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VOLUME 2, NUMBER 1

JANUARY 1985

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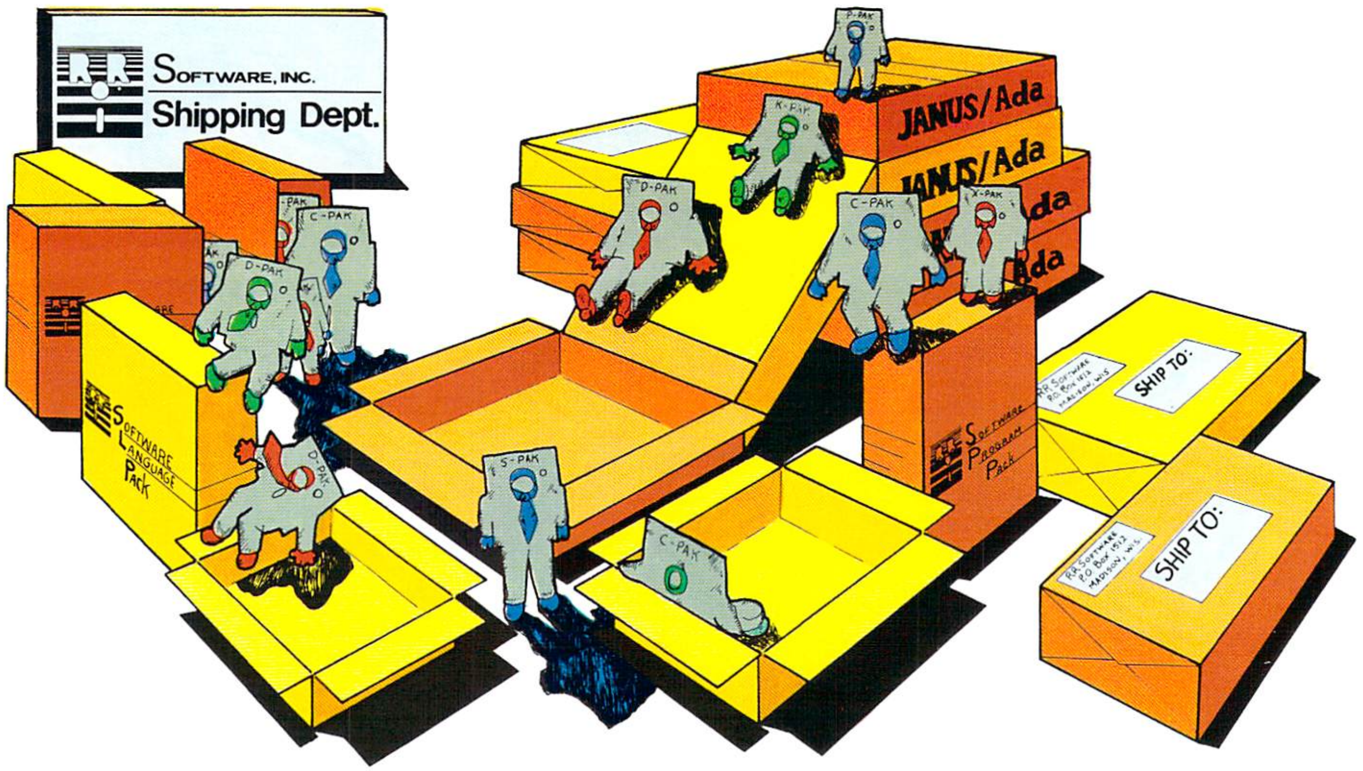

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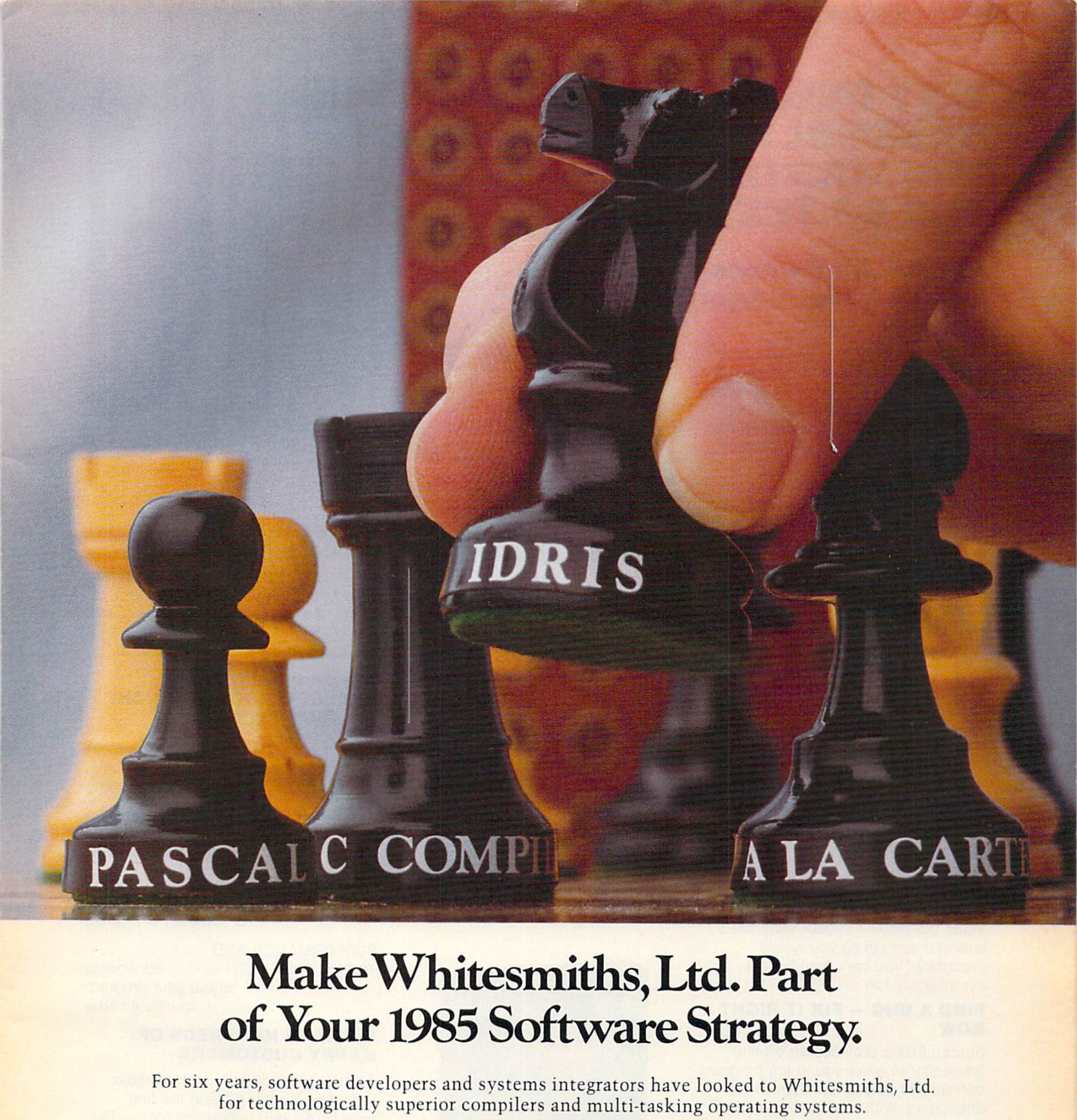

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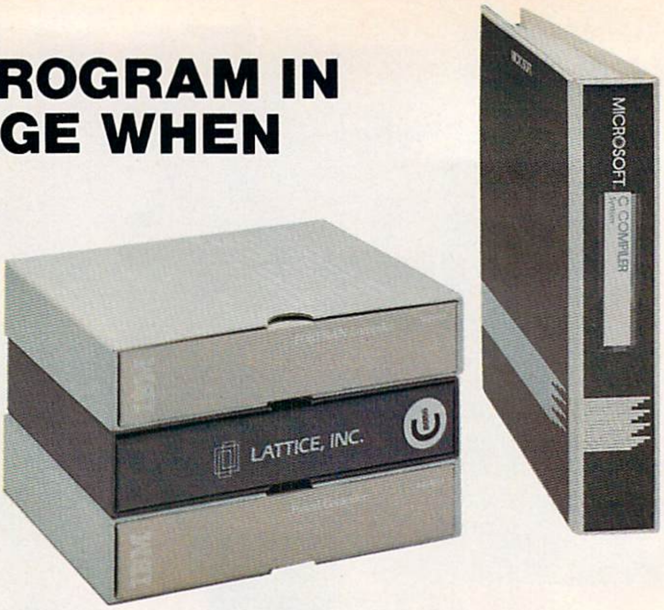

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Without source level debugging, the programmer must spend time mentally making translations between assembly language and the C, PASCAL, or FORTRAN source code in which the program was written. These tedious translations burn up valuable time which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 The low level hex and symbolic debuggers available today are superceded by ATRON'S solution — Source Probe.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

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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.

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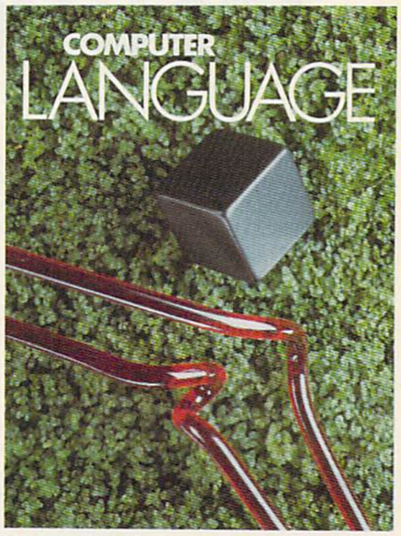


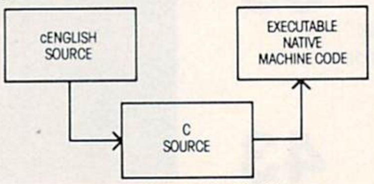
ARTICLES

DEPARTMENTS

c ENGLISH.™ The C Generation Language.

What is cENGLISH? cENGLISH is a comprehensive fourth generation procedural language based on dBASE II™ syntax. It is portable to a wide range of micros and minis. The language features user-transparent interfaces to a wide range of popular C compilers, operating systems, and data base managers.

How is portability achieved? cENGLISH through its compiler interface translates cENGLISH into documented C source and uses a host C compiler to produce native machine code.



C source can be embedded in cENGLISH source.

Differences in the operating system and data base manager are handled by the runtime libraries.

The result is that cENGLISH source can be compiled without modification on any micro or mini configuration supporting cENGLISH.

What about performance? cENGLISH executes FAST, just like any compiled C program.

How easy is cENGLISH to use? While cENGLISH is a powerful high level language that can accommodate complex software development, it remains simple and straightforward to use.

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Attention dBASE II and dBASE III users. dBASE II to cENGLISH Converter now available; dBASE III Converter available later this quarter. Converted code is portable to micros or minis and executes as fast as original cENGLISH source.

SAMPLE cENGLISH PROGRAM

```
IDENTIFICATIONS
  MODULE:  Mininame
  AUTHOR:  bcs
  DATE:    8/29/84
  REMARKS: Sample cENGLISH program that adds first
           names to a file
END IDENTIFICATIONS

GLOBALS
  FIXED LENGTH 1 ans
  FIXED LENGTH 15 Fname
END GLOBALS

MAIN PROGRAM

  BEGIN
    CLEAR SCREEN
    SET ECHO OFF

    USE "NAMES"
    VIEW BY "ID_FNAME" ASCENDING

    AT 23,1 SAY "Add a record? Y or N"
    AT 23,25 ENTER ans USING "!"

    WHILE ans EQ "Y"
      CLEAR GETS
      AT 6,1 SAY "Enter first name"
      AT 6,20 GET Fname
      READ SCREEN

      INSERT
        Fname = Fname
      END INSERT

      AT 12,10 SAY "Welcome to cENGLISH," & Fname
      WAIT
      AT 14,10 SAY "HIT ANY KEY TO CONTINUE"
      STORE "                    " TO Fname
      STORE "    " TO ans
      AT 23,1 SAY "Add another record? Y or N"
      AT 23,30 ENTER ans USING "!"
      CLEAR ROW 1 THRU 23

    END WHILE

    AT 12,10 SAY "That's all for now!"
    UNUSE "NAMES"
    SET ECHO ON

END PROGRAM
```

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Editor's Notes

Microcomputer programming has changed dramatically since the late 1970s, when magazines like *BYTE, Interface Age, Dr. Dobb's Journal,* and *S-100 Microsystems* were required reading for the informed few.

Even today, those who remember the early days speak nostalgically of the way these magazines acted as a kind of technical underground of valuable information. Back then magazines didn't have to be glossy, just good.

For this month's ComputerVisions interview, Carl Landau, publisher of *COMPUTER LANGUAGE*, flew out to New Jersey and spent some time with one of the more influential microcomputer people in the late 1970s—Sol Libes, editor of the now defunct *Microsystems*.

In this special interview, Carl talks with Sol about his memories of the early days of microcomputing and the beginning of *Microsystems*. He also reveals some of the reasons why this important magazine suddenly collapsed.

We have a deep respect for the role that magazines like *Microsystems* have played in the past. We hope *COMPUTER LANGUAGE* will fill some of the gaps caused by the loss of fine technical publications like *Microsystems*.

Now that the new year has just begun, let me briefly outline some special features we have planned for our 1985 Editorial Calendar.

Next month we present our first theme issue: the C programming language. The issue will feature a special comparative review of the 23 C compilers now being sold on the market. Over a two-month period, a *COMPUTER LANGUAGE* team of five C experts developed and used objective criteria to examine each compiler.

Throughout the year you can expect to see similar product comparisons on BASIC, FORTH, Modula-2, COBOL, and expert systems.

The month of May will be the setting for our BASIC theme issue, again with a product comparison of the over 25 BASIC interpreters and compilers on the market. In July we will feature a special artificial intelligence issue with articles on LISP, Prolog, and expert systems.

Many readers have written to me saying that our coverage of exotic languages like SNOBOL and PILOT has been the most creative and enlightening feature of our new magazine. In August we will devote the entire issue to articles on the many obscure, yet fascinating languages being used by small groups of people around the country.

Many people in our industry claim that the key to good programming is a working knowledge of algorithms. This, said Donald Knuth, is the backbone of good programming style. In November we will focus on algorithms from both a theoretical and mathematical sense.

Finally, to complete the 1985 calendar year, our December issue will focus on compiler writing design and techniques.

Over the past few months, *COMPUTER LANGUAGE* has enjoyed a rapid growth in all aspects—from advertising to circulation to editorial manuscript submissions. By providing you with a well-defined editorial focus and fresh material each month, we look forward to 1985 with a positive and confident attitude. Happy New Year!

[illegible]

Craig LaGrow
Editor

Telecommunicate to COMPUTER LANGUAGE

COMPUTER LANGUAGE has established two bulletin board systems for you to upload and download text and binary programs, as well as to leave your own electronic Letter to the Editor. All the program listings referred to in every issue of the magazine will be available here.

In addition, *COMPUTER LANGUAGE* has its own Special Interest Group on CompuServe's national data base. After calling into your local CompuServe node, simply type "GO CLM" at any prompt and you'll be in our SIG.

To access our bulletin board, set your computer or terminal to the following parameters: 8 data bits, no parity, 1 stop bit, full duplex, and either 300 or 1200 baud. The telephone number is (415) 957-9370. After your modem makes the connection, type RETURN several times, and everything else is easy.

Both systems are open 24 hours per day, 7 days per week. Due to the heavy number of callers, please do not log into the system more than one time per day. Messages left on either system will be combined the following day.

COMPUTER LANGUAGE

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FEEDBACK

COBOL author rebuttal

Dear Editor:

I think David Soderberg (Feedback letter in November issue) was upset by my discussion of left vs. right brain in the premier issue's "COBOL: Pride and Prejudice." I must have touched a nerve. He regards left-brain dominant thinking as "technical reason" while dismissing the right side as "strongly opinionated on non-substantive issues appealing to sensation."

Since I'm evidently pro-COBOL, what is his point about "60-70% of applications written is also in the realm of data processing. And *that's* the point which is overlooked . . . " Emphasizing *that* doesn't add meaning. Good writing would have.

Is COBOL functionally different from Pascal and C? I don't think so. They're all general purpose programming languages that can do anything. Try writing UNIX in COBOL. How about writing a compiler in COBOL. How about writing the best compiler written—any language, any machine. One that generates code that will run any benchmark twice as fast as TURBO Pascal, Lattice C or BASCOM. I'm referring to the Realia COBOL compiler. In my article I asked why COBOL compilers are never written in COBOL. I should have said seldom. Realia proves that the best compilers are written in their target language and COBOL is inherently faster than the rest.

The November issue also had a review of mbp COBOL. I feel you owe your readers a description of Realia. Not only does the compiler generate outstanding code, the indexed IO is even better. I've been running benchmarks against a mainframe (2 mips) running VSAM on 3370s (6,000 rpm) through a high-speed channel (1.75 mbs). The PC beats it.

I talked to a developer whose 3,000-line program takes 2.5 hours to compile under mbp. We haven't tried it yet, but Realia will do it in less than 2 minutes. In case anyone is hung up on the mbp screen manager, I wrote an interface allowing you to compile the same program under Realia and call the mbp library routines.

Robert Wagner
Lubbock, Texas

General criticisms

Dear Editor:

I'd like to offer some brief comments on your new magazine.

■ You have a good idea and so far a reasonable start, but I'm not nearly as enthusiastic as some of your letter writers.

■ "Batch—A powerful IBM 'language'", in the October issue, for instance, is overblown. It says nothing about the slowness of the facility or about the need to have a copy of COMMAND.COM in the A drive. I never did find the "greatest secret—The Undocumented Feature." Nothing was said about the limited environment space or the need to clean it up at the end of a file. As an example of a useful Batch file I offer the one presented in Listing 1, called MC for multi-copy. Note that the last line "set to=" has no blank after the equal sign. This removes the temporary variables from the environment.

■ Your Bulletin Board Service is an OK idea if one has a modem. I don't and find less pleasure in being told that all the good stuff is unavailable to me. *Dr. Dobb's* practice of printing code is much preferred by me, at least.

■ The Code Swap Shop, for instance, could include non-modem ways to get code. I wrote to Bruce Tonkin but can't write to Michael O'Quin as you gave no address. (Can you give me an address for him?)

■ I found the piece on Donald Knuth to be pure fluff. There must be some way to avoid Sunday Supplement level articles.

■ October's "MNSNUS (or, Using Mnemonic Atoms in Symbolic Naming)" was good as was "The Evolution of ZCPR" although the latter again suffers the "get it from the BBS" problem.

Samuel Green, Ph.D.
Stoddard, N.H.

Batch author Darryl Rubin responds: Batch's undocumented feature certainly isn't the greatest PC-DOS has to offer, but

```
USAGE:  MC file1 dest.dr file2 file3 . . .

EXAMPLE:  MC a:file1 b:  c:file2 file3

CODE:
                echo off
                set to=%2
                echo copy %1 %2 /v
                copy %1 %2 /v
                shift
                :loop
                shift
                if "%1"=="" goto out
                echo copy %1 %to% /v
                copy %1 %to% /v
                goto loop
                :out
                set to=
```

Listing 1.

I did explain it (page 34): Batch files can refer to environment variables with the %name% construction. It is true that environment space is limited, so you might want to use the SET test I described (page 35) for checking free space. For more speed, try running your batch files from a RAM disk. Va-voom!

Michael O'Quin's address is P.O. Box 4462, Medford, Ore. 97501. —Ed.

FORTRAN 77 musings

Dear Editor:

I appreciated Bruce Hunter's review of DR FORTRAN 77 in the November issue. I haven't used the implementation he refers to but have done some programming in Fortran 77 on a DEC-20 and can attest to his conclusion that much-maligned FORTRAN has grown into a powerful and flexible programming language.

I think people need to hear his point that FORTRAN 77 includes powerful number-crunching facilities and also facilitates the writing of well-structured programs. Unfortunately, the example given in his review demonstrates neither of these virtues.

The number-crunching in his example is thoroughly pedestrian and could be as easily coded in almost any programming language. (Well, maybe not LISP!) And it's not done well, at that. For example, the line

```
k = (4.0 * c – 1)/(4.0 * c – 4) +
      0.613 / c
```

would be more effectively written as

```
k = (c – 0.25) / (c – 1) + 0.613 / c
```

eliminating two floating point multiplications (and their potential for resulting truncation/roundoff errors) and speeding up a statement embedded in a loop that repeats many times.

As for program structures, we find that the main routine is a do loop that runs 65,535 times. Since most algorithms like this are terminated by a specific convergence criterion rather than after an arbitrary number of iterations, we are already puzzled.

Reading on, we learn that in fact there is little or no intention to do the loop 65,535 times. Rather, we will exit the loop and the program in the middle of subroutine calc or subroutine output, and the criterion for exit will be user specification after seeing the results so far. A better structure would use a main-routine loop that terminates when a Boolean variable tells it to.

In fact, since in all cases we want to do at least one iteration, the ideal structure for the program is with a test-at-bottom loop control structure such as Pascal's *repeat-until* or C's *do-while*. To my knowledge, FORTRAN 77 has no analogous control structure. The value of the *quit-or-continue* Boolean variable would be set by a separate subroutine whose sole function is to ask the user whether to continue. The calc and output routines would have nothing to do with this function. If this sounds like nitpicking, think what it would take to modify Hunter's program to display output for each iteration but offer the option of termination only after every 10th cycle!

It worries me that people may look at those listings and conclude that FORTRAN 77 is an inadequate language. An example displaying its full advantages would have been nicer.

Clyde Schechter
New York, N.Y.

Illustration: Anne Doering

Realia COBOL. Numbers speak louder than words.

Compilation Speed (minutes:seconds)

Lines in Program	Realia COBOL	mbp COBOL	Level II COBOL	R-M COBOL	Microsoft COBOL
1,000	:51	8:33	3:42	5:05	5:11
5,000	3:30	48:07	16:58	*	45:26

*Could not successfully compile the program.

Execution Time Ratio (Gibson Mix; calculated S-Profile)

Realia COBOL	mbp COBOL	Level II COBOL	R-M COBOL	Microsoft COBOL
1.0	3.6	14.7	21.6	22.3

Sieve of Eratosthenes

0.818 seconds per iteration

All benchmark tests were performed on an IBM PC-XT with 192KB of memory. IBM PC-XT is a registered trademark of International Business Machines Corporation; mbp COBOL, of mbp Software and System Technology; Level II COBOL, of Micro Focus; R-M COBOL, of Ryan-McFarland; and Microsoft COBOL, of Microsoft.

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Pascal points

Dear Editor:

"Pascal: Just a teaching language?" in November's Designers Debate was very interesting. Here are a few related points to consider.

Is Pascal a good teaching language? It has the triad syndrome: three assignment symbols (":=" for values, ":" for types to variables and "=" for types to identifiers) and three kinds of loop constructs. In both cases it requires the students learning, remembering and selecting three items which perform a single basic function. Perhaps the student is being taught who's boss.

We can learn from Pascal one basis for new computer language design: for simplicity and clarity in learning and use, a single construct is to be provided for a single function. In the case of Pascal this would have resulted in a single assignment symbol and a single flexible loop construct.

Starret C. Kennedy
New York, N.Y.

Editorial directions

Dear Editor:

Recent events have caused me to take a heightened interest in the continued success and well-being of your magazine. No sooner had I been accepted for *Microcomputing*'s Software Review Board then I read in *InfoWorld* that *Microcomputing* was folding! I found this distressing, as I have kept every issue (and thoroughly enjoyed most of the earlier ones), and their apparent attempts to rework their format looked promising.

Then I read a couple of days ago in *Dr. Dobb's* that *Microsystems* is giving up the ghost! This is serious. There hasn't been a more hard-core systems programming magazine for microcomputers since Lifeboat Associates' *Lifelines*. It hadn't been exhibiting the usual pre-collapse symptoms (less advertising, thinner, late, etc.) either.

I hope your advertisers and publisher see your magazine as positioned in an unfilled niche in the marketplace rather than a me-too in a dying market segment. I certainly do.

As far as I'm concerned, this leaves you and *Dr. Dobb's* as the only two remaining magazines of real substance at the advanced level. Your editorial directions are sufficiently different that I think you can co-exist without hurting each other.

Charles M. Somerville
Dayton, Ohio

You will probably be interested in our interview with the editor of Microsystems, *Sol Libes, in ComputerVisions on page 23.—Ed.*

OMNI listing available

An illustration of an IRA calculating program written in BASIC and OMNI (the featured language in December's Exotic Language of Month Club) can be downloaded by calling the COMPUTER LANGUAGE *Bulletin Board Service at (415) 957-9370 or CompuServe (type "GO CLM") and reading file OMNI.LTG.—Ed.*

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CIRCLE 83 ON READER SERVICE CARD

By Bruce Lynch

Integrating voice and data communication with computer processing is an important trend. Software is making the use of these capabilities more and more transparent for the end user. All elements—computer, telephone, modem, software, and voice input and output—should appear to the user as a unit. They should be packaged so they all can be used without creating concern over technical details or sequences of operations by the user that are disrupting or frustrating.

Several companies in the last couple of years have attempted to market products—for instance the IBM PC, the Apple, and the DEC Professional 350—that integrate telephones with computers. Recent products have been released for the Macintosh. Costs are now below the threshold needed for widespread adaptation.

However, without proper conceptualization of how an application should flow, marketing efforts will meet with resistance and frustration.

With today's readily available technology it should be practical to approximate an intuitive, unrestrained communication between user and computer through use of a keyboard, screen, and beeper. Add a microphone for the user and the capability could be included to have a speaker play back the message describing telephone call's topic. A widespread market should be practical without the computer understanding how to translate a message from voice recording into data to be played on the screen.

Voice mail systems are becoming fairly popular among very large corporations. They help to do three things:

■ When all that is needed is to convey some quick information to another person, the message can get through even though the target person is not available.

■ When you want a fairly complicated message to be made clear, you no longer have to use an assistant. You record the message for the recipient in the store and forward mode.

■ You also have the capability to branch out of the sequence. You can dial another extension or whatever without hanging up after the tone.

To a person who looks at software as a product category subject to economic forces, it is clear that a lot of software products should be sold at a price based on cost ($8.95 to $50.00). However, other microcomputer software should be sold at a price based on the value it delivers to the user.

Publishers of software above $100 justify their price by pointing to their research, development and marketing costs. Those issues are relevant, but the value delivered to the user is far more important when determining price.

A scenario: imagine a vendor has a magical software package MacTRANS. It will run on the XT. It will translate any commercial software product originally written for the PC or Apple II in any language (BASIC, C, Assembler) to run on the Macintosh. The program produced will fit within 128K RAM and will have full functionality. All of this will take zero programming effort. Of course, such a product isn't really likely to appear.

Should MacTRANS be priced for $30? Of course not—at $30 it might sell 10,000 copies. Remember, we arbitrarily defined this as a product only capable of translating commercial software, not end-user software, silly as that may be. There are definitely companies that would be willing to pay $20,000 for such a product. To balance volume with price, perhaps a price between $250 and $2,000 would be reasonable.

Should the idealist who says software should cost $30 prevent economic forces from encouraging the development of a product that will really only be viable for sophisticated programmer-users? A product that will require customization, be appropriate for only one source language as a starting point, and require a lot of technical support? Such a product would be likely to save six months in lead time to market, a huge amount of uncertainty, and a high cost. Would the natural market for the product really care whether it was $30 or $300?

Should DBMS products TOTAL or ADABASE be sold for $45 a copy to run on IBM mainframes? After all, it only cost $15 or so to manufacture a tape. Maybe $150 would be a better price. That would even cover the cost of documentation and provide a profit on each sale. Isn't it immoral for McCormick & Dodge to charge over $300 for a general ledger module to run on an IBM mainframe?

Certain products should and will quickly become commodities and be sold at commodity (cost plus a markup) prices (like $30). They will become commodity products because so many programmers and so many companies will be able to develop the software, market it, and provide all of the other facilities necessary to build a business around a product concept.

A substantial portion of products currently priced as high as $1,000 in the microcomputer software business are headed toward a $30 retail price. That process will probably take no less than one and a half years and no more than four years for a majority of the product categories that we see today.

Other products—and more are needed—deliver extremely high value to people who require that value and can appreciate it. They deliver value to small markets, markets so small that other companies who are interested in developing software will ignore them. Many of you who are creative will invest substantial effort building such products.

Even while parallel processor work proceeds, performance of single processors continues to progress. "Design-in" with 32-bit micros from National Semiconductor and Motorola will start in the spring with Intel six months behind.

Novics has announced a running prototype for a processor with the following characteristics: 10 mips processing speed (faster than most mainframes), an architecture that supports a very long stack, and an instruction set that supports about 100 Forth words. Delivering such a creature for less than $5,000 as an add-on to a fast bus or even to a PC bus should make possible applications that people normally would not consider.

The impact of the resources available to decision support systems in 1993 will be particularly significant to education and entertainment applications. Even current capabilities are pretty impressive. Ray Bradbury is one of several authors active in the development of science fiction material allowing a reader/user to act as a key participant in the plot and development of a story or game. As processing power and resolution improve and storage cost decreases, this medium is likely to experience tremendous success.

Simulation games will become very popular once the under $1,000 microcomputers have resolutions similar to the Macintosh and sufficient speed.

Low-price software is becoming more common. IBM, from "IBM Direct", is selling 40 products with prices ranging from $10 to $45. In particular, one of its products selling for $10 offers features that seem the same as those in another product by a company spending significant amounts merchandising a product they sell for $100.

Venture capital money for software companies has pretty well dried up. It is likely, in another nine months or more, the venture capital community will start to differentiate between companies doomed by me-too strategies and companies working in safe niches.

About 100,000 programmers with about 120,000 licensed machines work with UNIX now, according to AT&T Technologies.

TopView compatibility will be important to the success of many products fairly quickly.

The VDI graphics standard supported by Graphics Software Systems is catching on well. It got a big boost when IBM agreed to carry its products.

Home computer sales have slipped. A large proportion of those buying such systems are buying them with disk drives, making it easier to distribute commercial software.

ANSI BASIC looks like it has a large following. The market struggle between the de facto Microsoft standard and the ANSI specification will be interesting. There is probably a substantial marketing opportunity there. A large *critical mass* (a term I coined for the relevant factors in a product's marketability—including technical quality of documentation and software, scope of marketing effort, market positioning, money, major account sales efforts, manufacturing and quality control, and a healthy combination of key company employees) is necessary to sell properly to and support hardware OEMs.

Experimentation with robotics has reached a stage that is likely to mushroom. With home products that support reasonable functionality at $300 to $500, the market should become enormous beginning late next year.

The software industry is maturing quickly. Distribution channels for software are likely to see some substantial shifts in the next year. Margins paid to contributors will change markedly. A strong polarization will occur between outlets that sell generic products and other more specialized and consultative outlets.

Technical support after purchase will become a product purchased separately on a widespread basis. Through experimental efforts, IBM has evolved a pricing strategy that seems appropriate to market needs and fulfillment costs. $40 is paid for each problem solved whether it takes one call by the user or many.

Object management for C is moving forward, along with natural language interfaces.

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Specialized processors and new, creative approaches to search algorithms will make possible the huge applications required to allow people to work the way they would prefer rather than the way that the computer now imposes. Those efforts are proceeding quickly.

If you are intrigued by artificial intelligence you should take the time to at least lightly experiment with an expert system building tool. There are six to eight for use on PCs now that look reasonable. You can learn a lot with a standalone product like EXSYS for less than $300. Others act as supplements to a language (usually PROLOG) or are fairly costly ($2,000 to $20,000).

The continued increase in the number of programmers who have purchased the low-cost implementations of LISP, PROLOG and other tools should yield some pretty impressive experimental products by late spring. People with many years of pragmatic experience are building serious developer tools and end-user products. Many should be available this summer.

An interesting by-product of these efforts is the creation of more and more translators to translate from one language to another in computer and spoken languages. The pattern-matching technologies necessary for artificial intelligence will find fruitful application and translation work.

One very common practice results in use of illegal copies. Company A has six PC compatibles and 12 people who use the machines. Manuals and disks are kept wherever is convenient. The disks in use are not originals. They are copies made so that the original can be kept safe as backup.

It is likely that a user will not know or care to determine if she or he is using the legal copy. The user probably does not know or care how many copies the company has the right to use. It would not be unusual for six machines to have ready access to a software product, while the company has license for only one.

Should the company with six or 60 users pay the same price as the company with only one user? No. If 60 people are getting value, then it is not right to pay for only one copy.

If at all possible, copy protection and administration should not cause users to suffer. Any frustrations or decreases in the value delivered by a software product should be avoided when attempting to decrease the number of illegal copies.

The risk of noncompliance should be practically nonexistent for a company that wants to cooperate. Compliance should be easy.

ADAPSO, an industry trade group, has been of great service to the computer industry for many years. A group of its members have been sharing ideas on copy-protection issues.

Through efforts largely led by Lotus and supported by Microsoft, Ashton-Tate, and many other companies, ADAPSO is in the process of developing a standard copy-protection system. It seems likely to provide an answer addressing the needs of the software publishers and at the same time allowing legal users to avoid frustrations.

The hardware design will become available for public domain distribution from ADAPSO. Contact the group for a transcript of a recent meeting where the issues and alternatives were discussed. The address is: Software Protection Committee, ADAPSO, 1300-PS North 17th St., Arlington, Va. 22209.

It seems likely that production quantities of the same device will not be available until the first quarter of 1986.

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CIRCLE 64 ON READER SERVICE CARD

One particular proposal appears to be gaining acceptance as the members search for a solution. Since the proposed device incorporates its own hardware, we will call it H-Protect for now. Remember, the specification has not yet been finalized.

The design and development of H-Protect should make it largely independent of the operating system and operating environment.

End users will pay a price as low as $25 on a one-time basis for the master hardware. Software publishers would have a couple of options when deciding how to use the device. One is to ship hardware "keys," which should cost somewhere around $3 or $4 to the publisher. The other option is to tie the install program of the software product to the master key installed in the device.

H-Protect will attach to an RS-232 port and should make possible complete use of that port for two-way communication at speeds up to 19.6KB. The device comes with one master key and a variable number of auxiliary slots capable of supporting keys delivered by the software publishers.

Any user with the appropriate key could use the commercial software product protected by the system without going through any special effort. Hard disk, LANs, and multi-user systems all would be scheduled for support—in a manner transparent to the end user, we hope. The user could take a key if he or she wanted to walk down the hall to use a different machine.

H-Protect would include a special microprocessor to generate tables and other algorithms that can be integrated by the commercial software product. Commercial software developers could develop custom keys and custom algorithms to support whatever degree of sophistication they would like to have for their own copy-protection scheme. The design seems likely to make support of very secure algorithms possible.

The computer hardware and software components of a decision support system (DSS) in 1993 are likely to consist of the following:

- A central processor capable of processing at about 10 mips
- A word size of 32 to 64 bits
- 50MB of RAM
- Large screens
- The ability to use fingers or wooden pointers to point to things
- Super high resolution
- Integration of video disk capabilities with computer programs
- High-speed networks and interrelationships among computers
- Voice output
- Voice input with reasonable limitations
- Expert system capabilities
- Natural language capabilities
- The ability to retrieve from huge data bases
- Integration of complex combinations of mathematical calculations with what we think of now as data retrieval systems
- Integration of voice and visual communication devices with computers
- Digitizing and optical scanning . . . and real-time characteristics.

What might such a system cost? A wild guess based on long-term technological trends puts such a system in the range of $25,000 to $50,000 in 1993.

Key executives at companies like Northwest Industries, Boeing, and Esmark have been actively involved in the use of DSS for many years. They understand the capabilities well enough to practically eliminate the difficulty of working with technicians. In spite of this, it isn't practical today for them to get the kind of answers that a DSS will provide.

Assume you could use readily available technology and a total budget for one user

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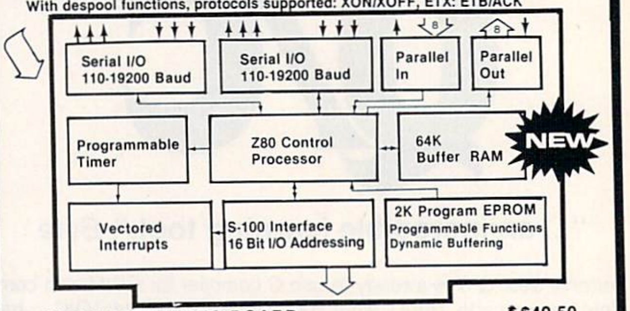
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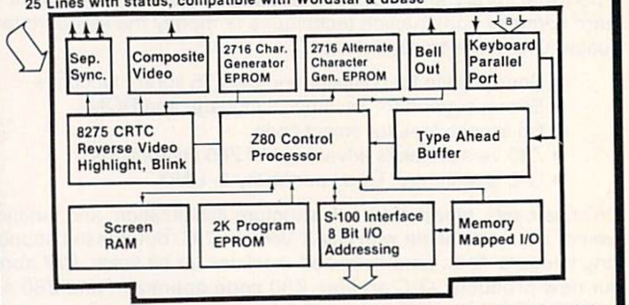
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of no more than $20. Send me your opinions of what would constitute the ideal developer's environment. Try to break up your recommendations into those that are commercially available now, naming the products and the manufacturers, and those that should be readily available now if developers did the work with available technology. Make your recommendations for either of two different types of programmers:

■ A systems programmer with eight years or more of experience who is fluent in at least four different programming languages and three different assemblers.

■ An applications programmer with at least four years of experience with IBM COBOL and Pascal, moderately familiar with assembler and fluent with at least one other high-level programming language.

Here is a flavor of what I am looking for. I have not gone through a thorough analysis or balancing of priorities. I will do this after I get your feedback.

Example: The systems programmer has an integrated development environment where each software component seems to function as if it were all in one system. The components include a source level debugger, a symbolic assembler level debugger, an editor with optional syntax support, a version of a compiler that turns around very fast or an interpreter, a compiler that produces extremely tight code and gives access to all hardware characteristics including registers and ports, an execution profiler, so much RAM that nothing needs to be on disk, numerous utility programs for analyzing and massaging source code, and specialized utilities for supporting link management and library management.

The hardware includes a processor supporting three large compile jobs simultaneously while still providing decent throughput for an edit session to go on. A separate computer is available on a different terminal by swinging one's chair around. Both computers share storage on the same disk. Special support for a circuit emulation is included. What else would be appropriate?

What products are good but need some substantial additional capabilities to be what you see is needed? Let me know your complaints about products that you think are pretty decent. For this purpose, at least, I am not concerned with specific bugs, etc.

Working together we can motivate vendors to make improvements they might otherwise ignore. We can also induce more companies to cooperate to make something that will serve the needs of programmers more effectively than what independent efforts would yield. ■

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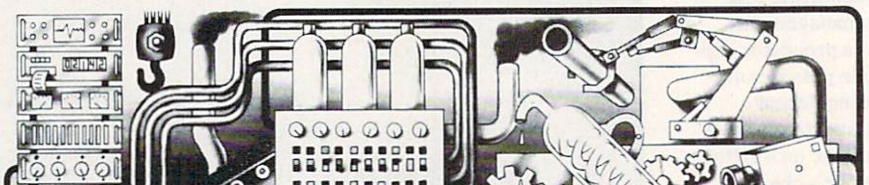
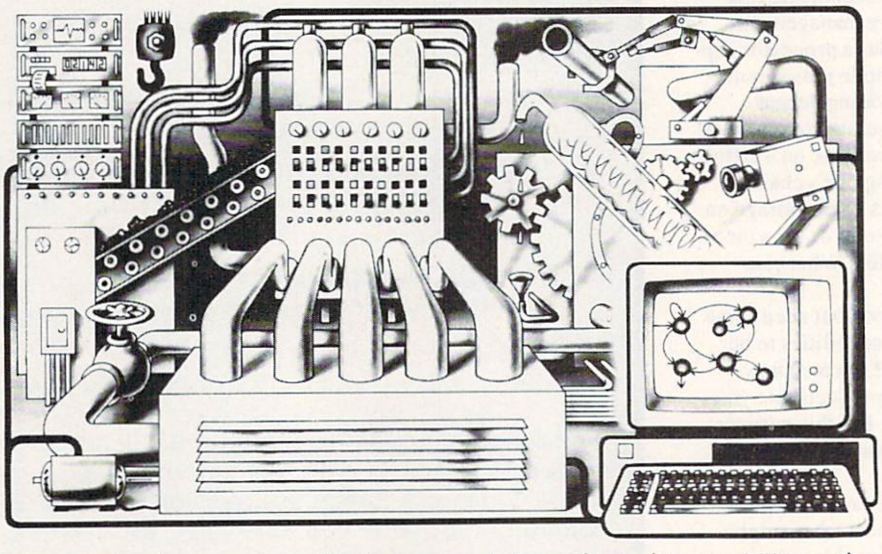

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CIRCLE 84 ON READER SERVICE CARD

FORTRAN vs. FORTRAN 8x

By Ken Takara

This month we go to the mainframe world with FORTRAN as our subject. In particular, we are concerned with a language known as FORTRAN 8x. FORTRAN has a long history as one of the earliest high-level languages, first appearing in the mid-1950s. An acronym for FORmula TRANslation, it has been the mainstay language for mathematical and engineering programmers.

FORTRAN has appeared in various incarnations, beginning with IBM's FORTRAN I in 1956, including FORTRAN II and FORTRAN IV. So far FORTRAN has been through two ANSI revisions, FORTRAN 66 (known as X3.9-1966) and FORTRAN 77 (X3.9-1978). The third revision, FORTRAN 8x, is still in process. Perhaps, following the pattern, it may become FORTRAN 88.

During the course of the committee meetings and public forums, many people have contributed to the 8x effort. The following individuals are represented in this column: Jeanne Martin, committee member and secretary; James Matheny, FORTRAN pioneer; Jeanne Adams, X3J3 chairperson; Rick Lutowski, commercial FORTRAN software developer; Dr. Loren Meissner, former X3J3 member and editor of the ACM SIGPLAN FORTRAN newsletter; Harvey Lynch, ex-FORTRAN programmer; and Bob Upshaw, FORTRAN observer.

Considering the advanced age of FORTRAN, some people wonder why it is still around at all and, even more, whether attempts to revitalize it by adding modern programming constructs are of any value. Will FORTRAN survive to the year 2000?

Upshaw: The one thing FORTRAN has going for it is its name. Sure, it will be around for a long time, at least in name. Other than that, I doubt it will be recognizable to contemporary FORTRAN programmers.

Lynch: FORTRAN is such an archaic language. It's a good 30 years old and totally obsolete. In modernizing FORTRAN, it will be necessary to keep the older features so that earlier code, which is quite abundant, will still be usable. The result will be a large, unwieldy language. One does not require new compilers for old code.

Lutowski: Incidentally, it's not just a mainframe language. It's found on micros now also. I use FORTRAN in my product line for several reasons. First and foremost is portability. In the microcomputer industry, a hardware system has a technological lifespan of about two to four years. In such an environment, it is essential for a commercial software company to write its products in a language that is guaranteed to be portable across hardware and across time. New and better is not portable; old but consistent is portable.

Martin: The FORTRAN standards committee is engaged in an experiment, the modernization of an existing programming language. The committee is aware of the burden of existing code and the absolute necessity of not abruptly invalidating any of it.

Matheny: With a language you want not only software portability; you also want programmer portability. If you change programmers or change jobs, you shouldn't have to start with a totally new language. For this reason, FORTRAN will be around a long time.

Alan Clarke in Britain has said that FORTRAN 8x will bridge the gap between FORTRAN 77 and other modern languages while retaining FORTRAN's unique advantages. As it stands now, 8x contains modern control structures, modular data and procedure definitions, abstract data types and data structures.

It will retain its unique advantages. It is the language of choice for large-scale scientific computing. This capability is enhanced by array processing and new precision facilities. FORTRAN 8x also retains its powerful and flexible I/O features. We hope and intend that the language will continue to facilitate the creation of efficient running programs.

Lynch: There is a lot of code lying around written in FORTRAN. Obviously, you can't ignore the considerable investment. X3J3 recognizes the need for modern features such as data structures and the like but they're also trying to be consistent with this rubbish of 1954.

Rather than fool with all this, they ought to just freeze it as FORTRAN 77. Break with the past. Leave that archaic code alone with the existing compilers. Then they could spend their time working on inter-language linkages. You could write programs using newer languages but still have access to all those FORTRAN subroutines.

Lutowski: Standards ought to be permanent. They shouldn't change. FORTRAN 77, with its features, has made both FORTRAN 66 code and programmers obsolete. I would suggest returning to FORTRAN 66 with the addition of an *INCLUDE* directive for accessing libraries, and a couple of added data types, with no additional foreign syntax. This is a radical suggestion, though, and I'm certain it wouldn't even be considered.

Adams: It is true that FORTRAN 66 is not upwardly compatible with FORTRAN 77 in the case of Hollerith. However, an appendix in FORTRAN 77 completely defines Hollerith for compilers that choose to implement this facility as an extension to FORTRAN 77.

This action has already been taken, though, and the current committee must work with the current standard, FORTRAN 77, in which Hollerith has been replaced with the character data type.

Lynch: A more dangerous incompatibility between FORTRAN 66 and 77 is the difference in the DO loop protocols, which cannot be flagged by the compiler. In FORTRAN 66, a DO loop is always executed at least once. In FORTRAN 77, the loop is executed only if the conditions are satisfied on entry. Sadly, there are some bits of code which assume that the FORTRAN 77 DO loop acts in the same manner as in FORTRAN 66. Such programs could deliver wrong answers with no diagnostic messages.

There seems to be a lot of discussion about the idea of deprecated features. What are deprecated features? And what does that mean to FORTRAN users?

Matheny: We say, FORTRAN will

live, not necessarily forever, but for the forseeable future. Deprecated means "a mild disapproval." We say that we think this feature is not good. We think that the next committee 11 years from now will take it out. We can't tell this next committee what to do. We can only say we think these things aren't good. If you're wise, you won't use it. We've provided something we think is better.

Deprecated features should be around 15 years; it takes a while for processors to come out after the standard is released. We are required by the users that FORTRAN 77 standard conforming programs continue into the future, until the next committee, having given 15 years notice, has the opportunity to take away as they choose.

We feel, though, that we have provided more attractive replacements for those features marked as deprecated. Because of pressure from the user community, X3J3 has decided to add new features on top of old language constructs. This way, the only trap is the use of implementor-defined extensions to FORTRAN 77 (and, of course, to FORTRAN 66).

Lynch: Once the deprecated features are really not supported, no existing program of any worthwhile magnitude will run. Mixing new FORTRAN with old FORTRAN will actually make conversion to the new form more difficult.

Meissner: I like the definition of deprecated I heard; you not only don't like it but you sort of sorrowfully don't like it. Everybody has taken FORTRAN 77 and extended it with all sorts of wonderful new features. Along comes X3J3 with all these beautiful, bold ideas and that's "Futuretran." That's where we're trying to get. The question is, how can we get there from here?

The answer that X3J3 came up with is to take everything you want and concatenate it to everything you've got and you build this huge compiler. You live with this huge compiler until the 1990s. It has to handle all of FORTRAN 77 plus everything you want in that compiler of the year 2001.

Then in the year 2000 these deprecated features fly away, leaving you with Futuretran. You get there, then, at the expense of having an unnecessarily large language for at least one revision cycle.

Lutowski: The X3 directive that requires language features to be marked "user discouraged" at least one full standard before removal is a step in the right direction. X3 should carry this policy to its logical conclusion by directing that no improvements to the methodology, semantics, or syntax of a language be made once the initial standard has been released. Advances in software technology should form the basis for new languages, rather than revisions in the old ones. Beyond developing the initial standard, the role of the language committees should be to correct errors and clarify the intent of the original standard, not to periodically redefine it. Standards must not be redefined, no matter how obsolete they become.

Sure, FORTRAN has its weaknesses. It has been denounced as unable to support maintainable code due to a lack of structure. Quite often, though, I've seen code full of these nested *IF* statements, where the programmer goes, *INDENT, INDENT, INDENT.* Pretty soon, you don't know where he is.

Many people feel that FORTRAN's greatest asset is its simplicity. As a somewhat primitive language, it has very few features to baffle a new programmer. It provides sufficient abstraction to permit one to work with mathematical formulas easily, yet allows one to work at a level close to the machine. Some people, in fact, consider it a high-level assembler.

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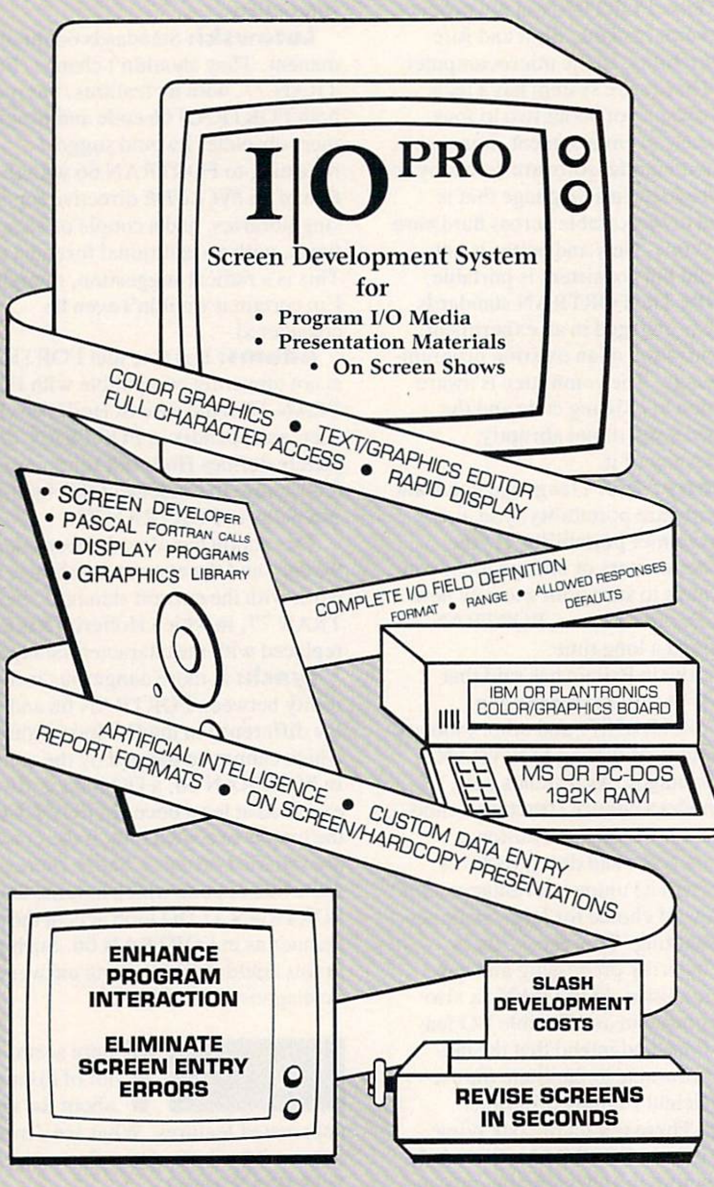
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Martin: Although FORTRAN 8x has some features that are similar to features in PL/I and Ada, it is still simpler than either of those languages. There were very good reasons why those features were put into Ada and PL/I. The fact that they exist in other languages does not make them readily accessible to the FORTRAN programmer who has many thousands of lines of FORTRAN that would be difficult to convert to any other language.

Matheny: Simplicity is, of course, a desirable feature in anything. Because we must retain all of the deprecated features of FORTRAN 77, FORTRAN 8x will not be simple. We believe that the language without the deprecated features is concise, consistent, complete and, if you will, simple.

Lynch: I don't like the idea of waiting ten years for another language. Even if 8x is adopted by 1987, it's going to be 1990 by the time anyone gets around to putting out a compiler for it. That's one of Ada's problems. It's so big, that writing a compiler for it is a tremendous task. So, by the time FORTRAN 8x is available, it will be superceded by the next revision.

Lutowski: Look at some of the things being deprecated, *COMMON* blocks and conditional *GOTOs*. The *GOTO* has always been on the blacklist of the structured-code people. Of course, you lose the three-branch *IF*. A lot of the new school of thought is all structured code and strong typing. They don't like *COMMON* because of the coupling problems. That's because people never learned how to use it properly.

If you think about it, there are two ways to transfer data to a subroutine, either via global variables (which are the same as *COMMON* blocks) or argument lists. If you get rid of globals, all you have left are argument lists. If you are passing a lot of parameters, it gets pretty unreal. From the standpoint of execution, it becomes pretty inefficient since these things have to be pushed onto a stack or to some global location. If you have 50 parameters in the list, you end up doing 50 pushes and 50 pops, and that's a lot more overhead. Using *COMMON*, you avoid all that overhead.

Adams: Your concern about your own software is a problem that we recognize as one that is generally felt. However, from its beginnings in 1966 certain features have fallen into disuse among the user community or have become less effective than a newer one. Some of these features are the *PAUSE* statement, and the *ASSIGN* and *ASSIGNED GOTO* statements (the unconditional *GOTO* is retained). These features are quite generally agreed to be obsolete.

Lutowski: I seriously believe that there are no computer scientists today who know how to use *COMMON*, as they all concluded a long time ago that it was bad and have avoided it ever since. I use it heavily within my graphic package, where huge lists are being passed around. But its all hidden from the person using it, since he or she only has to declare the block once, and all access to it is indirect via graphics subroutines. If we had an *INCLUDE* statement, it would become even more transparent.

Computer scientists are always trying to educate the neophyte. They penalize the experienced programmer by trying to protect the beginner. I think that as a result of this, FORTRAN will become much less desirable as a production language from execution and flexibility standpoints. I'd rather have things like *COMMON* there for use by the experienced, self-disciplined programmer rather than to have to declare these argument lists through 10 levels of subroutines.

Martin: *COMMON* is based on the concept of storage association. This has many unfortunate characteristics. It allows for inadvertently making variables equivalent, which is inherently unsafe. It requires that an integer variable and a real variable each occupy one numeric storage unit while a complex variable occupies two numeric storage units. This is unnecessarily restrictive and prevents the true portability numerical analysts have requested.

Heterogeneous data structures, which were universally requested by users, could not be global entities since, if they contained both character and numeric variables, they could not appear in a *COMMON* block. By latching onto Ada's *PACKAGE* concept, we were able to solve problems there. The utility of *COMMON* is provided by the *MODULE* and *USE* constructs, and *USE* provides the functionality of *INCLUDE*.

Lutowski: That restriction is only found in FORTRAN 77; it did not exist in FORTRAN 66. In fact, some implementations of FORTRAN 77 allow both character and numeric variables to exist in *COMMON* together.

There is a dichotomy between the original nature of FORTRAN and the attitude of X3J3. FORTRAN initially allowed the programmer to work at a level very close to the machine. It is now being changed to correspond to the notion of the machine as an abstraction. The deprecation of *COMMON* implies that storage association is bad. This is true only if you want to be kept far from the computer.

Matheny: These things (*COMMON* blocks, etc.) make FORTRAN very powerful but also very dangerous to the user. More formal control and data structures let the user say what he or she means in a way that some other reader of the program can understand.

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(*Continued on page 77*)

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CIRCLE 28 ON READER SERVICE CARD

Sol Libes—A man without a magazine

By Carl B. Landau

Sol Libes reminded me of Woody Allen. His dry wit, nasal voice, New York background, and pessimistic outlook brought to mind the characters Woody has portrayed in his movies.

Even the setting for the interview would have met with Woody's approval. We had lunch at the Ecko Queen Diner off Route 22 in northern New Jersey. I knew this must be an authentic diner because the waitresses had beehive hairdos and asked, "what can I get for you, honey?"

And like Woody, you can't help but like Sol Libes.

Meeting with Libes was particularly interesting at this point in time because *Microsystems*, one of the first technical microcomputer publications, had just stopped publishing with its November issue. Libes was the founder of *Microsystems* and its editor for five years.

Libes was born and raised mostly in the New York metropolitan area and partially in Los Angeles, Calif., in the 1930s "when it was mostly orange groves." As he puts it, he's "a graduate of publicly-funded universities." He received his undergraduate degree in economics from City Univ. of New York. His masters degree in technical education was earned from Rutgers Univ. in New Jersey.

People have been mispronouncing Libes's last name for all of his 55 years—it's Lee-bus not Lybs. Although he doesn't make a big deal of the frequent mispronunciations, it may have been partly why he became a teacher back in 1968.

The real reason he went into and stayed in teaching, Libes explained, was that he couldn't stand the rat race. He currently teaches digital electronics and microcomputer design at Union County College in New Jersey.

Libes joked about the communication skills of engineers. "Engineers can't write, read, or communicate verbally. But there are some terrific hardware and software designers out there," he said.

Libes first became interested in computers in the early seventies. Using an article Don Lancaster had published in a 1973 issue of *Radio and Electronics*, he and his students converted a TV into a terminal, interfaced it to a modem, called up their IBM computer at school, and "we were shocked at what we had done and how easy it was to do."

The next experiment was to build a small microcomputer with an Intel 8008 microprocessor chip. "In trying to do that project we learned that Intel was not providing any help at all," Libes said. "If you were going to buy 10,000 parts from them they would provide some assistance. But if you were just building one system they didn't want to know you."

"I started looking around for help. I found there was a very active computer society called the Amateur Computer Society, and I joined it. Steve Grey had organized this group back in 1965," Libes said.

"Then the Altair came out in 1975, and we had even more problems with it than the Intel 8008." As an effort to educate himself and others, Libes formed the New Jersey Amateur Computer Group in May 1975. One of the major accomplishments of this pioneering organization was the creation of the first personal computer show. Thus the Trenton Computer Festival was first held in 1976 and has been held annually ever since.

Libes first became involved with magazine publishing when he was writing a regular column—a gossip column on industry happenings—for *BYTE* starting in 1978. He also was using CP/M and an S-100 system while doing consulting work for a number of companies designing microcomputer systems.

Although several computer magazines were springing up during that time, no magazine was specifically oriented to CP/M and S-100 system users. "I approached several publishers with the idea of starting a magazine for this audience, and they thought I was crazy. Finally, after being turned down by everyone, I decided if they didn't want to publish one I would—being the fool that I was!"

In December 1979, *Microsystems* was born on Libes's Ping-Pong table in the basement of his house. Libes can laugh now about the mail list program that crashed the night before mailing the first issue. The subscriber list was lost for three hours.

"The magazine immediately turned into a big business. It took up every spare

minute of my time. My wife and I were literally working 24 hours a day, 7 days a week," said Libes, remembering the exhaustion. A few friends also pitched in and helped out.

Libes did not enjoy the publishing side of the magazine, especially dealing with the advertisers, subscribers, printers and mailing services. "I would receive long distance subscriber calls at 3 a.m. from Denmark. At that point I decided I wanted out."

"David Ahl [publisher of *Creative Computing*] was trying to build a publishing empire at the time," said Libes. Libes sold most of his equity interest to Ahl after six months of publishing *Microsystems* himself. At that point the magazine had a circulation of about 8,000.

When hard times fell on Ahl he sold *Creative Computing* to Ziff-Davis Publishing. *Microsystems* was part of the deal. Libes remained at *Microsystems* as editor until March 1984.

He always did his editing at home. "I'm not the type of person who can work in an office 9 to 5," Libes said. "If I went to an office I wouldn't accomplish a damn thing. Offices are an endless series of coffee breaks and meetings."

"What made *Microsystems* such a unique magazine was its practical orientation," said Libes. But despite a fervent

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CIRCLE 37 ON READER SERVICE CARD

"I think CP/M will gradually, over a period of time, fade into oblivion."

following, a "circulation problem" led to Ziff-Davis ending the publication.

"We were never able to get the circulation up to the point where it was worthwhile for Ziff-Davis," said Libes. "They needed a circulation of over 100,000, and we were catering to a very sophisticated readership, which is a very limited audience."

Libes had a very good relationship with Ziff-Davis. He feels they are a professional publishing house that treated him well. "But they're in business first and foremost. The bottom line is what they're interested in."

Libes has some strong opinions about CP/M, the operating system that was largely responsible for the launch of *Microsystems*. "CP/M-86 really had the potential to be something," he said. "But Digital Research was very slow in getting it out. They really did not seem to put a push on it."

"It came out so late that Seattle Computer Products, which was putting out an 8086-based system, gave up waiting for it. They had Tim Patterson write an operating system for them that emulated CP/M. Microsoft bought the operating system, which came out on the market six months to a year before CP/M-86."

"If Digital Research had brought out CP/M-86 when it had promised, MS-DOS would have never been born," said Libes. "And IBM would have gone with CP/M-86. They only have themselves to blame for giving away the market to Microsoft and MS-DOS. DRI is not an aggressive organization, and they are not marketing oriented, while Microsoft is hungry."

Libes is convinced OEM manufacturers and application software developers are moving away from CP/M. "I think it will gradually, over a period of time, fade into oblivion," he said.

"There is no doubt that there is a tremendous amount of application software running under CP/M," said Libes. "But since the introduction of the IBM PC and MS-DOS, commercial software suppliers are no longer developing software for CP/M. Probably only 300,000 to 500,000 systems are running on CP/M. There are probably about 3 million IBM PCs and clones. CP/M is a minor segment of the marketplace and CP/M-86 has never even gotten off the ground."

Although a CP/M and S-100 magazine, *Microsystems* also covered UNIX quite thoroughly. "With the amount of emphasis we put on UNIX, we were really too far ahead of the marketplace," said Libes.

"In early 1983 I became concerned with the future of CP/M. At that point we were very closely wedded to CP/M. We were *the* CP/M magazine. We had to shift our direction. I started to give coverage to MS-DOS."

"But Ziff-Davis was bringing out several magazines catering to the IBM PC user—*PC* and *PC Tech Journal*. I really did not want to step on their toes, so we sort of limited our coverage of MS-DOS."

"Instead I decided to direct our attention to UNIX. I felt that more and more sophisticated micro software developers would be moving toward the UNIX area. We probably made a mistake, because a magazine cannot lead its readers in a direction. I think you have to follow the readers and support them. You can't show them the way."

"Although CP/M was declining, it was declining at a slow rate," said Libes. "We shouldn't have moved so quickly and so aggressively. Our readers still wanted support for CP/M."

"I still think we were moving in the right direction by giving support to UNIX," reflected Libes. "Now we have IBM introducing Xenix on the AT. This would have given *Microsystems* a tremendous boost. It is unfortunate that Ziff-Davis did not want to stick with the magazine during this transitional period."

"As for the S-100 market, it will probably continue for quite some time. Most of the manufacturers are putting together multi-user systems and have largely abandoned the single-system market. Three of the S-100 manufacturers are already selling UNIX-based systems," said Libes.

"This microcomputer industry is not really that unique if you look at other industries. We are following in their footsteps, repeating the same evolutionary process."

"If you go back before World War I, there were over 1,000 auto manufacturers.

Many of them were just garage-type operations. Now we have four automobile manufacturers. I'm sure that is what it will come down to in the microcomputer industry. Independents will be forced out. And I have no doubt IBM will be the leader."

Libes certainly misses *Microsystems*, but his life sounds full without it. He is in his sixteenth year as a professor of electronic technology at Union County College in New Jersey.

He also is working on a grant for the state of New Jersey. The grant has to do with the use of microcomputers in electrical engineering—specifically, integrating spreadsheet programs and data aquisition systems in electrical engineering.

On the side, Libes is very active in the distribution of public domain software. He still works with the New Jersey Amateur Computer Group and the SIG-M PC Blue public domain software library. He proudly proclaims himself to be a computer hobbyist who likes to be both a teacher and a student.

Libes is also an amateur musician—he plays classical and jazz guitar. He also enjoys hiking in the mountains. But he admits he still spends quite a bit of time playing with his machines.

His wife, Lennie, is a professor of mathematics at the County College of Morris in New Jersey. His two children are both highly involved in science. His daughter, Susan, is a professor of ocean chemistry at the Univ. of South Carolina. "She likes to work with large quantities of chemicals," Libes chuckled. His son, Don, is involved in researching the next generation of robotics.

What does the future hold for Libes? He is interested in starting some new version of *Microsystems*—though with a different title since Ziff-Davis owns the rights to the name. He wants it to be a small magazine that comes out possibly every other month.

"I don't want to worry about circulation and advertising the way Ziff-Davis was constantly concerned," said Libes. Ideally he'd like to team up with a small publisher who will handle all the publishing aspects of the magazine. He would just concentrate on editing.

To date Libes has received no takers. But there is still a sparkle in his eye that indicates he is not finished with his magazine career.

Perhaps the next interview will be titled, "Play it again, Sol." ■

Carl Landau is publisher of COMPUTER LANGUAGE.

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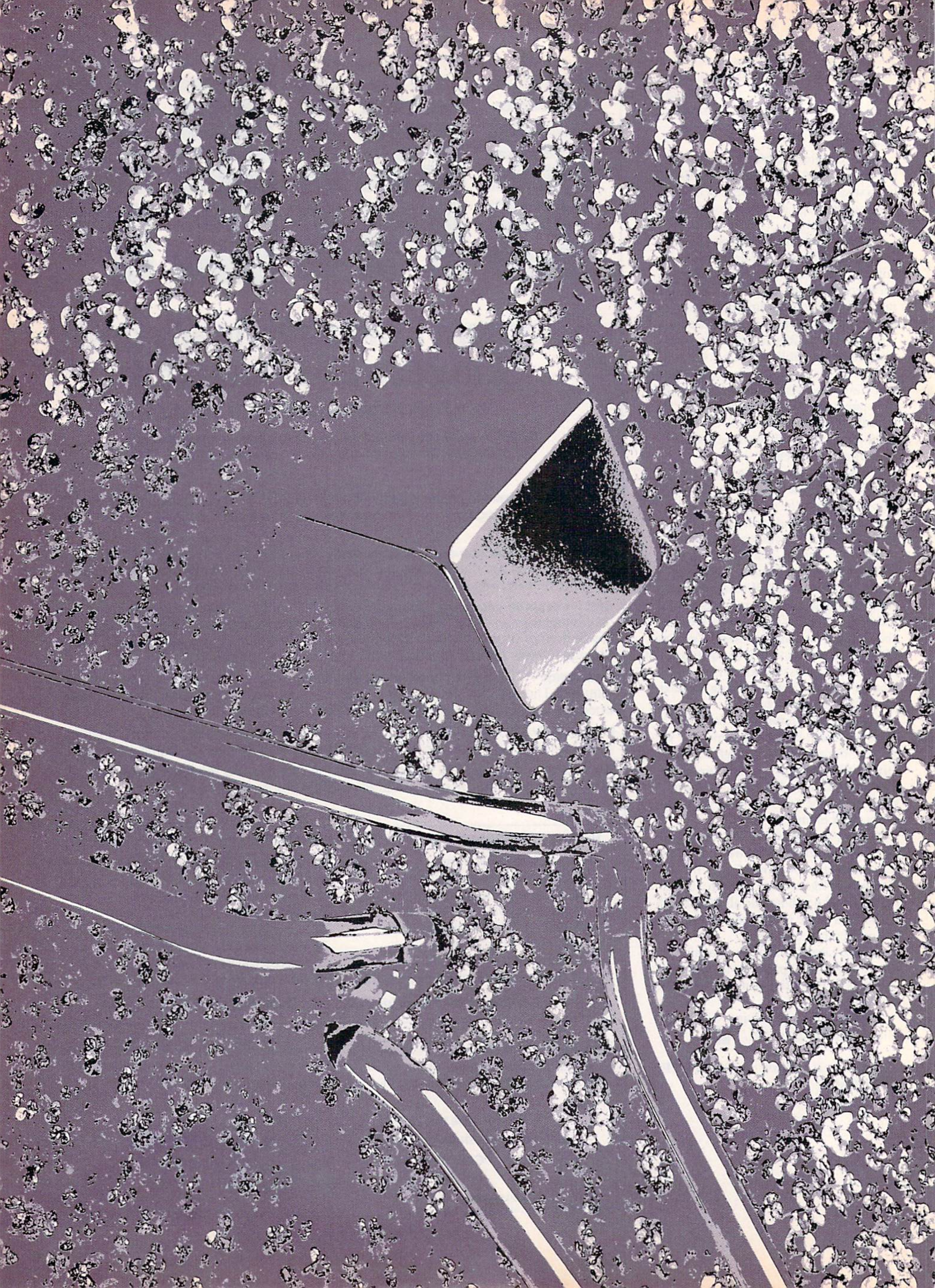

Macros & Procedures

By Morton F. Kaplon

One way to identify a real mathematician, I am told, is to give him (generically speaking) a problem of some complexity and see how he goes about solving it. The real mathematician's approach will always be one in which he does a few introductory steps and then says—"I have now reduced this to a problem previously solved."

Good programming reflects the real mathematician's approach even though we may not perceive it that way. Every programming language utilizes this approach with built-in routines that make it easy to do arithmetic, take a square root, evaluate trigonometric functions, handle strings, etc.

In BASIC, for example, the ability to multiply two numbers and display the result with the command *PRINT 345*57* shows this approach. The person who wrote the interpreter developed a routine for multiplying two numbers and then set things up so that it could be used over and over again by following the rule indicated above; for your benefit this person reduced the problem to one already solved.

The higher level languages take this one even further. Besides including a variety of "ready done" things for you (depending on the language and its realization, of course) many of them have created ways that allow you to do the same things for yourself.

Depending on the language, these things are given different names. BASIC has the subroutine concept, C has functions, Pascal has functions and procedures, and so on.

For example, if an engineer requires some very esoteric function that is used over and over again, practically any high-level language offers the ability to write, just one time, the code to evaluate the function and then, as needed each time, call for its evaluation by the code already written. High-level languages even allow you to nest procedures (to include procedures inside procedures or subroutines inside subroutines, etc.).

My intent is to discuss how the real mathematician is implemented at the assembly language level and to focus on one aspect of its implementation—macros—that does not have a ready counterpart in higher level languages. At the same time I will compare macros with procedures and consider the relative merits and utilities of each.

The particular assembly language used for examples is that of the Intel 8088 as realized in the macro assembler for the IBM PC. The comparison will primarily contrast execution time, run-time code size, and ease of use, and it will indicate the ability to accomplish certain tasks with macros that are not attainable by procedures.

What is a macro?

The word macro is used in several contexts in relation to programming and computers, but they all appear to imply the same thing. The basic idea is that a macro is standing in for something, and when the macro is used, it is replaced by what it was standing in for.

The concept involves two things: defining the macro(s) and using the macro(s). Depending on the context, the method of definition and the method of use is different, but the end result, so to speak, is the same.

A rather common and most useful form is the keyboard macro. A variety of programs enable the user to define a certain key or combination of keystrokes to represent a string of characters or even other keystrokes.

Anyone who has ever been introduced to macros finds them enormously useful tools. If you are writing text and the same expression recurs, rather than type it in each time, you assign some specific keystroke to represent it. When you enter that keystroke, the expression in its entirety is entered. The assigned keystroke is a stand-in for the desired expression, and when the keystroke is entered (the macro is invoked), the expression is displayed (the macro is expanded).

The application we are interested in is programming, and I will proceed somewhat generally for the moment and illustrate the use of macros with the multiplication example referred to in the introduction.

Suppose we want to define a macro to multiply two numbers. To do this we have to write in assembly language the code that does the multiplication, and we have to do something that defines a name for the macro, where its code begins, and where its code ends. We also need some way of passing to the program the numbers to be multiplied together.

I will use 8088 macro assembly language and explain what it means as I go along. The required commands relevant to the use of macros are displayed in UPPER CASE and the input from the programmer (symbolically reflecting the code to accomplish the task) in lower case; comments will follow on each line after the ";".

To define a macro whose name is *multiply*, the lines of code in Listing 1 must be included in the assembly language source code at a location whose specification we will discuss later. Because macros and procedures employ very different methods of passing parameters to be used, particular attention must be paid to this. To use this macro in the source code to multiply two specific numbers together, the macro is invoked as indicated. The "—" stand for lines of other code in the program that precede and follow the invocation of the macro.

Note that the lines in Listing 2 are in source code, and before you have a program that can be executed, the source code has to be translated (assembled) to machine code. When the assembler does the translation from source code to machine code, it does the following:

When the assembler scans the source code, if it comes across a name that it does not recognize as a valid command code or pseudo-op code, it looks in its table of macro names to see if that name corresponded to a macro defined somewhere in

```
Defining the macro "multiply"

multiply  MACRO  x,y        ;"multiply" is name of macro--this line marks
                            ;the beginning of the macro and says the two
                            ;numbers  represented by the  parameters x,
                            ;y are to be used in the code below as the
                            ;stand-in operands for multiplication
line 1                      ;the programmer supplied code in the MACRO
line 2                      ;of programmer supplied macro code
--------
mov    ax,x                 ;the parameter x is put in register ax
mov    bx,y                 ;the parameter y is put in register bx
                            ;these lines of code will be referred to as
                            ;the p(arameter passing) code.
--------                    ;note that somewhere in this section of
--------                    ;macro code we might have a command
--------                    ;moving the result to some specific location
line n                      ;(last line) of programmer supplied code
          ENDM              ;this indicates the end of the MACRO code.
```

Listing 1.

```
Using the macro "multiply"

------------------          ;the two numbers to be actually multiplied
------------------          ;are passed to the program and replace the
multiply 345,47             ;stand-in parameters when the macro is
------------------          ;expanded
------------------
------------------
```

Listing 2.

the source code. If the assembler finds that macro, it then expands the macro by replacing its invocation by the actual lines of code contained within the body of the macro, substituting for the parameters *x* and *y* the actual values of 345 and 47, respectively, that were passed with its invocation.

Thus when the source code is prepared for assembly into machine code, what the translator sees is as in Listing 3.

When the macro is assembled, it is expanded at that location to its full textual value, and any parameters that were defined for it are substituted for in the expanded text, as indicated previously for *x* and *y*.

We will characterize the code, in its assembled form, as consisting of *a* bytes associated with the non-parameter passing aspect and *p* bytes associated with the parameter passing. Thus this macro when assembled will consist of $a + p$ bytes of executable code. If it is a non-parameter passing macro, then it has only *a* bytes. In the previous example, the parameter passing aspect comprises the two lines involving *x* and *y* in the macro definition.

Thus, if the macro *multiply* was used 37 times in the source code and if the size in bytes of the assembled code inside the macro was 50 bytes $(a+p)$, then the assembled code will contain 37 × 50 bytes of code, representing the use of the macro *multiply* 37 times.

This is quite different from the way the real mathematician is handled in the translation of higher level languages. It is important to understand and consider that difference, as it is reflected at the assembly language level where the counterpart is called a procedure in the 8088 assembly language.

Procedures

In 8088 assembly language the real mathematician may also be implemented by the use of procedures. The way that procedures are used is rather similar conceptually to subroutines in BASIC and, more importantly, what actually occurs is similar to the utilization of functions and procedures in higher level languages.

Using procedures (or their equivalent in other assembly languages) is again a two step process—they must be defined and they must then be used. Again the example is for the Intel 8088 in the IBM macro assembler, using *multiply*. The operands for the multiplication will be passed using the same form as in the macro; this will enable meaningful comparisons to be made between procedures and macros and it also represents the minimal way of effecting the procedure with respect to code utilization.

Somewhere in the source code must be the lines of code to define the procedure, as presented in Listing 4. In order to understand the difference between a

```
Source code of expanded macro as presented to the assembler

line 1              ;of programmer supplied macro code
line 2              ;of programmer supplied macro code
--------
mov     ax,345      ;345 replaces x and is put in register ax
mov     bx,47       ;47 replaces y and is put in register bx
--------
line n              ;(last line) of programmer supplied code
```

Listing 3.

```
Defining a procedure

multiply  PROC  FAR  ;define a procedure of type FAR, named "multiply"
line 1 of procedure  ;programmer supplied code
line 2 of procedure  ;of programmer supplied code
---------            ;note, no parameter passing code inside PROC
---------            ;again, the code here must contain the location
---------            ;of the answer; for procedures, the stack is
---------            ;not always the ideal location.
line n of procedure  ;(last line) of programmer supplied code
          RET        ;RETurn to location where "multiply" was invoked
multiply  ENDP       ;Indicates the End of PROCedure "multiply"
```

Listing 4.

macro and a procedure we must again look in a little detail at how the procedure is handled by the assembler (Listing 5).

When the assembler sees a procedure being defined, it takes the code inside the procedure, translates it into executable machine code, and stores it at that location in the program where it was defined. When it comes across the invocation of the procedure *CALL multiply*, it checks to see that such a procedure name exists, determines the location in the program sequence where it is, and then proceeds to transfer program execution from the current location to the location of the executable code for *multiply*.

Before the assembler does the transfer, it saves the address in the program code of the next instruction after *CALL multiply* by pushing it on the run-time stack; for a procedure of type *FAR* it would first save the address of the segment in which the program is currently running by pushing that on the run-time stack and then pushing the address of the next instruction.

The assembler then transfers to the location where the machine code for *multiply* is, executes it, and in that execution, when it sees the code for *RET*(urn), takes the values stored on top of the stack to use to return back to the next instruction after *CALL multiply*.

Each time the assembler sees a *CALL multiply* it does the same thing. Thus we note the first difference. The source code that does the *multiply* is only translated into executable machine code once. No matter how many times a *CALL* is made for the services of *multiply*, the same executable code in the same location is used. An obvious savings occurs in the amount of executable code as compared to the macro for repeated invocations—just how much we shall see shortly.

But there is, as with anything, a price to be paid. Note that no parameters are passed on the line that was used to invoke *multiply*. They were passed before the procedure *multiply* was *CALL*ed, in this example, utilizing the same code as was utilized for the body of the macro in passing parameters. Thus, when parameters are to be passed, we must account for this code.

In addition, there is another overhead in execution time. With a macro, the machine code is in-line, ready to be executed each time the macro is invoked. But with a procedure, the machine has to save one (or two, if the procedure is of the *FAR* type) addresses on the stack; transfer execution to the location of the procedure *multiply*; and at the conclusion of the procedure, recover those addresses and transfer back. So a procedure will take more time to execute than a macro— the extra time is required for the execution of these actions (the *CALL* and the *RET*urn).

Because the addresses needed for transfer back to the *CALL*ing location are on the stack, the programmer must be very careful that the code in the procedure does not change the top of the stack at the conclusion of the procedure from its initial value entry to the procedure. Therefore it makes the stack, as a means of passing parameters to and from the procedure, much less flexible for use than it would ordinarily be. (Some CPUs maintain separate run-time stacks, not accessible to the programmer, so this problem is eliminated.)

Finally, a brief explanation is needed on the type of procedure. The 8088 processor, for example, has a segmented structure, with each segment 64K bytes in size. If the code for a procedure is in the same segment as existed in the program execution at the time of its *CALL*, then the procedure type is said to be *NEAR*. If the procedure is in a different segment, then the type is *FAR*. For a *FAR* type, the address of the current segment must be saved as well as the address of the next instruction to be executed in that segment so that the processor knows which segment to return to.

Table 1 compares features of macros and procedures by showing their dependence on various parameters.

We can, at this point, draw some general conclusions as to relative performance. The most interesting question is the value of *N* for which macro and pro-

```
Using a procedure

----------------        ;the values to be used in the procedure must be
----------------        ;passed to it before it is CALLed since there
                        ;is no way to pass them on the CALLing line as
----------------        ;for macros.  We do it in the same way as in macro
mov        ax,345       ;body; pass one of the operands needed for
mov        bx,47        ;multiply and then pass the other operand
CALL     multiply       ;CALL for the procedure "multiply"
----------------        ;continue on with program code
----------------        ;
```

Listing 5.

cedure run-time code is the same. Equating the two values for run-time code yields, after some very elementary algebra, $N \doteq (a+R)/(a-C)$, independent of p (which should not be surprising, considering how it was handled).

Since R and C may depend on the type (*NEAR* or *FAR*), we can specify no more at this point, except to note that if a is very large, much larger then either R or C, then N will be approximately 1, for that case. C is 3 or 5 bytes depending on whether the type is *NEAR* or *FAR*. R is 1 byte for either type if there are no additional stack pops.

It is clear that the run-time code size increases much more rapidly with repeated invocation for the macros than it does for the procedures. However, consider execution time, listed in Table 2, in terms of clock cycles. There we see clearly displayed the execution time penalty for the use of procedures. A procedure will always take at least $N^*[t(C)+t(R)]$ clock cycles longer per invocation than a macro.

Whether this is acceptable or not depends of course on the application. If the procedure is being used to display error messages or prompts, then clearly the execution time per invocation is relatively unimportant and the savings in run-

Comparison of macros and procedures

Function	**Macros**	**Procedures**
Define beginning	macroname MACRO p1,.,pn	procname PROC TYPE
Executable code	<between Define Beginning and Define Ending>	
Define ending	ENDM	RET procname ENDP
How invoked		
Without parameters	macroname	CALL procname
With parameters	macroname v1,.,vn	parameters v1,.,vn passed in code before CALL procname
Execution	Code expanded in-line	At location of PROCEDURE RETurn to CALL location
Source code size	Size of MACRO + N * (size of invocation)	Size of PROC + N * (size of invocation) + N * (parm passing code)
Run-time code	N * (a + p) bytes	(a * R) + N * (C + p) bytes
Execution overhead	None	Stack use, IP transfer
LIBRARY inclusion	Relatively easy, no additional overhead	Requires care and planning, overhead

a = assembled code size in bytes, non-parameter passing
p = assembled code size in bytes for specific parameter passing
N = Number of invcations iof MACRO or PROCEDURE
C = bytes of assembled code associated with CALL
R = bytes of assembled code associated with RET(urn)
vn = actual value of nth parameter value passed
pn = place value of nth parameter
IP = instruction pointer/program counter

Table 1.

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time code is preferable. On the other hand, if the application is one in which time-consuming operations become important, such as sorting, searching, or screen manipulation, then the savings in execution time may have priority over any savings in run-time code.

Though a flat statement cannot be made to cover all possibilities, experience strongly suggests that in those cases where the *a* code size is appreciable and repeated invocation is anticipated, the use of procedures is to be preferred unless execution time is of the absolute utmost priority.

If you're really ambitious about following up on this discussion on macros and procedures, call the *COMPUTER LANGUAGE* Bulletin Board Service or this magazine's account on CompuServe to download two very long examples that use the same services but implement them as macros (testmac.asm) and as procedures (testproc.asm). The file name on the BBS/CompuServe will be called MACPRO.LTG. In each case a detailed accounting in the source code of run-time byte size is kept.

These are executable (albeit trivial) programs written in a format to produce a .COM file. They provide a useful framework for testing macros or procedures in such a way that the assembled run-time code displayed in the directory for the .COM file is the same as that calculated using the data from the Intel manual on code size.

So many diverse ways exist to utilize macros that it is difficult not to continue. However, good instructional practice requires the reader to explore and discover on his or her own. Think of the many things you do repetitively in writing programs and create the macro structures to accommodate them. Build your libraries and use them. Doing this will make programming go much faster.

Morton Kaplon has a Ph.D. in physics and teaches computer science at City College of New York. He considers this job to be his third career; he was formerly a practicing physicist—with more than 70 articles on physics published—and vice president of administration at the City College of New York.

Execution time

Function	**No. of invocations**	**Clock cycles: No parameters passed**	**Clock cycles: Parameters passed**
Macro	N	N*t(a)	N*[t(a)+t(p)]
Procedure	N	N*[t(a)+t(C)+t(R)]	N*[t(a)+t(p)+t(C)+t(R)]

t(a) = number of clock cycles for code a
t(p) = number of clock cycles for code p
t(C) = number of clock cycles for the CALL (type dependent)
t(R) = number of clock cycles for the RETurn (type dependent)
t(C) is 19(23) or 28(36) depending on the type being NEAR or FAR. t(R) is 20 or 32 depending on the type being NEAR or FAR. (The number in the ( ) is used if the instruction operand is a word.)

Table 2.

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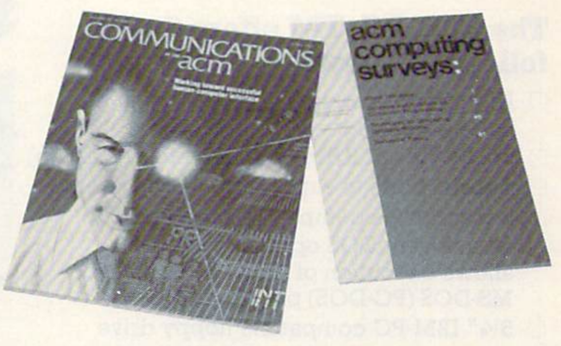

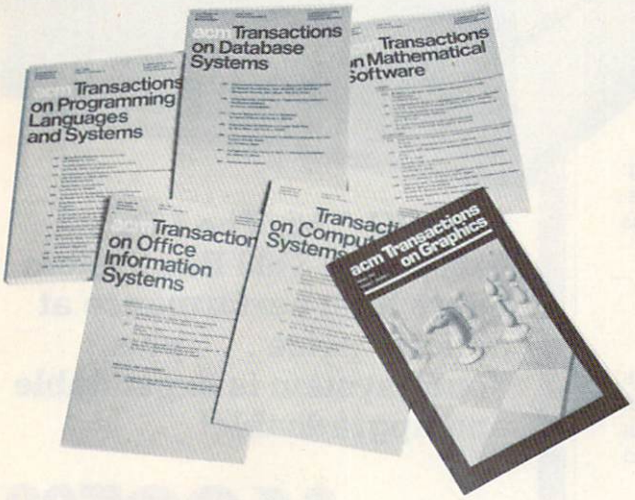
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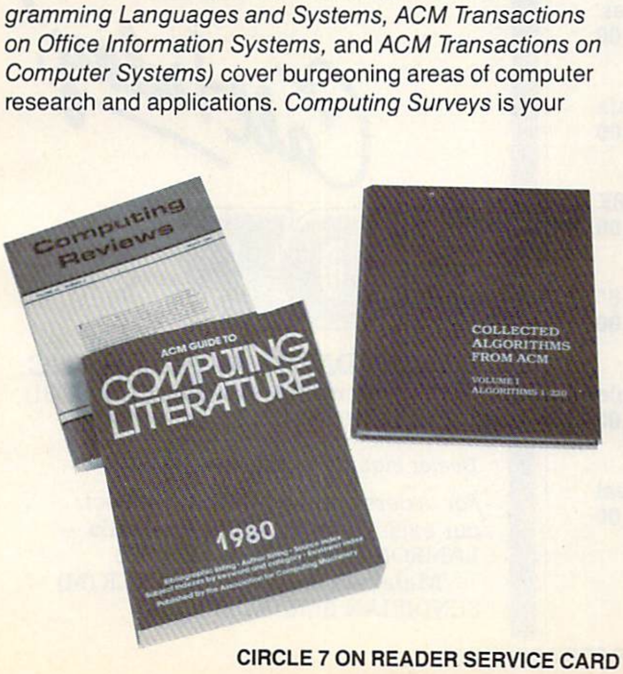
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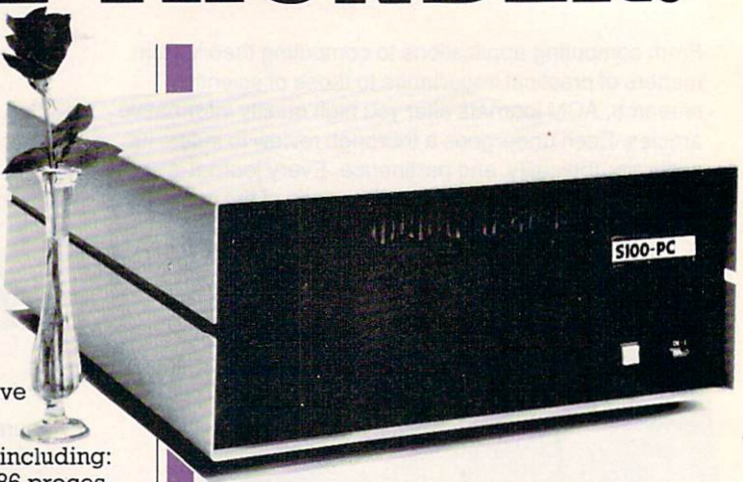

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The IIIrd Dimension

Writing programs in dBASE III

By Darryl Rubin

How do you repeat a stunning success? In an industry of one-product companies and technological brinkmanship, this is a multimillion dollar question.

One company, Ashton-Tate, seems to have at least part of the answer: build on your strengths.

In developing a new data base product, Ashton-Tate had a marvelous strength to build on—its dBASE II programming language. Ashton-Tate is no slouch at marketing products, but it was dBASE II's programmability that made it such a longstanding winner at the retail counter against its more sophisticated but nonprogrammable competitors.

Enter dBASE III. Not only is this whiz of a data base loaded with features customers asked for, it sports an enhanced language that brings data base programming into a new dimension.

In this article we'll look at the unique features of dBASE III's language and learn how to write programs using them. We'll also highlight what's changed since dBASE II and present two utility programs for your library.

You never know, we might even uncover some bugs and undocumented features. So if you're new to data base programming or an old dBASE II hand who's ready for a step up, read on.

To download copies of the software presented in this article, call the *COMPUTER LANGUAGE* Bulletin Board Service at (415) 957-9370 or CompuServe (GO CLM) and read the file DBASEIII.TOC.

II steps forward

If you're a dBASE II fan, you'll find a lot to like about dBASE III because much of the language has been carried forward, with welcome improvements.

dBASE III is an interpreted rather than a compiled language, though its syntax hardly suggests this. Procedures are symbolically named—no line numbers here—and the block-structured *DO WHILE* and *CASE* statements resemble PL/I's.

Data types include character string, numeric, logical, and a unique one, date. This major advance over dBASE II directly supports date comparison and arithmetic, as in *NEXTWEEK = TODAY + 7*. Two new functions, *DTOC* and *CTOD*, let you convert date variables between internal format and printable character strings.

dBASE III has room for up to 256 variables, way up from dBASE II's limit of 64. You can implicitly create or retype variables just by assigning them values. Fleet-fingered dBASE II users will certainly appreciate the new, terser syntax for assignment (*A = B* vs. *STORE A TO B*).

Unlike their dBASE II counterparts, variables in dBASE III are locally scoped. A subprogram inherits all its caller's variables and any new variables created by that subprogram disappear when it returns.

By introducing these new rules, Ashton-Tate has at once simplified modular programming and thrown a monkey wrench into every major dBASE II program ever written. This is because dBASE II variables are globally scoped and persist until explicitly released.

If you need global variables in dBASE III, declare them PUBLIC and they'll behave just like dBASE II variables. You can also declare variables PRIVATE, which has the effect of hiding any variables of the same name that already exist. This lets a subprogram define variables using any names it pleases without unintentionally modifying variables it inherits. (The hidden variables reappear with their values intact when the subprogram returns.)

Now let's evaluate a few expressions using dBASE III's BASIC-like print statement, *?*:

```
    ? 1 < 2 .AND. 2 < 1
.F.
    ? 'CON' + 'CAT'
CONCAT
    ? 'A' = 'ABC'
.F.
    ? 'ABC' = 'A'
.T.
```

Does it surprise you that *'ABC'* seems to equal *'A'* even though *'A'* doesn't equal *'ABC'*? This isn't a bug—really!—because dBASE doesn't compare strings for equality, it does prefix matching. In other words, it checks whether the second string matches the prefix of the first. This makes it a snap to program queries like "Display names starting with A" but beware: the result of a string comparison depends on the order of the strings.

If you prefer exactitude in your comparisons, you can *SET EXACT ON*. This statement also circumvents a particularly bothersome side effect of prefix matching, namely, that all strings compare equal to the null string.

dBASE III has more surprises in store, both good and bad, as we'll see. But first let's explore the part of the language that sets it apart from all others: those magical statements for manipulating data bases.

Tables for III

Like its illustrious predecessor, dBASE III is a relational data base. This means that it stores data in two-dimensional tables having a fixed number of columns and a variable number of rows.

In dBASE III, tables are called data base files, columns are called fields, and rows are called records. You students of relational algebra will know these same things as relations, attributes, and tuples, respectively. (And people have accused Ashton-Tate's manuals for being abstruse!)

Relational algebra defines three primitive operations that create new data bases from existing ones: *select*, *project*, and *join*. *Select* creates a new data base by copying selected rows from an existing one, while *project* copies selected columns. *Join* combines two data bases into one by concatenating records that have matching values in a common column.

Let's save *join* for later and see how dBASE III accomplishes *select* and *project*. We'll work with a sample data base called CATALOG.DBF that contains directory information from several diskettes of public domain software (Figure 1).

```
USE CATALOG
* Project two columns
COPY TO PROJECAT
     FIELDS NAME, SIZE

* Select certain rows
COPY TO SELECAT
     FOR VOL = 'DISKA'
     .AND. SIZE > 2048
```

Do you see how field names can be used in expressions just like variable names? This is true anywhere that dBASE III permits expressions.

You can simultaneously select and project a data base by including both the *FOR* and *FIELDS* clauses in the same *COPY TO*. In fact, one or both of these clauses can be used in almost all of dBASE III's data base statements, including *LIST, DISPLAY, SORT, REPLACE, APPEND, JOIN, COUNT, SUM, AVERAGE, TOTAL,* and *DELETE*. Amidst this diversity, selection and projection are anything but primitive operations. Here are some more examples:

```
* Count old files
COUNT FOR DATE
     < CTOD('12/01/84')

* Convert size to Kbytes
REPLACE ALL SIZE WITH
     INT(SIZE/1024)

* Sort on three fields
SORT TO SORTCAT ON
     NAME, EXT, DATE/D
```

If you're a dBASE II user, please try not to drool at how easily we just sorted a data base on three fields. dBASE III will let you sort on up to 10, with per-field options for ascending (/A), descending (/D), and ignore-case (/C) sort order. (Now you may drool.)

Meaningful relationships

So far we've seen how dBASE III lets you manipulate individual data base files. But the real power of relational data bases lies in their ability to relate information in different files based on common key fields.

Figure 2 shows a set of data base files you might use in conjunction with CATALOG.DBF to sell public domain software by mail order. Notice how key fields like BBSID, ORDERID, and FILEID are used to relate files so that data fields like CUST_NAME and BBS_NAME are never duplicated.

Compared to its predecessor, dBASE III's ability to relate files is positively incestuous. This is because you can now manipulate up to 10 files at once rather than two and create dynamic (run-time) relationships.

dBASE III gives you two ways to combine related information: with *JOIN* and

Catalog of public domain software

CATALOG.DBF

FILEID	Name	Ext	Vol	Path	Size	Date	Time	BBSid
0001	CATALOG	PRG	DISKA	\DB3	2667	11/03/84	10:02p	0003
0002	CALANDR	085	DISKB	\ART	8096	11/18/84	4:32a	0001
0003	BOZO	PIC	DISKB	\ART	9999	11/19/84	5:20a	0001
0004	123	ZAP	DISKC	\HMM	456	12/23/84	11:19p	0002
0005	WONDER	PRG	DISKA	\DB3	1024	12/23/84	12:02a	0003

Figure 1.

SET RELATION TO. As we explained in the last section, *JOIN* physically concatenates the records from two data bases based on matching values in a common field. The idea behind *SET RELATION TO* is similar, but rather than physically concatenating records, this statement dynamically links them at run time (a much more efficient process).

Here's an example that uses *JOIN* to concatenate ORDERS and ITEMS records having the same ORDERID; the resulting DETAILS data base would tell you, for example, what files each customer ordered.

```
USE ITEMS
SELECT 2
USE ORDERS
JOIN WITH ITEMS TO
    DETAILS FOR ORDERID=
    ITEMS->ORDERID
```

Notice how the *SELECT* statement differs from dBASE II's. You now specify the work area to select as a number from 1 to 10 or a letter A to J. Once you've opened a file in a work area, you can also specify its name on the *SELECT* statement rather than the work area ID.

The other thing to notice is how the new pointer notation (->) lets you refer to fields in other work areas. Reminds you of PL/I pointers, doesn't it? The same notation comes in handy for manipulating files linked by *SET RELATION TO*. For example, it's a cinch to relate several files and list selected information from each:

```
SELECT 3
USE CUSTOMER
SELECT ORDERS
SET RELATION TO
    CUSTID INTO CUSTOMER

SELECT ITEMS
SET RELATION TO
    ORDERID INTO ORDERS
LIST FIELDS AMT_PAID,
    CUSTOMER->CUST_NAME,
    ORDERS->ORDER_DATE
```

Deleting a relationship is just as easy: just *SELECT* the source file and say *SET RELATION TO* with no parameters. In dBASE III, breaking up isn't hard to do!

Command performance

Writing programs in dBASE III isn't hard to do, either, because it's an interpreter. Just type your program into a text file with a name of your choosing and the extension .PRG, then say *DO <NAME>* to run it. Try this simple example, which you should save as REPT.PRG:

```
PARAMETERS CH,N,STROUT
SET TALK OFF
DO WHILE N > 0
    STROUT = STROUT + CH
    N = N - 1
ENDDO
```

```
Data bases related on key fields

CUSTOMER.DBF                                    BBS.DBF
|         |                                     |     |
|CUSTID   Cust_name          Address       |    |BBSID    BBS_name    Phone   |
|========================================= |    |================================|
|0001     Fred Flintstone    Boulder, CO   |    |0001     Fun Spot    123-4567|
|0002     Nowhere Man        Nowhere Land  |    |0002     Techie      314-1592|
|                                          |    |0003     Nerdmicro   555-5555|
|                                          |    |                             |

ORDERS.DBF                                      ITEMS.DBF
|         |                                     |         |
|ORDERID  Custid   Order_date    Ship_date|     |ORDERID   FILEID    Amt_paid|
|=========================================|     |============================|
|0001     0001     12/18/84      12/19/84 |     |0001      0002      0.01    |
|0002     0002     12/20/84       1/03/85 |     |0001      0003      0.01    |
|0003     0002     12/23/84       1/03/85 |     |0002      0002      1.00    |
|0004     0001      1/02/85       1/03/85 |     |0003      0001      0.50    |
|                                         |     |0004      0001      0.00    |

Note:  Field names in ALL CAPS designate key fields.
```

Figure 2.

You've just added a new command to dBASE III that builds repeated character strings. For example, *DO REPT WITH* '-',5,X will add five dashes to a character variable *X*.

This little example shows off one of dBASE III's towering improvements over dBASE II: the ability to pass parameters to a command file. Banish forevermore the clumsy and error-prone method of passing arguments through global variables.

As if one towering improvement weren't enough, here's another: dBASE III has procedure libraries. This means you can put up to 32 commands into a single .PRG file. Surround each one with *PROCEDURE/RETURN* statements as follows and you're all set:

```
PROCEDURE FOO
     <statements>
RETURN
```

To use a procedure file, just *SET PROCEDURE TO <FILE NAME>* and *DO* the procedures like any other commands. You'll find that procedures run much faster than command files. You'll also find they have an undocumented and most welcome property—they're recursive. (Just be sure to declare any local variables as PRIVATE.) One of the programs we present later puts this discovery to excellent use.

Speaking of unexpected properties, try this experiment: write a procedure that takes two arguments and call it with a duplicated variable, as in *DO REPT WITH X,5,X*. dBASE III will complain "Variable not found." Not found? What do you mean not found? I passed it to you twice!

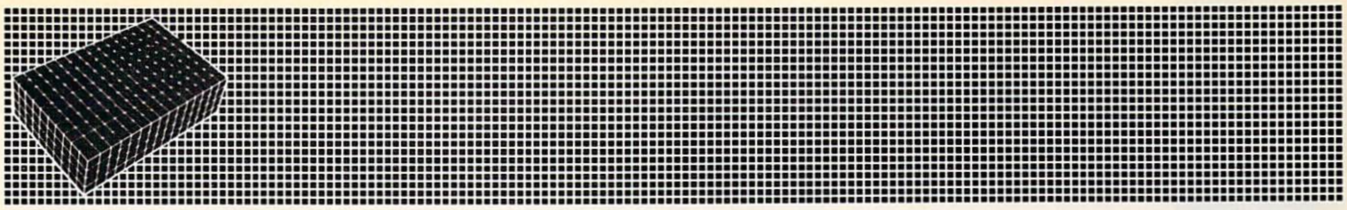
Diskette jockey

If you liked the idea of having a diskette directory like CATALOG.DBF, do I have a program for you (Listing 1). It's called

```
CATALOG.PRG -- Program to build catalog data bases

* Structures of data bases used by this program:
* CATSPEC: LINE - C 80
* CATWORK: NAME - C 9; EXT - C 4; SIZE - C 10; DATE, TIME - C 8.
* CATNEW:  Like CATWORK, but DATE is D and add VOL - C 11, PATH - C 29
*
parameters pathspec,catfile
close databases
select 1
use catspec
set talk off
set safety off
zap
*1: Call DOS to put the desired directory into file CATDIR.TXT
if file('catdir.txt')
  erase catdir.txt
endif
cmd = 'dir ' + pathspec + '>catdir.txt'
run &cmd
*2: Specified path bad if CATDIR.TXT not found or < 3 records long.
if file('catdir.txt')
  append from catdir.txt for recno() <= 3 sdf
  if recno() >= 3
    goto 2
*3: Path is OK, extract Volume and Path names from dir listing
    voln = upper(trim(substr(line,23,11)))
    goto 3
    pathn = upper(trim(substr(line,at('\',line),29)))
```

Listing 1 *(Continued on following page).*



CATALOG.DBF and I'll bet you can guess what it does.

Try *DO CATALOG WITH 'A:','MYCAT'*, then *USE MYCAT* and manipulate it with the data base statements we discussed earlier. You'll go where no directory has gone before.

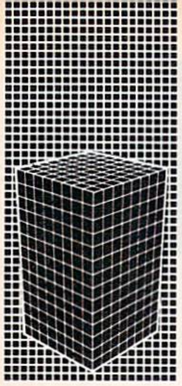
CATALOG.PRG shows off some of dBASE III's hottest new features. Foremost among these is *RUN*, which passes commands to PC-DOS. CATALOG.PRG uses this to list the desired directory into a file called DIR.TXT (see *1). The program then uses *APPEND FOR RECNO() < = 3* to read the first three records of DIR.TXT into a data base called CATSPEC (*2) from which the volume and path names are extracted for assignment to *VOLN* and *PATHN*.

Neat but that's just the beginning. CATALOG.PRG next uses another data base, CATTEMP, to pull in the whole DIR.TXT file (*4). Although most of this is the directory information we're looking for, a few records have other stuff and need to be discarded. What would be a chore in dBASE II is child's play in dBASE III, thanks to the new statement *SET FILTER TO*.

Remember *SET RELATION TO*, which dynamically joins records? Well *SET FILTER TO* dynamically selects them, based on a specified filter condition. Records not satisfying the condition become totally invisible to the accessing program. By saying *SET FILTER TO SIZE > 0*, CATALOG.PRG deftly banishes the unwanted records from the directory listing.

```
*4: Now prepare a temp data base and read the directory into it
    copy file catwork.dbf to cattemp.dbf
    use cattemp alias temp
    append from catdir.txt sdf
    set filter to size > 0
    select 2
*5: If the specified catalog doesn't exist, create it.
    if .not. file('&catfile..dbf')
      copy file catnew.dbf to &catfile..dbf
    endif
    use &catfile
    goto bottom
    select temp
    goto top
*6: Read cattemp into catalog, reformatting date & adding vol/path
    do while .not. eof()
      select &catfile
      append blank
      replace name with temp->name, ext with temp->ext,          ;
              size with temp->size, date with ctod(temp->date), ;
              time with substr(temp->time,3), vol with voln,    ;
              path with pathn
      select temp
      skip
    enddo
  endif
endif
close databases
erase catdir.txt
erase cattemp.dbf
set safety on
set talk on
```

Listing 1 *(Continued from preceding page).*



Macro economics

Have you noticed the strange *&CMD* and *&CATFILE* constructs below *1, *5, and *6 in Listing 1? You old-time dBASE II'ers should be smiling out of your seats by now, because here we talk not about magic but about wizardry.

About macros.

Alas, in this one area dBASE III grovels before its ancestor.

Mundanely speaking, a macro is a character variable prefaced by an ampersand, like *&CATFILE*. Seems harmless enough but so does a chain reaction at first glance.

What dBASE does with macros is deceptively simple. Before interpreting a command line, dBASE scans it for macros, replacing any it finds with their assigned string values. That's it. But suddenly the command line has changed.

dBASE II would repeat this process, looking for nested macros, scanning and substituting again and again until no more macros materialized. A chain reaction indeed. This process could turn lead into gold!

Not so with dBASE III. In the name of performance, it quits after one scan. Say good-bye to recursive macros. Still, even one-level macros have their uses.

For example, CATALOG.PRG uses the macro *&CATFILE* to reference the catalog name you pass as a parameter. If CATFILE equals 'MYCAT', *USE &CATFILE* becomes *USE MYCAT*. This is why the *USE* statement near *5 opens the file you specify rather than a file called CATFILE, as it would without the ampersand.

Macros also let you do math on character variables or change their type to numeric:

```
N = '1'
N = STR(&N+6)  (= '7')
N = &N         (= 7)
```

Macros can even turn memory variables into arrays, a data structure that dBASE III otherwise lacks. For example, create a set of variables *A_1*, *A_2*, *A_3*, and *I*. Assign *I* = '1' then *I* = '2' then *I* = '3'. For each value of *I* what is the meaning of *A_&I*? *A_1* and *A_2* and *A_3*.

Here are some more time-saving tricks you can play with macros:

```
*Show a centered string
&CENTER =
    '80 - LEN(TRIM(PROMPT))'
PROMPT = 'ANY STRING'
@24,&CENTER SAY PROMPT

*Abbreviate a command
&CMD = 'DIR *.PRG'
&CMD
```

Macros are also the source of a small mystery. The dBASE III manual makes an elaborate show of explaining how Ashton-Tate disabled the use of macros in the condition clause of *DO WHILE* statements in exchange for a 30% speedup. How odd. When I tried them, *DO WHILE* macros worked every which way. Maybe there really is magic here.

Screen gems

And now for our starring attraction, the program that pulls it all together: data base access, macros, recursive procedures, full screen I/O, even a guest appearance by an undocumented feature.

This program—a pair of procedures, really—is called MENUSYS.PRG (Listing 2). It implements a surprisingly compact yet fancy menu system. The menus it draws have a highlighted selection bar you can move up and down with F3/F4 or skip right to an item by typing its first character. Help text for the highlighted item is shown centered on line 25. To select an item hit Enter, and your wish becomes dBASE III's command.

You might like to try this out using the demo menus I uploaded to the *COMPUTER LANGUAGE* BBS. Just type *SET PROCEDURE TO MENUSYS* followed by *DO MENU WITH 'MENUDEMO'*.

A menu is a .DBF file having up to 23 records, one for each screen row. Each record in the menu file has three fields: the ITEM to display, the associated HELP text for line 25, and the COMMAND to execute when the item is selected.

COMMANDs can be anything dBASE III would understand at the dot prompt, except they mustn't contain macros. If you leave a COMMAND field blank, the associated ITEM will be treated as a title—the selection bar will automatically skip over it.

Can one menu call another? Of course—just use *DO MENU <NAME>* for the COMMAND. The menu system will call itself recursively, and when the recursive invocation returns, the original menu will be redisplayed. (Menus return when the user hits F2 or selects a menu ITEM whose COMMAND is *RETURN*.)

Like CATALOG.PRG, MENUSYS puts *SET FILTER* to good use (*0). It filters based on *TRIM(COMMAND) <> "*, which hides records with blank COMMAND fields. The result? We don't need special logic to make the record seeking commands *SKIP*, *LOCATE*, and *GOTO* bypass menu titles.

Macros are also put to good use, as you can see right below *5, where the COMMAND field is assigned to the variable *EXEC* for execution via *&EXEC*. (Sorry, field names can't themselves be macros.)

Now for that undocumented feature: the *WAIT TO* statement that inputs a keystroke to a character variable is capable of reading certain function keys, including backspace and F2 through F10. These keystrokes produce the respective character values CHR(127) and CHR(254) down to CHR(246). This is the secret behind MENU.PRG's testing for F3 and F4 at *3 and *4 in the listing.

Third base

Undoubtedly, many other features lie unknown in dBASE III, awaiting discovery. So too must many bugs. Like its predecessor, dBASE III may become known as much for its quirks and secret features as it will for its scope and programming power.

But scope and power it has. What we've seen here is only a slice through a structure of much broader dimensions. Although we can't be sure what dBASE III is destined to become known for, one thing seems certain: it is a base to build on.

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

```
MENUSYS.PRG -- Interactive menu system

procedure drawmenu
  use &menufile
  set talk off
  set exact on
  set filter to
  goto top
  clear
  do while .not. eof() .and. recno() <= 23
    @recno()-1,20 say trim(item)
    skip
  enddo
  set filter to trim(command) <> ''
return
*0
procedure menu
* Presents a menu from a specified menu file.  Menu files have
* structure ITEM (C 38), HELP (C 40), COMMAND (C 80).
  parameters menufile
  private first, last, exec, lastpos
  do drawmenu
*1: Determine screen rows of first and last selectable items
  goto bottom
  do while recno() > 23
    skip -1
  enddo
  last = recno()
  goto top
  first = recno()
  key = chr(255)
  do while key <> chr(254)
*2: Highlight the currently selected item and get next keystroke
    @recno()-1,20
    selectn = trim(item)
    set color to 7+
    @recno()-1,20 say selectn
    @24,0
    @24,(80-len(trim(help)))/2 say help
    set color to 7
    set console off
    wait to key
    set console on
    @recno()-1,20
    @recno()-1,20 say item
```

Listing 2 *(Continued on following page).*

```
    @24,0
    do case
      case key = chr(252)
*3: User hit F4.  Select next item.
        if recno() < last
          skip 1
          if recno() > last
            goto first
          endif
        else
          goto first
        endif
      case key = chr(253)
*4: User hit F3.  Select previous item.
        if recno() > first
          skip -1
          if recno() < first
            goto last
          endif
        else
          goto last
        endif
      case len(key) = 0
*5: User hit enter or other extended key.  Exec the COMMAND field.
        clear
        exec = command
        lastpos = recno()
        set exact off
        &exec
*6: We're back, now pause if not returning from another menu.
        if .not. upper(trim(substr(exec,1,8))) $ 'DO MENU HELPASSIST'
          ?
          wait to key
        endif
        do drawmenu
        goto lastpos
        key = ' '
      otherwise
*7: User hit some other key, skip to matching menu item, if any
        lastpos = recno()
        locate for substr(item,1,1) = key
        if eof()
          goto lastpos
        endif
    endcase
  enddo
*8: All done, restore settings and quit
  clear
  set exact off
  set talk on
return
```

Listing 2 *(Continued from preceding page).*

Extensibility in Forth

By Michael Ham

Forth is extensible—that is, programmers can easily add commands to the language. If the job at hand requires some basic tools that Forth lacks, the programmer creates them and they become part of the language, either permanently or for that application.

Programmers who do not use extensible languages may not realize the power that extensibility confers. This article shows an example of using Forth's extensibility to create new commands that make it possible to use bit arrays.

An array is a string of "boxes"—often bytes or cells—in which a program can store data. For an example of the use of an array, consider a mailing list on diskette where each record must contain the state of the mailing address. Since Forth can use a single byte to store numeric values up through 255, you can save room on the diskette by storing a numeric state code, from 00 through 50, in one byte instead of using the two-letter state abbreviation, which would require two bytes. But when the list is printed, the numeric code must be replaced by the abbreviation: IA, CA, etc.

An easy way to do the conversion is to include in the print program an array of two-byte cells, each cell containing one of the two-letter abbreviations for the 50 states or the District of Columbia. Suppose the array was initially defined by

```
CREATE STATES 102 ALLOT
```

When the word *STATES* is executed, it puts on the stack the address of the first cell of the array. Then by doubling the state code from the record (because each abbreviation occupies two bytes) and adding the result to the top of the stack, you can retrieve the state abbreviation.

For example, the following word, given the state code, will display the state abbreviation: *15 STATE* displays IA.

```
: STATE  ( n – ) 2* STATES + 2 TYPE ;
```

If you wanted to use the complete state name, the array would consist of larger entries, each 15 or so bytes long. It is much easier to retrieve data from an array when every element is the same length, even if you must pad short names with blanks so that they take the same number of bytes as the longer names.

If every entry is the same length, you merely multiply *i* by the length of an entry to go directly to the *i*th entry. But if the entries of an array vary in length, perhaps with the end of each entry marked by some special character, then to pick out the *i*th entry you must do one of two things. Either you have to read every entry until the *i*th one, counting your way through the array, or else you must maintain a collection of pointers, with the *i*th pointer containing the address of the beginning of the *i*th element of the array.

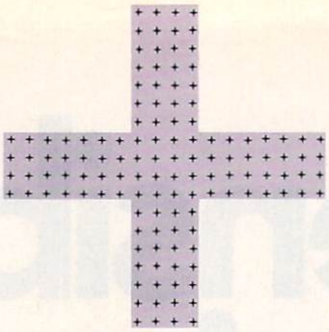
Note that the pointers are themselves kept in an array of their own, with each entry the same length, so that you can readily retrieve the *i*th pointer.

Two-dimensional arrays are also used. Two numbers—the row and the column—are used to locate an entry. Two-dimensional arrays require as many bytes as the product of the number of rows, the number of columns, and the number of bytes in each entry. This product tends to be large. Arrays of three and four dimensions take correspondingly more room.

Even one-dimensional arrays can take up a lot of room. Recently I wrote a program in which an array was used to show which of 160 possible characteristics an organization possessed. I could have used an array of 160 bytes in the organization record, with each byte either Y (if the organization had the characteristic) or N (if it did not). But the file consisted of 3,700 organizations; at 160 bytes each, these arrays would take 592,000 bytes, which exceeded the capacity of the diskette. The diskette had to hold not only the arrays, but also other data about the organizations and computer program.

The solution was to use an array of bits rather than bytes. Since each characteristic was either present or not, I could assign each characteristic a single bit position in the array. The bit was 1 if the organization possessed the characteristic, 0 if it did not.

Eight characteristics could then be recorded in a single byte, and an organization's entire list of 160 characteristics



would occupy only 20 bytes—or only 74,000 bytes for the entire file. The problem was that Forth has no commands to read or store individual bits. The solution? Add such commands to Forth for this application.

Logic operators

To create commands that make it easy to use a bit array, you use Forth's bit operators *AND*, *OR*, and *NOT* or *XOR*. In playing with these words to see how they work, it would be nice to have a command that displays the bit structure of the number on top of the stack. Forth doesn't have that command either, but the lack is readily remedied. The word *.B* will display the bit structure of the top of the stack:

```
: .B ( n -- n ) BASE @    2 BASE ! OVER
        BASE ! ;
```

BASE is a variable that holds the current base; executing *BASE* puts on the stack the address of the variable. @ (pronounced fetch) replaces the address on the stack with the contents of the address. *!* (pronounced store) takes what is second on the stack and puts it at the address that is on top of the stack. *OVER* puts on top of the stack a copy of what was second on the stack, and . (pronounced dot) takes the top of the stack and displays it on the screen as a numeral in the current base.

The original contents of *BASE* are then restored. The comment in parentheses shows that the effect of this word is to leave the stack undisturbed.

The binary (base 2) representation of a number shows its bit pattern, with 1 being a bit that's on and 0 a bit that's off. The high-order (leftmost) zeros are not displayed. Thus a byte with only bit 3 on would be displayed as decimal 8 or binary 1000. The three zeros to the right of this 1 represent bits 0, 1, and 2 (reading from right to left), and the high-order bits (bits 4, 5, 6, and 7) are not displayed since they are also zero.

Note that I number the bits with the low-order (rightmost or least-significant) bit in each byte being bit 0 and the high-order (leftmost or most-significant) bit being bit 7. This convention is common but by no means universal.

Experiment by entering numbers and using *.B* to see the resulting bit patterns. You will see that the number 0 consists of all bits off and −1 of all bits on (16 bits will be shown since each stack entry is a cell that is two bytes wide).

The effects of the bit operators, shown here as acting on bytes, is shown in Figure 1. The *NOT* operation shown is the Forth-83 Standard *NOT*. It can be simulated in earlier Forths by using the phrase *−1 XOR* or *NEGATE 1−*.

As you can see, *NOT* operates on only one operand (the top of the stack) and simply flips each bit: 0 becomes 1 and 1 becomes 0. *AND*, *OR*, and *XOR* do a position-by-position comparison of bits, and each bit of the result is determined by the corresponding two input bits:

- *AND*—result is 1 if and only if both input bits are 1
- *OR*—result is 1 if and only if at least one input bit is 1
- *XOR*—result is 1 if and only if exactly one input bit is 1.

These words are used to construct commands that can set and fetch individual bits. I also needed to be able to toggle a bit (turn it on if it was off or off if it was on) without having to know its initial state. This capability was needed so the user could indicate a given characteristic in the selection list and the program would turn it on if it were off (meaning the user was selecting that characteristic) or turn it off if it were on (meaning that the user had previously selected it and was now "un"selecting it).

Operands:	11011001 00111000	11011001 00111010	11011001 00111010	11011001
Operator:	AND	OR	XOR	NOT
Result:	00011000	11111011	11100011	00100110

Figure 1.

```
 ( Bit Operators                                      M Ham
14Jul84)
 FORTH-83    DECIMAL
 CREATE BITS  1 C, 2 C, 4 C, 8 C, 16 C, 32 C, 64 C, 128 C,

 : MASK  ( bit# - mask )  BITS +  C@ ;

 : +BIT  ( bit# adr - )  SWAP MASK OVER C@  OR SWAP C! ;

 : -BIT  ( bit# adr - )  SWAP MASK  NOT  OVER C@ AND SWAP C! ;

 : @BIT  ( bit# adr - ? )  C@ SWAP MASK AND ;

 : ~BIT  ( bit# adr - )  2DUP @BIT IF  -BIT  ELSE  +BIT THEN ;

 : ~BIT&FLAG  ( bit# adr - ? )  2DUP ~BIT @BIT ;

```

Figure 2.

The list of new commands is shown in Figure 2. These definitions take a total of 160 bytes of memory, using Laboratory Microsystems' PC/Forth version 3.0.

FORTH-83 will execute (but do nothing else) in systems that satisfy the 83 Standards. If *FORTH-83* fails to execute, then the Forth is not an 83 Standard Forth and the *NOT* in line 8 will probably have to be replaced by *−1 XOR*. The word *DECIMAL* executes to define the appropriate base for the numbers that are stored into the *BITS* array in the second line of the listing. The command *C,* puts into the Forth dictionary the byte that is on top of the stack.

MASK accepts a bit number and executes *BITS* to put on the stack the address of the first byte of the *BITS* array. The command *C@* (C fetch) then replaces the address with the byte's contents. Thus *MASK* accepts a bit number and puts on the stack a cell with all bits off except for a specified bit in the low-order byte. For example, *3 MASK* provides a byte with bit 3 as 1, all other bits as 0. (In this application I work with bytes rather than cells, which are two bytes wide.) Notice that *MASK* itself uses an array, in which each byte has a single bit turned on.

In operating on specified bits at specified addresses, I decided that it was most comfortable to present first the bit number and then the address of the byte, on the analogy of the way *!* works: it expects the value to be entered first and then the address, so the address is on top of the stack. Similarly, *+BIT* (turn bit on) expects bit number followed by address even though *+BIT* then swaps the two stack entries.

+BIT stores a 1 bit at a specified address. By using *MASK*, a byte is obtained with (only) the specified bit set to 1, and *OR* combines that byte with the byte brought from the specified address; this produces a byte with all bits left as they were except that the specified bit in the result must be a 1 (since the specified bit in the byte created by *MASK* is a 1). The resulting byte is then stored back at the address by *C!*.

−BIT (turn bit off) uses a similar procedure to store a 0 bit at a specified address. In this case, however, the bits in the byte provided by *MASK* are reversed by using *NOT* (or, if your Forth is not 83 Standard, by using instead the phrase *−1 XOR*).

The result is a byte that consists of all 1 bits except for the specified bit, which is 0. The effect of using *AND* to combine this resulting byte with the byte from the specified address is to leave all bits as they were except for the specified bit: the 0 bit forces the result of the *AND* to also have a zero bit in that location.

@BIT first uses *MASK* to get a byte with the bit of interest set to 1 and then uses *AND* to combine that byte with the byte fetched from the address. The resulting flag will be zero if the specified bit at the address is 0—otherwise the result will be nonzero (either 1, 2, 4, 8, 16, 32, 64, or 128, depending on which bit was specified). This nonzero value will function as a true flag in any of the logical tests, such as *IF*, since Forth treats zero flags as false and nonzero as true. The other bits in the specified byte have no effect on the result since they are wiped out by the 0 bits in the *MASK* byte.

~BIT (toggle bit) first uses *2DUP* to make a second copy of the bit number and address. It uses one copy to fetch the given bit and the other copy to store the result of the toggle. If the fetched bit was 1, *~BIT* stores 0 in its place, or if it was 0, stores 1 in its place. The effect is to toggle the bit. *~BIT&FLAG* does the same thing except that it leaves a flag (zero or nonzero) on the stack to show the result of the toggle.

These are the elemental commands that can be used to define a variety of array commands. I have made the elemental commands a permanent part of my Forth, but the words defined with them vary by application.

For example, suppose the array I mentioned was created with the name *TYPES*

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since each characteristic defines a type of organization. Then for a given characteristic you need to obtain the precise bit number and address in the array. Assuming the characteristics are identified by sequential numbers beginning with zero and the array is in memory, you can define the command *AIM*:

```
: AIM    ( c# -- bit# adr )   8  /MOD
    TYPES + ;
```

AIM uses */MOD* to divide the characteristic number by 8, so the quotient (on top of the stack) is the byte number within the array and the remainder (underneath) is the bit number within the byte. *TYPES* is executed, which puts on top of the stack the beginning of the array, and this is simply added to the quotient from the */MOD*.

The result is the address of the byte on top of the stack and the bit number directly beneath, which is exactly the configuration needed by my bit-manipulation commands. The stack diagram comment within the parentheses documents the behavior of the command.

Then, to fetch the flag for a given characteristic, simply put on the stack the number indicating which characteristic and execute *@TYPE* (fetch type), as defined below, and the result will be a flag (zero or nonzero—shown in the stack diagram as "?") that will indicate whether the particular characteristic is present (i.e., the bit is 1) or not. For example, to see if characteristic 37 is present, use the phrase *37 @TYPE* and the stack will be topped by a true or false flag that tells whether that bit is set or not.

```
: @TYPE ( c# -- ? ) AIM @BIT ;
```

To store a characteristic, on the other hand, you need only put the characteristic number on the stack and execute *+TYPE*, as defined below. If you wanted to set characteristic 113 on, then you would use the phrase *113 +TYPE*.

```
: +TYPE ( c# -- ) AIM +BIT ;
```

Other words can be similarly defined to turn off the bit for a given characteristic (*−TYPE*), toggle the bit for a given characteristic (*~TYPE*), and so on.

The preceding definitions assume that *TYPES* is an array in memory. What if you instead want to work with the array as stored in the individual organization records on diskette? That can easily be done by changing the definition for *AIM*.

Forth typically works with 1K blocks on the diskette, using the absolute block number to reference the block. A 320K diskette thus consists of 320 blocks.

Suppose each organization record is 64 bytes long and the records are sequentially stored beginning with organization number 0 at the start of block 165, with 16 organizations per block. Suppose further that the array begins in the 20th byte of each record. *AIM* would then be defined in this way:

```
: AIM ( c# org#—bit# adr ) 16 /MOD
    165 + BLOCK
    SWAP 64 * + 20 + SWAP 8
    /MOD ROT + ;
```

This version of *AIM* expects *two* numbers on the stack: the characteristic number and the organization number. The first phrase (*16 /MOD 165 + BLOCK*) divides the organization number by 16 to get the relative block number for the block this organization record is in and adds 165 to it (since the organization records begin in block 165) to get the absolute block number. *BLOCK* accepts a block number and leaves in its place the address of the beginning of the block. (*BLOCK* reads the diskette if necessary so the block is in memory and the address is simply a memory address.)

The second phrase swaps the block address and the remainder from the */MOD* division. This remainder tells us which record within the block is the record for this particular organization. We multiply that record number (within the block) by 64 (since there are 64 characters per record) and then add this product to the address of the beginning of the block to get the address of the first byte of the organization record. Then 20 is added to that sum to produce the address of the first byte of the array for the organization we are interested in.

The final phrase swaps this address and the characteristic number to put the latter on top of the stack and then calculates the byte offset into the array. The *ROT* puts the earlier address on the top of the stack so the offset can be added to it.

Exactly as in the earlier *AIM*, we are left with the byte address on top of the stack and the bit number beneath it. This definition may seem somewhat complex (though it is a pattern that quickly becomes familiar), but it allows us to treat arrays on the diskette exactly as if they were in memory. All the complexity is hidden within the new command *AIM*.

You now can define *@TYPE*, *+TYPE*, *−TYPE*, *+TYPE*, and so on, exactly as described, except for two minor changes.

First, the stack diagram comment in the definition (which shows what values the definition expects) should be changed to show two values instead of one on the input side: characteristic number and organization number.

Second, the words that alter the contents of the block, such as *+TYPE*, *−TYPE*, and *~TYPE*, must include the word *UPDATE* and the end of the definition, or they must be followed by *UPDATE* when they are executed. *UPDATE* flags the block as being updated, which ensures that the revised block will be written back to diskette.

With these exceptions the new definitions of these commands are word for word the same as the old ones because we hid in *AIM* all the work of setting up the array.

Of course, if you are working with arrays in memory as well as on diskette, you will want two sets of commands with different (though probably related) names—one set for each type of array. Or you can use the same names for both types of commands by using a Forth technique known as vectored execution.

In this technique you define two words—say *DISKETTE* and *MEMORY*—that control the array commands. *DISKETTE* will set the commands to work on diskette arrays, and they will be diskette commands until *MEMORY* is executed, whereupon they will revert to being memory array commands. But vectored execution is a topic for another article.

Bit arrays work well if each entry has only two values: on/off, yes/no, true/false, male/female, red/green, left/right, big/little, new/used, on hand/out of stock, and so on. If the range of values is greater than two but doesn't exceed four, you can use two bits to cover the range (00, 01, 10, and 11—decimal values 0, 1, 2, and 3) and thus use a single byte to hold four entries. Similarly, you can use four bits to cover a range of 16 or fewer values, packing two entries per byte.

The ease with which you can create high-level commands that permit individual bit manipulation is an illustration of the power of extensibility. A language is extensible if it is easy for the programmer to add commands to the language. Because most programming languages are not extensible, the criterion of extensibility is seldom included among the selection criteria for a programming language.

Forth's extensibility is especially powerful because the Forth compiler consists of commands that are a part of Forth (for example, the *:* and the *;* in the definitions above). This means that even new compiler commands can be created and added to the language so that the Forth compiler is itself extensible.

This example of bit-array commands illustrates why programmers who have used an extensible language value that extensibility so highly. Extensibility is a basic and essential characteristic for a language; every spoken language is extensible, and after using an extensible language, programmers want never to go back to more limited languages. ■

Michael Ham has worked in program and systems design, development, and documentation for many years. He currently is a free-lance programmer and technical writer/editor residing in Santa Cruz, Calif.

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A Structured FORTRAN

By David Salomon

Back in the early seventies, before FORTRAN 77 became established, there was considerable interest in redesigning and extending FORTRAN IV to reflect the ideas and principles of structured programming.

Most works in this area[1-6] approached the problem by including new keywords or symbols in their designs. In many of those cases the results bore very little resemblance to FORTRAN IV, 77, or any other version, and looked more like a new language. *Structured FORTRAN With No Preprocessor*,[7] though, was an example of a different approach.

The design presented there is novel and based on the following principles:

- The control structures commonly used by structured languages, such as *IF-THEN-ELSE*, *DO-WHILE*, *REPEAT-UNTIL*, and *CASE*, should be included
- No new keywords or symbols should be added to the original language
- The new, extended version should be compatible with FORTRAN IV in the sense that every valid statement in FORTRAN IV should be valid (and have the same meaning) in the new version.

To satisfy these principles, the proposed version assigns special meaning to:

- Certain combinations of existing keywords (like *IF . . . DO* or *IF . . . CONTINUE* in the same statement)
- The keyword *CONTINUE* (in some cases)
- Statement indentation (in one case).

Several control structures are proposed: the *IF-THEN-ELSE*, *REPEAT-UNTIL*, *WHILE-DO*, and *CASE* constructs.

IF-THEN-ELSE

Two forms, long and short, are proposed (Figure 1). When analyzing this figure, several points need to be considered.

The short form is the case where only the *THEN* part exists and contains a single statement. The short form is therefore identical to the *IF* statement in FORTRAN IV.

The word *CONTINUE* precedes the *ELSE* clause. The *CONTINUE* should only appear if there is an *ELSE* clause and, to avoid any dangling *ELSE*s, should be aligned with the corresponding *IF*. This statement is the only case in the design where statement indentation is syntactically significant.

All the statements in the *THEN* clause should have the same indentation as well as all the statements in the *ELSE* clause. The two parts, however, need not have the same indentation.

Both *THEN* and *ELSE* clauses may have nested *IF*s. Any of the *ELSE*s may be omitted (with their corresponding *CONTINUE*s) without any ambiguity. Figure 2

```
Long form                   Short form

IF(condition)               IF(condition) statement

      statement

         .

         .

      statement

CONTINUE

      statement

         .

         .

      statement
```

Figure 1.

shows a typical nested *IF*, and Figure 3 is a quadratic equation subroutine with a nested *IF*.

REPEAT-UNTIL
The *REPEAT-UNTIL* construct also has two forms, as follows:

```
      DO n

      statement(s)

n     IF(condition)CONTINUE
```

This form repeats while the condition is true, at least once.

```
      DO n

      statement(s)

n     IF(.NOT.(condition))CONTINUE
```

This form repeats until the condition becomes true—again, at least once.

```
IF(condition)
        __________
        __________
        __________
     IF(condition)
           __________
           __________
           __________
     CONTINUE
           __________
           __________
           __________
CONTINUE
        __________
        __________
        __________
```

Figure 2.

```
SUBROUTINE QUAD(A,B,C,H1,H2,MODE)
DISC=B*B-4*A*C
IF(DISC.GT.0)
     MODE=1
     D=SQRT(DISC)
     H1=(-B+D)/(2*A)
     H2=(-B-D)/(2*A)
CONTINUE
     IF(DISC.EQ.0)
          MODE=2
          H1=-B/(2*A)
          H2=H1
     CONTINUE
          MODE=3
RETURN
END
```

Figure 3.

```
      Long form                          Short form

      GO TO Var n                        GO TO Var n
           const1[,const2]...                 const1[,const2]...statement
                statement                     const3[,const4]...statement
                .                             .
                statement                n    const5[,const6]...statement
           const3[,const4]...
                .
                statement
                .
           const5[,const6]...
                statement
                .
n               statement
```

Figure 4.

WHILE-DO

The *WHILE-DO* construct is:

```
      IF(condition) DO n
            .
            .
      statement(s)
            .
n     statement
```

The range of statements is executed while the condition is true. As in any *WHILE-DO*, the range of statements will be skipped if the condition is initially false. This construct uses no special indentation and the only problem may be a long condition that separates the *IF* from the *DO* and makes it hard to recognize the construct as a *WHILE-DO*. This, however, can be solved by writing the *DO* directly under the *IF* on a continuation line.

CASE

The *CASE* construct has two forms, long and short (Figure 4). In this figure, notice how:

- Brackets denote an option and ellipses (. . .), a repetition. Each case must therefore include at least one constant and could optionally have more.
- The *CASE* variable can be of any type. The constants must be of the same type.
- No special indentation is used. The end of every group of statements (except the last) is specified by a new line containing constant(s). Constants are easily identified in FORTRAN—they start with a digit, a sign, a quote, a period, or the letter O (for the octal constants, but then they must be longer than the longest variable name to remove any ambiguity)— so they cannot be confused with the beginning of a statement.
- The short form is used when a group contains a single statement. The two forms can be mixed (Figure 5).
- The *CASE* construct is terminated with a statement number and not with a *CONTINUE* since the special use of *CONTINUE* should be limited.
- This construct presents a certain difficulty to the compiler. When the compiler reads the first line, e.g., *GO TO COLOR 4*, it does not know whether the line is the beginning of a *CASE* statement or is an assigned *GO TO*. To decide, the compiler has to read the next line. If the

```
          GO TO OPRTR 1000
                'PLUS'  X=X+Y
                'MINUS' X=X-Y
                '*'     X=X*Y
                'ABS'   IF(X.LT.0)X=-X
                'AND','OR','NOT'
                      PRINT 15
      15              FORMAT('LOGICAL OP')
    1000              CALL LOGOP(OPRTR,X,Y)
```

Figure 5.

```
      ASSIGN 2000 TO COLOR 4
         _____
      COLOR = 'BLUE'
         _____
      GO TO COLOR 4  an assigned go to (GO TO 2000) because
      IF...          this line starts with a non-constant.
         _____
      GO TO COLOR 4       a case statement since
          'BLUE' Y=1      this line starts with a constant.
          'RED'  Y=2
    4     'GREY' Y=3
```

Figure 6.

```
         FUNCTION SQRT(X)
         DATA EPS/E-6/
         X1=1.
         DO 10      a repeat-until construct
         X0=X1
         X1=.5*(X0+X/X0)
      10 IF(.NOT.(ABS(X1-X0).LE.EPS))CONTINUE
         SQRT=X0
         RETURN
         END
```

Figure 7.

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CIRCLE 3 ON READER SERVICE CARD

```
      SUBROUTINE BINSRC(AR,N,X,MID)
      DIMENSION AR(N)
      INTEGER HIGH
      LOW=1
      HIGH=N
      DO 35                         repeat-until
      MID=(LOW+HIGH)/2
      IF(AR(MID).LT.X)              if
           LOW=MID+1                then
      CONTINUE                      else
           IF(AR(MID).GT.X)         nested if
                HIGH=MID-1
           CONTINUE
                RETURN
   35 IF(.NOT.(LOW.GT.HIGH))CONTINUE
           MID=-1
           RETURN
           END
```

Figure 8.

```
      LOGICAL FUNCTION VALDAT(MONTH,DAY,YR,DWEEK)
      LOGICAL LEAP
      INTEGER DAY,YR,DWEEK,CENT,DAWEEK
      IF(YR/100*100.EQ.YR)
           LEAP=.FALSE.
           IF(YR/400*400.EQ.YR)LEAP=.TRUE.
      CONTINUE
           LEAP=.FALSE.
           IF(YR/4*4.EQ.YR)LEAP=.TRUE.
      GO TO MONTH 100               case
           'JAN','MAR','MAY','JUL','AUG','OCT','DEC'
                MAXDAY=31
           'FEB'
                IF(LEAP)
                     MAXDAY=29
                CONTINUE
  100                MAXDAY=28
      CENT=YR/100
      YR=YR-100*CENT
      DAWEEK=INT(2.6*MONTH-0.2)+DAY+YR+YR/4+CENT/4-2*CENT
      DAWEEK=MOD(DAWEEK,7)
      IF(DAY.GE.1.AND.DAY.LE.MAXDAY.AND.DWEEK.EQ.DAWEEK)
           VALDAT=.TRUE.
      CONTINUE
           VALDAT=.FALSE.
      RETURN
      END
```

Figure 9.

next line starts with a constant, the construct is a *CASE*. Otherwise it is an assigned *GO TO*. Figure 6 is an example of this situation.

This difficulty is general to FORTRAN and is not introduced by the new design. It arises because of two syntax rules in FORTRAN. One rule says that keywords are not reserved (thus *IF* and *DO* may be variable names), and the other says blank spaces do not count (except inside a string) and may appear even in a variable name (thus *COLOR4* and *COLOR 4* are the same name).

These rules make it hard for any FORTRAN compiler to identify statements. A statement such as *GO TO GO TO* is valid if *GOTO* (or *GO TO*) is an assigned variable. The statement *IF(IF)* . . . is valid if *IF* is a logical variable. When the compiler reads *DO 10 I = 1* . . . it has to read beyond the 1 in order to identify the statement. It could be a *DO* statement (if the 1 is followed by a comma) or an assignment statement (if the 1 is the start of an expression).

Figure 5 is an example of the *CASE* construct with short and long groups.

The proposed extension

Figures 7, 8, and 9 are examples of a square-root function, a binary search subroutine, and a date validation function. They all contain the proposed control structures, and it is clear that they look familiar. They in fact look like FORTRAN IV.

A quick look at these short examples is enough to convince anyone that they are in fact written in FORTRAN. The question of clarity and readability still exists, though.

The proposed version does not use any new keywords and the special use of indentations or *CONTINUE* is limited. It could be argued that writing *CONTINUE* instead of *ELSE* does not contribute to clarity and is not really an advantage. It should be noticed, however, that the way *CONTINUE* is used in FORTRAN IV (as a loop terminator) does not suggest continuation either. A word like *RESUME* (or *REPEAT*) would have been a better choice for a loop terminator. The fact that FORTRAN users quickly get used to the meaning of *CONTINUE* suggests that they might quickly get used to its new meaning as well.

The use of indentations in the *IF-THEN-ELSE* construct implies that indentations cannot be used to add clarity to an *IF*. This is a disadvantage of the proposed design, especially for long *IF*s. In practical cases, however, long *IF*s usually contain nested *IF*s that will be indented (because of our syntax rules), thereby making the entire *IF* easier to read.

The next natural step in the extension of FORTRAN should be the introduction of block structures with local and global variables. Three possibilities seem promising and should be explored:

■ Extending the compound statements proposed by L.P. Meissner[3] to become blocks with declarations.

■ Defining blocks as sections of code that start with declaration(s) and end with an END. This seems to conform nicely to the other extensions proposed here and seems worth experimenting with.

■ Defining a block to be a subprogram (a subroutine or a function). This means that *internal* subprograms will have to be defined, which goes against the grain of FORTRAN IV, but at least can be done without adding new keywords. ■

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Note: All items appeared in SIGPLAN Notices.

David Salomon has a Ph.D. in physics from Hebrew Univ. in Israel. He has taught for the past 12 years—first at the State Univ. of New York, Buffalo, N.Y., and now at the State Univ. of California, Northridge, Calif. He is interested in computer algorithms and graphics.

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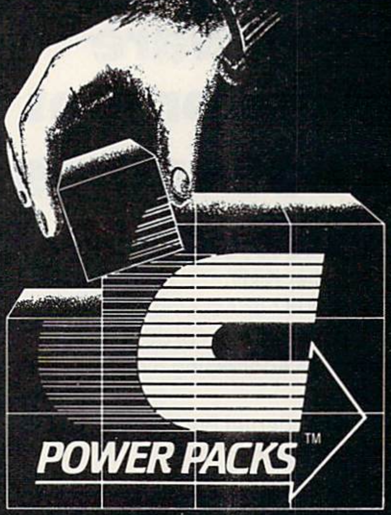

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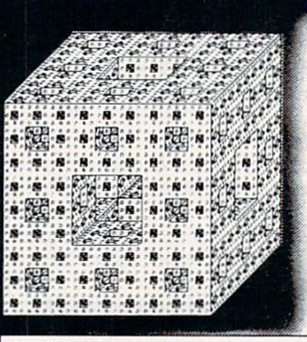

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CIRCLE 60 ON READER SERVICE CARD

Program in Style

By William E. Weinman

We often see particular programming techniques emphasized in the literature. Some have been given names, such as structured programming, egoless programming, top-down design, and stepwise refinement. Each of these disciplines has its merits and will be described and even encouraged in this article.

But never let it be said that the practice of any set of specific rules can give your code performance, readability and maintainability unless the purpose of the act of coding, as well as the purpose of the code itself, is kept in the forefront of your mind as it is being written.

The objective of this article is to help us all keep in mind the purpose of our programming efforts from conception through design and execution to completion and delivery of the final product.

For example, let's say that we're writing a set of routines to allow a computer operator to manage a table of data. The operator needs to insert entries into the table, delete them, edit them, move them, etc.

We could start with a general concept and refine it in logical steps, then code it piece-by-piece—top down so to speak—and avoid *GOTO*s by using plenty of modern control structures in their stead (*WHILE*, *FOR*, etc.). Using this approach we would efficiently generate some good-looking and readable code.

Right? Don't be too quick to agree. I've seen plenty of programming efforts fall by the wayside for reasons completely unrelated to those addressed by these techniques.

In this example our purpose was stated as being the management of a specific set of data. The data was of a dynamic nature—having the need for adding to the set, deleting from the set, editing it, etc.—and our coded system was to be used by an operator as opposed to a programmer. This problem is data-related and user interface-related. So, before considering the structure of the code, we would need to design the data base schema and user interface.

This is not in any way meant to imply that coding technique is unimportant. However, the intent here is not to build technicians but to build, with a measure of rationality and coherence, the foundation for good, efficient programmers. This will allow us to concentrate more on the creative aspects of our trade.

First let's analyze each of the previously mentioned programming techniques in some detail. Then, based on their similarities, we can draw some interesting conclusions that give us the benefits of all of the techniques without a lot of confinements that could constrict our creativity.

Structured programming

I put this one first because the term has been so abused over the last 10 years or so that the controversial nature of the title has overshadowed the tremendous effect that the techniques described by it has had on our profession.

The term structured programming was made controversial by a book published in 1972 by the same name.[1] Essentially the technique promotes the modularity of code to the end that each distinct functionality has its own section (or structure) that it operates within.

The advantage of this is that the code becomes maintainable. In other words, when you need to make a change, fix a bug, or add a feature to code that is written in this fashion, it is much easier to isolate the particular section of code that needs attention.

What are the structures to which the name refers? Disagreement on this point is prevalent but, being brave by nature, I'll venture a set of definitions.

Consider the previous example of the set of programs for managing a table of data. For argument's sake, let's say that this system could be written in two ways:

- It could all be written in-line or as a long list of instructions with conditional branches (the abominable *GOTO*) for the various different functions that need to be executed or

■ According to the discipline of structured programming, it could be written with different sections, or structures, for each major function and, in turn, each minor function could be implemented in a separate "workhorse" function, each of which could accommodate more than one of the major functions.

A structured language such as Pascal, ALGOL, Ada, or C is not required to have structured code but it does help. These languages were designed with facilities that not only accommodate good program structure but actually encourage it. They do not guarantee structured code, however. It is not significantly easier to write structured Pascal than it is to write structured BASIC or FORTRAN. It takes mental discipline.

Let's consider an example.

I will present it in Pascal for two reasons. First, I dislike the fact that so many have embraced Pascal as the best thing to happen to programming since M&Ms with peanuts. At best it is a good language for teaching beginners and quickly weaning them from. (I might as well come out and say it—I don't really like Pascal.) The second reason is that people seem to think that all they need to write good code is a Pascal compiler. We'll see why this is a misconception.

In Listing 1 we have a program that compiles without error and executes properly, effecting the function its designer intended. Is it immediately obvious, however, what it is that it was designed to do?

Perhaps it is more obvious in Listing 2. In this example, I have used a control structure to replace the label, the *goto*, and the initialization and incrementing of the index variable. Additionally I've indented the code according to a convention that is consistent, used spaces to clearly delineate operators, and utilized a comment to indicate the location of the main procedure which is by necessity detached from its declaration in Pascal.[2]

Most compilers will generate essentially the same object code for both examples, but which would you rather maintain?

Technically speaking, most of these improvements are not part of what was originally termed structured programming, but they have become part of its scope over the years and therefore are included here.

To summarize, structured programming is the use of structures, control structures, and modularized functionality to improve the performance and readability of computer program code.

Egoless programming
This is a term that makes reference to the tendency of most of us to promote the misconception that programming (and especially good programming) requires a level of mental agility that can only be claimed by a select few.

This elitist attitude has an undesirable side effect, however. It encourages us to write code in a vacuum. In other words, many of us have a bent toward writing code that is so clever and cryptic that others will look at it and say, "Wow! What does THAT do?" and be impressed with our cleverness. However, more often than not, if we strive to write code that is so simple that anyone can read it, the code will be easier and more economical to maintain (and usually more efficient!).[3]

It is suggested that we take several steps to avail ourselves of the help of other programmers. One way is to have someone read the section of code in question, making suggestions where he or she sees the need. Another way would be the telephone test—read the code over the telephone to someone and see if the person can understand what it is supposed to do. If it can not be understood, chances are that it can usually be improved to become clearer.

Many of us have the tendency to think egotistically, "This code is so good that it can't be improved anyway," so this technique has been dubbed egoless programming. However, in the interest of maintaining the dignity of this valuable source of constructive criticism, I would prefer to euphemize the title. Any suggestions?

Top-down/stepwise design
Top-down design and stepwise refinement really refer to the same technique of programming from the top down or as a series of step-by-step refinements. In other words, design the highest level of the program first, leaving the details for

```
program example1 (output);

var i : integer;

label 7;

procedure something; begin  writeln('Something'); end;

begin i:=0;
7:  something;
i:=i+1; if i<10 then goto 7;
end.
```

Listing 1.

later. Then design the next level, still leaving the details for later . . . until they have all been attended to.

For example, for the Pascal program in Listings 1 and 2, we could first pseudocode the problem as:

```
do something ten times
```

and further refine it to:

```
for i := 1 to 10 do
    something;
```

then write the procedure for something. But of course this is too simple an example for a technique that is obviously meant for more sizable problems. Let's start designing the data management system instead:

```
              —MAIN—
display a menu
select one of the following from the
        menu
        insert item
        delete item
        move item
        edit item
        browse through items
        squirziklize items
```

Then we can write each of the individual functions using the same technique:

```
              —INSERT—
display form for data
get data from operator
while data still needs editing
        allow operator to edit data
if data is ok
        ask for correct position in table
        insert in table
```

This really serves two excellent purposes. First, of course, it forces the programmer to fully conceptualize each detail of the code before writing it, thus producing far more functional code on the first few passes (sometimes even the first pass!). Second, it provides us with an excellent start for the dreaded documentation effort.

What they have in common

What do these three programming disciplines have in common? Their objective. They are all intended for the programmer who feels a need to write immortal code, code that will be used and modified by others over a period of time somewhat longer than a few days or weeks.

Structured programming encourages modularity of code so that the author and those reading the code later will be able to discern easily the purpose of the various logical sections of code.

The so-called *egoless programming* technique encourages us to share our code with others for our mutual education. Working together will make all of our code more readable, maintainable, and functional.

The *top-down design* and *stepwise refinement* techniques implore us to carefully consider the design of our programs before setting any of it to code. This would have the effect of adding coherence to our finished products and forcing us to pay attention to details that might otherwise be missed.

Why write code for the future? I hope you can understand why without having an experience like one I once had. I was contracted to debug over 5,000 lines of Pascal that bore a significant resemblance to those in Listing 1 but were longer. The programmer that wrote the code appeared to be of the opinion that if it worked (sort of), then it was OK.

I can't complain though; I learned how to *not* write programs.

References

1. Dahl, O.J., Dijkstra, E.W., and Hoare, C.A.R. *Structured Programming*. Academic Press, 1972.
2. Kernighan, Brian. *Why Pascal is Not My Favorite Programming Language.* Bell Laboratories Computing Science Technical Report No. 100, 1981.
3. Kernighan, Brian, and Plauger, P.J. *The Elements of Programming Style.* McGraw-Hill, Second Ed., 1978.

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```
program example2 (output);

var
    i : integer;

procedure something;
begin
    writeln('Something');
end;

begin { main procedure }
    for i := 1 to 10 do
        something;
end.
```

Listing 2.

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PUBLIC DOMAIN SOFTWARE REVIEW

By Tim Parker

A few years ago (in this galaxy), a machine was developed that revolutionized the home microcomputer field. This machine had the somewhat unlikely name of Apple. It succeeded Commodore's PET, which had a toy-like keyboard, a somewhat limited screen, and hardly any expansion possibilities.

While the PET was usually regarded as a fun machine, the Apple actually had a function. The Apple, as we all know, caught on rather well. When the next improvement came along in the form of the Apple II, true home computing reached new limits.

The Apple set the market standard for an amazing number of years. The number of home computerists who developed programs to enhance the machine and the enthusiastic support of third-party hardware support made it "the" machine to own for nearly a decade—a remarkable feat in this highly competitive world.

While the Apple has had its day in th~ sun and now has been generally dismissed as a viable programmer's microcomputer, lots of them are still out there. They are still being bought in one reincarnation or another and hang on as tenaciously as a mosquito enjoying a bit of skin (which may not be the ideal simile, but you get the idea).

So a rather awkward situation can arise when someone such as your narrator has finished describing the wonderful things that can be done with a CompuPro 8/16 with an 8087 coprocessor and how it compares with the 68000 running at 10MHz and asks the question "what machine(s) do you have?" Instead of a similar description of a home brewed 286/287 board, the person will proudly say, "an Apple IIe with CP/M!"

At its peak, my Apple public domain collection numbered almost 300 disks, all crammed with a bewildering variety of material available. There was (and still is) a plethora of companies and software distribution centers that catered entirely to Apple public domain material. Some specialize in their topics—for example, one company handled only scientific and engineering software.

A complete list of programs available takes several books; you can see this by wandering into any local computer bookstore. Also, the Apple is used by a large percentage of *COMPUTER LANGUAGE* readers, so we hereby dedicate this section of the column to the world of the Apple.

One source of Apple programs is The Public Domain Exchange (address, as usual, at the end of the column). They have compiled a catalog of several hundred disks broken down by topic and each checked for content.

As Apples became the machine in use in most educational institutions (thanks in part to Apple's policy to donate machinery), the amount of education-oriented material rose phenomenally. For instance, the Public Domain Exchange lists 24 Apple dissemination disks contributed by the San Mateo, Calif., County Office of Education and Computer-Using Educators. These disks are aimed at secondary and elementary school levels and have both integer and floating point routines.

Most disks have game-like approaches to teaching. Concepts are introduced by use of text or high-resolution graphics. Most programs require input from the user and provide a dialog.

The disks have the usual assortment of hangman and similar games of interest to youngsters and some nicely executed high school physics programs such as Millikan's Oil Drop and Simple Harmonic Motion. However, these are probably not of too great an interest to *COMPUTER LANGUAGE* readers.

Neither will be the games, of which there are lots, including the typical assortments as well as the still growing Eamon Adventure series. (For those who liked Adventure from Crowther & Woods, this set goes further.) Apparently the number of available adventures exceeds 100 now, but I haven't got the time to play that many.

So the relevant material arises at last. Twenty-nine disks are devoted to Pascal and are packed with utilities for writing Pascal programs and manipulating the Apple. Most of the disks are full, with programs available in source code format. The disks, unfortunately, are rather randomly assembled, so any disk examined will have an assortment of applications, games and utilities. This may be preferable for some people, but theme disks have proven their value in almost all public domain distributions and would be a nice touch here.

Apple CP/M is supported by eight disks, again of a general variety. The ubiquitous MODEM7 version abounds on a number of the disks in various reincarnations as do adaptations of most standard CP/M utilities. These include the squeezer/unsqueezer, cyclic redundancy check (CRC), disk utility (DUU), NCAT-XCAT cataloging program, disassembler (REZILOG and RESOURCE), and yet more games.

Utilities for DOS cover 16 disks and include copy routines by the dozen, sorts, debuggers, disk examination routines, catalogers, system tests and diagnostics, printer drivers, graphic aids, and so on. A couple of disks cover the HELLO program in all its glory and have menu drivers as well.

On the practical side, several disks of mathematical and statistical routines are available. Several curve fitting programs are presented, with various approaches to the least-squares fitting of straight line, logarithmic, exponential, and curve data with a best fit. Simple calculus (definite integrals) is handled by a number of programs, as is matrix manipulation. As expected, routines such as matrix complement take quite a while, as do some of the statistical analyses. Fourier transforms, Poisson distributions, chi square, and the other standard stats functions work well in most cases, although some tend to hiccup at times, losing the programmed data.

Eight disks in the catalog are business and finance applications and include amortization, finance routines such as present and future values, inventory management, and loan calculations.

Finally, a number of disks are devoted to graphics, sound and (gads!) "passion (sex)." No comment on the latter. (Maybe it's time to dust off the old Apple, though . . .)

The Public Domain Exchange charges a very reasonable $5.00 a disk, plus $4.00 more for shipping and handling. Turnaround on orders is usually fast, and so far I've heard no complaints about their service.

The Apple blazed its own path. Now we'll consider the IBM PC, a machine that had a path blazed for it by a company name. Two months ago I discussed some of the software available for the PC and its clones from the PC-SIG organization. Since then I have talked to the people who run the group and have been very impressed with their support and attention.

PC-SIG vol. 194 has the ROFF text formatter that is becoming the rage these days. ROFF got quite a boost from an article in one of the recently demised magazines. Vol. 194 is an update of the earlier PC-SIG vol. 50, and the C source code is supplied. Also on the same disk is a program called FOGFIND, which "determines the clarity of text." I haven't tried that one, but it sounds very much like a typical grammar checker except for the fact that it is free.

To round out vol. 194 is an integration routine written in a pair of languages: C and Pascal. A comparison provides an interesting look at the programmer's approaches to the two languages and their suitability for the task. Without starting a big debate, it is probably obvious which code is more efficient. Support and example files for the integrators are provided in both languages.

DVED, a screen editor on PC-SIG vol. 191 has been adapted for use with a mouse. Also on the volume are a few graphics utilities for most routine graphic applications, all written in BASIC. One program, EASEL, allows good graphics manipulation through a light pen and a color display.

A BASIC preprocessor called RASCAL is on PC-SIG vol. 162. It works equally well on MBASIC. A number of utilities are on the disk for BASIC programmers. The same disk has a screen-oriented text editor called RED with documentation, but I didn't check this one.

An IBM macro assembler tutorial is on PC-SIG vol. 166. More than adequate documentation is contained in five files and two disassemblers, with documentation. These should be in every assembler programmer's library, as they work well.

Finally, in the mathematics and statistics department again, PC-SIG vol. 180 features several dozen programs. They all are driven by a master menu that calls the programs by the rather cryptic names of S# or M# where # varies from 1 to 26. Completely in BASIC, they are not as fast as they would be if assembled, but they work very well on tested data.

Stats programs include binomial, Poisson, chi square, F, and normal distributions, with geometric, linear, multiple linear, exponential, and Nth order regression. Integration, matrix manipulation, roots, conversions, and simultaneous equations are a few of the mathematics routines. None have a great impact; they could be programmed by a reasonably competent programmer. However, having them all available on one menu is a nice alternative to hours at the keyboard.

After the Apple and the IBM, we're left with machines that don't have quite the elegant history these two have or the mystique that surrounds them. In my opinion, the more mundane machines are much more interesting.

In the next few months we'll return to an old favorite, CP/M, and check its latest polish from Richard Conn—ZCPR3. Also, UNIX users (Xenix, etc.) can start gearing up for an all too brief look at the public domain world accessible to them.

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. The Public Domain Exchange is at 673 Hermitage La., San Jose, Calif. 95134, (408) 942-0309. ■

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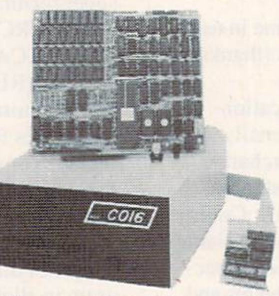

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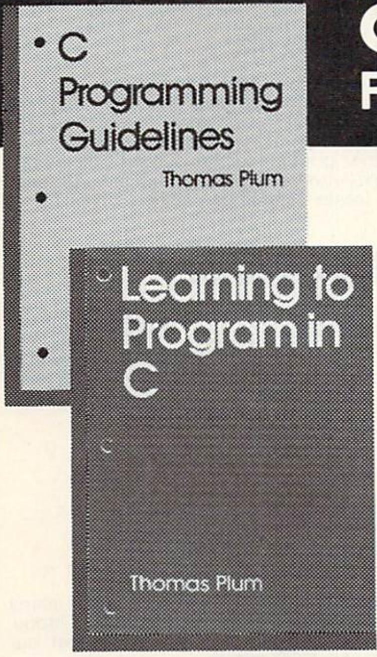

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EXOTIC LANGUAGE OF THE MONTH CLUB

Transaction Application Language

By Serg Koren and Pierre Provencher

A relatively recent advance in computer systems has been the development of fault-tolerant computers. One such system is the TANDEM machine—a multiprocessor, multiuser transaction-oriented minicomputer, which the manufacturer claims experiences minimal downtime. To take advantage of the NON-STOP (TANDEM trademark) capabilities of the system, TANDEM developed and implemented a high-level, block-structured language known as TAL (Transaction Application Language).

TAL is used by TANDEM to develop all of its system software and by programmers to write applications where performance is a consideration or where system-level access is needed. TAL is proof that communication and system module applications do not need to be developed at the machine-code level. This article will touch briefly on TAL's main points.

TAL has many similarities to Pascal and ALGOL. It has procedures, subprocedures, and functions and is strongly-typed— although not as strongly as Pascal. TAL also has a standard I/O and function library as well as the ability to access the bit level.

TAL comments are delimited by !. Like Pascal, TAL permits local and global variables and has the same *BEGIN END* structure. A TAL identifier is up to 31 characters long and starts with a letter. The ^ is considered a letter permitting readable identifiers:

```
int line^buffer^of^terminal[0:39];
```

TAL's assignment operator is := and = represents a logical test. Assignment can be used after a variable declaration, making initialization easy. (Strangely, literals use = for assignment). Using apostrophes around the assignment statement transforms assignment into a move of multiple elements. Assignment can also be chained.

```
array1':=' array2 for 4;
a:=b:=c:=d;
```

One of the unique features of the language allows the user to interface non-standard hardware or to temporarily override the original sysgen configuration of a piece of hardware.

TAL is compiled in one pass and generates true TANDEM machine code (a custom processor board, not a CPU). The language allows calls to COBOL, FORTRAN, and library routines. In addition, TAL routines are callable by both COBOL and FORTRAN.

Procedures (known as PROCs) in TAL have their own local data area and can be called recursively. Like most other procedure-oriented languages, TAL's PROCs can pass or receive parameters. Parameters can be passed as a reference or a value although arrays are always passed by reference. A procedure or a function can also be passed as a parameter. A typical PROC shell is presented in Listing 1, with a typical call being,

```
CALL Sampleproc(A,B);
```

In addition, PROCs can return a value which makes the PROC equivalent to functions in other languages. To do this the procedure is given a type, and a *RETURN* statement is included in the body of the procedure which will return a value of that type. The procedure in Listing 2 can be called with

```
Result := Typedproc;
```

Procedures may also be assigned attributes. For example, the attribute RESIDENT indicates that the portion of code for this procedure should not be swapped out of memory. The procedure where execution begins is known as the main PROC

```
PROC Sampleproc(Param1,Param2);

    INT Param1,
        Param2;
BEGIN

    INT Localvariable1,
        Localvariable2;

       <code here>

END;       ! end of proc
```

Listing 1.

```
INT PROC Typedproc;          !without parameters
BEGIN
     <code>
     RETURN Intvalue;        !where Intvalue is global here
     <more code>
     RETURN Intvalue;        !you can have more than 1 RETURN
END;
```

Listing 2.

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and is designated by the attribute *MAIN* following the PROC name:

```
PROC Starthere MAIN;
```

In addition to one procedure calling another, TAL allows PROCs to contain and call SUBPROCs. Just as with PROCs, SUBPROCs can pass parameters and be typed. Similarly, SUBPROCs have their own local data space and attributes.

TAL has the standard loop constructs found in other languages: the *FOR*, *DO UNTIL*, and *WHILE DO*. The *FOR* loop can be ascending (*TO*) or descending (*DOWNTO*). A primitive *CASE* is also provided. The *CASE* statement works with an index variable that starts at zero. *OTHERWISE* can be used to assure that a value greater than the last case index specified will have predictable results.

```
CASE indexvariable of
    begin
    a:=a+1; !indexvariable = 0
    b:=b+1; !indexvariable = 1
    otherwise c:=c+1;
                    !indexvariable > 1
    end;
```

Although it is confusing and not structured, TAL allows the use of *DEFINE*. The *DEFINE* assigns a portion of program source text to an identifier.

```
DEFINE total= count:=count+1 #;
    . . . . .
    if new^customer then total;
```

One unique feature of the TAL *IF* statement is that it can be used in an assignment statement:

```
Result := IF Thisistrue THEN 3 ELSE 0;
```

which will assign a value of 3 if the variable *Thisistrue* is logically true. If *Thisistrue* is logically false, a value of 0 will be assigned. As long as an expression can be evaluated as logically true or false, it can be imbedded within an *IF*.

```
IF (X := Y - Z) THEN CALL Myproc;
```

will evaluate the expression within parentheses. If the resultant value of X is greater than zero then the expression is true and the *CALL* will be executed.

TAL handles six data types, single-word (16 bit), double-word, strings (8-bit bytes), fixed point (64 bit), and reals (64 or 32 bit). Individual data types can be converted to any other through built-in type transfer functions. Data declaration can be specified as direct or indirect addressing (Listing 3). A TANDEM word is 16 bits.

A dot before an identifier indicates standard indirect addressing. Indirect addressing was introduced because of a

TANDEM restriction on memory addressing by a program. Without using extended addressing, 64K work is available for the data area of a TAL program. Only the first 32K is byte addressable. Standard indirect addressing provides access to the 64K while extended addressing (increasing the address to 32 bits from 16 bits) permits the user to define a larger memory segment.

For extended addressing it is the programmer's responsibility to manage memory through *ALLOCATESEGMENT* and *DEALLOCATESEGMENT* calls. The individual address of a variable can be accessed by prefixing the @ operator to the identifier.

Any data variable (except literals) can be specified as a one-dimensional array by specifying bounds. Multiple dimensional arrays are not permitted. Any variable can be indexed as an array. A pointer is an indirect addressing variable with no dimension. The compiler does not build run-time boundary checks even if bounds are specified.

```
int .pointer; !is a standard pointer
int .ext top; !is an extended
              !address pointer
```

Variables and arrays can be defined as read only and then are coded in-line instead of in the data area.

```
string
  .three^letters[0:2] = 'P' := [''abc''];
```

TAL also allows the user to perform block moves of data through the use of the move statement. For example, consider the code segment presented in Listing 4.

This example is a bit strange but none the less sometimes useful. Again, you can only move data of the same type although, as in the last example, the system does not check variable bounds.

Numerous data conversion functions are available to transform one data type to another. The built-in function *CODE* enables entry of machine assembler in the program and can be useful to write such things as a trap handling routine.

After an I/O or a GUARDIAN call, the condition code of the operation can easily be checked using an *IF* statement with no test variable.

```
if < then call error;
!the condition code is less than 0
```

Bit manipulations can only be done on integers and are useful for bit maps, etc. The examples presented in Listing 5 show the major statement types. TANDEM numbers the bits from the high-order bit (bit 0 is the high-order bit). A test on bit

```
literal
    true = 1,                              !definition of
    false = 0;                             ! constants
int
    counter:=0,                            !direct integer
   .array^of^ten^elements[0:9];            !indirect array
int(32)
    dblword;                               !double integer
string
   .a^to^c:=["abc"];                       !string declaration
```

Listing 3.

```
INT A,
    C;
STRING B[0:3];  !a 4 byte string array

C := 1;
B ':=' "TEST";  !would "move" the 4 bytes into the array
A ':=' C FOR 2; !would "move" the 2 words starting at variable
                !C into the memory starting at variable A.
                !A would then have the value 1 and C would have
                !the value of "TE".
```

Listing 4.

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15 is an easy way to determine if the value is even or odd.

```
word1.<8:9>:=word2.<10:11>;
if word.<15> then ...
```

TAL allows the software developer to use address pointers to either byte or word data as the following shows:

```
INT .Indirectvariable[0:5];
              !six word array
STRING .Stringpointer :=
      @Indirectvariable '<<' 1;
```

The @ indicates "address of" and '<<' 1 does a logical left bit shift of 1 bit. This effectively multiplies the integer address by 2 in order to get the address of the string. This is one way of dealing with integers as if they were strings. The statement

```
Stringpointer[1] := "A";
```

would set the rightmost byte of the first word of *Indirectvariable* to the letter A.

Since TAL is used to write all of TANDEM's compilers and interpreters, a string search facility is provided in the form of a *SCAN* statement. *SCAN* tests a string of any length until either a target character or an ASCII null is encountered. The address of the target character is returned as a result of the *SCAN*. Whereas *SCAN* searches strings from left to right, a similar command, *RSCAN*, does so from right to left. The form of the syntax for *SCAN* is:

```
SCAN <string array> WHILE (or
    UNTIL) <target character> ->
    <next address>
```

In all TAL has 19 different types of statements, none of these dealing with I/O. All I/O is handled through a standard library of PROCs. A typical I/O statement is *READ*, and appears as a *CALL* in the body of a user PROC. For example:

```
CALL READ(filenum,filebuf,
    readcount,countread);
```

is typical. Filenum is the file to be read, filebuf is an integer array into which data is to be read, readcount is the number of bytes to read, and countread is returned by the *READ PROC* and indicates the actual number of bytes read. All other I/O is handled similarly.

TAL also allows the user to code applications that communicate with each other by means of inter-process messages. Library routines are provided to handle these. *AWAITIO* is a PROC that either awaits an I/O completion, specifies a time-out period for an I/O, or checks for a completion of an I/O. This PROC is used to code applications where processing need not wait for I/Os, where I/Os must be funneled, where I/O timing is critical, etc.

Library routines are provided for creation, deletion, and system management

```
A.<1> := 1;  ! set bit one of variable A
A := A.<3:6>;! set the value of A to the value of bits 3 thru 6
             ! bit extraction
IF A.<4> THEN RETURN; ! bit test
```

Listing 5.

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of other processes, files, etc. If additional efficiency or capability is necessary, TAL allows for actual TANDEM assembly code to reside within TAL PROCs. Device control is another major TANDEM function—everything from laboratory equipment to automatic tellers in banking (a common application).

SETMODE is the TAL library PROC that allows the user to temporarily override the device characteristics originally specified during sysgen. This procedure allows the user to code an application such that any device used by the application becomes virtually port-independent.

For example, if a data communications line is normally sysgened as being 9600 baud with 7 data bits, an application could alter this to 300 baud with 8 data bits for special communications needs. *SETMODE* can handle printers, terminals, communications lines, etc. and lets the user alter a wide range of characteristics.

Tal becomes a really powerful tool when associated with the GUARDIAN operating system. File access, process control and checkpointing are not defined in the language itself, but the calls needed are sourced in the TAL program. This gives serious advantages: only the needed procedures are sourced in by the programmer, the guardian routines are not reserved TAL identifiers, and the program stays structured since those calls are treated as procedures.

As is the case with most languages, TAL is still evolving to accommodate new uses, hardware, etc. Although TAL is usable only on TANDEMs, it is a highly structured and powerful language with a wide following. Part of the strength of TAL lies in the simplicity of its statement types and part in the wide range of standard library procedures provided. ■

Serg Koren is a professional programmer with Smith-Kline Clinical Laboratories and has been using TAL for six years.

Pierre Provencher graduated with a degree in computer science from the Univ. of Montreal, Que. He has been consulting for online full tolerance systems for five years.

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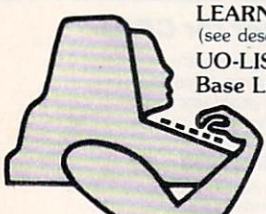

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BetterBASIC is a serious attempt to make a structured language out of BASIC. Some unusual control structures have been added, and the result is a language that feels like a cross between BASIC and Pascal with some of the strengths and weaknesses of each.

Overall, BetterBASIC is fast, modular, extensible, and flexible. It is also somewhat nonstandard in its syntax, more complicated to configure, requires much more memory than the standard Microsoft BASIC supplied with the IBM PC, and has less explanatory error messages.

Whether BetterBASIC is a language suited for program development depends very much on the job you want to do. For many if not most business applications BetterBASIC certainly merits a close look.

I was supplied with BetterBASIC version 1.0, which contained 16 files. Instead of CONSOLE.IBM, mentioned in the documentation, the review distribution had module WINDOWS.IBM. (CONSOLE.IBM allows use of the keyboard edit keys, COLOR, LOCATE, and CLS functions.)

The manual (on page 16—not on the page showing the configuration files) states that the WINDOWS module is a replacement for the CONSOLE module. It would have been nice to be able to use the CONSOLE.IBM module to see what the differences were.

BetterBASIC can be run without WINDOWS; however, the lack of this module prevents you from running the demonstration programs. If I tried to run them, I was told that the demonstration programs weren't programs, not that I lacked a required module. This error message is not only misleading—it's downright wrong.

I can't know how big the CONSOLE.IBM file was, but if it were much larger than about 10K, it wouldn't have fit on the single-sided DOS 1.1 distribution disk. Since the graphics module takes about 10K, it's possible that the CONSOLE.IBM module would have fit. Unfortunately, the graphics module requires the color graphics monitor; I don't have one and neither do most business users. Therefore the GRAPHICS module wasn't tested.

Once you've configured BetterBASIC for your computer, all that's necessary in order to run BetterBASIC is to type the single letter B and a return. BetterBASIC will load, read the B.CNF file, and load the modules you specified.

Loading BetterBASIC takes about 10 sec from a floppy disk— slower than IBM's BASIC but understandably so. There is a lot more to load.

Summit isn't kidding about BetterBASIC needing 192K of memory. If you have a 128K machine, you're going to have only about 15K of memory available even if you just use the mandatory modules and the FILE.DOS module. Since most machines are now being sold with 256K of memory, most users should have few problems.

The configuration file can contain, in addition to the list of modules you want, commands to set the status line on or off (requires CONSOLE.IBM to work so I couldn't test this); default numeric precision (4 to 24 digits, default is 8); stack size needed (default is 640 bytes); and the amount of memory to reserve for other purposes (default is 0).

The last command illustrates an important difference between BetterBASIC and IBM BASIC—BetterBASIC can use all available memory. Because of BetterBASIC's modular design and because BetterBASIC encourages modular programming, this added memory can be very useful in constructing programming applications.

Each module and subprogram, as well as each array used, cannot be larger than 64K bytes though. I suspect that restriction is imposed by the 8088/8086 chip for which BetterBASIC was written. That's too bad, but it's hardly Summit's fault. If anything, it's another argument against using chips that force segmented architecture.

The stack size may be increased if you're planning on doing much recursion. That's right: BetterBASIC supports recursion. Things keep looking better and better!

BetterBASIC will recognize and correctly execute nearly all of IBM BASIC's commands and statements. In addition, BetterBASIC has some useful new commands like *UPPER$* and *LOWER$* (convert a string to upper or lower case), *SPAN* (counts the number of characters in a string contained in the character set defined by another string), *WOR* (selects a 16-bit word at a memory location), *OFFSET* (returns the offset address of a given datum), and *SEG* (returns the segment address of a given datum). BetterBASIC also adds shift and pointer operators to BASIC.

BetterBASIC adds still more commands and functions, some of which I'll refer to in the course of this review.

Some of IBM BASIC's commands are not supported. *FRE(X)*, which returns the amount of available memory, has no equivalent in BetterBASIC. Nor is there any way to obtain the amount of memory available while running BetterBASIC. The manual suggests that *SIZE* is equivalent—it isn't. *SIZE* returns the space used by a variable, not the amount of memory available.

ERL isn't supported. *LINE INPUT* can't include a prompt. *TRON* and *TROFF* aren't supported. *WHILE . . . WEND* are replaced by *DO . . . REPEAT* or *DO . . . END DO*. Of these, the missing *TRON, TROFF,* and *ERL* are perhaps the most

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serious; their absence will make programming more difficult. I strongly recommend that Summit include these commands in future releases of BetterBASIC.

The random file I/O commands are also different. BetterBASIC has no *FIELD* statement and no *CVI, CVS, CVD, MKI$, MKS$*, or *MKD$* functions. Here is a very important area where BetterBASIC shows quite intelligent design. Other language developers should profit from Summit's example.

Instead of using *FIELD* to allocate space in a file's I/O buffer, BetterBASIC uses a named structure to hold an accumulation of data. The design of the structure is similar to Pascal and C. An example given in the BetterBASIC manual will prove instructive:

```
STRUCTURE: Man
INTEGER: Age, Height, Weight,
    EmpNumber
REAL: Salary, SocSecNumber
STRING: FirstName, MiddleName,
    LastName
END STRUCTURE
```

Following this definition, you can declare variables of type Man named *Fred, Oscar*, and *Joe* and a 10-item array of records of structure Man:

```
Man: Fred, Oscar, Joe
Man ARRAY(10):People
```

A request to print Fred.Age will print the age field from the Man-type variable *Fred* in the array *People*. To write *Fred*'s record to a suitably-sized file at record Recnum, you could use the statement:

```
WRITE RECORD #1 Recnum Fred
```

An analogous *READ RECORD* command can be used to retrieve a record from a file into a variable in a named structure.

The only shortcoming I can see to this approach is that BetterBASIC's strings are limited to 16 bytes in length unless otherwise declared (declared strings can be up to 32K bytes in length). Certainly, the record approach to file I/O is more intuitive and more easily understood than the somewhat clumsy *FIELD* statement used in IBM's BASIC.

On the other hand, IBM could improve its approach substantially by allowing a *FIELD* statement to spread out over more than one line. Perhaps something like this would be appropriate:

```
FIELD #1, 2 AS AGE$, 2 AS HEIGHT$,
    2 AS WEIGHT$, 2 AS
    EMPNUMBER$
4 AS SALARY$, 4 AS
    SOCSECNUMBER$
25 AS FIRSTNAME$,25 AS
    MIDDLENAME$,25 AS
    LASTNAME$
FIELD END
```

Even if IBM's BASIC were to be modified in such as fashion, the result would not be as easy to use and understand as BetterBASIC's approach. Plus BetterBASIC's approach to reading and using string data (in or out of a record structure) permits the programmer to actually treat any string as though it were input data. This approach has another important strength which can only be compared in flexibility to C's formatted input operation.

BetterBASIC sure seemed a lot faster than IBM BASIC in operation. To see just how fast BetterBASIC was, I wrote some small benchmark programs. Except where noted, the IBM BASIC versions of the programs are identical to the line-numbered part of the BetterBASIC version. BetterBASIC supplied the indentation—a nice touch. The programs were typed in without any attention to formatting and without the un-numbered lines.

Test 1 is a simple empty loop. In BetterBASIC, here's the listing:

```
SOURCE
PROCS=0
INTEGER: I%
      5 PRINT TIME$
      10 FOR I%=1 TO 10000
      20 NEXT
      30 PRINT TIME$
ENDFILE
```

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This first test ran in 5.2 sec under IBM BASIC and in 2.0 sec under BetterBASIC. A second test added a little more complication:

```
SOURCE
PROCS=0
INTEGER: I%,J%
    10 PRINT TIME$
    20 FOR I%=1 TO 10000
    25    J%=J%+1
    30 NEXT
    40 PRINT TIME$
ENDFILE
```

This test revealed an interesting difference between BetterBASIC and other versions of BASIC: BetterBASIC doesn't zero variables between runs. If you don't set the variable *J%* to zero between runs, eventually you'll get an overflow error in line 25. I don't know if this should be classified as a bug since a documented *CLEAR* function will zero all variables, but the difference should have been more clearly pointed out in the BetterBASIC manual.

Test 2 ran in 23.0 sec under IBM BASIC and 5.8 sec under BetterBASIC.

Test 3 added still more complications:

```
SOURCE
PROCS=0
INTEGER: I%,J%
    10 PRINT TIME$
    20 J%=0
    30 FOR I%=1 TO 10000
    40    J%=J%+1
    50    J%=J%*2
    60    J%=J%/2
    70    J%=J%-1
    80 NEXT
    90 PRINT TIME$
ENDFILE
```

BetterBASIC ran this in 19.0 sec. IBM BASIC took 100.6 sec, an advantage of over 5:1 for BetterBASIC. This series of tests completed my test of integer operations and simple looping for BetterBASIC.

The next series of tests covered real arithmetic operations. I immediately ran into a snag in BetterBASIC, something I can only ascribe to a Pascal-originated deficiency. Suppose you type in the immediate-mode statement:

```
INT 11/43
```

In IBM PC BASIC, you'll get the result .255814. In BetterBASIC, you'll get 0. However, if you use the statement:

```
PRINT 11/43.0
```

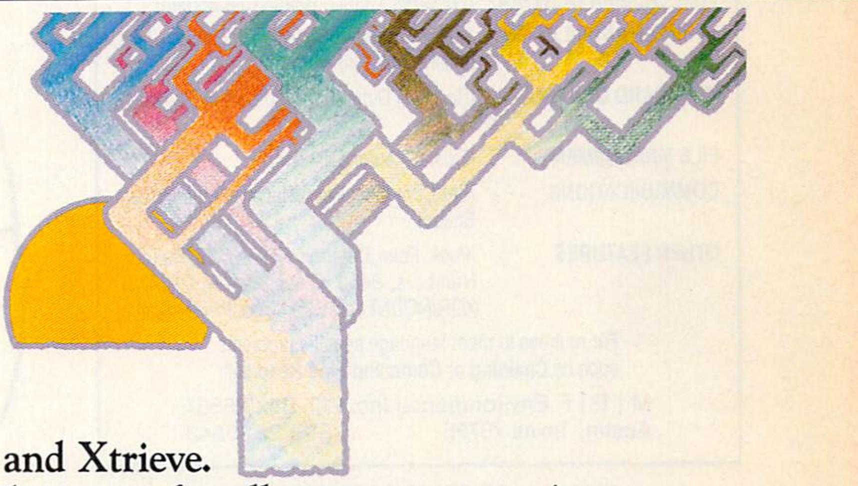
you'll get the correct result. This is contrary to all the rules I learned in every other version of BASIC I've used (over a dozen) and comparable in silliness only to Pascal. Pascal is famous for requiring added verbosity; part of BASIC's appeal

Benchmark speed comparison table

Test no.	IBM BASIC (interpreter)	BetterBASIC	IBM BASIC (compiled)
1	5.2	2.0	0.2
2	23.0	5.8	0.4
3	100.6	19.0	7.2
4	109.0	31.6	12.2
5	8.4	12.2/31.0[1]	2.2/6.8[1]
Average times	49.24	14.12	4.44

1. The result following the / is test 5 done with 16-digit precision.

Table 1.



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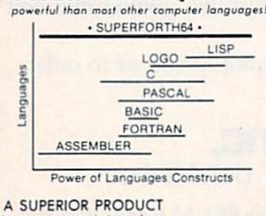

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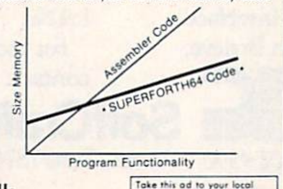

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is its lack of strong typing for variables and constants. BetterBASIC has a *PRECISION* statement that allows the user to specify the default precision for arithmetic operations, and I expected that command to allow me to get the correct answer. It didn't. I had to supply the decimal point and the zero to get a real result.

This is unfortunate, but perhaps this is as good a place as any for a digression on programming using BetterBASIC.

The BetterBASIC manual abounds with program examples. In fact, the manual is excellent. The index could be a little more complete, but the 400+ pages of documentation supplied are clear, concise, and well-organized. I've read and written more pages of documentation than I care to think about. The BetterBASIC manual is among the very best language manuals I've seen.

Every single function, procedure, or command is documented and easily located in the manual. If it requires a particular module or modules for execution, the module or modules are listed. The purpose of each function, command, or statement is listed, so is its FORMAT (syntax), a list of possible arguments, at least one example of use, and some valuable comments about any differences from the IBM BASIC equivalent.

As an example, I just flipped the manual open to page 131. On that page was a description of the *DATA* procedure. Now, *DATA* is very simple, but BetterBASIC has implemented the *DATA* procedure so that not only integer, real, or string constants can be data. Integer, string, or real variables can also be data items! This allows run-time computed values to be included in the list of constants in a *DATA* statement. The BetterBASIC manual modestly notes that this capability can "greatly simplify many programming situations."

This is one example of many I could make. The point, here, is that the documentation is complete.

The difficulty in using BetterBASIC lies not in the manual and not in the documentation of each of the functions and statements. Rather, it lies in which functions and statements are included in the language. Here we get into difficulties in basic philosophy and orientation. What should BASIC be?

Should BASIC be a rationalized Pascal? A simplified C? Or should BASIC be just a better BASIC?

Again, let's take an example program from page 55 of the BetterBASIC manual. The procedure given is called *BELL*.

```
INTEGER N
PROCEDURE:Bell
INT ARG Count/OPT=N
10 DO Count TIMES
20    PRINT CHR$(7);
30    DO 1000:REPEAT 'Time delay
40 REPEAT
```

This example is for a procedure that can be called from another BASIC program. To invoke it, just include a line like this in the calling program:

```
100 Bell(X)
```

where *X* is the number of times you want the bell to be sounded. This is too verbose and too much like Pascal for my taste.

BetterBASIC uses the concept of a workspace rather than a single program. All the programs and procedures you need can be kept in the workspace at one time and be invoked by using their names. This approach is much like APL's workspace.

Let's go on to the next series of tests: real and string-handling benchmarks.

Test 4 was a test of the BASIC string operation *MID$*. Since BetterBASIC uses a fixed location for each string and the size of the string must be pre-allocated if longer than 16 bytes, I expected BetterBASIC to be quite a bit faster than IBM

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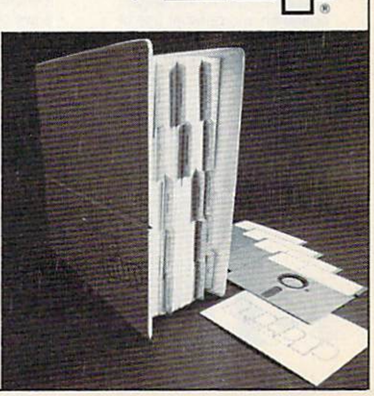

CIRCLE 39 ON READER SERVICE CARD

BASIC. I was not surprised. Here's test 4:

```
SOURCE
PROCS=0
STRING: TEST$[255]
INTEGER: I%,J%
   10 PRINT TIME$
   20 TEST$=STRING$(255,65)
   30 FOR I%=1 TO 100
   40    FOR J%=1 TO 255
   50       MID$(TEST$,J%,1)
              =CHR$(66)
   60    NEXT
   70 NEXT
   80 PRINT TIME$
ENDFILE
```

BetterBASIC ran this test in 31.6 sec; IBM BASIC took 109.0.

The next test pitted the two BASICs in real arithmetic. For compatibility, BetterBASIC's precision was set at 6 digits. The program:

```
SOURCE
PROCS=0
INTEGER: I%
REAL: J
      10 PRINT TIME$
      20 FOR I%=1 TO 100
      30    J=1
      40    J=J*1.5/6.3+2.411-7.38
      50    J=SIN(J)+COS(J)+TAN(J)
              +LOG(ABS(J))
      60 NEXT
      70 PRINT TIME$
ENDFILE
```

BetterBASIC ran this test in 12.2 sec compared with IBM BASIC's 8.4 sec. That's the first test where IBM BASIC was faster than BetterBASIC. However, BetterBASIC was able to run this test in 31 sec with precision set at 16; the IBM BASIC interpreter can't return results from transcendental functions like *SIN* accurate to more than 6 digits. BetterBASIC's precision can be set as high as 24 (BCD) digits.

Further notes about BetterBASIC: the BetterBASIC interpreter catches errors as they are entered. If you make a syntax error while entering a line, the error is flagged for you as soon as you depress the return key. This is very nice and a feature I wish IBM BASIC had.

One the other hand, you can't break a running BetterBASIC program. The CTRL-BREAK pair is ignored, as is CTRL-C. That's not so nice and is much like the operation of the IBM BASIC compiler.

For comparison purposes, I compiled the test programs with the IBM BASIC compiler, release 1.00 (Table 1).

Over the five benchmarks, BetterBASIC seems to be nearly four times as fast as IBM BASIC, but the IBM BASIC compiler is over three times (on some tests as much as 14) as fast as BetterBASIC. If speed is your prime concern, the IBM BASIC compiler should fill the bill better than BetterBASIC. Of course, BetterBASIC has advantages over the IBM BASIC interpreter and compiler other than those a sheer speed comparison would imply:

- ■ The syntax checking on entry is a nice feature, especially for beginning BASIC programmers
- ■ An excellent manual
- ■ Being able to use all available memory
- ■ The modularity of BASIC, its procedural orientation, and the modularity of the code you can write
- ■ A speed advantage over the IBM BASIC interpreter
- ■ The excellent record I/O facility
- ■ BCD arithmetic and high accuracy (up to 24 digits)
- ■ Added control and loop structures
- ■ Recursion is explicitly supported.

Disadvantages of BetterBASIC can also be summarized:

- ■ As an extra-cost optional BASIC, the IBM BASIC compiler has higher compatibility with standard IBM BASIC and greater speed than BetterBASIC
- ■ IBM BASIC loads itself and loads programs faster than BetterBASIC
- ■ BetterBASIC wants stronger typing of variables
- ■ The nonbreakable programs are unfriendly to beginners
- ■ The default string length of 16 bytes is too small
- ■ The verbose and Pascal-derived nature of the newer commands
- ■ The greater memory requirements

(Continued on next page)

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CIRCLE 5 ON READER SERVICE CARD

FORTRAN vs. FORTRAN 8x

(Continued from page 21)

although there are those who believe that FORTRAN is and should remain an assembler, and that most language enhancements should be via one of many preprocessors.

Martin: I don't think the experienced programmer will be hampered. Experienced FORTRAN programmers at my laboratory have invented all sorts of ingenious schemes involving macros, preprocessors, and subprogram libraries to achieve many of the capabilities that the proposed standard will provide. The problem with ingenious schemes is that each project has invented its own, and this hampers portability of programmers among the projects.

There seems to be some feeling that the X3J3 is perhaps a bit biased in favor of the academic community. What is the nature of X3J3?

Matheny: Biased? We have perhaps 40 strong-minded people on X3J3. And each of us has his or her own point view. Any bias of X3J3 is toward the large-scale, scientific user.

Martin: At the present time, X3J3 has 37 members that can be categorized as follows:

Hardware vendors	19
Software vendors	3
Users	9
Academics	5
Other	1

I would like to see a better ratio of users to hardware vendors on the committee. Certainly all major vendors should be represented but it is the users who should have the larger voice.

Meissner: X3J3 is an ANSI committee, and has to follow certain rules. For example, whenever anybody writes them a letter, it has to be answered. With FORTRAN 77, 2,400 questions were received and had to be answered. Of course, you could group those questions together; there is an awful lot of duplication among the questions.

In order to get a proposal through X3J3, you have to really become part of it. You have to get close enough to find

BetterBASIC

(Continued from previous page)

- Errors are reported by number; there are few explanatory error messages and at least some of them are misleading
- Variables aren't cleared between successive runs of a program
- There's no *ERL, TRON,* and *TROFF* functions for debugging programs.

BetterBASIC is an interesting attempt at creating a new version of BASIC. It is strong in a few areas and weak in a few others but overall appears to be a language that should entice Pascal programmers to return to BASIC. It should also appeal to BASIC programmers looking for an easy way to develop modular programs, business programmers requiring modular construction and BCD arithmetic, and all programmers desiring a more natural and efficient way of handling file I/O.

BetterBASIC is faster for most operations than the IBM BASIC interpreter, and its use of all available memory and support of program modularity ought to facilitate the construction and development of larger applications.

This language is well worth a look. I strongly recommend you investigate the package if any of the listed strengths appeal to you. Despite my stated misgivings about particular parts of BetterBASIC, this is definitely a good implementation of the BASIC language.

By Bruce W. Tonkin

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out what has gone before. There could be five years of minutes, including abbreviated discussions on all these topics. A lot, of course, goes on in hallways outside regular meetings. The question is why was it done this way or that way? What were the reasons or were there any reasons? It's very hard to keep track of what's happening when you're watching from the outside.

The best way to get a change in something you hear about is to go through someone on the committee who knows what has been going on. Or go to the meetings and take the opportunity to buttonhole people in the corridor and ask, "Hey, why has this feature been done that way? Is there support to do it that way? Is it a dead issue?" The committee is political as well as technical.

Martin: The committee seems to change by two members every other meeting, and that can mean two more people who have to get up to speed in what has gone before.

Before joining the committee, I would never have thought that language design could be successfully conducted by a committee. I have since changed my mind. The members and consultants have widely diverse backgrounds. This ensures that any accepted change of direction or any new feature that gets enough support to be adopted will meet the needs of many application areas and many user communities, not just one.

Any feature that is accepted gets a trial by fire. All the arguments, pro and con, are aired. It is a very democratic process. Unfortunately, it takes a lot of time. Design by committee is certainly not the most efficient method but it is thorough and painstaking. In the end I think it produces a superior product. The resulting language is not exactly what any one person on the committee would have wanted but it is acceptable to the majority or it would not be proposed as a standard.

Adams: This year, X3J3 is holding forums in most sections of the country to explain the design of the language and the new features. During the sessions, these issues are discussed. Before we release the standard, we hope to have spoken with and heard from the FORTRAN user community. Depending on the response, the list of changes will undoubtedly be modified.

FORTRAN is undergoing a major revision of a kind not attempted before. Whether it succeeds or fails, the results should prove quite interesting. Even if you are not a FORTRAN user, the results of this effort can be invaluable, if not instructive. Consider that every language in use, both formal and natural, requires some sort of standardization. And consider that there are standards committees for many programming languages extant.

If you are a FORTRAN user, you will undoubtedly be affected by the proposed changes. Your input to the committee can influence the direction that FORTRAN will take in the future, whether toward a system level or problem level orientation.

If you wish to keep current with the activities of the X3J3 committee or if you wish to make your comments known, you can write to: Dr. Loren Meissner, editor, ACM SIGPLAN FORTRAN Newsletter, Univ. of San Francisco, Ignatius Heights, San Francisco, Calif., 94117-1080. Letters may be published in the newsletter and will be passed on to X3J3.

If you wish to become a member of X3J3, you can contact Jeanne Martin, L-300, Lawrence Livermore National Laboratories, Livermore, Calif. 94550.

If you wish to make comments on the proposal, contact Andrew Johnson, MS 10C17-3, Prime Computer Inc., 500 Old Connecticut Path, Framingham, Mass., 01701.

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"Despite the recent press notices, multiuser microcomputers aren't anything new!"

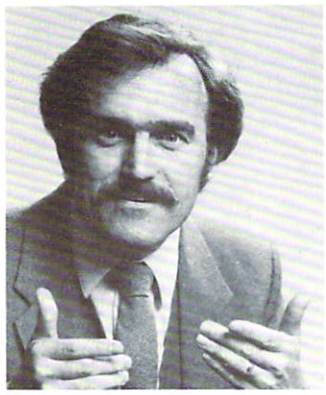
This is the first in a series of discussions with Rod Coleman, President of Stride Micro (formerly Sage Computer) on the 68000 multiuser market and its current environment.

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 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."



"A surprising feature is compatibility. Everybody talks about it, but nobody does anything about it."

Q: Are things changing now?

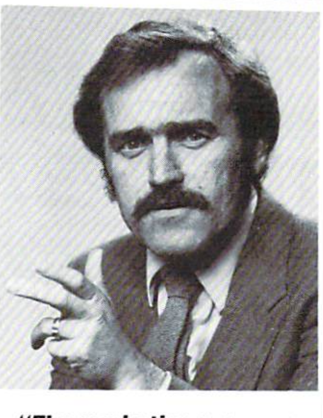
RC: "Yes and no. With the business world starting to take more and more interest in microcomputer solutions, the advantages of a solid multiuser system couldn't be kept hidden forever; companies like ours and a few others were beginning to make a dent. Instead of taking a fresh approach, some of the 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 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."



"The marketing pressure to be compatible instead of being better, has blinded the industry."

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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