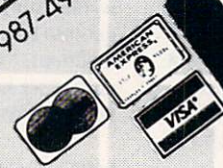
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some time as Quinn's apprentice. On the business level he found it intriguing as a case study on how companies dispose of their excess inventory. On another level, the quasi-hobbyist or hacker in him thought, "gee, here's a neat treasure to be shared."

So in the early seventies Godbout started a mail order business that was strictly parts. In 1973 he started playing around with the new microcomputer equipment and then made a deliberate attempt to gather different pieces of computer parts and offer them for sale. The first computer kit was done in September 1973 and went over very well. He also got into music kits. These two business angles later became separate divisions: CompuKit and MusiKit.

Godbout started catering to the small groups of people who were actually building their own machines. CompuKit was the first company to nationally distribute a semiconductor memory kit, said Godbout.

The kit was pre-Altair and "a marvel of its time," said Godbout, with proper awe in his voice. "It was a 4K byte board about 1-foot square and just teaming with power hungry parts. Nowadays, using the same technology, we could easily stick a megabyte on the same size board and consume a hell of a lot less power."

CompuPro has come quite a long way in the 11 years following the first computer kits. The company primarily became known as a leading supplier of S-100 microcomputer products used to integrate packaged systems.

In 1982 the company introduced the System 816 series, its first fully integrated business systems. A year or so later, CompuPro introduced the CompuPro 10, the first product that was a real departure from the company's usual S-100-oriented products.

The System 816 series and the CompuPro 10 are considered two subsets of the same family and are referred to as the letter series and the number series, respectively.

The System 816 series is based on microprocessors from four manufacturers—Intel, Motorola, National Semiconductor, and Zilog—and distinguished with a slash and letter following the 816.

The number series, though conceptually single-board machines, are essentially fixed architecture with limited growth or modification potential, said Godbout. They are not bus-based—they have expansion slots. The CompuPro 10 has six slots.

The CompuPro 10 is aimed at the business office environment. In contrast, a large percentage of the S-100 market business is actually OEM business, which Godbout estimates to be more than 50% of the product manufactured. He can cite

numerous large companies that use CompuPro S-100s.

The introduction of the CompuPro 10 has not been without a number of problems, Godbout states openly. The 10 has a Master-Slave architecture where a central 16-bit, 8-MHz 8088 processor is dedicated to handle system resources and four 8-bit, 6-MHz Z80B processors act as individual users.

"We had test problems, we had code problems, and we ended up, albeit very quietly, putting binders on shipments after the initial introduction. We froze shipments and we pulled back all the machines and exchanged them. With everyone we could identify we just shipped them a machine and said send the old one back. If they called up and said, my hortneimer valve doesn't ragfrazzle, we said please put that machine in a box and send it back to us collect."

The 10 had a number of problems. "And we had a number of false starts. We thought we had the problem pegged—we were doing field tests and beta tests and running everything parallel at top speed to catch these things. But it was a matter of months till we really got the 10 settled down and stabilized."

All the machines that have been shipped since May of this year have been stable and no changes have been necessary since then, said Godbout. CompuPro is now effecting one planned change—moving the operating system from Digital Research's MP/M to Concurrent. CompuPro 10s shipped in October have the Concurrent operating system.

CompuPro has stayed with the CP/M products rather than follow the PC-DOS path, and Godbout is quite a supporter of CP/M.

"I look upon CP/M and the CP/M family like Listerine. You may not be in love with it but it's the best damn game in town."

"I think DRI products are clearly superior products. MP/M 86, CP/M 86, and Concurrent are true operating systems," said Godbout. "They provide a real interface that makes for true hardware independence. You can't really say that for any other operating systems. I can't think of anything that approaches Concurrent and its successors."

"I'm personally convinced that from an applications programmer's standpoint, and from a hardware designer's standpoint, you can do a lot more, better, in a Concurrent CP/M environment than any other environment. It is a general purpose operating system. The market we're dealing with is a general purpose market."

But Godbout considers the future of CP/M "iffy." As he says, "it wouldn't be the first time that a really technically superior product has gone down the drain in the face of a really less meritorious product. But I don't think DRI's demise is imminent. They just have a big marketing task ahead of them."

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
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Godbout categorized PC-DOS as the approximate equivalent of CP/M 2.2—a job control language. "At the risk of sounding churlish or foolish," said Godbout, "IBM has not been noted for the technical excellence of its hardware or software."

"You won't see the 10 running IBM PC-DOS software," said Godbout. But CompuPro purchased the license for PC compatibility along with Concurrent and will be shipping the PC compatibility module with every Concurrent operating system for bus-based machines.

"I don't care what you call the operating system itself—what you're going to end up with as I see it is a framework, a hierarchical structure that will provide for calls for a number of job control languages or subset modules to interface with things like PC-DOS, the older CP/M, the new CP/M, and even a UNIX-like operating system. And the appropriate one will be called when you load a program."

Godbout believes that the point is just now being reached where a realistic piece of hardware is available for doing this type of thing. He feels CompuPro's System 286, based on Intel's iapx 80286, is an example of such a machine that permits very rapid context swaps without a tremendous amount of software or operating systems or systems programmer manipulation or overhead. The 286 hardware has backup to support software partitioning between users or tasks and provides four levels of privileged access.

The CPU 286 was introduced in November 1982 at Comdex. The 286s were tough to come by last year, said Godbout, and they were high priced machines—\$15,000 to \$20,000 without a terminal or printer.

Although it has not yet been announced, Godbout said that CompuPro now has a UNIX System V running on the 32016. It's being tested in Europe and, as soon as AT&T "anoints it" and the System V is released, CompuPro will have a System V on the street for the 32016.

Godbout says the product is a true 32-bit processor that fits on an S-100 bus. "The 32016 bus is a 32-bit guy that's double pipelined and has both an instruction queue and memory address processor queue."

The 286 was designed from the ground up for multi-using and multitasking and has the fast context swap instruction plus instructions like popa and pusha, which make for very fast changes of personality. (The "a" on the end stands for all—pusha will take all of the stack and move it with just that one instruction.) The 286 also has an onboard memory manager that provides for up to a gigabyte of virtual storage space per user. So big virtual machines can be built in the operating system and you get a hardware base to execute it with, Godbout said.

The 32016 requires an external memory manager. It has virtual memory but its instruction set is very orthogonal.

It's more suited to the UNIX-type environment than some of the other machines, he said.

Now that CompuPro has branched off into a very different market area, which market will it push more strongly?

CompuPro is coming down with feet planted on both sides of the fence, according to Godbout. The CompuPro 286, which is bus based, was to be introduced at Comdex in November, so CompuPro is not ignoring the bus machines, he said. And to go to the 32-bit and bigger machines CompuPro will have to go to a new bus. A final decision has not yet been made except that a new bus will definitely be added to CompuPro's bus line.

Godbout considers the development systems to be solid business and doesn't want to abandon or neglect this area at all. But he expects that CompuPro will experience its largest growth in the next three to five years in the office automation area.

Selling in the competitive business market requires a strong marketing program. In addition to this new area, CompuPro plans to pursue other markets, including artificial intelligence. For example, CompuPro now has LISP for the 68K system, the Cambridge LISP. CompuPro Europe has released UNIX for the 68K system—it was tested in the U.K., is now in Canada, and will be showing up in the U.S.

The name CompuPro did not seem adequate to appeal to these new markets and to cover a diverse product mix. Marketing tests showed that many people found it hard to pronounce and weren't able to relate the written and the spoken word.

So CompuPro went to Namelab, a company that thinks up new names, early this year. Eight possible new names have been chosen and are being run through trademark searches and word checks in other languages.

CompuPro would like to announce the new name January 1. The number one contender, says Godbout, is nice, euphonious, different, and in 9,999 times out of 10,000 times it is pronounced correctly when read. It is three syllables long, has more than five letters, and doesn't sound high-techy like Exxon.

"We had to have a name that would be totally neutral or Pablum—a standard brand," said Godbout.

It's hard to imagine this witty man, never without a sparkle in his eye, helping to come up with a Pablum name. A real zinger would probably be a better bet.

Another good bet would be to go with this entrepreneur, who claims there is no secret to success. "In all endeavors you've just got to do it. You give it your best shot and you get it out the door."

Regina Starr Ridley is managing editor of COMPUTER LANGUAGE.



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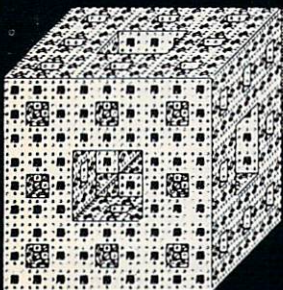
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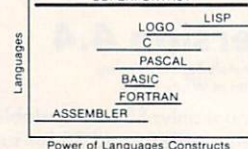
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A comparison of Pascal compilers

By Namir Clement Shamas

Pascal's popularity has lead to the development of many commercial packages. All of the implementations have extensions to make one or more aspects of the language more versatile.

Which package is the best? What are the differences? Is the implementation you are using really appropriate for you, or did you buy it because of the brand name? If you're just learning Pascal, which is the one to select? Will the price affect your decision to purchase a particular version?

These questions lead me to carry out this review. I will compare six Pascal compilers for the IBM PC. The aspects of comparison will include the language implementation, compilation speed, code size and speed of program, and suitability for big software projects. The compilers I will review (by no means all the Pascal compilers on the market) are:

■ **MS-Pascal**, a product of Microsoft, was first released in 1981 for the IBM PC, using IBM labels. The compiler has gone through two major revisions. One was to accommodate the use of the 8087 numeric coprocessor chip. Microsoft is also directly selling its compiler for micros running MS-DOS, such as the IBM PC, Compaq and HP-150. The language implementation is rich with additional functions and procedures to perform a variety of low- and high-level data manipulations. The package is one of the "heavyweights."

■ **Pascal MT+** is sold by Digital Research. The language has an earlier implementation in the CP/M-80 environment and thus has been on the market for a few years for the Z80 machines. The compiler was more recently implemented for the CP/M-86, PC-DOS and CP/M68K. This implementation offers numerous functions and procedures to perform high- and low-level data manipulation. This is another extensive package.

■ **SBB Pascal** is a product of Software Building Blocks. The implementation stems from a previous 8-bit version sold as Pascal/Z. The latter has a good number

of public domain software and user groups.

■ **Turbo Pascal** is a product of Borland International. The product first appeared in 1983 and is marked by its low, affordable price. This fact and Turbo Pascal's speed of compilation and execution are the ingredients of its popularity and success. This product is excellent for "getting one's feet wet" with Pascal. It is very suitable for small projects.

■ **Practical Pascal** comes from the Canadian firm, Network Consulting, a licensee of Softech MicroSystem. It has been selling the UCSD Pascal and p-system for the IBM PC and compatibles. The company has made a number of smart improvements over the original UCSD Pascal (version IV) sold by Softech. Practical Pascal is an affordable, scaled-down version of the company's full package. This product is suitable for those who want or need to use software developed for the UCSD Pascal.

■ **Utah Pascal** is sold by Ellis Computing. The product is essentially a repackaged version of the famous JRT Pascal, a p-code implementation. The company has been selling for a few years its low-price Nevada software line for the CP/M environment. This line includes COBOL, FORTRAN, BASIC, PILOT and Pascal. Utah Pascal seems to be the first in a series of Utah software, similar to the Nevada series, aimed at the MS-DOS environment.

The original JRT Pascal first appeared for the CP/M environment. It was one of the early low-cost software packages. JRT

systems filed Chapter 11 but seems to be willing to sell its Pascal through Ellis Computing. The product is suitable for the novice who does not mind the slowness of the p-code execution.

Table 1 shows some basic data concerning the contents of the commercial packages. This information includes the compiler, linker, assembler, debugger, editor and whether the compiler produces native code or pseudocode.

All the compilers have implemented extensions to ISO Pascal. They vary from one package to another. Table 2 shows a comparison of implemented data types.

Integers. MS-Pascal and Pascal MT+ implement the most extensions on data types. This includes wider integer ranges used for higher addresses. Both have the *WORD* type with a range from 0 to 65,535. Both offer, together with Turbo Pascal, the absolute data type—variables declared to reside at specific memory locations. SBB Pascal has adopted the basic standard types. The predefined *ADDRESS* type is offered by MS-Pascal.

Others, as Table 2 shows, use a function call to return the address of a variable. This extension in integer types is aimed at making the implementations versatile for low-level data manipulations.

Reals. MS-Pascal, Pascal MT+, SBB Pascal and Practical Pascal offer either long reals, BCD reals or both. This is aimed at scientific, engineering and financial applications.

Basic data

| | MS | MT+ | SBB | Turbo | Utah | Practical |
|----------------------|-----|-----|-----|-------|------|-----------|
| Compiler | yes | yes | yes | yes | yes | yes |
| Linker | yes | yes | no | no | yes | yes |
| Assembler | no | yes | no | no | no | yes |
| Debugger | no | yes | yes | no | yes | yes |
| Editor | no | no | yes | yes | no | yes |
| Version | 3.2 | 3.2 | 3.0 | 2.0 | 4.1 | 4.1 |
| Produce machine code | yes | yes | yes | yes | no | no |

Table 1.

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The support for the 8087 numeric coprocessor chip is unanimous for compilers generating native machine code. It allows floating point calculations to execute at a higher speed since all floating point arithmetic and function calculations are "hard-wired."

The benchmark tests presented later show, for example, that Pascal MT+ executes trigonometric functions 114 times faster with an 8087 chip than without it. Many implementations have recently added and/or improved the support for using the 8087.

Strings. MS-Pascal allows for a string variable to be up to 32KB long. This is second only to Utah Pascal which allows for 64KB strings. The rest maintain the standard maximum length of 256 bytes per string.

Open and conformant arrays. Pascal is a strongly-typed language, which has advantages and disadvantages. Disadvantages include limitations occurring when procedures and functions deal with arrays. The variables passed as arguments must be of the same type and size as stated in the routine declaration.

This poses a problem for programmers wishing to develop general purpose routines, such as matrix operations. To overcome the size limitations, dynamic arrays have been implemented in two ways.

The first, used by MS-Pascal, declares an upper array type with an unspecified upper bound. Variables can be declared as the upper array type with the upper limit specified. The same upper array type can be used in declaring the arguments of a function or procedure. MS-Pascal has predefined functions to obtain the array's limits.

Utah Pascal uses a similar technique: declaring dynamic array types. The variables can be declared with an unspecified bound too. The procedures *ALLOCATE* and *DEALLOCATE* are used to create and remove dynamic variables, respectively. These procedures can be used inside user functions and procedures.

The second method is to use conformant arrays. They are declarations appearing in the function or procedure arguments defining the type and dynamic size. Integer or character identifiers are used to specify the bounds of the arrays.

Data types

| | MS | MT+ | SBB | Turbo | Utah | Practical |
|----------------------------|-----|------|-----|------------------|------|-----------|
| Binary numbers | yes | no | yes | no | no | no |
| Octal numbers | yes | no | yes | no | no | no |
| Hex numbers | yes | yes | yes | yes | yes | no |
| WORD (0 to 65,535) | yes | yes | no | no | no | no |
| Byte (0 to 255) | yes | yes | no | yes | no | no |
| ADDRESS | yes | func | no | func | func | no |
| Absolute type | yes | yes | no | yes | no | no |
| Long integers | yes | yes | no | no | no | yes |
| Long reals | yes | no | no | no | no | yes |
| BCD reals | no | yes | yes | no | no | no |
| 8087 support | yes | yes | yes | yes | no | no |
| Structured constant | yes | no | no | no | no | no |
| Sub-range type | yes | yes | yes | yes | yes | yes |
| Enumeration type | yes | yes | yes | yes | no | yes |
| Set type | yes | yes | yes | yes | yes | yes |
| Open arrays | yes | no | no | no | yes | no |
| Conformant arrays | no | yes | yes | yes ¹ | no | no |
| Max string size (bytes) | 32K | 256 | 256 | 256 | 64K | 256 |

1. Only for strings.

Table 2.

Pascal MT+ and SBB Pascal use this method. Multidimensional dynamic matrices are also implemented. Turbo Pascal has tackled the problem for dynamic strings only. It uses a compiler directive to relax the parameter type checking on strings. Thus strings of any length can be passed.

All the Pascal implementations have a similar program component. MS-Pascal introduces the VALUE section, where variables declared in the VAR section are assigned initial value.

All implementations except Practical Pascal introduce the ELSE or OTHER-WISE clause to the CASE construct. MS-Pascal, Pascal MT+ and SBB Pascal

allow for functions to be passed as procedural parameters. This is valuable in writing procedures that process user-defined functions.

A simple example is developing procedures in numerical analysis to perform numerical integration or root seeking. Table 3 compares programming elements. Both Pascal MT+ and Turbo Pascal have procedures to handle in-line machine code and interrupts. These offer effective low-level machine access techniques.

Most of the implementations allow for DOS calls. SBB Pascal barely mentions this capability. MS-Pascal, Pascal MT+ and Turbo Pascal allow for bit and byte manipulation to benefit low-level data handling applications. Graphics are offered by SBB Pascal, Turbo Pascal and Practical Pascal. The last two offer cursor

Programming elements

| | MS | MT + | SBB | Turbo | Utah | Practical |
|-------------------------------|-----|------|-----|-------|------|-----------|
| Procedural parameter | yes | yes | yes | no | no | no |
| ELSE clause in CASE statement | yes | yes | yes | yes | yes | no |
| In-line machine code | no | yes | no | yes | no | no |
| Interrupt procedure | no | yes | no | yes | no | no |
| MARK/RELEASE | yes | yes | yes | yes | yes | yes |
| NEW/DISPOSE | yes | yes | yes | yes | yes | yes |
| ROM call | no | no | yes | yes | no | no |
| DOS call | yes | yes | no | yes | yes | no |
| Bit/byte manipulation | yes | yes | no | yes | no | no |
| Byte/char manipulation | yes | yes | no | yes | no | no |
| String manipulation | yes | yes | yes | yes | yes | yes |
| Graphics | no | no | yes | yes | no | yes |
| Windows | no | no | no | yes | no | yes |
| Screen cursor control | no | no | no | yes | no | yes |

Table 3.

I/O operations

| | MS | MT + | SBB | Turbo | Utah | Practical |
|----------------------|-----|------|-----|-------|------|-----------|
| DOS 2.0 file support | yes | no | no | no | no | no |
| GET/PUT | yes | yes | yes | no | yes | yes |
| Port/I/O | no | yes | no | yes | yes | yes |
| Untyped file | no | yes | no | yes | no | yes |

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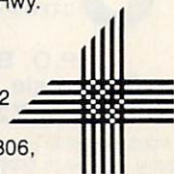
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control in text mode and some window capability in the graphics mode. Turbo Pascal allows text windows too.

I/O operations. Table 4 is a comparison of I/O features. Only MS-Pascal has support for an MS-DOS 2.0 file structure. Its availability is expected since Microsoft authored MS-DOS.

For random I/O most implementations use *GET* and *PUT* to write and read records, respectively. The procedure *SEEK* is used to select the address of the target record. Turbo Pascal allows for the record number to be included in the *READ* and *WRITE* verbs.

Pascal MT+, Turbo Pascal, and Practical Pascal allow for untyped file I/O using *BLOCKREAD* and *BLOCKWRITE*. They allow for reading and writing a specific number of bytes. The same compilers allow for port I/O. This is useful in developing software for communications.

Perhaps using Pascal in large software projects is the acid test to show its versatility. This involves developing external general purpose functions, library modules, and units. Chaining programs and the use of overlays are other program segmentation methods. Table 5 compares segmentation capabilities.

All implementations allow for external functions. Pascal MT+ and Turbo Pascal allow for chaining where global or absolute variables can be passed from one program to another. Chaining with SBB Pascal is not as versatile. Data should be passed via data files.

Pascal MT+ implements powerful and flexible procedure overlays. Up to 255 overlays, up to 15 separate overlay areas, and nested overlays are supported. Nested overlays are also supported by Turbo Pascal but not by SBB Pascal.

MS-Pascal and Pascal MT+ allow for modules, a collection of procedures and functions without a main body.

MS-Pascal and Practical Pascal implement the UNIT libraries. They are composed of the *INTERFACE* and *IMPLEMENTATION* sections. Units are separately compiled modules and offer a powerful method for program segmentation and building routine libraries. Other programs call these units via the *USE* declaration.

Compiling with the six implementations ranges from very simple to a multistage process. A process requiring several steps reflects the compiling and linking options offered by the implementation.

Table 6 compares the number of stages to compile, whether a linker is invoked, and the optional use of an optimizer. At the linking stage, the user has a choice of linked libraries, such as the floating point support and transcendental functions libraries.

A software developer may ask the following practical question. How friendly is the implementation in handling compilation and run-time errors?

I have tested two types of code errors in some test programs: using an undeclared variable and adding an integer variable to a floating point constant. The run-time error that I tested is a division-by-zero error while attempting to divide two reals.

Here is a brief rundown of how each implementation reacts:

■ MS-Pascal will display the code line containing the error and will point at the error with a message. For run-time errors, a message will be displayed and the program halts, leading you back to DOS.

■ Pascal MT+ will display the error number and the line number on which it occurred. For run-time errors, a message is displayed inquiring whether you want to continue or abort.

■ SBB Pascal displays a very brief error message. You have to list the LST file to see the location and error type. During my division-by-zero run-time test, the program just kept going! It did not bother to tell me that I had just committed a mathematical sacrilege.

■ Turbo Pascal is the friendliest. For both error code and run-time errors, the system displays an error message and then invokes the editor to point out where things went wrong.

■ Utah Pascal outputs the processed code lines to either the screen, printer, or file. It shows a message below the error-containing line. The message lacks a little bit of clarity. It does not point out the error. You have to examine the code line to discover where the error is. For the run-time error, the program displayed a warning about error in floating point operation, but the program kept going.

■ Practical Pascal is similar to Turbo Pascal in reacting to an error found during compilation. Handling run-time error is done using very vague messages.

The review of the compilers included a benchmark test to compare the speed of compilation, size of executable code, and execution time. I carried the tests using an IBM XT with 512K bytes of memory and an 8087 chip.

All the compilers, except Practical Pascal, ran from the hard disk. Practical Pascal sets up a RAM drive upon booting. A single drive was used. The Hewlett-Packard HP41CV programmable calculator with a Timer Module was used for timing. The benchmark programs were:

■ **The Sieve of Eratosthenes.** This is a very popular benchmark test used for a

Program segmentation

| | MS | MT + | SBB | Turbo | Utah | Practical |
|--------------------|-----|------|-----|-------|------|-----------|
| Include | yes | yes | yes | yes | yes | yes |
| External functions | yes | yes | yes | yes | yes | yes |
| Chaining | no | yes | yes | yes | no | no |
| Overlays | no | yes | yes | yes | no | no |
| Modules | yes | yes | yes | no | no | no |
| Units | yes | no | no | no | no | yes |

Table 5.

Compiling steps

| | MS | MT + | SBB | Turbo | Utah | Practical |
|--------------------|-----|------|-----|-------|------|-----------|
| Compiler steps | 2 | 1 | 2 | 1 | 1 | 1 |
| Link | yes | yes | yes | no | opt. | opt. |
| Optional optimizer | yes | no | yes | no | no | yes |

Table 6.

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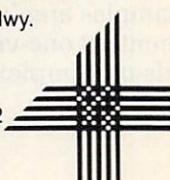
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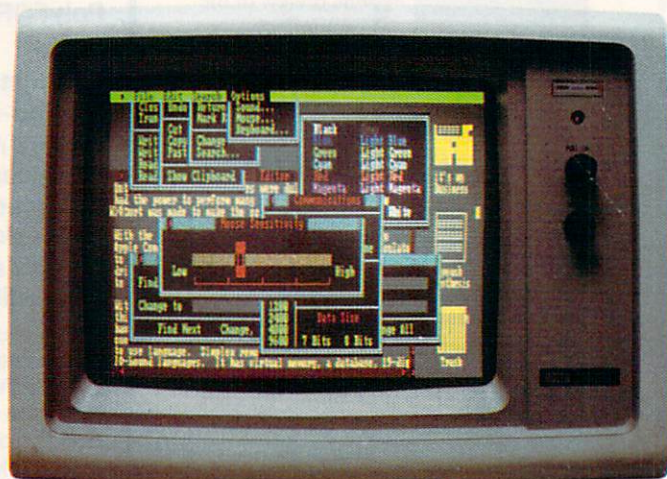
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variety of computers and languages.

■ **Integer array sorting.** This program creates an orderly array of 1,000 integers. Then the array is sorted to reverse the initial order. The time for the sorting process is measured.

■ **Matrix inversion.** This is the first test program to examine the speed of floating point arithmetic. The program creates a 20 by 20 matrix with ones in the non-diagonal elements and twos in the diagonal elements. The time needed to invert the matrix is measured. The program is recompiled to use the 8087 support when possible.

■ **Trigonometric test.** A program for comparing the computing speed of the sine and cosine function 1,000 times each.

Again, the program is recompiled to use the 8087 support when possible.

Table 7 shows the results for each test program. The compiling time recorded includes the time for the number of compiler passes plus the linking time.

The timer is stopped at the end of each stage and resumed as the next one starts in a multistage situation. It is worthwhile to point out that MS-Pascal automatically detects the presence of the 8087 chip and uses the 87 code library. All other compilers supporting the 8087 do so at the users command.

The results of the sieve test program show the following:

■ The compactness of the Utah Pascal p-code

Benchmark test results Sieve test

| | Source/compiled code size (bytes) | Compiling and linking time (min:sec) | Execution time (min:sec) |
|-----------|---|--|--------------------------------|
| MS | 659/27,708 | 1:02 | 0:11.5 |
| MT+ | 768/10,752 | 0:41 | 0:15.6 |
| SBB | 659/5,120 | 0:33 | 0:15.0 |
| Turbo | 659/10,299 | 0:03 | 0:15.0 |
| Utah | 659/384 | 0:25.4 | 8:15.0 |
| Practical | 4 blocks/2 blocks | 0:17 | 2:26.0 |

Integer sort test

| | Source/compiled code size (bytes) | Compiling (and linking) time (min:sec) | Execution time (min:sec) |
|-----------|---|--|--------------------------------|
| MS | 1,119/21,692 | 1:05 | 0:01.5 |
| MT+ | 1,152/10,752 | 0:42 | 0:03 |
| SBB | 1,119/5,248 | 0:35 | 0:02 |
| Turbo | 1,119/10,454 | 0:03 | 0:02 |
| Utah | 1,119/512 | 0:29 | 1:05 |
| Practical | 4 blocks/2 blocks | 0:18 | 0:21 |

Matrix inversion test

| | Source/compiled code size (bytes) | Compiling and linking time (min:sec) | Execution time (min:sec) |
|------------|---|--|--------------------------------|
| MS | 1,792/34,984 | 1:49 | 0:2.84 |
| MT+ | | | |
| without 87 | 1,792/18,944 | 0:56 | 2:10 |
| with 87 | 116,384 | 0:51 | 0:06.4 |
| SBB | | | |
| without 87 | 1,792/10,112 | 0:42 | 0:43 |
| with 87 | 8,320 | 0:43 | 0:02.2 |
| Turbo | | | |
| without 87 | 2,793/11,108 | 0:03.5 | error |
| with 87 | 10,027 | 0:03.5 | 0:05.39 |
| Utah | 1,792/896 | 0:36 | 2:12 |
| Practical | 4 blocks/3 blocks | 0:24 | 0:20 |

Table 7. (Continued on a following page).

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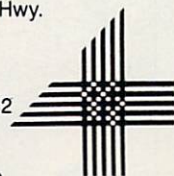
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- The size of the code from Pascal MT+ and Turbo Pascal is almost identical and so is the execution time
- SBB Pascal has produced the smallest non-p-code file sizes
- The compilation speed of Turbo Pascal
- Small variation in execution time for non-p-code programs—MS-Pascal is slightly faster.
- The Practical Pascal program is faster than that of Utah-Pascal.

The conclusions drawn from the results of the integer sorting test seem to agree with those of the sieve test.

With the matrix inversion, the Turbo Pascal compiler version that does not support the 8087 gave a run-time error. All other compilers, including the 8087 Turbo Pascal version, produced executable code that ran smoothly. The conclusions to be drawn are:

Not using the 8087

- Pascal MT+ is almost as fast as Utah Pascal. This indicates the floating point operation of Pascal MT+ may be written in the same language.
- Practical Pascal has faster math operation than SBB Pascal. The reason may be similar to the previous one.

Sine and cosine trigonometric test

| | Source/compiled code size (bytes) | Compiling (and linking) time (min:sec) | Execution time (min:sec) |
|------------|-----------------------------------|--|--------------------------------|
| MS | 902/20,934 | 1:21 | (sin) 0:10.79 (cos) 0:10.80 |
| MT+ | | | |
| without 87 | 1,024/22,528 | 0:58 | (sin) 22:29 (cos) 32:46 |
| with 87 | 16,896 | 0:51 | (sin) 00:11.8 (cos) 00:11.8 |
| SBB | | | |
| without 87 | 902/9,856 | 0:39 | (sin) 5:38 (cos) 5:49 |
| with 87 | 1,024/8,064 | 0:38 | (sin) 0:09.6 (cos) 0:11.5 |
| Turbo | | | |
| without 87 | 902/10,620 | 0:02.89 | (sin) 5:01.5 (cos) 5:06.4 |
| with 87 | 9,565 | 0:02.86 | (sin) 0:10.56 (cos) 0:11.05 |
| Utah | 1,024/640 | 0:29.5 | (sin) 10:08.67 (cos) 10:53 |
| Practical | 4 blocks/3 blocks | 0:39 | (sin) 1:52.36 (cos) 1:57.88 |

Note: A block of storage for the UCSD p-system has 512 bytes.

Table 7. (Continued from a preceding page).

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The 8087 supported test

- SBB Pascal has the fastest executing code (sorry Turbo), with MS-Pascal a close very second.
- Using the 8087 for math operation with Pascal MT+ is a must.

The trigonometric test helped us to draw the following conclusions.

Not using the 8087

- Turbo Pascal has the fastest executing code, followed by SBB Pascal, a close second.
- Pascal MT+ performed the poorest in trig functions. Even Utah Pascal is twice as fast.

The 8087 supported test

- A very slight variation was evident in the speed of running code. SBB Pascal has the fastest execution of a sine function. Turbo Pascal has the lead for cosine functions. Basically all 8087 generated code runs at about the same speed.


At the end of this review, I can say that the six implementations examined offer something for everyone.

- The novice Pascal programmer who does not want to spend a lot of money will enjoy Utah Pascal or Turbo Pascal. Turbo Pascal will probably be more attractive due to its speed, built-in editor, graphics and popularity.

- For a programmer interested in using a UCSD implementation, Practical Pascal would be an excellent choice. It will allow a good degree of compatibility with, say, Apple UCSD Pascal.

- The professional programmer working on large software projects and/or those involving low level machine access would make use of MS-Pascal or Pascal MT+.

- The professional programmer working on scientific, engineering, statistical and financial applications would find MS-Pascal, Pascal MT+ and SBB Pascal suitable. MS-Pascal has versatile utilities written by other software companies.

- Turbo Pascal, characterized by its speed of compilation and execution, can be used for front-end software development and testing. Batches of routines are developed and tested. Once the code is working properly, it is incorporated in a bigger implementation. 

Information on the six Pascal compilers

| Product name | Available from | Price | Hardware required |
|------------------|---|----------|---|
| MS-Pascal | Microsoft Corp., 10700 Northup Way, P.O. Box 97200, Bellevue, Wash. 98009, (800) 426-9400 | \$300.00 | IBM PC and compatibles, and all other MS-DOS machines. |
| Pascal MT+ | Digital Research Inc., P.O. Box DRI, Monterey, Calif. 93942, (408) 649-3896 | \$400.00 | Any 8086- or 8088-based machine running either PC-DOS or CP/M-86. Minimum 192K; 256K recommended. |
| SBB Pascal | Software Building Blocks Inc., P.O. Box 119, Ithaca, N.Y. 14851, (607) 272-2807 | \$350.00 | IBM PC and compatibles, and Z8000-based machines. |
| Turbo Pascal | Borland International, 4113 Scotts Valley Dr., Scotts Valley, Calif. 95066, (800) 227-2400 ext. 968 | \$49.95 | Any Z80- or 8086-based machine running either MS-DOS, PC-DOS, CP/M-86 or CP/M-80. |
| Practical Pascal | Network Consulting Inc., P.O. Box 8040, Blaine, Wash. 98230, (604) 430-3466 | \$145.00 | IBM PC, PCjr, or most compatibles. |
| Utah Pascal | Ellis Computing Inc., 3917 Noriega St., San Francisco, Calif. 94122, (415) 753-0186 | \$39.95 | IBM PC, XT, or AT with minimum 128K. |

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ADVERTISER INDEX

| | PAGE NO. | CIRCLE NO. |
|--|-------------|---------------|
| ACM..... | 19 | 7 |
| Alcor Systems..... | 64 | 1 |
| Alpha Computer Service..... | 64 | 2 |
| Atron..... | 4 | 4 |
| Awareco..... | 67 | 3 |
| BD Software..... | 10 | 5 |
| Borland International..... | 6,7 | 6 |
| C Systems..... | 70 | 16 |
| C Users Group..... | 78 | 10 |
| C Ware..... | 72 | 18 |
| Carousel Micro Tools..... | 46 | 8 |
| Catspaw, Inc..... | 78 | 9 |
| Code Works, The..... | 77 | 42 |
| CompuPro..... | Cover IV | 12 |
| Computer Innovations..... | 57 | 11 |
| Computer Resources of Waimea..... | 78 | 14 |
| DWB Associates..... | 17 | 20 |
| Datalight..... | 68 | 19 |
| David Data..... | 30 | 17 |
| Dedicated Micro Systems, Inc..... | 78 | 21 |
| Earth Computer..... | 12 | 24 |
| Ecosoft..... | 11 | 22 |
| Essential Software Inc..... | 23 | 28 |
| FairCom..... | 17 | 29 |
| Forth, Inc..... | 71 | 30 |
| Forth, Inc..... | 73 | 37 |
| Forth, Inc..... | 75 | 40 |
| Goodyear Aerospace..... | 1 | 43 |
| Greenleaf Software..... | 16 | 44 |
| HSC, Inc..... | 56 | 31 |
| Harvard Softworks..... | 65 | 47 |
| Introl Corp..... | 60 | 32 |
| Korsmeyer Electronics Design Inc..... | 76 | 34 |
| Laboratory Microsystems, Inc..... | 11 | 35 |
| Lattice Inc..... | 61 | 36 |
| MBP Software & Systems Technology..... | 18 | 39 |
| Megamax, Inc..... | 64 | 13 |

| | | |
|------------------------------------|-----------|----|
| Mendocino Software Co., Inc..... | 13 | 48 |
| Micro Methods..... | 22 | 52 |
| MicroTec Research..... | 8 | 77 |
| MicroWay..... | 20 | 57 |
| Microcompatibles..... | 20 | 15 |
| Miller Microcomputer Service..... | 11 | 61 |
| Mindbank, Inc..... | 66 | 63 |
| Next Generation Systems..... | 72 | 45 |
| Northwest Computer Algorithms..... | 31 | 46 |
| Opt-Tech Data Processing..... | 31 | 66 |
| Opt-Tech Data Processing..... | 40 | 67 |
| Parsec Research, Inc..... | 68 | 49 |
| Plum Hall..... | 25 | 50 |
| Poor Person Software..... | 61 | 51 |
| ProCode..... | 67 | 53 |
| Programmer's Connection..... | 77 | 54 |
| Programmer's Shop..... | 25 | 69 |
| QCAD..... | 68 | 23 |
| Quest Research Inc..... | 74 | 55 |
| RR Software..... | Cover II | 58 |
| Rational Systems, Inc..... | 24 | 56 |
| Ream, Edward..... | 12 | 27 |
| SLR Systems..... | 32 | 59 |
| Simpliway Products, Co..... | 13 | 70 |
| Software Horizons..... | 62 | 25 |
| Software Toolworks..... | 80 | 26 |
| Solution Systems..... | 22 | 60 |
| Solution Systems..... | 67 | 71 |
| Spruce Technology Corp..... | 79 | 33 |
| Stride Micro..... | Cover III | 72 |
| Summit Software..... | 13 | 62 |
| Syntax Constructs Inc..... | 40 | 73 |
| Systems Engineering Tools..... | 68 | 64 |
| Systems Guild..... | 23 | 76 |
| TeleSoft..... | 2 | 74 |
| Thunder Software..... | 56 | 65 |
| UniPress..... | 32 | 38 |
| Western Ware..... | 78 | 75 |
| Wordtech Systems..... | 14 | 41 |
| Workman & Associates..... | 77 | 68 |

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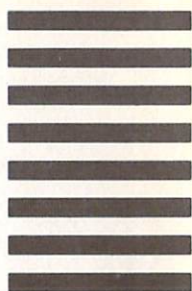
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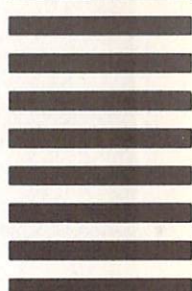
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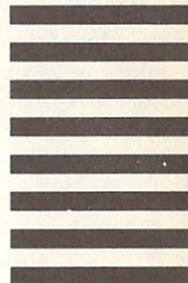
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| 1 | 11 | 21 | 31 | 41 | 51 | 61 | 71 | 81 | 91 |
| 2 | 12 | 22 | 32 | 42 | 52 | 62 | 72 | 82 | 92 |
| 3 | 13 | 23 | 33 | 43 | 53 | 63 | 73 | 83 | 93 |
| 4 | 14 | 24 | 34 | 44 | 54 | 64 | 74 | 84 | 94 |
| 5 | 15 | 25 | 35 | 45 | 55 | 65 | 75 | 85 | 95 |
| 6 | 16 | 26 | 36 | 46 | 56 | 66 | 76 | 86 | 96 |
| 7 | 17 | 27 | 37 | 47 | 57 | 67 | 77 | 87 | 97 |
| 8 | 18 | 28 | 38 | 48 | 58 | 68 | 78 | 88 | 98 |
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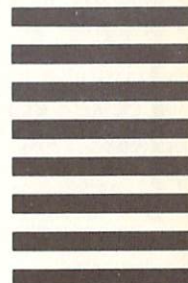
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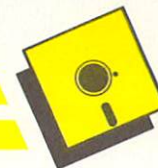
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"Despite the recent press notices, multiuser microcomputers aren't anything new!"

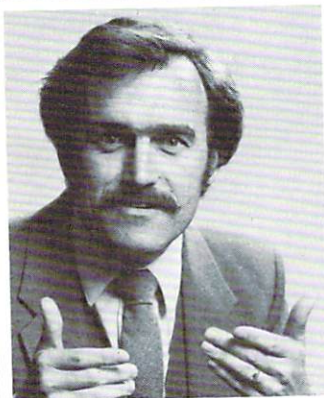
This is the first in a series of discussions with Rod Coleman, President of Stride Micro (formerly Sage Computer) on the 68000 multiuser market and its current environment.

Q: Why do you say that?

RC: "The technology to build a high performance multiuser system has been around for five years. And while some of the leaders in this industry have been pretending that micro multiuser didn't exist, we've been shipping complete systems for nearly three years. The benefits of multiuser are undeniable; it is more cost effective, and offers greater flexibility and utility. But until just recently, the marketing pressure to be compatible instead of being better, has blinded the industry."

Q: What do you mean?

RC: "Well, for example, the Motorola 68000 processor introduced 16/32-bit technology to the personal computer world a long time ago. It was fully capable of



"A surprising feature is compatibility. Everybody talks about it, but nobody does anything about it."

meeting high performance and multiuser design requirements in 1980. Instead of this trend taking off, most energy was spent promoting 8088/8086 products that

were clearly inferior from a technical point of view. This phenomenon leads me to believe that they will soon rewrite the old proverb: 'Build a better mousetrap and the world will beat a path to your door,' but only if they can find the way through the marketing fog."

Q: Are things changing now?

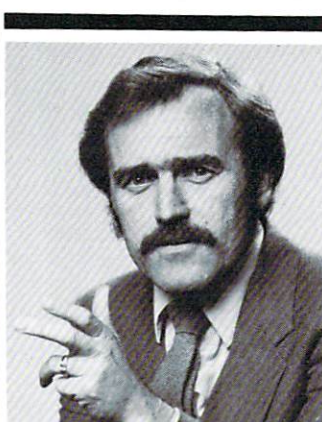
RC: "Yes and no. With the business world starting to take more and more interest in microcomputer solutions, the advantages of a solid multiuser system couldn't be kept hidden forever; companies like ours and a few others were beginning to make a dent. Instead of taking a fresh approach, some of the newest multiuser offerings will probably only give the technology an undeserved black eye! Multiuser is far more than the ability to plug in more terminals. It involves things like machine compatibility, fast processors, adequate memory, large storage capacities, backup features, networking, and operating system flexibility."

Q: Is this what makes the new Stride 400 Series different?

RC: "Exactly. That sounds self-serving, but it's true. Today a number of companies are introducing their first multiuser system. We've been building and shipping multiuser machines for almost three years. We know the pitfalls, we've fallen into some of them. But we have learned from our mistakes."

Q: Give me some examples.

RC: A hard disk is almost mandatory for any large multiuser installation. Yet, backing up a hard disk can be a nightmare if you only have floppies to work with. That's why we've added a tape backup option to all the larger Stride 400 Series machines. It's irresponsible for a manufacturer to market a multiuser system without such backup. Another good lesson was bus design. We started with one of our own designs, but learned that it's important not only to find a bus that is powerful, but also one that has good support and a strong future to serve tomorrow's needs. We



"The marketing pressure to be compatible instead of being better, has blinded the industry."

think the VMEbus is the only design that meets both criteria and thus have made it a standard feature of every Stride 400 Series machine."

Q: What are some of the other unique features of the 400 Series?

RC: "A surprising feature is compatibility. Everybody talks about it, but nobody does anything about it. Our systems are completely compatible with each other from the 420 model starting at \$2900, through the 440, on to the powerful 460 which tops out near \$60,000. Each system can talk to the others via the standard built-in local area network. Go ahead and compare this with others in the industry. You'll find their little machines don't talk to their big ones, or that the networking and multiuser are incompatible, or that they have different processors or operating systems, and so on."

Q: When you were still known as Sage Computer, you had a reputation for performance, is that still the case with the new Stride 400 Series?

RC: "Certainly, that's our calling card: 'Performance By Design.' Our new systems are actually faster; our standard processor is a 10 MHz 68000 running with no wait

states. That gives us a 25% increase over the Sage models. And, we have a 12 MHz processor as an option. Let me add that speed isn't the only way to judge performance. I think it is also measured in our flexibility. We support a dozen different operating systems, not just one. And our systems service a wide variety of applications from the garage software developer to the corporate consumer running high volume business applications."

Q: Isn't that the same thing all manufacturers say in their ads?

RC: "Sure it is. But to use another over used-term, 'shop around'. We like to think of our systems as 'full service 68000 supermicrocomputers.' Take a look at everyone else's literature and then compare. When you examine cost, performance, flexibility, and utility, we don't think there's anyone else in the race. Maybe that's why we've shipped and installed more multiuser 68000 systems than anyone else."



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