BYTE

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THE SMALL SYSTEMS JOURNAL

COMPUTERS AND EDUCATION
On every desk, in lab and field

Introducing Macintosh. What makes it tick. And talk.

Well, to begin with, 110 volts of alternating current.

Secondly, some of the hottest hardware to come down the pike in the last 3 years.

The garden variety 16-bit 8088 microprocessor.

Macintosh's 32-bit MC68000 microprocessor.

Some hard facts may be in order at this point:

Macintosh's brain is the same blindingly-fast 32-bit microprocessor we gave our other brainchild, the Lisa™ Personal Computer. Far more powerful than the 16-bit 8088 found in current generation computers.

Its heart is the same Lisa Technology of windows, pull-down menus, mouse commands and icons. All of which make that 32-bit power far more useful by making the Macintosh™ Personal Computer far easier to use than current generation computers. In fact, if you can point without hurting yourself, you can use it.

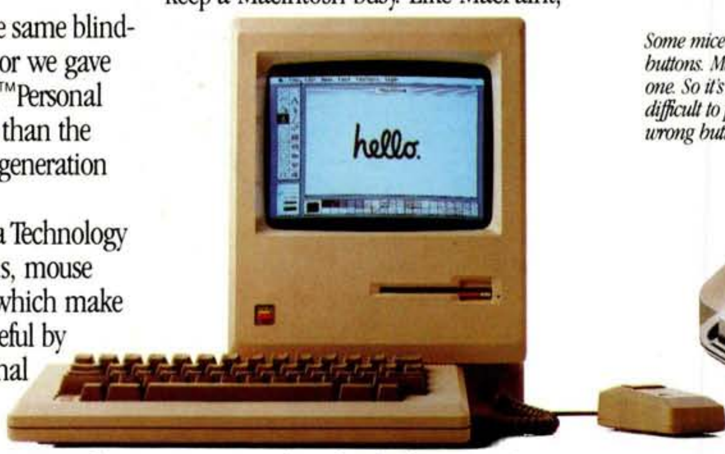
Now for some small talk.

Thanks to its size, if you can't bring the problem to a Macintosh, you can always bring a Macintosh to the problem. (It weighs 9 pounds less than the most popular "portable.")

Another miracle of miniaturization is Macintosh's built-in 3½" drive. Its disks store 400K—more than conventional 5¼" floppies. So while they're big enough to hold a desk full of work, they're small enough to fit in a shirt pocket. And, they're totally encased in a rigid plastic so they're totally protected.

And talk about programming.

There are already plenty of programs to keep a Macintosh busy. Like MacPaint,™



a program that, for the first time, lets a personal computer produce virtually any image the human hand can create. There's more software on the way from developers like Microsoft,® Lotus,™ and Software Publishing Corp., to mention a few.

And with Macintosh BASIC, Macintosh Pascal and our Macintosh Toolbox for writing your own mouse-driven programs, you, too, could make big bucks in your spare time.

You can even program Macintosh to talk in other languages, like Yiddish or Serbo-Croation, because it has a built-in polyphonic sound generator capable of producing high quality speech or music.

The Mouse itself. Replaces typed-in computer commands with a form of communication you already understand—pointing.

Some mice have two buttons. Macintosh has one. So it's extremely difficult to push the wrong button.

The inside story—a rotating ball and optical sensors translate movements of the mouse to Macintosh's screen pointer with pin-point accuracy.

All the right connections.

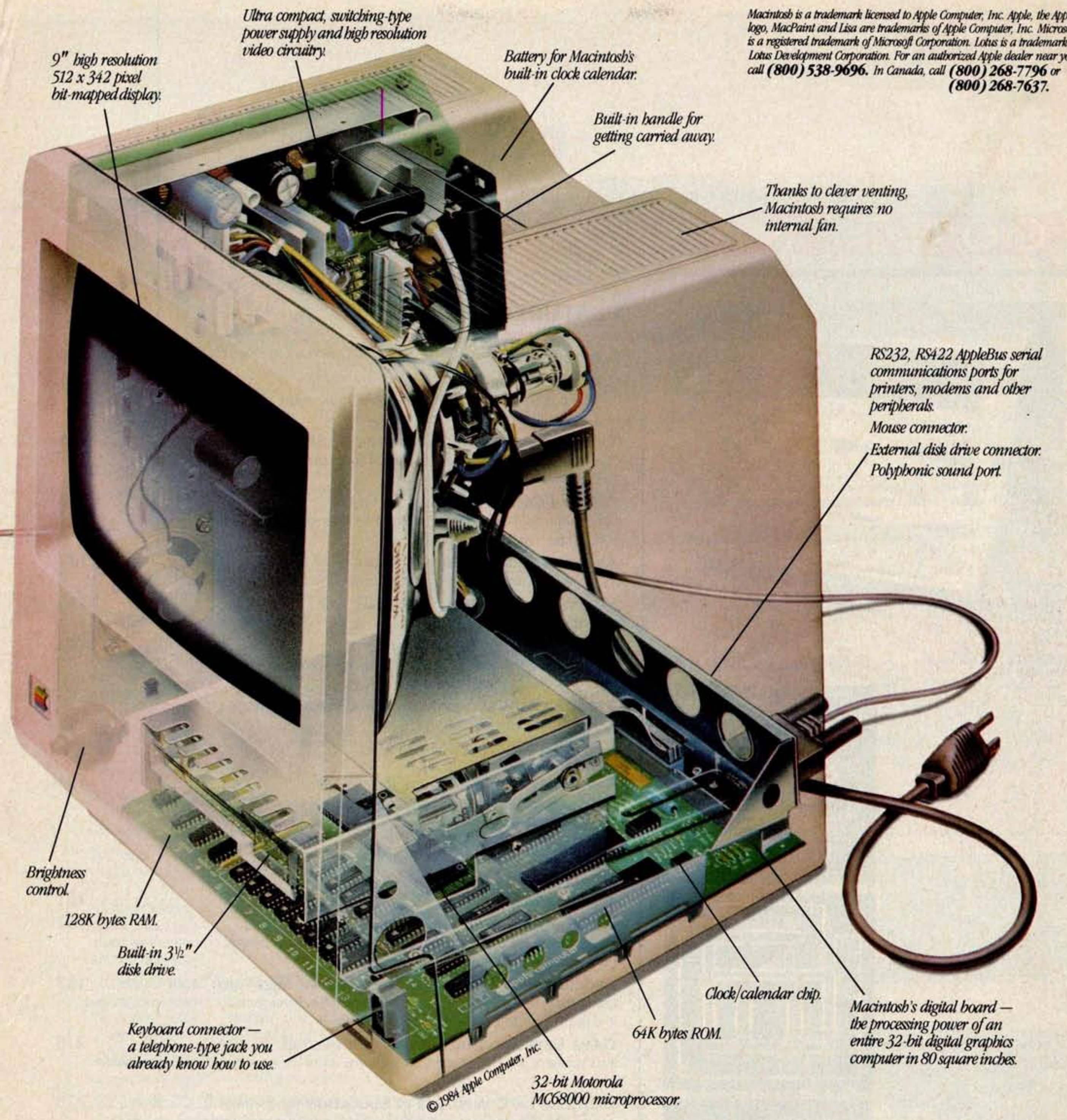
On the back of the machine, you'll find built-in RS232 and RS422 AppleBus serial communication ports. Which means you can connect printers, modems and other peripherals without adding $150 cards. It also means that Macintosh is ready to hook in to a local area network. (With AppleBus, you will be able to interconnect up to 16 different Apple computers and peripherals.)

Should you wish to double Macintosh's storage with an external disk

Macintosh automatically makes room for your illustrations in the text.

MacPaint produces virtually any image the human hand can create.

Microsoft's Multiplan for Macintosh.



drive, you can do so without paying for a disk controller card—that connector's built-in, too.

There's also a built-in connector for Macintosh's mouse, a feature that costs up to $300 on computers that can't even run mouse-controlled software.

One last pointer.

Now that you've seen some of the logic, the technology, the engineering genius and the software wizardry that separates Macintosh from conventional computers, we'd like to point you in the direction of your nearest authorized Apple dealer.

Over 1500 of them are eagerly waiting to put a mouse in your hand. As one point-and-click makes perfectly clear, the real genius of Macintosh isn't its 32-bit Lisa Technology, or its 3½" floppy disks, or its serial ports, or its software, or its polyphonic sound generator.

The real genius is that you don't have to be a genius to use a Macintosh.

You just have to be smart enough to buy one.

Soon there'll be just two kinds of people. Those who use computers. And those who use Apples.

E·D·I·T·O·R·I·A·L

BYTE's New Look

The redesign of a magazine always requires some adjustment by the reader, and so we pondered the matter before proceeding to change BYTE's appearance. In the end, we went ahead for several reasons. We want to make BYTE easier to read without making it less technical. We want to include more input and feedback from readers, to make reviews easy to distinguish from feature articles, to make review findings clearer by using graphics, and to give some of BYTE's most popular articles the best possible setting.

Note that we have made no changes for change's sake. There is much continuity. Robert Tinney, whom time only improves, remains our cover artist. Our new typeface, Novarese, has a classic feeling, like that of our old Palacio, but is more chiseled. Steve Ciarcia and Jerry Pournelle still appear prominently in major sections. The redesign, developed by McGraw-Hill's Joe Davis and refined and implemented by Rosslyn Frick, our new art director, keeps BYTE clean and simple. We think the judicious use of art and white space makes BYTE more pleasing to the eye and not garish or splashy.

The front of the magazine now includes an "Update" section where we can bring important matters to your attention. "Update" will contain, among other things, corrections of errors in previously published articles. Another addition to the front is a few pages of the most important items from "What's New." You will also find up front "Ask BYTE," "Book Reviews," "Clubs and Newsletters," and "Event Queue."

We have included more reader input and feedback by setting letters to the editor in smaller type, by introducing "Review Feedback" at the end of the Review section, by introducing "Update," by expanding the space for responses to Jerry Pournell's popular column (more on this below), and by enlarging Steve Ciarcia's "Ask BYTE."

The four main sections of BYTE are the Feature section, the Theme section, the Review section, and the Kernel. The distinguished artist Ivan Chermayeff has done graphics to introduce the first three of these sections. The Feature section now comes first. This section provides a variety of previews and descriptions of major new products and in-depth articles on topics of interest to sophisticated personal computer users. This month we provide a close look at the HP 110 portable, the second half of Steve Ciarcia's blockbuster article on building a Z8000 board for the IBM PC, part 1 of an Ada primer, and other articles including a preview of the innovative Macintosh Pascal and a clever way of making FORTH work faster. We have moved "Ciarcia's Circuit Cellar" to the Feature section because Steve really writes a major feature article each month rather than a traditional column.

Next comes the Theme section, which explores in depth a different subject each month. This month's theme articles discuss computers in education, with an emphasis on their use at the university level. Thanks to DEC, IBM, Apple, Zenith, and other companies, personal computers are now reaching campuses in volume. Associate Editor Donna Osgood's introduction to the Theme section shows the variety of uses for personal computers in universities, schools, and outside the formal educational system.

The Review section follows the Theme section. Reviews carry a slug on each page identifying them as reviews. The graphics in reviews of the Chameleon Plus, Infoscope, and C compilers give an indication of what to expect in BYTE's future reviews. Note how the graphs in the Chameleon review compare that machine's features and performance with two de facto standards—the IBM PC and the Apple IIe. From now on, you will see similar graphs for every system

(text continued on page 8)

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SEEQUA BELIEVES PAYING IBM PRICES FOR A PERSONAL COMPUTER COULD MAKE A TRAMP OUT OF ANYONE.

PRESENTING THE CHAMELEON BY SEEQUA FOR JUST $1995.

The Chameleon by Seequa lets you run popular IBM software like Lotus® 1-2-3™ and dBase II.® It gives you a keyboard just like the IBM. A disk drive like the IBM. And a bright 80x25 character screen just like you know who. And it all comes complete at a price that isn't at all like an IBM.

But the Chameleon's $1995 price tag isn't its only advantage over its famous competitor. The Chameleon also has an 8 bit microprocessor that lets you run any of the thousands of CP/M-80® programs available. It comes complete with two of the best programs around, Perfect Writer™ and Perfect Calc.™ It's portable. And you can plug it in and begin computing the moment you unwrap it.

So before you spend all your money on an IBM, consider the IBM compatible Chameleon by Seequa.

It's a tool for modern times that won't set you back a fortune.

The Chameleon by

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Chameleon shown with optional second disk drive.
To learn more about Seequa or for the location of the Seequa dealer nearest you, call (800) 638-6066 or (301) 672-3600.

Circle 294 on inquiry card.

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(text continued from page 6)
we review, making general month-to-month comparisons much easier than before.

After the Review section comes the Kernel, a major new section that starts with Jerry Pournelle's popular column, includes "BYTE West Coast," and will soon include "BYTE Japan" by William Raike and a rotation of other columns on important topics such as artificial intelligence and telecommunications. You will find Bill Raike's name on the masthead with those of other new contributing editors who will help make the Kernel a mainstay. Jerry Pournelle's fans will have no trouble recognizing his column under its new title, "Computing at Chaos Manor." What makes Jerry's writing so popular is his unique way of looking at things from Chaos Manor's techno-cluttered halls. His writing was originally entitled "The User's Column" not because Jerry is a typical user, but because in earlier days, Jerry was virtually BYTE's only writer who was a mere user—he didn't create compilers and computers, he just used them. We have renamed Jerry's column in recognition of his individuality. Feedback to Jerry's column now comes immediately afterward in "Chaos Manor Mail."

"Programming Insights" (formerly "Quickies"), "Technical Forums," "Application Notes," "What's New," "Books Received," and "Unclassified Ads" round out the magazine (although we may not have material in every category every month).

To make it easier for readers to learn something about our authors, we've moved "about the author" information to the front of each article. Look for it near the bottom of the first or second page of each piece.

The AIM Inquiry System

This month, BYTE inaugurates the first electronic reader service processing system for readers and advertisers of computer magazines. Just as BYTE's new design is intended to refine the magazine and make it easier to read, the new electronic inquiry system is intended to modernize our reader inquiry service and make it easier for you to get information about products seen in BYTE. This automated inquiry management (AIM) system allows subscribers to request information from advertisers by using any Touch-Tone telephone. The AIM system will trim the typical six-week response time of the current reply-card system to as few as seven days. Here's how it works.

During the next three months, every BYTE subscriber will receive by mail a Subscriber Identification Card and ID number. Using your unique number, you can call the BYTE Reader Service Computer and then key in your subscriber number and the reader service numbers from the ads in BYTE you'd like more information about. When you're finished, close the session with a special ending code, and then watch your mailbox for replies from the manufacturers of products you've expressed an interest in.

Complete instructions appear in your copy of BYTE (if you've received your identification number) on the page facing the traditional reader service card. In this location you'll also find a form to help you organize your AIM system call before you make it.

If you did not receive your subscriber identification number this month, yours will be arriving in the next two months. The AIM system is being brought to a new one-third of our subscribers each month for the June-July-August period.

For those who live in an area without Touch-Tone service, who are not subscribers, or who prefer the traditional reply method, we'll continue to provide reader service reply cards.

—*Phil Lemmons, Editor in Chief*

Writing For BYTE

BYTE continues to solicit and publish articles and reviews that keep you informed about what's new and important in microprocessor-based technology, and many of our articles are still written by you, the people directly involved with the field we report on. Details on querying us about article, product-review, and book-review ideas are listed below. We also welcome submissions (typed and double-spaced, please) to our Letters to the Editor column. Please contact us, via the appropriate department at: BYTE
POB 372 Hancock, NH 03449
(603) 924-9281

You may also want to call or write us (send a stamped, self-addressed business envelope) for our current author guidelines.

Articles

Because our editorial needs are very specific and subject to change, we prefer receiving query letters instead of completed articles. A query letter should contain one or two pages explaining the subject to be covered, its importance to the BYTE reader, and the focus of the proposed article; it should also contain a one- or two-page outline and a tentative first two pages of the proposed article. Query letters should be addressed to the features editor.

If you send us a completed article, we need double-spaced printed versions of the main text (up to 25 numbered pages) and all listings, figures, and tables; please label all items and place all captions on a separate page. Photos should be 35 mm (or larger) transparencies or 5- by 7-inch (or larger) prints. If possible, we would also like to receive magnetic copies of the text, listings, and tables on Apple DOS, IBM PC, Kaypro, or 8-inch CP/M disks; we will pay an additional $20 for this. The files should be standard ASCII text files and should not contain any nonprintable characters; we prefer files that use carriage returns *only at the end of each paragraph*. You should also include a stamped, self-addressed return envelope of the appropriate size. Address these to the features editor.

Product Reviews

We frequently need good product reviewers and sometimes accept unsolicited reviews. BYTE product reviews must be fair, accurate, and comprehensive. Reviewers must have considerable experience in the microcomputer field. Writing experience is preferred but not required, and reviewers must have no financial connection to the company whose products are being reviewed. If you are interested in becoming a BYTE reviewer, send a letter to our product-review editor stating what computer products you own, what products you are interested in, and what writing experience you have.

Book Reviews

BYTE is always looking for qualified book reviewers. Submit queries and proposals accompanied by a resume, writing samples, or a list of computer-related interests and expertise to the book-review editor. Unsolicited book reviews also will be considered.

We pay competitive rates for articles and reviews and offer you the chance to share your expertise with hundreds of thousands of BYTE readers. Your comments and submissions are always welcome.

The second BYTE Computer Show takes place June 14–17 in the Los Angeles Convention Center. Subscribers are especially welcome and receive a full-day pass to exhibits and conferences for $7.50. See you at the show. . . . P. L.

Staff-written highlights of late developments in the microcomputer industry

Franklin Unveils CX Series Computers

Franklin Computer Corp. has introduced a line of transportable computers. All are said to be Apple II compatible; MS-DOS or CP/M options are available. The CX-1, with a 6502 processor, 64K bytes of RAM, serial and parallel ports, a 7-inch display, and one disk drive, costs $1425. The $1730 CX-2 adds a second disk drive. The $2049 CX-3 also adds a card with a Z80 processor and 64K bytes of additional RAM, while the $2395 CX-4 adds an 8086 and 128K bytes of RAM.

The CX computers use a 12K-byte write-once memory (WOM) to store the operating system, which is loaded from floppy disk after power-up; after this, the memory cannot be written to until the machine is turned off and on again.

Hayes Enters New Field: Data-Management Software

Hayes Microcomputer Products Inc., best known as a maker of modems, has moved into the software arena with its data-management system called Please. Not surprisingly, a modem-communications link is part of the program. Please has extensive help screens to ease learning and is written in assembly language for speed of execution. The menu-driven program allows up to 999 characters per field and 99 fields (2000 characters total) per record; the number of records per file is hardware limited. Hayes also sells application templates for the program, including mailing list, membership, household records, and appointments. Please retails for $349; application templates are $29.95 each.

Videotex Capabilities Added to Micros

Several manufacturers have recently announced videotex capability for microcomputers. Wang introduced the PC Viewdata Decoder, a $250 program for its Professional Computer. Digital Equipment Corp. unveiled Pro/NAPLPS, a $195 program for its Professional 350 computer. Sony showed a NAPLPS/ASCII terminal, the VDX-1000, as well as a videotex frame-creation system. Avcor, in Toronto, announced a $100 cartridge enabling the Commodore 64 to act as a NAPLPS/ASCII terminal.

IBM announced PC/Videotex, software enabling the IBM PC, PC XT, or PCjr to act as a videotex terminal. PC/Videotex will be available in October for $220 to $250. Network Videotex Systems Inc. of Toronto is selling Quick-Pel, a $625 expansion card allowing the IBM PC to function as a NAPLPS videotex terminal. TVOntario, also of Toronto, offers a NAPLPS page/frame-creation system for the IBM PC for $1450.

Texas Instruments has developed a single-chip video-display processor that supports the NAPLPS standard used for American videotex. TI's Advanced Video Display Processor is software compatible with TI's popular 9918 video processor.

Wilcom Announces Telecommunications Device for IBM PC

Wilcom Inc., Roswell, GA, has introduced Asher, a telecommunications device for the IBM Personal Computer. Asher includes an expansion card with a 300-bps modem, a telephone handset, and MS-DOS software for memory partitioning, appointment scheduling, and card file/speed dial functions. While several applications can be in memory simultaneously, they do not execute concurrently. The Asher software uses 128K bytes in addition to the memory needed for other programs, so a minimum of 256K bytes is needed. Asher will be available this month for $795.

TeleVideo Personal Mini Uses IBM PCs as Workstations

TeleVideo Systems has introduced the Personal Mini, a 16-user computer that uses IBM-compatible computers as intelligent workstations. The Personal Mini includes a 40-megabyte hard disk and 80186 and Z80 processors. Microcomputers can be linked to the system using a $99 interface card and cable; special "diskless workstations" are also available. TeleVideo says users can run any PC-DOS or MS-DOS software on the workstations or can use any of 50 available multiuser software packages. The Personal Mini should be available this month for less than $10,000.

(text continued on page 10)

(text continued from page 9)

Fourteen Firms Back Network Standard

Fourteen computer makers, communications firms, and manufacturers announced their support of a network based on the IEEE 802.4 broadband token bus standard. General Motors and Boeing Computer Services signed an agreement pledging support of the standard and promising to demonstrate a working network at the National Computer Conference next month. Also participating in the demonstration will be IBM, Hewlett-Packard, Digital Equipment Corp., Honeywell, NCR, Charles River Data Systems, Intel, Motorola, and others. While the demonstration will be of a factory-floor network, 802.4 could also be used to network personal computers. General Motors showed the network earlier this year at its technical center in Warren, Michigan.

Epson and Commodore Show New Computers

Epson showed the PX-8, a new notebook computer, at the recent Hannover Fair in West Germany. The computer includes 64K bytes of RAM, an 8-line by 80-column LCD, a microcassette tape drive, a Z80-compatible processor, and the CP/M 2.2 operating system in ROM. MicroPro announced that ROM-based versions of its application software programs, including Portable WordStar, Portable Calc, and Portable Scheduler, are bundled with the PX-8, which is not yet available in the U.S.

Although Commodore showed prototypes of several computers, it didn't announce details, pricing, or availability dates for any of the products. The most talked-about machine was an 8088-based MS-DOS computer, reportedly based on Bytec's Hyperion. Commodore also displayed a Z8000-based computer with dual floppy-disk drives, 256K bytes of RAM, and the UNIX-like Coherent operating system. Commodore also showed the Commodore 16, a scaled-down version of its 64.

Microrim Offers Conversational Query Language

Microrim Inc. has introduced a conversational query language for its R:base series of database-management programs. The language, called CLOUT, allows a user to get database information by using commands that resemble English-language questions. CLOUT requires an IBM PC with at least 256K bytes of RAM and two double-density double-sided disk drives; a hard disk is recommended. The $195 program works with PC-DOS, MS-DOS, BTOS, and UNIX, using R:base, which costs $495.

Microrim also announced two new versions of R:base—the Model 6000 for multiuser systems and the Model 2000 for the IBM PCjr and other small systems.

NANOBYTES

IBM has developed an experimental 1-megabit dynamic random-access memory (DRAM) chip using existing manufacturing facilities. The chip uses a silicon and aluminum metal oxide semiconductor (SAMOS) technology. . . . **Phoenix Software**, Norwood, MA, is offering its custom-written IBM-compatible ROM BIOS for MS-DOS to computer makers. Phoenix says the code was written without any knowledge of IBM's BIOS and thus companies using it should be free from lawsuits. . . . **Holmes Engineering**, Murray, UT, is offering the Portable Micro Drive, a wafer tape drive for the Radio Shack TRS-80 Model 100 notebook computer. The $370 unit can store up to 64K bytes on a tape cartridge and includes a rechargeable battery. . . . **Fujitsu America**, San Jose, CA, announced a 671-megabyte 14-inch Winchester disk drive with a price of $7045 in quantities of 100. . . . **Digital Equipment Corp.** is now offering an eight-user Micro/PDP-11 for about $20,000, including two terminals and a printer. . . . **Seequa Computer Corp.**, Odenton, MD, will use **Tabor's** 3¼-inch disk drive in its Seequa 325, an enhanced version of its Chameleon. Seequa is the first computer maker to use the drive.

From Nikkei BYTE, Tokyo: Epson appears ready to unveil two hand-held computers, the HC-80 and HC-88, with built-in Japanese-language processing functions. The high-resolution LCD will show either 90 kanji (Chinese) or 640 English characters at a time. . . . **Mitsubishi** and **B-Con Systems** are selling a kanji version of Microrim's R:base 4000 database software for Japanese MS-DOS computers.

Integrated. Printegrated.

Now, translate your integrated software into integrated hard copy, with the TI OMNI 800™ Model 855 printer. So versatile, it combines letter-quality print, draft-quality print and graphics as no other printer can.

It prints letter-quality twice as fast as comparably priced daisy wheel printers, yet gives you characters just as sharp, just as clear.

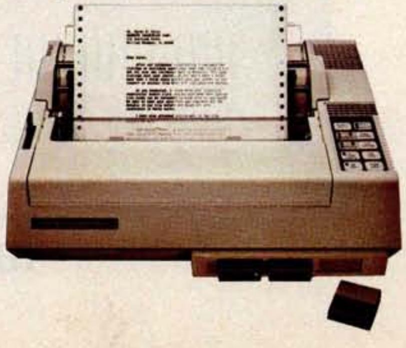
It prints rough drafts ten times faster than daisy wheel printers... faster than most any other dot matrix printer.

Only the TI 855 has snap-in font modules. Just touch a button; change your typestyle. The 855 gives you more typestyles to choose from than ordinary dot matrix printers. It makes them quicker, cleaner, easier to access than any other dot matrix or daisy wheel printer.

The 855's pie charts are rounder... all its graphics are sharper than on other dot matrix printers, because the TI 855 prints more dots per inch. As for daisy wheel printers... *no* graphics.

The TI 855 Printer

The printer for all major PC's



For under $1,000 you get twice the performance of typical dot matrix printers. Or all the performance of a daisy wheel printer, and then some, for half the price.

So get the best of all printers, and get optimum results from your integrated software. With the TI 855. See it at your nearest authorized TI dealer. Or call toll-free: 1-800-527-3500. Or write Texas Instruments Incorporated, P.O. Box 402430, Dept. DPF-182BY, Dallas, Texas 75240.

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Creating useful products and services for you.

"Dare to

TI makes the best software perform even better.

When choosing a computer, there are two important things to look for. Who runs the best software—and who runs the software *best*! That's why we're staging a dramatic country-wide side-by-side comparison against IBM™ called "Dare to Compare."

Come to a participating dealer and take the "Dare to Compare" challenge. You'll see first-hand how...

TI makes software faster to use.

Take a closer look. See how we give you more information on-screen than the IBM PC? That way you'll spend less time looking for data, and more time using it. We also give you 12 function keys, while they give you 10. Unlike IBM, we give you a separate numeric keypad and cursor controls. And that saves you both keystrokes and time. We also isolated the edit/delete keys to reduce the chance of making mistakes.

TI makes software easier to use.

TI gives you up to 8 colors on-screen simultaneously, which makes separating the data a lot easier. IBM displays only 4. Our graphics are also sharper. And easier on the eyes.

IBM Personal Computer

Compare”

And TI makes it easier to *get* your data on-screen. Our keyboard is simpler—it's more like the familiar IBM Selectric™ typewriter than the IBM PC keyboard is.

TI lets you see for yourself.

Right now, you can “Dare to Compare” for yourself at participating TI dealers all over the country. Stop in, present your business card, put both machines through their paces using the same software titles, and see the difference for yourself. We'll give you a TI solar powered calculator, free, just for taking our challenge*.

For the name of a participating dealer near you, please call TI toll-free at 1-800-527-3500, or write: Texas Instruments Incorporated, P.O. Box 402430, Dept. DCA232BY, Dallas, Texas 75240.

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Texas Instruments Professional Computer

DTC 2763-69

L·E·T·T·E·R·S

CONTROLLER CORRECTION

I recently ran into a problem with my Apple II disk drive. I couldn't find a controller card that wouldn't stop every two seconds while reading in a text file longer than two sectors. This pause was annoying because the disk drive sounded like it was dying and it took me twice as long to read the file.

I don't know how many companies and how many of their controller cards have this problem, but I have experienced it twice. I asked some people at the Hughes Apple Byter's Club, with which I'm affiliated, about this problem, but nobody really knew what caused it. It has been suggested to me that there may be a POKE command that keeps the motor running, but I have yet to find out if this is true.

My roommate noticed that while using an Apple controller, the drive continued to run approximately 1½ seconds after control had returned to the user. I solved this problem by increasing the size of the tantalum capacitor on the threshold of the timer chip by about 10 microfarads. The capacitor controls the amount of time the output line stays enabled on the motor control. This allows the drive motor to stay on a few milliseconds longer than before, so DOS has a chance to finish transferring the contents of the file buffers and return for more data before the motor stops spinning. Otherwise it would have to restart the drive motor before it could resume reading. This is what added the extra time it took to read in the file(s).

I hope this information will save your readers some unnecessary frustration.

CHRIS A. NIELSEN
Nielsen Engineering
2910 Seventh St.
Santa Monica, CA 90405

AMERICAN AS APPLE PIE

The introduction of the Apple Macintosh computer has been eagerly awaited by many home and business computerists. The complete description in the February BYTE ("The Apple Macintosh Computer" by Gregg Williams, February, page 30) is certainly impressive and I can see many applications for the Macintosh. I would consider the Macintosh for those applications were it not for one negative factor. The Apple computer has been, since its introduction, one of the most popular computers, regarded as American as apple pie. Now comes the Macintosh computer and, lo and behold, it uses a Sony storage medium. It seems to me that if the United States is going to lead the world in computer technology, it has to be innovative and responsible enough to develop those leading technological products that make it the world leader.

When I go look at television sets, videocassette recorders, cameras, etc., I find an almost total predominance from the Japanese manufacturers. This is appalling. What has happened to U.S. technology in these fields? It has appeared that our technical excellence has returned in the areas of computers and certainly the world has looked to the U.S. for computers in the past several years. If the American-as-apple-pie computer suddenly incorporates Japanese-supplied hardware, what is the next step?

I, for one, have given up considering the Macintosh computer for any application I have. I will not contribute in any way to the furthering of Japanese technology into the American computer industry, and I think Apple Computer Inc. deserves a failing grade for contributing to an already substantial balance of payments deficit with its Macintosh design. I hope the rest of the computer-buying public will recognize this un-American approach and express their reaction at the computer store purchase counter.

DAVID A. NIBBELIN, P.E.
President, Variable Acoustics Corp.
2222 West Vickery Blvd.
Fort Worth, TX 76102

IN THE RAINBOW CORNER

I would like to comment on recent criticisms of the DEC Rainbow that appeared in two March articles ("The User Goes to COMDEX, 1983," by Jerry Pournelle, page 352, and "Reviewer's Notebook," by Rich Malloy, page 213) and in a letter to the editor by Carter Scholz (page 20) in the same issue. It was just last month (February 1984) that the (then) editor in chief of BYTE, Lawrence J. Curran, editorialized on the drive to be compatible with IBM equipment. Mr. Curran's point was that the compatibility craze might be stifling innovation that usually arises from smaller companies. Now in March, Messrs. Pournelle and Malloy criticize the DEC Rainbow for not running IBM software and for not having the IBM disk format, and because it is not being cloned. Possibly they should read the March editorial, because they too seem to be caught up in the compatibility craze.

Mr. Pournelle's article correctly grasps the obvious, that the DEC Rainbow was never intended to mimic the IBM, therefore it will not run IBM software. Many initial purchasers of the Rainbow (and I can assure Mr. Pournelle that there are many Rainbow owners) were individuals who were already familiar with DEC minicomputers. These people wanted a home computer compatible with other DEC equipment that also ran the popular commercial software packages (the Rainbow emulates the VT100 terminal, an industry standard that is often cloned). In providing for the needs of the initial market, DEC created a product superior to the IBM. The screen resolution is better, there are built-in communications and printer ports, and space is provided for a second set of half-height floppy-disk drives or a hard-disk drive. I disagree with Mr. Pournelle about the keyboard, and I feel that it is superior to that of the IBM and may be the best in microcomputers today.

Mr. Malloy makes some remarks about the DEC that I feel are incorrect. He implies that the Rainbow 100 Plus is required to format MS-DOS disks. Rather, it is the version of MS-DOS that determines whether the Rainbow will format MS-DOS disks. My regular Rainbow using version 2.05 of MS-DOS formats disks perfectly. The version 2.05 MS-DOS was a no-cost option with my computer, and it is supplied by default with the 100 Plus computer. Mr. Malloy also slighted the Rainbow because the Rainbow 100 Plus looks like the 100 except for a plastic sticker. This is a cheap shot: DEC's Plus option to the Rainbow is merely an addition of the hard-disk drive, hardly requiring a change in the processor enclosure. I recall Mr. Pournelle discovering that he had the IBM PC XT motherboard only after he had removed the cover and inserted his own memory chips ("Chaos Manor Gets Its Long-Awaited IBM PC," February, page 113).

The Digital Classified Software (DCS) needs some clarification. The DCS program ensures that the software is adapted to the Rainbow hardware and special-function keys. The DCS program also requires DEC to provide software support. I can't imagine calling IBM in San Jose to ask about Lotus 1-2-3, yet this is the service DEC provides. DEC is providing hardware and software support from one source, a trend I find comforting. Also, third-party software is now available; in fact, I saw a DEC booklet (at the local computer store) listing hundreds of independent (nonauthorized) vendors providing programs on Rainbow-compatible disks. Eventually software will provide translation links between disk formats that all manufacturers (IBM, DEC, Tandy, etc.) fail to provide.

Finally, I would like to state that the Rainbow is a capable home and business computer that has sufficient and improving software. (Don't be fooled, all the biggies provide software for the Rainbow.) The Rainbow was never intended to be a hacker's machine and Mr. Scholz should never have purchased one. The Rainbow has sufficient slots for extra memory, a superb

(text continued on page 16)

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(*text continued from page* 14)

graphics board and a second storage medium (floppy or hard disk). Recall that the I/O ports are already installed and not sold as extras. The Rainbow has filled the needs of this nonhacker with good installation and software documentation.

CAMERON T. MURRAY
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As far as reviews are concerned, BYTE has no bias either for or against DEC or any other company. We are concerned with how well a product works, how much software is available for that product, how readily available that software is, and how easy it is to turn that product into an even better product. IBM PC compatibility is desirable only because it provides a tremendous amount of readily available software and hardware peripherals. For a long time, Rainbow software was not available in local computer stores. And there are still few readily available third-party hardware peripherals for it. If, in a year's time, you can buy third-party hardware for the Rainbow at your local computer store, then the Rainbow will be a much stronger machine.

—RICHARD MALLOY
Senior Technical Editor
BYTE Magazine

Having just received the March issue of BYTE and, obviously, not having seen the April issue for which you have scheduled a review of the DEC Rainbow, I would like immediately to comment on the letter from Carter Scholz, lest other readers get a misleading impression of this machine.

Mr. Scholz admits to 50 hours of intensive use. Having obtained my machine in February 1983, I have over 1650 hours of experience with it in connection with my consultancy business—a figure I feel sure must exceed even that of most reviewers of any one machine. To that extent, I suggest that my comments may have more than ordinary validity.

The observation that the documentation is "wretched" is, at the least, an overstatement. It is true that screen formatting and the use of function keys are not covered, which certainly is regrettable. With one exception—the manual for the LA50 printer, which, I readily admit, is appalling—the documentation is perfectly sound and helpful.

Mr. Scholz may not have wished to make an outlay for the technical manuals; but I had nothing but the most courteous cooperation and help from DEC's Canadian Customer Support Center when, at an early stage, I too had to raise screen-formatting and function-key questions.

DEC has not claimed that "thousands" of CP/M and CP/M-86 disks can be run on the Rainbow. As their *Guide to Personal Computing* points out, the machine can run a "very wide selection" of the "thousands" of software programs available on CP/M, CP/M-86, and MS-DOS. At the beginning there was a shortage of available programs because of the then-new disk format; today there are several hundreds of software packages available, the great majority of which are from third-party vendors and are not part of the "DEC-approved" program. Even the problem of nonavailability of DEC's distinctive disks—except from DEC—is no longer a problem, and most of the major disk manufacturers have added the Digital RX50 format to their lines at reasonable prices.

As one who can claim extensive experience with the Rainbow, I cannot speak too highly of a machine that is a real joy to use, and I would hate to have readers draw unfavorable conclusions on the basis of Mr. Scholz's inaccurate letter. I might add that the only hardware problem I have had was with the LA50 printer which, due to a faulty chip, packed up after about three months. Under warranty, it was replaced in about four hours. (Incidentally, this printer, bearing the Digital logo, is considerably more versatile than the look-alike model produced by the same manufacturer.)

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Canada

As a DEC Rainbow user for over a year, I've learned to ignore most of what I read in the computer trade press about the product. Rarely are the facts in order. If other products were comparably reported, the computer trade press would have earned a reputation comparable to that of the computer salesperson.

Of course, after a year, I'm happy to see the product mentioned at all. Please accept my sincere gratitude for printing the words "DEC Rainbow"—and for promising (as you always have) to review it.

But your March issue was somewhat misguided, and I'd like to set the record straight.

Although Chaos Manor is one of my favorite haunts, Jerry Pournelle's reaction (from afar) to the DEC keyboard was hardly responsible journalism (and his disclaimer at the beginning of the article doesn't justify *that*). [See "The User Goes to COMDEX, 1983," March, page 352.]

The test of a keyboard is daily use. Seven people have used the Rainbow keyboard at our weekly magazine for a year. They universally acknowledge it as a work of art. Sure it's unconventional—so is a Ferrari. The point of doing ergonomic research, as DEC did for its personal computers, is to find out how things *ought* to be designed, not how they *have* been designed. Despite its unique design, it is easy to learn the keyboard. Within one session, almost all of us had accustomed ourselves to its enhancements.

Specifically, I found Mr. Pournelle's complaint about the Shift and Return keys ridiculous. The Shift key measures the same travel as a Selectric Shift key (I regularly use both without trouble adapting), and the Return key is large and easily located. The Compose Character key is a very handy user-defined key in many word-processing programs, and it is easily learned

(*text continued on page* 18)

"We bought an IBC Middi Cadet™ because no other system could do the job."

Sue Kardas
Director of Career Training
Burlington Area Vocational-Technical Center

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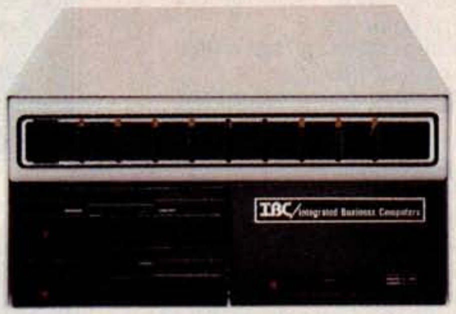

For more information on the Middi Cadet, see your local IBC dealer.

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Circle 371 for Dealer inquiries. Circle 372 for End-User inquiries.

(*text continued from page* 16)

by a touch-typist. Obviously, Mr. Pournelle didn't look closely enough to notice the dip in the F and J keys—a more subtle and successful "homing" device than some other keyboards that distinguish the home row.

Carter Scholz's letter in the same issue raised more serious points. First of all, "wretched" is an irresponsible description of the documentation, hardly earned by a missing bottle of screen cleaner (which *was* supplied with the first monitors). I frankly don't find the errors he seems to have run across.

Second, my prejudice may be that I can't take BASIC seriously, but we have formatted the screen very easily in dBASE II, Turbo Pascal, and assembly language.

Third, he fails to distinguish between disk formats and software. The machine can read several disk formats (Robin, VT180, Rainbow, IBM 8 and 9 sector) and hundreds of programs off the shelf (not counting RCP/M software), and with additional software can read many more disk formats.

Mr. Scholz intimates a use for the machine quite different from that for which it was designed. And his representation of DEC's software-classification program (which we think of as insurance against uninstallable or immature products) and disk format (400K is an enhancement over 320K in my book, not "perverse") is libelous.

Let me explain what this "collage of impressive features with limited utility" did for my company in the last year:

- It typeset 45 magazine pages of insurance-company statistics using Multiplan and transmitted them to our typesetter using nothing more than the communications parameters in ROM and the operating-system commands.
- It stepped in to typeset our stories when our typesetter went down.
- It scheduled and billed our advertising, then it took over the scheduling, billing, and circulation maintenance of our directory.
- It estimated and billed all our commercial printing.
- This year it replaced our ledger, no mean achievement for an "immature product" with little utility.

DEC understands us. We want an appliance that gets specific jobs done and doesn't break down. If we have a question (even about programming function keys), we want a number to call with a prompt and courteous answer at the other end. DEC delivers that at a very low cost.

In fact, any intelligent cost analysis of their formatted quad-density disk offering proves it is competitively priced. Again and again we find (with rare exception) DEC on our side.

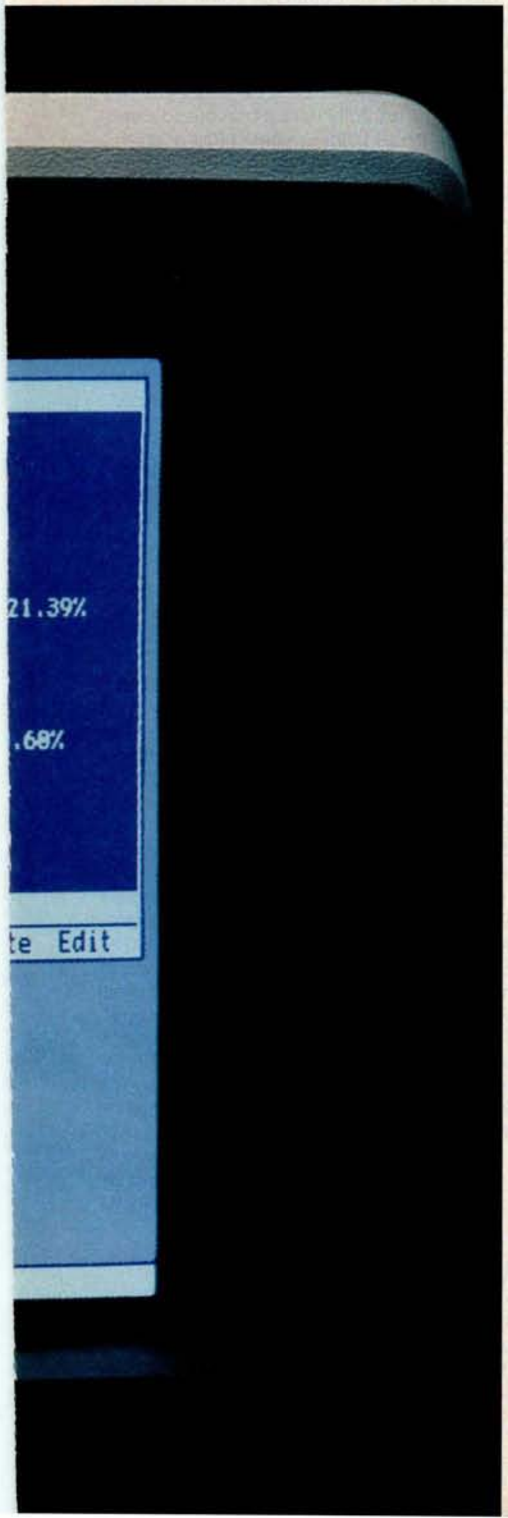
Finally, Mr. Scholz appears as naive about the stock market as he is about the business world. As all Rainbow users have come to know, the wheels of justice grind slowly, but they grind exceeding small.

Well, I'm still looking forward to your review

(*text continued on page* 22)

"Just beautiful."

That's what Bill Coleman of VisiCorp* calls our iAPX 86 architecture. He should know. He and his staff of over 50 people spent three years with it. Writing VisiOn,* the application software destined to become a multitasking industry standard.



The key to creating VisiOn was memory management. Allowing Coleman and his team to create an efficient concurrent processing environment, where different processes are active all at once.

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William T. Coleman, VisiCorp's Director of Product Development

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Who knows? You might find yourself looking at your own work in a whole new way.

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(*text continued from page* 18)

of the Rainbow. I hope it will be as professional as the machine itself.

MIKE PASINI
Underwriters' Report
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San Francisco, CA 94105

I read with interest Carter Scholz's letter on the DEC Rainbow 100 PC. We purchased five Rainbow PCs and I am sorry now that we did not return them as did Mr. Scholz. Although I agree in part with Mr. Scholz's criticisms (particularly in regard to the documentation) and I have additional complaints about the Rainbow and DEC in general, all of Mr. Scholz's criticisms are not correct, at least in my experience:

1. In an attempt to modify MODEM7 for the Rainbow I needed the communication-port status and data addresses. This is not in the documentation supplied by DEC (unless one purchases the extended documents referred to in Scholz's letter—we are still waiting for ours). However, a phone call to Customer Support not only produced the information over the phone but also a copy of the appropriate section of the extended document in the mail. As it turned out, the MODEM7 cannot be configured for the Rainbow. Once again however, Customer Support came to my aid and supplied me with an article (actually the whole magazine) giving the address for obtaining public-domain software equivalent to MODEM7.
2. DEC has an "authorization" program for Rainbow software but that does not mean that third-party software is not available. We purchased Spellbinder (which to my knowledge is not "authorized" by DEC), after finding that the so-called "authorized" word-processing software was either so slow that the secretaries were frustrated or so complex that it was not usable.

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I have been a Rainbow owner since April 1983. Although I have had some problems, I feel Mr. Scholz's conclusions are incorrect. I offer the following replies to his objections.

1. Documentation for the Rainbow is professionally produced. I would be surprised if there weren't contradictions. This would be consistent with other machines and software, particularly a new machine. In use, however, the machine and the software perform as advertised. The escape sequences of all function keys are listed on pages 32 and 34 of the *Rainbow 100 User's Guide*. Utilizing them in user-written programs is the simple matter of interpreting the sequences they generate. Screen formatting is more difficult. DEC published a set of basic subroutines in *Prospective* in the summer of 1983. You could also obtain a copy of a VT100 manual, which explains all the attributes of the Rainbow screen that it emulates.
2. Lack of high-level language support is found only in Microsoft BASIC or perhaps languages that are not screen intensive such as COBOL. I have the new Turbo Pascal from Borland International and both function keys and screen attributes are supported. Many other machines or software vendors have failed to initially support some of the features of their environments, some because they felt other features were more important and deserved more initial support.
3. The contention that the Rainbow cannot run "thousands" of CP/M-80 and CP/M-86 programs is totally false. I purchased Condor III directly from Condor in Rainbow format, Reportmaker from Krepec, and TURBO Pascal from Borland. I think that Mr. Scholz has failed to look beyond the magazine advertisements. Most advertise IBM and IBM compatibles because that's the largest segment of the market. MS-DOS is also available for the Rainbow. Any authorized software dealer can obtain numerous software-applications packages in Rainbow format. Many of us do not consider the fact that this format allows about 400K bytes per disk to be a drawback.

I think that there is a difference in philosophy in the design and marketing of DEC microcomputers. Their philosophy seems to be that their primary market is the plug-in-and-go non-programmer. This is supported by the fact that there are only a few expansion ports and a private bus structure. That does not inherently produce a bad machine, just one that may not fit a "hacker's" needs.

DEC supports its hardware and authorized software. This support includes a toll-free line for help (try that at IBM), factory service, and extended warranties. Few other manufacturers offer this commitment to their purchasers. I cite Mr. Scholz's own statement that he was able to return the machine for a refund. That is the true test of factory support if there ever was one.

Rainbows are relatively new on the market and market support has been slow. Part of this could be the big push to get IBM software out first due to its market share. There are, however, two DEC micro-oriented magazines now available—*Digital Review* and *Personal and Professional*. There also have been changes in DEC operations that should enhance users' options. However, based on hardware and ease of use, the Rainbow is still one of the better machines on the market.

GERALD ARTMAN
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Royal Oak, MI 48067

VIVE LA DIFFERENCE

I greatly appreciated the December 1983 BYTE article on the TI personal computer ("The Texas Instruments Professional Computer," page 286). The unbiased evaluations and the well-chosen

(*text continued on page* 24)

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(text continued from page 22)

industry-wide comparisons were a welcome change from the maudlin treatment given the IBM machine in November 1983. Your intro to the IBM articles left me perplexed. How could such phrases as "transformed the computer industry" or "legitimized personal computers" or "single-handedly enabled microcomputers to assume a greater percentage of the world's computational tasks" be used with a straight face? All conscience aside, the IBM PC is widely accepted and is making a lot of money for a lot of people. I could wish, however, that as an industry we were more self-critical.

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SIMSCRIPT II.5

Although a good general overview, the article "Computer Simulation: What It Is and How It's Done" by Richard Bronson (March, page 95) was incomplete and somewhat inaccurate in its treatment of SIMSCRIPT II.5

Despite being lumped with GASP, SIMSCRIPT does not require that "a complete coded model [consists] essentially of calls to subroutines and assignment statements. . . ." For example, the essence of the barbershop problem given in the article could be represented by

```
Process GENERATOR
  For N = 1 to 100,
  Do
    Activate a CUSTOMER now
    Wait Exponential.f(25.,2) minutes
  Loop
End
Process CUSTOMER
  Request 1 BARBER
  Wait Normal.f(20.,5.,1) minutes
  Relinquish $ BARBER
End
```

In the example, the number 1 is specified before BARBER to give the number of units of the *resource* needed. Units other than 1 are used, for example, when modeling computer resources, where a 42K-byte allocation of 256K-byte main memory is sought. The final parameter in the two SIMSCRIPT-defined random distribution functions is a stream number that allows isolation of the inherent side effects of taking successive samples from a pseudorandom generator.

Contrary to the article and as suggested in the example, SIMSCRIPT II.5 is a process-oriented simulation language. At the same time, it retains the event-based capabilities of the Rand Corporation's original SIMSCRIPT I.

Finally, a word about language preprocessors such as GASP and SLAM. Although they can be valuable tools for developing simulation models, they are not true programming languages. For medium- and large-scale applications (1000 to 100,000 lines) a user is usually forced to revert to the underlying programming language—FORTRAN—thus losing the preprocessor "language." A preprocessor is a good short-term solution, but no substitute for a complete compiler and support library, which is why SIMSCRIPT abandoned its FORTRAN translator with the introduction of SIMSCRIPT I.5 in 1965.

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What Is a Typical Computer Professional?

Yesterday I took the kids to see *WarGames*. Apparently the movie has entrenched the latter-day meaning of the word "hacker" (synonymous with database intruder). I recall when the word was simply the computer equivalent of the radio "ham."

What really upset me was the way the movie portrayed the (typical?) computer professional. The two main characters, certainly escapees from the loony bin, apparently were able to think only in binary, and they obviously were unfit for human company. Is this the image computer people and computer magazines such as BYTE want to project to the general public?

Back in the dark ages, before the microprocessor, I used to read *Computers and Automation*, edited by Edmund C. Berkeley. The magazine strove to place computers and computer people in a meaningful relationship with the community. I don't know what became of *Computers and Automation*. Perhaps this is something to consider? "If you prick us, do we not bleed?"

Opinions please!

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N-3440 Royken
Norway

Standardization Encourages Innovation

While I am one who always looks forward to advances and innovation in the computer field, I fail to find the flaws in the home-computer market you claim exist in your February editorial ("The Compatibility Craze," by Lawrence J. Curran, page 4). The fact that IBM has become the de facto standard in microcomputers has led, I believe, to more, not less innovation. While the rate of change of new and radically different hardware pieces may have slowed down, both the quality and quantity of software have increased tremendously. The fact that one standard is dominating the hardware market means it's possible and profitable for larger and/or more unique software packages to be produced. One need only look at the success of a piece of software like Lotus 1-2-3. Would such a product have come to market had there not been standardization through the large sales of IBM PCs and PC-compatibles? Probably not. The cost of writing sophisticated software is high, both in terms of time and money. It has become less risky for software firms to introduce a new product because their initial ver-

(text continued on page 26)

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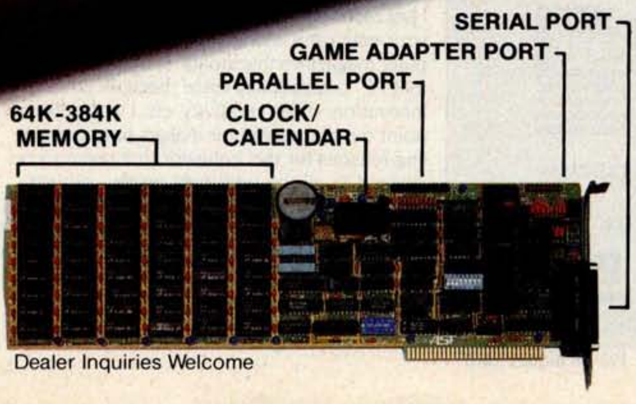

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(*text continued from page* 24)

sion (assuming it's written for the IBM and its compatibles) has the potential to reach a larger audience. No longer do software houses and individuals have to create a myriad of different versions to capture just a small share of the market. The success of Lotus 1-2-3 is largely based on this one standard. Other firms and individuals who can't afford, in terms of time or money, to write software for all of the different machines in existence have the opportunity to write software with a better chance for returns. If this means that other, lesser "standards" such as CP/M-80 fall by the wayside, so be it. Consumers have already benefited significantly from the software that might not otherwise have been introduced.

Second, I do not see a decline even in the introduction of new, innovative hardware. Just because much of what's being introduced isn't as radically different as some might like does not mean that innovation has ceased. I like to think of this time as a period of refinement, versus the last period of a hodgepodge of products, many with dubious quality. I think the area of printers is a fine example. Over the past five years the price of the letter-quality machines has declined markedly while quality and durability have increased. And what of disk drives, modems, and other peripherals? One finds the same situation as with printers.

Over the past three years we have seen the introduction of new and innovative machines. Look at Osborne, Kaypro, the Epson QX-10, the NEC and Tandy "lap" computers, Grid, etc. Surely, these machines qualify as new and innovative.

I believe that the de facto standard that IBM has established in the home-computer market is a good thing. Further, I do not believe that this has led to a decrease in innovation. If anything is responsible for any perceived slowdown in innovation, I would place the blame with the nature of the new technology itself. Gone are the days of computers made in garages. The technology of late is complex. Smaller firms cannot compete with many of the larger ones because of this complexity. One need only read the series of articles on the latest Apple, the Macintosh, in your February issue. If Jobs and Wozniak were starting now and had to compete with the likes of an Apple or an IBM in the home-computer market, their chances for success would be slim.

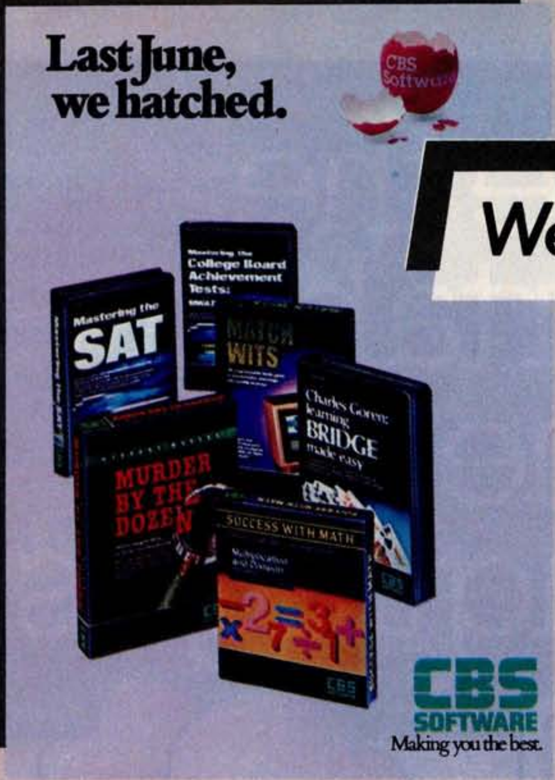
I remember a few short years ago when everyone was hollering for standardization. The market has done much in achieving this end. The fact that the composition of the businesses in the market is changing does not mean that innovation has died. If one is convinced that innovation is dead with respect to the manufacture of computers proper, look to the peripherals market, as here you will find an abundance of diverse firms producing a multitude of innovative products. The market is a mechanism that works. Entrepreneurial spirit is anything but dead in the computer industry. To "urge" funds to be spent differently, as you do in the aforementioned editorial, is a form of coercion no different from the urging done by Luddites (see your January editorial), albeit to different ends. The market has taken us this far already. As consumers, let us sit back and enjoy. We are the dictators of the market, not editors of magazines.

RAYMOND FRIGO
64 Hamilton Park West
London N5
England

I just received the February BYTE and I see that your magazine, along with several other computer magazines this month, is objecting to the IBM PC "compatibility craze" because it hinders innovation, stifles creativity, etc. I would like to point out that computer makers have compelling reasons for this behavior that seem to be ignored in all the editorials on this subject.

First, the phenomenal success of the IBM PC shows that it is exactly what a large number of computer buyers want. The market ultimately provides what the consumer demands. When

(*text continued on page* 30)



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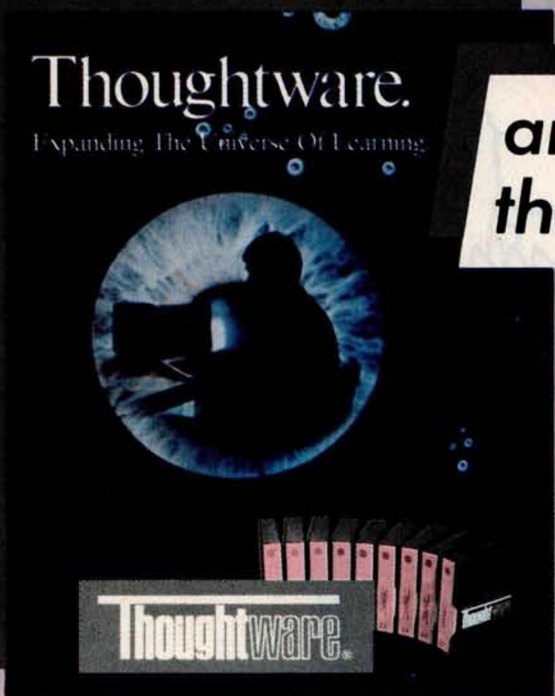

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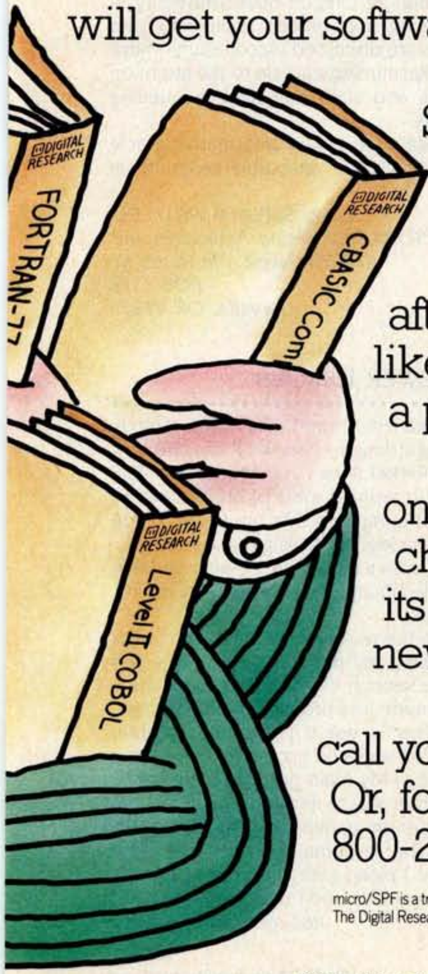

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(text continued from page 26)

innovation is required (by the user) it will be forthcoming.

Second, today's "innovation" is tomorrow's "for sale" item when the newness has worn off and something more advanced comes along. A de facto standard like the IBM PC provides stability in the marketplace and allows the computer purchased today to retain its value—both monetarily and functionally—for a longer time.

Third, a new computer, no matter how advanced, cannot succeed if there is no software to run on it. What software manufacturer (except the very largest) can afford to modify its products every time a new innovation comes along? Small companies could not possible afford to provide versions for every kind of computer. A proliferation of incompatible hardware clearly would inhibit the innovative small software manufacturer.

HERBERT R. SOROCK
2241 Thornwood Ave.
Wilmette, IL 60091

THANKS AGAIN

Please express my appreciation to E. Hart Rasmussen on the quality of his article entitled "Queue Simulation" (March, page 157).

I teach a class called "Port and Harbor Facilities Planning" at Oregon State University in which queuing applications relative to ship movements are discussed. Accordingly, I have called Mr. Rasmussen's article to the attention of students and staff interested in queuing applications.

Thanks again for a most informative article and for including an adaptable program on queuing.

LARRY S. SLOTTA, PH.D., P.E.
Slotta Engineering Associates, Inc.
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Corvallis, OR 97339

A REVIEWER REPLIES

I just read the letter from David Colver (March, page 15) regarding my review of what HP now calls the HP9000 Series 200 Model 16. I feel compelled to reply to some of his statements.

Mr. Colver complains that my review of HP BASIC was inadequate, feeling that a game program is trivial as an example. He also said that I ignored file I/O and the subroutine and function features.

I stated in the review that I was not a fan of BASIC, making my prejudice clear. This was stated more strongly in my original manuscript, but it was made less prominent in the editing process. (This is not a complaint—my rant against BASIC was a bit excessive for a review of this nature.) My main purpose in using the game program was to illustrate the use of the knob, the user-programmable softkeys, and the graphics. The program in fact has four subroutines. I plead guilty to ignoring file I/O. I tried it, it worked, and I didn't feel the need

(text continued on page 33)

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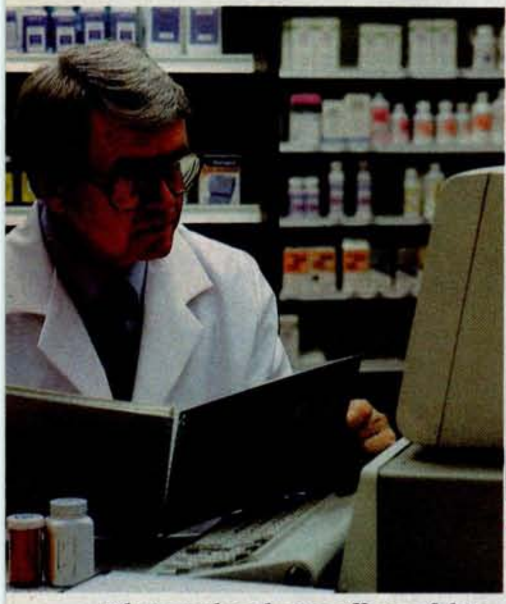
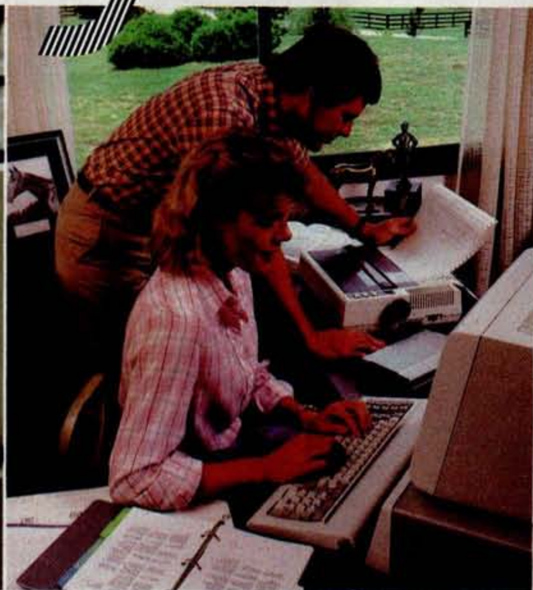
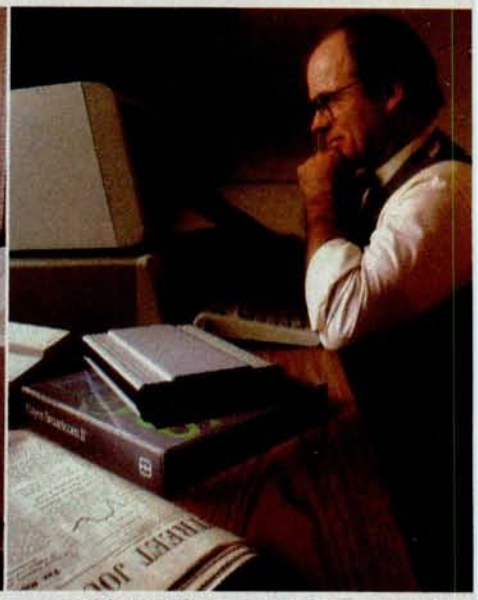


What are the adverse effects of this compound?



Gary: The pedigrees for next week's auction are as follows...



Sold 1000 shares at 33 for net profit of 6000. Richard.

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Smartcom II. We spent a lot of time developing it, so you can spend less time using it. Smartcom II prompts you in the simple steps required to create, send, receive, display, list, name and rename files. It even receives data completely unattended—especially helpful when you're sending work from home to the office, or vice versa.

If you need it, there's always "help." This feature explains prompts, messages, etc. to make communicating extra easy.

With Smartcom II, it is. Case in point. Before you communicate with another system, you need to "set up" your computer to match the way the remote system transmits data. With Smartcom II, you do this only once. After that, parameters for 25 different remote systems are stored in a directory on Smartcom II.

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You can store lengthy log-on sequences the same way. Press one key, and Smartcom II automatically connects you to a utility or information service.

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(*text continued from page* 30)
to test it further because there was so much other stuff to test.

Mr. Colver also complains about my treatment of HP Pascal, saying that I ignored the elegant features of modules borrowed from Modula-2 in favor of picking on the bleeper. The point of the bleeper raillery was to illustrate the rigmarole needed to access the simplest hardware functions and the lack of attention to detail I found in the Pascal package. Yes, the module feature is neat and elegant, but it renders programs that use it incompatible with either the ISO Pascal standard or Modula-2. Further, this feature was not borrowed from Modula-2 at all, but from MODCAL, HP's proprietary version of a hybrid (that's the nice word) between Pascal and Modula-2. (MODCAL was the implementation language of the Pascal system).

I still liked the machine. I think my impressions were summed up well in the March editorial ("Where BYTE Is Going," page 4), but a further problem I found was the alleged compatiblity with the other members of the Series 200 family. *Almost compatible* is often more frustrating than *incompatible*.

BERRY KERCHEVAL
Zehntel Inc.
2625 Shadelands Dr.
Walnut Creek, CA 94598

MAC FLAK

Although I can understand your enthusiasm for the technical "bells and whistles" on the Macintosh ("The Apple Macintosh Computer" by Gregg Williams, February, page 30), I must say that as a practical productivity tool for business, it is abysmal. It is slow going from one function to another, text editing with the mouse is inefficient and cumbersome (try deleting or adding a single character—it's difficult to know exactly where the pointer is pointing), and its one strong point—the graphics free-form capability and creative fonts—is of limited value in a serious business environment. In short, it's a delightful, expensive, toy computer for those who have been afraid of trying computers. It is *not* a productivity aid.

SUSAN GOLD
POB 6095
Santa Fe, NM 87502

FIGHTING CITY HALL

Your editorial comment "that IBM's burgeoning influence in the PC community is stifling innovation because so many other companies are simply mimicking Big Blue" ("The Compatibility Craze," February, page 4) is too little too late. How can a company dare to introduce a better machine when Microsoft's Word runs only on IBM PC hardware (no graphics/keyboard device drivers or overlays). (Perhaps for a sizable fee, Microsoft will create a special version for MS-DOS.) And what about the glitches with INT 14 for servicing the RS-232C or the hardware problems in the 8150 UART? Very few software packages go through MS-DOS or PC-DOS ROMs because they are either slow or incorrect.

Unless magazines such as BYTE encourage software vendors such as Lotus and Microsoft to centralize their software screen and keyboard handlers to go through overlay or device driver files (if done correctly, only one subroutine call overhead in performance), only clones will succeed. BYTE also could encourage reviewers not to grade machines solely on IBM compatibility. Some machines have implemented the communications interrupts correctly, it's just that nobody uses them and the software authors have made no provisions for supporting MS-DOS. If it's true that operating system compatibility is dead, then hardware is where it's at. And if that's true, we have taken a giant step backward and some of the responsibility lies with magazines such as BYTE.

AVRAM TETEWSKY
555 Tech Sq. MS 92
Cambridge, MA 02139

SIMPLE INNOVATIONS

Your editorial call for innovation in the February issue ("The Compatibility Craze" by Lawrence J. Curran, page 4) was well placed. Three articles in the same issue deal with useful, fairly simple enhancements that vendors could add to new or even existing microcomputer designs:

- "A Low-Cost, Low-Write Voltage EEPROM" by Joe D. Blagg, page 343, explained how to add circuitry to allow the in-memory reprogramming of EEPROMS.
- "Foot^Control" by Dennis M. Pfister (page 346) shows how to add sockets to the keyboard to allow the attachment of foot switches to activate the Control key, Escape key, etc. The user could even activate both keys, using two such switches, one for each foot. This would eliminate most double keystroke operations, and give microcomputers most of the convenience of dedicated word processors. Hopefully, some computer stores will offer to retrofit keyboards with such sockets and sell foot switches to go with them.
- More ambitiously, vendors might offer a built-in, software-selectable 132-column by 48-line display option (as described in "The Videx Ultraterm" by Peter V. Callamaras, page 310). Such a display truly expands the user's horizons.

ROGER KNIGHTS
5446 45 Ave. SW
Seattle, WA 98136

COMPARING COMPILERS

I found Kaare Christian's "Inside a Compiler: Notes on Optimization and Code Generation" (February, page 349) most intriguing, and I rushed to my IBM PC to see what kind of optimized code Microsoft's 3.13 Pascal compiler produces for the Sieve of Eratosthenes. [For more information see "Eratosthenes Revisited: Once More through the Sieve" by Jim Gilbreath
(*text continued on page* 34)

(*text continued from page* 33)
and Gary Gilbreath, January 1983, page 283.] Eagerly comparing my .COD listing to the DRI and Intel listings, I saw a close correlation between Microsoft's and Intel's optimization strategies.

My summary: Where Intel dedicates CX and AX to somewhat specific functions, Microsoft seems to use AX generally. This results in five instructions (that the Intel code did not require) to load AX with the desired values. In one case, Microsoft saves an instruction, adding directly to the count in memory whereas Intel adds to and then stores AX. The bottom line is that Intel produces a tighter, faster Sieve, but not by much.

Because I use MS-DOS and do not have access to iRMX/86, I was pleased to see how well Microsoft Pascal optimizes. Although some may be bothered by the fact that the Microsoft .COD file is just a memo listing and not an assembly-language source that can be modified, this suits me just fine. Code that is not tinkered with is one less picket in the fence to come loose—or one less to be hammered up in the first place. The fact that the compiler does such a good job of optimizing is key to my happiness.

As Christian points out, the use of COD lists is most helpful in analyzing alternative coding tactics. In one case, a piece of my Pascal source code looked redundant because a variable expression was explicitly stated in two consecutive lines. When I compiled this alongside an alternative that precomputed the expression, I discovered that the compiler carried the results of the expression evaluation to the second line, doing automatically, and in less code, what I attempted to achieve in my alternative.

As a final note, Christian's discussion of ways to beat the FOR loop control was most instructive. Microsoft, by the way, exhibits the same weakness that Intel does.

CHET FLOYD
664 18th St.
Manhattan Beach, CA 90266

STILL MORE ON THE MODEL 16

I have read with interest the correspondence regarding the performance of the TRS-80 Model 16 under XENIX (Letters, October 1983, page 20; December 1983, page 20; and February 1984, page 24). In one sense Radio Shack is not to blame for the slow response under MBASIC or Multiplan because the use of floating-point arithmetic in both these products appears to substantially downgrade the potential.

We have been using the Model 16 for almost a year with both MBASIC and Multiplan and have found it surprising that with these products the performance was not impressive but that the system commands (written in C) suggest that the machine had all the power we wanted.

More recently we benchmarked the system in C. For a simple processing loop we found that even with floating-point arithmetic, C will perform the operation around 15 times faster than interpretive MBASIC, but if integer arithmetic is used, the speedup becomes a factor of around 90 times.

The message is clear. Floating-point arithmetic on the Model 16 is the main cause of poor performance.

Given the speedup provided by software written in C, there seems little doubt that, in terms of processing, the Model 16 is more than adequate to deal with the number of users that Radio Shack says can be supported. I would be interested to learn from your readers whether there are any hardware solutions I could use to overcome the floating-point arithmetic problem.

D. O. ROWE
109 King Charles Rd.
Surbiton,
Surrey,
England ■

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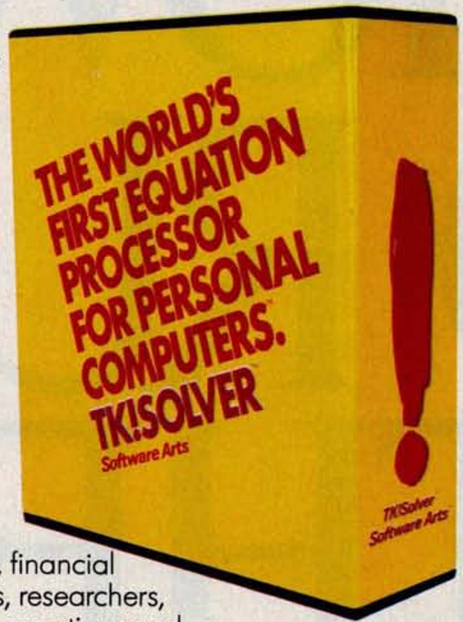

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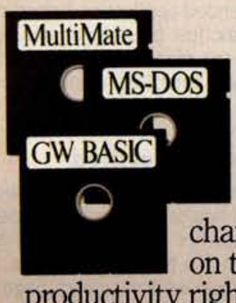
MultiMate
MS-DOS
GW BASIC

Developments

More on the Tandy TRS-80 Model 2000

In our Product Description of the Tandy Model 2000 (March, page 306) Rich Malloy mentioned that a numeric coprocessor chip may be offered as an option at some future date. The chip he suggested was the Intel 80187. We have since learned that the motherboard for the Tandy 2000 does not have a socket for a numeric coprocessor chip and that such an option will most likely be offered as part of an add-on board for one of the expansion slots.

We have also learned that Intel has decided not to market an 80187 coprocessor chip to work with the 80186 microprocessor. According to Rick Schue, a Regional Applications Specialist at Intel's Dayton, Ohio, sales office, Intel instead will make available an integrated bus-controller chip called the 82188. This chip will allow the 80186 processor to work with the 8087 numeric coprocessor, which is readily available. The new bus controller will also permit the 8086 family of processors to work with two other coprocessors: the 82586, a local-area-network coprocessor, and the 82730, a text coprocessor that will simplify such things as proportional spacing and superscripts.

Sweet Talker II

If you're interested in buying the SSI263 speech-synthesizer chip described in the March Circuit Cellar project, "Build a Third-Generation Phonetic Speech Synthesizer" (page 28), it's available from CCI, Box 428, Tolland, CT 06084, (203) 875-5795, for $65 plus $2 shipping (includes the Apple algorithm and data sheets).

You also can buy the assembled and tested Sweet Talker II speech-synthesizer board. This board comes with the SSI263, demonstration software, a user's manual, and a text-to-speech algorithm on a DOS 3.3-formatted floppy disk. It costs $100 plus shipping, from The Micromint Inc., 561 Willow Ave., Cedarhurst, NY 11516; to order toll-free, call (800) 645-3479. For information only, call (516) 374-6793.

If you decide to build the board yourself, be aware of an error in figure 2 (page 32). IC1 pin 22 should connect with the Apple Bus pin 38.

Product News

Santa Clara Systems recently announced that increased outlays for components have forced the company to raise the price of its PCterminal to $1595. The PCterminal is an IBM PC-compatible computer with a built-in local-area network. It can function as an intelligent terminal in a PCNet network. The original price was $1295.

• The Word Processor—Professional Version has undergone a number of changes according to its Fresno-based publisher, Mirage Concepts. Primarily, its price has dropped to $89.95 from $99.95. Also, a spelling checker has been added, and its print and loading capabilities have been streamlined.

• 3Com Corporation has reduced the cost of its Etherlink interface and software to $795, a 16 percent reduction. In addition, EtherShare software now supports a single IBM PC as both a network server and workstation; previously, a dedicated server was required. A new chip, called EtherStart, which allows the IBM PC to function on the network without local drives or controllers, was also announced by the Mountain View, California, communications company.

• From Solana Beach, California, we learn that Kaypro Corporation has dropped the price of the Kaypro 2 to $1295. The company hopes this move will encourage more people to try its popular computer.

• Novation has announced across-the-board price reductions of its Apple-Cat II communications line. Cutbacks range from $40 off the Apple-Cat II 1200-bps modem upgrade (now $349) to a $130 price cut for the 300/1200-bps 212 modem, which now lists for $595. Novation, headquartered in Chatsworth, California, is also trying to induce consumers by offering a free CompuServe demonstration pack with their purchase.

• Staff Technology Corporation, Del Mar, California, has lowered the price of the serial version of The Key to $210 (1 to 99 units). The Key is a hardware module that protects software from unauthorized use.

• Lotus will no longer market a version of 1-2-3 for the Victor 9000 computer. Jim Manzi, vice-president of sales and marketing for the Cambridge, Massachusetts, software developer, cited Victor Technologies' recent financial woes as reason for the decision. Lotus will continue to support all Victor users who have purchased 1-2-3.

Info Interchange Standards

The American National Standards Institute (ANSI) has been working on a set of standards and formats to facilitate the electronic interchange of business information. When fully implemented, the new procedures should eliminate such paper exchanges as purchase orders and invoices for companies desiring the greater speed and efficiency of electronic communications.

A free report discussing these standards is now available. Single copies can be obtained from X12 Secretariat, TDCC, 1101 17th St. NW, Washington, DC 20036, (202) 293-5514.

Feedback

Benchmarks and Age

Mike Forman, employed with Hewlett-Packard's Systems Division in Fort Collins, Colorado, wrote us in defense of the HP 9845A computer, which he felt was slighted in Jeffrey Star's article "Favorite Benchmarks" (February, page 436). While running his CBASIC benchmarks, Mr. Star noticed that the $30,000 HP computer was "not suited for plain number-crunching because of its BASIC-in-ROM interpreter" and that it was "faster than the $5000 IMS5000's pseudo-interpretive CBASIC (version 2) but slower when compared with compiler Microsoft FORTRAN-80."

Mr. Star attributed the slow response to the fact that CBASIC and CB-80 use double-precision real mathematics. Mr. Forman points out that the HP 9845 employed quad-precision mathematics.

"The crux of the matter," says Forman, "is that comparing an older product against current competition will always give a false indication of the price/performance ratio. Newer products cost less for a given performance level."

He then ran Mr. Star's benchmark on an HP 9000 Model 216, which costs approximately $5000 with BASIC. The benchmark was run in interpretive, interactive BASIC, using quad-precision (i.e., 64-bit numbers); integers were not used for loop counters. Table 1 on page 40 shows the results.

In summary, Mr. Forman reminds us that benchmarks can be misleading. "One must be aware of the intended application before selecting a benchmark. Just because a language is interpreted doesn't mean that the machine is slow. Conversely, a compiled language doesn't assure speed."

Technical Point Clarified

Katherine Hammer, Texas Instruments' section manager/natural-language branch, dropped us a line to express her satisfaction with Mark Haas's article on TI's NaturalLink to the Dow Jones News/Retrieval service (January, page 324) and to clarify a technical misunderstanding that cropped up in the article.

The point in question was Mr. Haas's suggestion that NaturalLink's "Build Questions" option is table-driven. "Such a deduction," explains Ms. Hammer, "is understandable since the syntactic simplicity of the command language for Dow Jones News/Retrieval would lend itself to such an approach. Nevertheless, the actual software underlying [NaturalLink's] component . . . is a general-purpose parser/translator capable of handling a large portion of the structures that

(text continued on page 40)

(text continued from page 38)

Table 1: *The results obtained by Mr. Forman after a 40-run loop of the benchmark program described in "Favorite Benchmarks." All the results, except for those listed for the HP 216, appeared in Jeffrey Star's February article.*

			IMS 5000		
	HP Model 216	HP9845	CBASIC	FORTRAN-80	CB-80
Time (seconds)	16	74	443	44	285

occur in natural language. Consequently, this software can be used to provide a similar kind of interface to any number of underlying systems."

Our thanks to Ms. Hammer for clearing up this issue.

MISCELLANEA

Library Templates Sought

Microcomputer Libraries would like to hear from librarians willing to share general-purpose software templates that they might have developed. Any librarians desiring to use the templates or contribute to the group's collection are encouraged to write Microcomputer Libraries, 145 Marcia Dr., Freeport, IL 61032.

Computer Science Programs to Share

The ECN, an educational forum promoting the interchange of ideas and applications, has a number of computer-science programs to share with educators. In all, 15 programs can be obtained for the price of the disk and postage. The programs are designed for the Apple II+ and IIe and include BASIC, machine-language, and DOS tutorials. For information, send a self-addressed stamped envelope to Educational Computing Network, POB 8236-CS, Riverside, CA 92515.

Address Update

LDH Computing, publisher of the Tutor-PC/Graphics program, which was recently mentioned in BYTE, has moved. The new address is 1496 North Morningside Dr. NE, Atlanta, GA 30306, (404) 885-9735; Source account: TCD257; CompuServe account: 70270,140.

Music for Your Ears

PC Musician, a free musical-composition program for the IBM PC, lets you create and edit music on screen as well as store, retrieve, and play back your creations. PC Musician requires 64K bytes of memory, a single disk drive, PC-DOS, and a monochrome or color-graphics adapter. A donation is requested if you find the program useful or enjoyable. Send a formatted disk and a postage-paid mailer to Christopher Wiley, POB 111, VAMC, Prescott, AZ 86313.

$10,000 Scholarship to be Awarded for Best Program

Software City has announced that it will award a $10,000 college scholarship to the student who produces the most marketable computer program. In addition, four runner-ups will receive $1000 scholarships. Eligible programs must be formatted to run on Adam, Apple II/IIe, Atari, Commodore 64, or IBM Personal Computers. Other formats may be announced, and

(text continued on page 44)

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(*text continued from page* 40)

applications for other computers will be considered on a case-by-case basis. Applications will be judged in one of five categories: business, home, recreation, and system software. Applicants must have graduated high school after January 1, 1984.

All entries must be received by December 31, 1984. For complete information and scholarship application, contact Software City Corporate Headquarters, 1415 Queen Anne Rd., Teaneck, NJ 07666, Attn: Scholarship Director. Software City, which specializes in software and accessories, had more than 60 franchises in operation at the end of 1983.

Free Update for Macintosh Multiplan

Microsoft Corp. was to begin shipping free updates of Macintosh Multiplan version 1.00 in mid-April. Registered owners should receive the update, Multiplan version 1.01, automatically. The 70 percent of owners who have not registered their purchase should send the warranty card to receive the update. If the warranty card is lost, a sales receipt as proof of purchase can be sent to Microsoft Corp., Customer Service, 10700 Northup Way, Box 97200, Bellevue, WA 98009.

Art Curricula Available from Museum

The Capital Children's Museum has made available two courses for classroom teachers: "Teaching Art Through Computers" and "Teaching Computers Through Art." Both curricula come with complete lesson plans and suggestions for supplementary materials. Designed for students ages 11 to 15, they are based on the use of the Atari 800 and a graphics program called Paint. Computer use is a part of each lesson.

Either curriculum can be obtained for the price of copying and shipping by teachers who will test the programs and provide the museum with suggestions for improvements. The cost is $5. Additional information is available from Computer Curricula, Capital Children's Museum, 800 Third St. NE, Washington, DC 20002.

Educational Conference Proceedings

Arizona State University has announced the availability of the *1983 Microcomputers in Education Conference Proceedings*. The proceedings cost $20. The 1982 conference proceedings are still available for $15. Purchase-order transactions cost $5 more. Contact Arizona State University, College of Education, Payne Hall B203, Tempe, AZ 85287, Attention: Tina Hite.

BYTE's Bugs

Confusion's Cause: Omitted Symbols

The greater-than and less-than symbols were inadvertently omitted from Richard Willis's IBM PCjr benchmark programs, which accompanied G. Michael Vose and Richard S. Shuford's article "A Closer Look at the IBM PCjr" (March, page 320). Make the following corrections to listing 1:

```
 820  IF A(I)<=A(I+1) THEN 870
1220  IF ASC(C$(I))<65 THEN 1250
1230  IF ASC(C$(I))>90 THEN 1250
```

Gremlins in Utility Program

Gremlins bit into listing 1 in James Folts's "A Cross-Reference Utility for IBM PC BASIC Programs" (August 1983, page 378). In line 610, the conditional statement checks for REM or data codes. If true, the remainder of the line is skipped. The 2-byte code for the FRE function is 255 143, and the code for SGN is 255 132. Byte 143 will be interpreted as a REM and byte 132 as a data code, which causes the rest of the line to be discarded.

To correct this, make the following changes:

(*text continued on page* 46)

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(text continued from page 44)

```
610 IF (C=143 OR C=132) AND COLD
    <> 255 THEN WHILE C
    <>0 ....
7050 COLD=C : C=ASC(C$(PTR))
```

The variable COLD contains the value of the previous byte. Line 610 will now check the new byte as well as the previous one.

Many thanks to J. A. Griffioen for this correction.

Typo Mars Listing

Sharp-eyed Ken Dawson of Louisville, Kentucky, found a typo in Kaare Christian's article "Inside a Compiler: Notes on Optimization and Code Generation" (February, page 349). Under the Pascal-86 code in listing 3 on page 358, change the second line in P7 to read

```
INC AX
```

Our thanks to Ken Dawson.

Bugs Blemish Character Editor

P. E. Burcher of Alexandria, Virginia, has reported a number of minor errors in Raymond A. Diedrichs's "A Character Editor for the IBM PC" (November 1983, page 467). For listing 1, Burcher recommends that you change FFREPEAT in line 1320 to FREPEAT and that you delete the word REM in line 3140. To avoid an unwanted scroll when the last line of the experiment page is displayed, change line 3160 to read

```
3160 IF I<EXPROW THEN PRINT
```

Also, correct the number 1024 to read 1023 in line 8065. This allows the BASIC interpreter and the Font Editor to read user-defined symbols correctly.

Like most programmers, Burcher couldn't resist the urge to tamper with a program. Listing 1 (presented here) is Burcher's prescribed patch for a more graceful exit to the BASIC command mode.

Raymond Diedrichs wrote us with an update of the Font Editor's initialization of the interrupt vector for newer PCs. (It's correct for older versions.) Change line 8070 to

```
8070 DEF SEG= 0: POKE 124,0:
     POKE 125, (TABLEADDR/256)
```

and add line 8071

```
8071 POKE 126,0: POKE 127,0
```

An improved copy of the Font Editor program is available to any interested readers who send Mr. Diedrichs a formatted disk and return postage.

Listing 1: *P. E. Burcher prescribes this patch for a more graceful exit to the BASIC command mode from Raymond Diedrichs's character-editor program for the IBM PC.*

```
1055 CLOSE: GOTO 9100          'STOP

9100 'RESTORE SOFTKEYS AND END
     GRACEFULLY

9105 KEY 1, "LIST": KEY 2,
     "RUN"+CHR$(13): KEY 3, "LOAD"
     KEY 4, "SAVE"+CHR$(34):KEY 5,
     "CONT"+CHR$(13)

9110 KEY 6, ","+CHR$(34)+"LPT1:"+
     CHR$4(34)+ CHR$(13): KEY 7,
     "TRON"+ CHR$(13): KEY 8,
     "TROFF"+ CHR$(13): KEY 9,
     "KEY": KEY 10, "SCREEN 0, 0, 0,
     "+CHR$(13)

9115 KEY ON: SCREEN 0, 0, 0: CLS

9120 END
```

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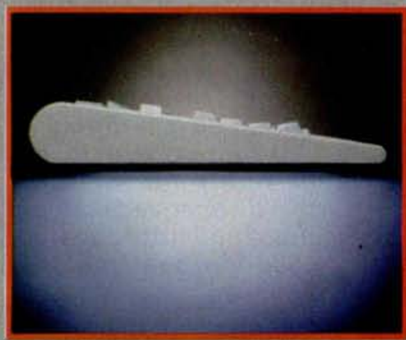

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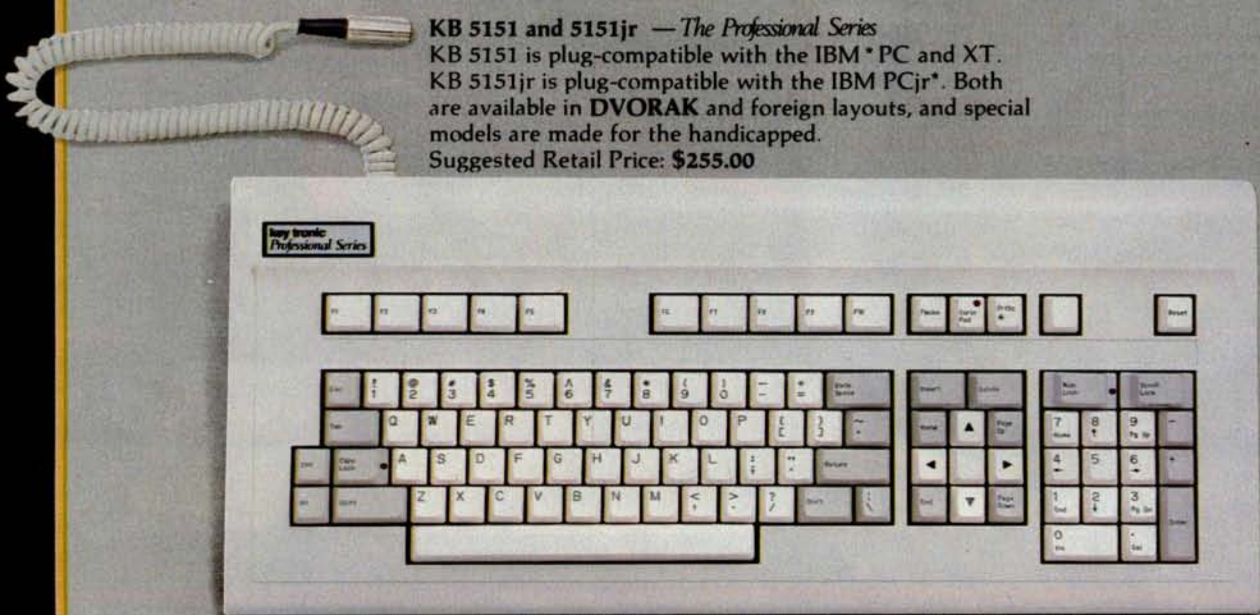

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Hicomp Corporation's MBM-550 Bubble Drive family gives you either 256K or 512K bytes of nonvolatile high-speed mass storage on a single card that plugs into any IBM PC's I/O slot. The MBM-550 is compatible with PC-DOS 1.1 and 2.0 and appears to the user, DOS, and applications software as an additional floppy disk. The MBM-550 can be used as a stand-alone unit or in conjunction with floppy and hard disks. With a Bubble Drive, you can store applications programs, programs that are disk intensive, or critical data.

Inasmuch as the MBM-550 is nonmechanical, it is practically maintenance free and many times more reliable than a floppy-disk drive. Nonvolatile bubble memory retains data without battery backup and is immune to dust, dirt, extreme temperatures, humidity, shock, and vibrations. These characteristics also make the MBM-550 bubble drives suitable for storing the DOS or programs and data files when the operating environment precludes the use of mechanical disk drives.

Write-protect and boot-enable switches are standard features of the Bubble Drives. The write-protect feature prevents stored files from being erased or written over, while the boot-enable lets you boot your PC from the drive.

Other features include a self-installation feature that automatically installs the Bubble Drive software after power-up.

The 256K-byte MBM Bubble Drive offers an average access time of 45 milliseconds and an average transfer rate of 17K bytes per second. The 512K-byte version has a 45-millisecond access time and a 34K-byte-per-second transfer rate. They list for $995 and $1495, repectively. An optional RS-232C port increases the price $50. Contact Hicomp Computer Corp., 5016 148th Ave. NE, Redmond, WA 98052, (206) 881-6030.

Circle 700 on inquiry card.

HP Laser Printer

Hewlett-Packard's LaserJet prints either text or graphics at a speed of eight pages per minute, or about 325 cps. This high-speed laser printer has an RS-232C interface so that it can be used with many personal computers, including the HP-150 and IBM PC. While graphics can be printed with a resolution of 300 by 300 dots per square inch, configuration software will be needed for most graphics programs. Although the printer is a version of Canon's LBP-CX, it adds a special intelligent interface card.

Priced at $3500, the LaserJet will compete with high-speed daisy-wheel printers. Type-font cartridges cost $200 each. The ink, toner, and drum come in a $99 cartridge, which has an estimated life of about 3000 pages. Contact your local Hewlett-Packard sales office, or call (800) 547-3400; in Oregon, (503) 758-1010.

Circle 701 on inquiry card.

Rainbow 100B

The Rainbow 100B is an enhanced version of DEC's dual-processor personal computer. The 100B includes 128K bytes of RAM (now expandable to 768K bytes), two 5¼-inch 400K-byte floppy-disk drives, dual Z80 and 8088 processors, and three expansion slots. An optional hard-disk drive can be added more easily than in the earlier Rainbow.

Bundled with the DEC Rainbow 100B are the CP/M-80, CP/M-86 version 2.0, and MS-DOS version 2.05 operating systems. Concurrent CP/M-86 is also available as an option for $150.

The DEC Rainbow 100B is priced at $2750 without keyboard or monitor. For more information, contact Digital Equipment Corp., 200 Baker St., Concord, MA 01742, (800) 344-4825.

Circle 702 on inquiry card.

Stand-Alone Videotex for the Pro 350

Pro/Videotex allows a Digital Equipment Corporation Professional 350 computer to be used as a stand-alone single-user videotex system. Screens of videotex graphics and text are stored on the system's 10-megabyte hard disk and can be recalled through menus, by keyword, or by page number.

Graphics and text are displayed using the NAPLPS protocol with a resolution of 768 by 240 pixels on a monochrome or color monitor.

The videotex database can be modified either by loading new information via floppy disk or by calling a remote mainframe computer. Pro/Videotex costs $895. It requires a Professional 350 computer with Pro/Communications software, the P/OS version 1.7 operating system, the extended bit-map graphics option, and a 10-megabyte hard disk. Contact Digital Equipment Corp., 200 Baker St., Concord, MA 01742 (800) 344-4825.

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A NAPLPS-coded image is displayed on the DEC Professional 350 computer's color display using Pro/Videotex.

(text continued on page 52)

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Eagle Turbo Reportedly Twice as Fast as IBM PC

The Eagle Turbo XL has network file-server capabilities and is said to be twice as fast as the standard IBM PC-compatible. Operating at 8 MHz, the Turbo XL is designed with the 16-bit Intel 8086 microprocessor and with a minimum of wait states. A 256K-byte computer, the Turbo XL comes with a 10-megabyte hard-disk drive and a 360K-byte IBM-format double-sided, double-density 5¼-inch floppy-disk drive. The processing speed is switch-selectable from 4.77 MHz to 8 MHz to accommodate a variety of programs.

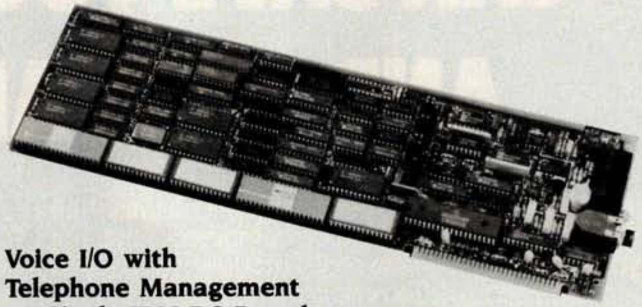
A detached 84-key Selectric-format keyboard is augmented with 10 function keys, a numeric pad, and LED indicators on all lock keys. Five IBM PC-compatible slots and a parallel port comprise the Turbo XL's expansion capabilities. Up to 512K bytes of RAM can be installed on the main circuit board.

A 12-inch, P39 green-phosphor monitor and a 13-inch RGB monitor are available. Both provide high-resolution displays (i.e., 720 by 352 pixels monochrome or 640 by 200 color) and 80 by 25 formats.

Additional options such as EagleNet 1 local-area networking software, monochrome adapter board, a color/graphics board, and interface ports are offered.

The Eagle Turbo XL costs $4995. Contact Eagle Computer Inc., 983 University Ave., Los Gatos, CA 95030, (408) 399-4200.

Circle **704** on inquiry card.



Voice I/O with Telephone Management on Single IBM PC Board

Votan's VPC 2000 Voice Card is a single plug-in card that provides the IBM PC with voice recognition, speech generation, and telephone-management functions. With its accompanying software, you can use the Voice Card for speech command and control of your existing IBM PC programs.

For each applications program, you can define and incorporate up to 64 voice utterances that are linked to a sequence of applications-specific keystrokes. Each keystroke can contain as many as 30 characters. Thus, you can replace cumbersome keystroke combinations used to activate a word processor or spreadsheet with the voice input of your choosing.

The Voice Card features Votan's continuous speaker-dependent recognition (CSDR), which lets you speak to your computer in a normal conversational flow, without pause between words. A word-spotting capability homes in on target words located anywhere within a stream of conversation. Rather than using fragmented grammar, a series of commands or data input can be issued using normal sentence structure.

Votan asserts that its technology is the only commercially available speech recognition that operates over telephone lines. These abilities let you talk to your IBM PC from remote locations and have it respond to your commands verbally. The Voice Card's telephone-interfacing capabilities include auto-answer, auto-dial, and Touch-Tone encoding and decoding. A supplied program gives you immediate access to these features. In addition, these abilities give you a voice-controlled telephone dialer and an automatic answering/voice mail system.

The VPC 2000 Voice Card is contained on a single printed-circuit board that plugs into any of the IBM PC's long auxiliary system bus slots. A microphone, speaker, software, and documentation are included in its $2450 list price. Contact Votan, 4487 Technology Dr., Fremont, CA 94538, (415) 490-7600.

Circle **705** on inquiry card.

Briefcase Computer's Integrated Software Has Windows

The IS-11 briefcase computer by Sord Computer of America comes with an integrated software package with multiwindow screens. Data handling, calculation, word processing, and communications capabilities are standard. The IS-11's six function keys provide access to these applications and to a Help key. Optional applications software, including financial, communications, and advanced word-processing programs, comes in 60K-byte ROM packs.

The IS-11's hardware features are 32K bytes of nonvolatile RAM, 64K bytes of ROM, and an 8-line by 40-character LCD display with an angle adjustment. A high-speed recorder provides mass storage; each tape can accommodate more than 128K bytes of data. The IS-11, built with CMOS technology, operates on rechargeable NiCad batteries. One charge is good for eight hours of operation. An AC adapter/battery charger is supplied. The unit weighs 4 pounds 6 ounces and measures 11$\frac{13}{16}$ by 8$\frac{7}{16}$ by 1$\frac{7}{16}$ inches.

A thermal printer, a numeric keypad with 16 additional function keys, and a micro-floppy-disk drive are options. The base price is $995. A version with a built-in modem will cost $1095. Contact Sord Computer of America Inc., 645 Fifth Ave., New York, NY 10022, (212) 759-0140.

Circle **706** on inquiry card.

(text continued on page 54)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$399 Modem Emulates Smartmodem Command Structure

The Signalman Mark XII modem emulates the Hayes Smartmodem's command structure. You can manually manipulate this answer/originate modem from your computer's keyboard or set it for automatic operation.

For Bell 103 compatibility, Mark XII can send or receive calls at 300 bps, while its 1200-bps data rate provides Bell 212A compatibility. The Mark XII detects dial tone and busy signals, automatically displaying the status.

An on-board CMOS microprocessor, an RS-232C serial interface with built-in cable, and dual telephone jacks are provided.

The Signalman Mark XII is $399. Further information is available from Anchor Automation Inc., 6913 Valjean Ave., Van Nuys, CA 91406, (213) 997-6493.

Circle 707 on inquiry card.

Color Display for PCjr

IBM recently introduced a color display monitor for its PCjr. In its 80-character mode, this direct-drive display is said to provide better character definition than a color composite-video monitor. Features include a 13-inch (diagonal) screen, 40- by 25-character mode, 320 by 200 lines, 16 colors, nonglare face, internal speaker, earphone connector, and front-panel controls. The display, which can tilt 10 degrees, can be placed on top of the PCjr system unit.

The IBM PCjr Color Display is $429. Contact IBM Corp., Entry Systems Division, POB 2989, Delray Beach, FL 33444.

Circle 708 on inquiry card.

DisplayWrite Software For IBM's Personal Computers

In a move intended to tie the IBM PC, PC XT, and PCjr more closely to the world of the company's larger computer systems, IBM has announced software for its personal computers that emulates many of the features employed by its minicomputer and mainframe computer word-processing systems and that can share files with those machines.

Both DisplayWrite 1 and DisplayWrite 2 have user interfaces that resemble those used by the DisplayWriter.

DisplayWrite 1 is a general-purpose menu-driven word processor for the full range of IBM personal computers. It requires DOS 2.1 and 128K bytes of RAM.

DisplayWrite 2 extends the features of DisplayWrite 1 by adding a spelling checker, automatic hyphenation and pagination, and merge functions. However, because it requires 192K bytes of RAM, it will not run on the PCjr. An optional legal dictionary is available for DisplayWrite 2.

Both programs can generate ASCII files; DisplayWrite 2 can produce output that is directly compatible with that of the DisplayWriter.

PCWriter for the PC, PC XT, and Portable PC is designed to look like and replicate most of the functions of word processing on the IBM 5520 Administrative System and the IBM System/23 Datamaster.

IBM will also market software called DisplayComm BSC for personal computers equipped with the IBM Personal Computer Binary Synchronous Communications Adapter, a minimum of 256K bytes of RAM, and an appropriate modem.

DisplayComm BSC provides emulation of IBM 2770/3780 and 2780 terminals and can be used to transmit DisplayWrite 2 files to the DisplayWriter as well as a selection of larger IBM systems.

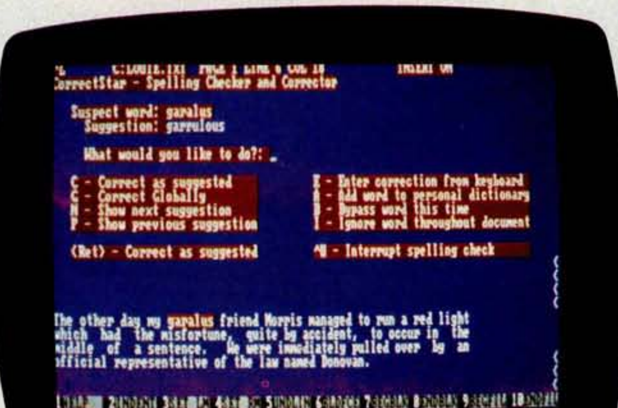
DisplayWrite 1 will sell for $95, DisplayWrite 2 for $299, DisplayWrite Legal Support (optional legal dictionary) for $165, PCWriter for $199, and DisplayComm BSC for $375. Contact IBM Corp., Information Systems Group, 900 King St., Rye Brook, NY 10573.

Circle 709 on inquiry card.

MicroPro Spelling Checker Features Phonetic Analysis

MicroPro International has unveiled a successor to SpellStar, the spelling checker sold as a complement to the company's WordStar word-processing package. The new program, named CorrectStar, is based on Houghton Mifflin's *American Heritage Dictionary*. Predictably, CorrectStar is fully interactive with WordStar—when it replaces a misspelled word in a WordStar file with a correction of a different length, the paragraph containing the error is reformed automatically and soft hyphens are inserted into text where appropriate. Corrections can be made one by one or replaced globally.

The program is a full-word checker; i.e., it uses no algorithms for attaching prefixes and suffixes to a list of roots, and hence is relatively foolproof. CorrectStar uses three dictionaries: a 9000-word basic vocabulary that it reads into memory, a main dictionary of 65,000 words kept on disk, and a user-generated 1500-word personal dictionary. Personal dictionaries for specific subjects can be maintained and used for different documents, and all dictionaries can be edited as if they were WordStar text files.



The major advance in spelling checker design, however, is CorrectStar's ability to suggest corrections based on phonetic similarities. For every word it can't locate in one of its dictionaries, CorrectStar recommends an alternative, and the program's algorithms enable it to "sound out" improbable spellings and achieve a high rate of success in determining replacements.

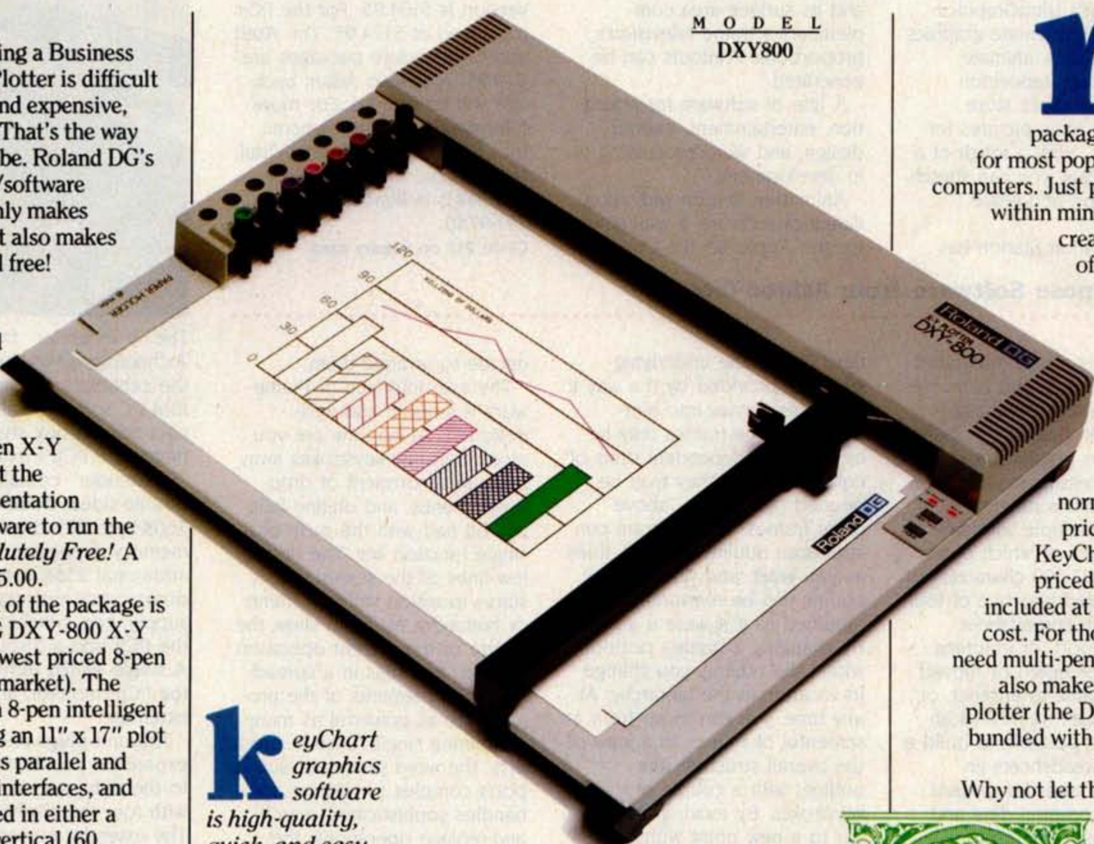
CorrectStar is available for the IBM PC, generic MS-DOS machines, the TI Professional, the DEC Rainbow, and the Tandy 2000. The memory requirement is 192K bytes of RAM. Suggested price is $195, and SpellStar owners will be able to purchase upgrades for $85. Contact MicroPro International Corp., 33 San Pablo Ave., San Rafael, CA 94903, (415) 499-1200.

Circle 710 on inquiry card.

(text continued on page 56)

Free and Easy

MODEL
DXY800



Using a Business Plotter is difficult and expensive, right? Wrong! That's the way things used to be. Roland DG's new hardware/software package not only makes plotting easy, it also makes part of the deal free!

During the months of April, May and June with the purchase of a Roland DG DXY-800 8-Pen X-Y Plotter, you get the KeyChart Presentation Graphics Software to run the plotter—*Absolutely Free!* A savings of $375.00.

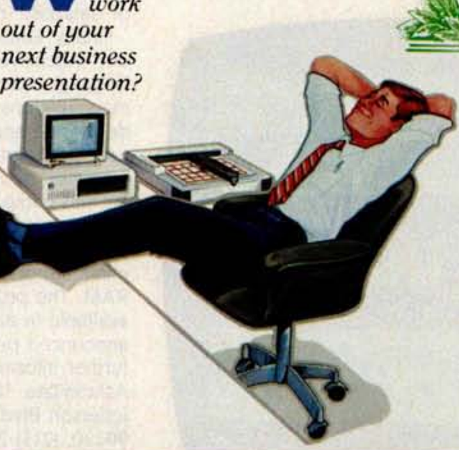
At the heart of the package is the Roland DG DXY-800 X-Y Plotter, (the lowest priced 8-pen plotter on the market). The DXY-800 is an 8-pen intelligent plotter offering an 11" x 17" plot bed, Centronics parallel and RS-232 serial interfaces, and can also be used in either a horizontal or vertical (60 degree inclined) position, to conserve your desk-top space. Use regular paper or even acetate to produce overhead projection graphics.

Next add KeyChart, probably the quickest, and easiest software program for generating presentation-quality business graphics. You don't have to be a programmer to use KeyChart. It is completely menu-driven and can provide automatic default values for every characteristic. Load in your data from the keyboard, or from almost any electronic spreadsheet, including Lotus 1-2-3.

KeyChart graphics software is high-quality, quick, and easy.

Why not take the work out of your next business presentation?

Thanks to Roland DG, KeyChart can come to you for free.



Roland DG's DXY-800 KeyChart package is available for most popular personal computers. Just plug it in, and within minutes you'll be creating the kind of graphics you thought might take days of programming. All of this comes to you for the DXY-800's normal low retail price of $995.00. KeyChart, normally priced at $375.00 is included at no additional cost. For those who don't need multi-pens, Roland DG also makes a single pen plotter (the DXY-101), also bundled with KeyChart for only $750.00

Why not let the Roland DG graphics system improve the quality of your business presentations? But you'd better hurry, this kind of free and easy dealing isn't going to last forever, just until June 30th.

For a dealer near you contact: Roland DG, 7200 Dominion Circle, Los Angeles, CA 90040, (213) 685-5141.

KeyChart is a trademark of SoftKey Software Products Inc. Lotus and 1-2-3 are trademarks of Lotus Development Corp.

Roland DG

Circle 288 on inquiry card.

Create Graphics with Tablet, Software

Suncom's Animation Station touch-sensitive graphics tablet and DataSoft's UltraGraphics software let you create graphics for presentations, animate screen displays, reposition words and symbols, store images, and draw pictures for the fun of it. With a touch of a finger or stylus, you can stretch, reshape, copy, and erase images.

The Animation Station has side-mounted dual left- or right-hand function buttons, and its surface area complements a home television's proportions. Printouts can be generated.

A line of software for education, entertainment, interior design, and word processing is in development.

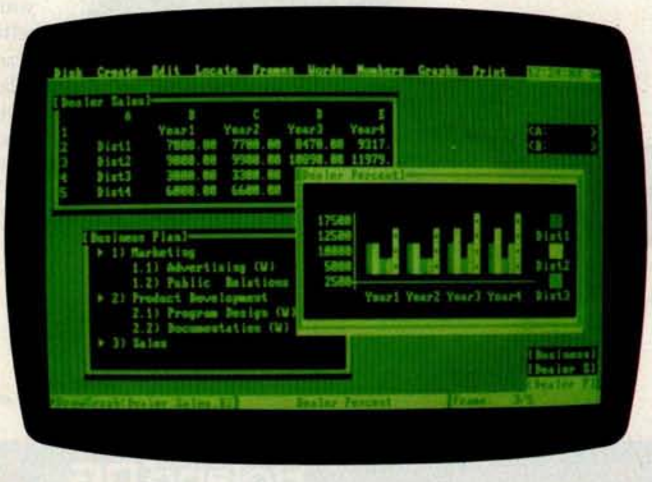
Animation Station with UltraGraphics software is available for the Apple IIe, the Commodore 64, the IBM PCjr, and Atari computers. The Apple IIe version is $104.95. For the PCjr, it's priced at $124.95. The Atari and Commodore packages are $79.95. A Coleco Adam package will be offered. For more information, contact Suncom Inc., Suite E, 650 Anthony Trail, Northbrook, IL 60062, (800) 323-8341; in Illinois, (312) 291-9780.

Circle 711 on inquiry card.

Multipurpose Software from Ashton-Tate

Framework is a fully integrated software package that combines word processing, database management, financial modeling, business graphics, and outline processing in a flexible windowing environment. Users can create multiple windows, or "frames," each of which contains up to 32,000 characters of data organized into one of four formats: text, spreadsheet, database report, or graphics. Data can be copied or moved from one frame to another, or linked between frames; as an example, it's possible to build a series of spreadsheets (in manageable units for output) that share common data and that recalculate themselves automatically when linked cells are modified. Though an individual frame can be treated as a complete file, the program is designed to allow frames of differing formats to be chained together into larger documents.

The heart of the program (and what gives Framework its great flexibility) is the underlying structure provided by the way it organizes frames into hierarchies. Single frames may be created as independent units of equal status, or they may be opened "within" or "above" other frames. The program constructs an outline of frame titles as you work, and the resulting outline can be rearranged or modified as if it were a text file. By changing a frame's position within the outline, you change its location in the hierarchy. At any time, you can move from a screenful of frames to a view of the overall structure (the outline) with a couple of keystrokes. By moving the cursor to a new point within the outline and reversing the process, you can shift rapidly to working in a frame that's far removed from your starting point. It's also possible to organize your work flow by first writing an outline and then creating the related frames one at a time, in any order you decide to arrange them.



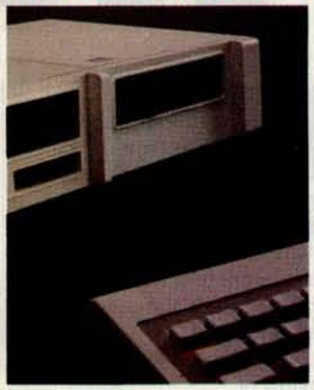
The user interface of Framework is smooth and well-designed. At no time are you more than two keystrokes away from an assortment of drop-down menus, and on-line help can be had with the push of a single function key. The bottom few lines of the screen report status (position within a frame or hierarchy, etc.) and show the nature of the current operation, e.g., cell formulas in a spreadsheet. All elements of the program are as powerful as many competing single-function products: the word processor supports complex formatting and handles sophisticated search-and-replace operations; the spreadsheet accepts intricate formulas and macro functions, either built-in or user-defined; the database manager is a table-oriented relational system that can also be used to generate views of existing dBASE II files; graphics can be derived from either spreadsheet or database information.

Finally, Framework includes its own extensive programming language; complicated manipulations can be developed and reused by any user or programmer.

Framework runs on the IBM PC and compatibles and requires only a two-floppy (double-sided) system with a minimum of 256K bytes of RAM. The program will be available in early July, at an announced price of $695. For further information, contact Ashton-Tate, 10150 West Jefferson Blvd., Culver City, CA 90230, (213) 204-5570.

Circle 712 on inquiry card.

Adult Power for PCjr



The "jr extender" from Falcon Technology gives the IBM PCjr the capability of running "real" IBM PC software—all in a compact add-on box styled to match the PCjr's exterior. The "jr extender" contains a second double-sided, double-density 360K-byte disk drive; sockets for memory expansion up to an additional 256K bytes of random access memory; a power supply; two switched outlets for the PCjr and a display monitor. A single switch turns on or off the PCjr, monitor, and "jr extender."

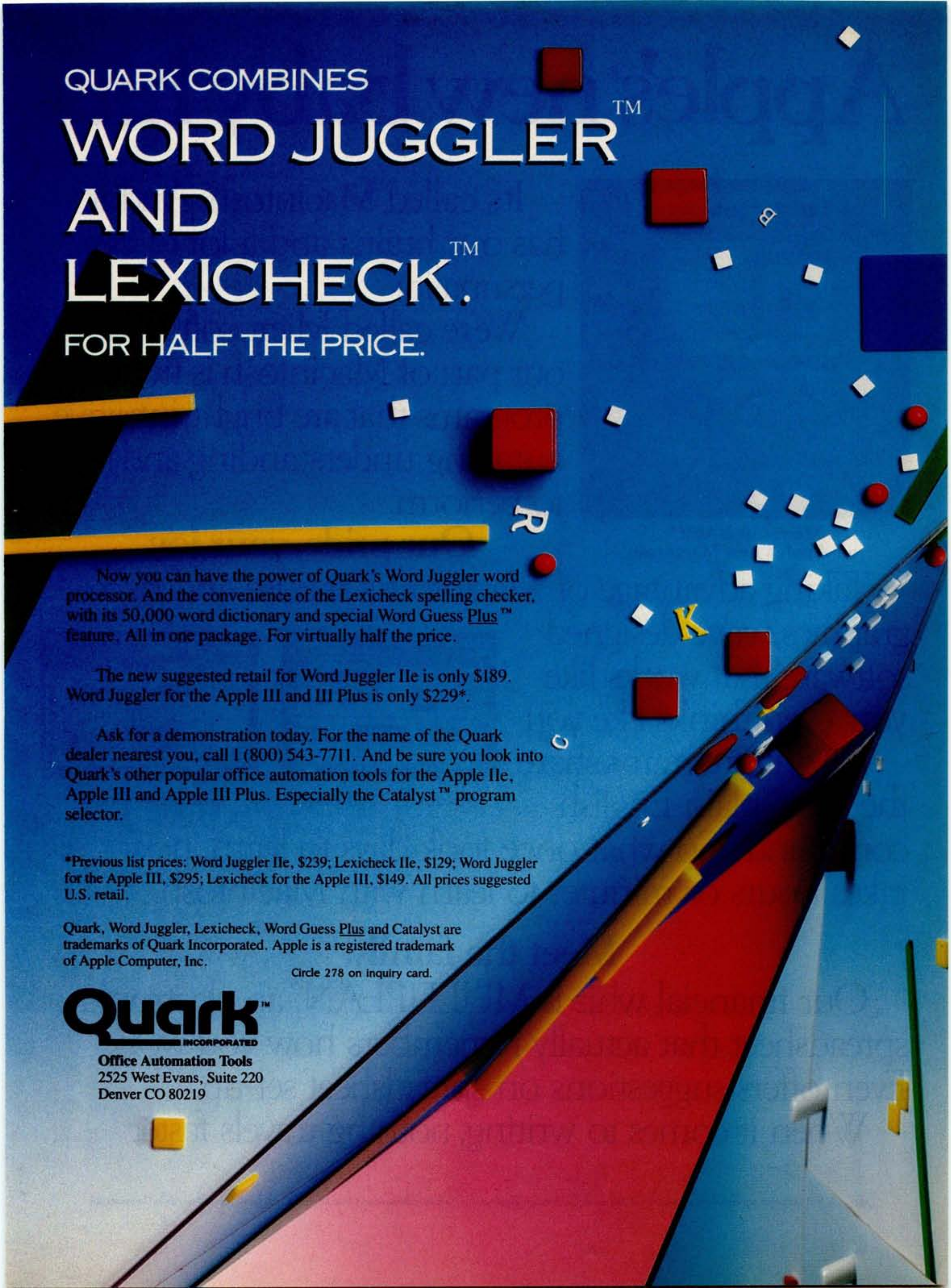
The unit plugs into the PCjr's expansion port and attaches to the right side of the PCjr with four thumbwheel screws. The extender comes with a version of DOS 2.1 enhanced to accommodate the modifications.

As an option, you can purchase a lithium-powered clock and mouse port combination; you can attach either the two-button Microsoft mouse or a licensed version of the same product from Falcon. The clock board has an automatic timer function that allows you to preset the system to perform a task at a specific time.

The "jr extender" will retail for $995. No fixed prices were available for the options at press time, but a company spokesperson estimated that the clock/mouse port would sell for around $100, and the mouse for approximately $175. Contact Falcon Technology Inc., Suite T-101, 6644 South 196th St., Kent, WA 98032, (800) 722-2510; in Washington, (206) 251-8282.

Circle 713 on inquiry card.

(text continued on page 468)


QUARK COMBINES
WORD JUGGLER™
AND
LEXICHECK™.
FOR HALF THE PRICE.
Now you can have the power of Quark's Word Juggler word processor. And the convenience of the Lexicheck spelling checker, with its 50,000 word dictionary and special Word Guess Plus™ feature. All in one package. For virtually half the price.
The new suggested retail for Word Juggler IIe is only $189. Word Juggler for the Apple III and III Plus is only $229*.
Ask for a demonstration today. For the name of the Quark dealer nearest you, call 1 (800) 543-7711. And be sure you look into Quark's other popular office automation tools for the Apple IIe, Apple III and Apple III Plus. Especially the Catalyst™ program selector.
*Previous list prices: Word Juggler IIe, $239; Lexicheck IIe, $129; Word Juggler for the Apple III, $295; Lexicheck for the Apple III, $149. All prices suggested U.S. retail.
Quark, Word Juggler, Lexicheck, Word Guess Plus and Catalyst are trademarks of Quark Incorporated. Apple is a registered trademark of Apple Computer, Inc.
Circle 278 on inquiry card.
Quark™ INCORPORATED
Office Automation Tools
2525 West Evans, Suite 220
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Apple's® new baby has

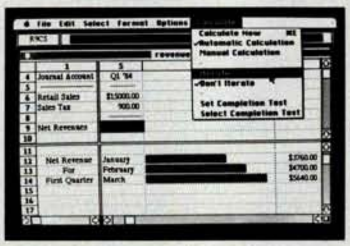
Microsoft BASIC
on Apple's new Macintosh

It's called Macintosh.™ And it has our brains and a lot of our personality.

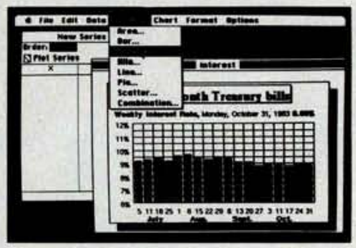
We're called Microsoft.® And our part of Macintosh is five new programs that are bright, intuitive, outgoing, understanding and born to perform.

Our pride, your joy.

Taking advantage of Macintosh's mouse and rich graphics, we've designed software that works like you, even thinks like you.



Microsoft Multiplan



Microsoft Chart

All our programs share the same plain English commands. So what once took days to learn, now takes hours or minutes to learn with Macintosh.

Meet the family.

Our financial whiz is MULTIPLAN,® an electronic spreadsheet that actually remembers how you work. Even offers suggestions on spreadsheet set-up.

When it comes to writing, nothing travels faster

our best features.

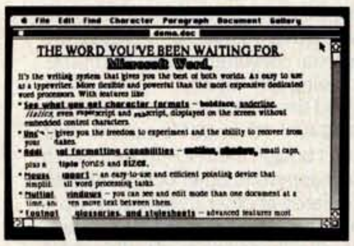
than our WORD. Using the mouse, it lets you select commands faster than you can say "cheese."

Our most artistic child is CHART. It gives you 40 presentation-quality chart and graphic styles to choose from.

FILE is our most manageable child, an advanced personal record management program.

MICROSOFT.
The High Performance Software

And BASIC, the language spoken by nine out of ten microcomputers worldwide, is the granddaddy of them all. Now enhanced to take advantage of the Macintosh mouse, windows and graphics.



Microsoft Word

Microsoft File

We'll be adding more to the family soon. So call 800-426-9400 (in Washington State call 206-828-8088) for the name of your nearest Microsoft dealer.

RS-232C for the Apple IIe

Dear Steve,

I would like to build an RS-232C card for my Apple IIe to use with your modem described in the March 1983 BYTE ("Build the ECM-103, an Originate/Answer Modem," page 26). Just what would be involved? Could you recommend a good reference? Thanks.

TONY SIMON
St. Paul, MN

An article in a back issue of the Amateur Computer Group of New Jersey (POB 319, South Bound Brook, NJ 08880) newsletter should answer your need for an RS-232C serial interface for your Apple IIe computer. "An Apple II Serial Interface" by Jeff Galinat, while written for an Apple II, will work equally well on your IIe. The circuit need not be copied exactly, and sufficient information is provided if you wish to customize it. The MC14411 bit-rate generator chip, which is rather expensive, can be replaced with one of the less expensive versions on the market.—Steve

Stalking the MCL1303

Dear Steve,

I recently decided to build your breakout box ("Build an RS-232C Breakout Box," April 1983 BYTE, page 28), but I'm having trouble locating a source for the MCL1303 diodes. Can you help? Thank you.

GARY GLASSCOCK
Renton, WA

The MCL1303 diode is a field-effect current-limiting diode manufactured by Motorola. It is designed for applications requiring a current reference or a constant current over a specified voltage range. It can be obtained from any Motorola distributor.—Steve

More on Line Filters

Dear Steve,

In your December 1983 Circuit Cellar project ("Keep Power-Line Pollution Out of Your Computer," page 36), you show how to modify a four-outlet power strip for better protection. How can I modify a six-outlet power strip?

MILES RINEHART
Hoffman Estates, IL

Because all four outlets are in parallel, it does not matter where the MOVs (metal-oxide varistors) are placed. While figure 1 on page 43 shows the MOVs ahead of the sockets, each is protecting an entire side of the line and can be installed in any convenient manner. For a six-outlet power strip, any three positions will be adequate. The important thing is to connect an MOV to each side of the line and across the line.—Steve

LCD Sources

Dear Steve,

I'd like to build or buy an LCD (liquid-crystal display) that shows a 16-character message whose content depends on the presence/absence of voltage on 10 input lines. Can you provide some information? Thank you.

KEVIN DWAN
Nevada City, CA

My article on page 54 in the February 1983 BYTE, "Build a Handheld LCD Terminal," featured a 16-character LCD that should suit your applications. Two sources for such a display are AND Inc., 770 Airport Blvd., Burlingame, CA 94010, (415) 347-9916 (for its Model 1811) and Epson America Inc., LCD Division, 23155 Kashiwa Court, Torrance, CA 90505, (213) 534-0360 (for its Model MA-B955B).

Interfacing and scrolling can be simplified by using the CY300 LCD controller chip from Cybernetic Micro Systems, POB 3000, San Gregorio, CA 94074, (415) 726-3000.—Steve

Home-Security Resources

Dear Steve,

My home recently fell prey to burglars, and my fairly expensive computer is gone. I'd like to use my old computer to guard my house while I'm away. Can you recommend any good publications to help me computerize a home-alarm system? Any help would be appreciated.

MARC WEIGEL
Delta, British Columbia, Canada

Home security is a high-technology field. The abundance of low-cost microprocessors has produced a plethora of devices to protect any given area. Reasonably priced sensors are available to detect motion, heat, smoke, noise, and vibration, as well as the simple opening or closing of a door or window. Before a computerized alarm system can be designed or installed, you must first decide on the level of protection that you need and the price that protection costs. I wrote a series of articles in the January–March 1979 issues of BYTE that describes a security system built and installed in my home. In it, I discuss the philosophy of protection, typical sensors and where to mount them, circuit diagrams, flowcharts, and a computer program to control the system. This series of articles has been reprinted in Ciarcia's Circuit Cellar, Volume II.

An excellent source for security devices is Mountain West. Its catalog features a complete line of burglar-alarm controls, switches, sensors, wiring aids, and advice. Write for a copy to Mountain West, 4215 North 16th St., POB 10780, Phoenix, AZ 85064.—Steve

Two Questions

Dear Steve,

I have a Zenith Z-90 with two disk drives and three serial ports. My printer is on the blink, and I have gone to a backup system (a Royal typewriter). Most of the printers here are the Centronics parallel type, and my Zenith has only serial ports. I was wondering if I could construct a serial-to-parallel converter like the one in your September 1981 article on the Votrax phoneme synthesizer. Will that logic drive a printer as well? Would it be easier to make a whole new port? I am worried about having to change the BIOS. Commercial converters run around $100. Would I be saving any money?

I have noticed that some equipment will run on either 110–240-V, 50- or 60-Hz current. That was the reason I bought the Z-90—it has a switch for that. What happens to other power supplies if they are not rated at other frequencies? Voltage differences are usually amenable to transformers, but what happens to my disk drive when I run it at 110 V, 50 Hz? The drive itself takes only DC, so the only problem should be the power supply. I've been told that it can be damaged.

I once had an old Hammarlund Super Pro receiver with a monstrous power supply that would go to 25 Hz. Was its size related to those capabilities? Thank you.

JONATHAN YUEN
Taiwan, Republic of China

The circuit shown on page 48 of the September 1981 BYTE can be used to convert the serial output from your computer to a parallel input for a Centronics-type printer. The conversion is accomplished completely with hardware; no software is required.

In a transformer-type power supply, the frequency rating is a function of the amount of iron in the transformer core. Transformers rated at 60 Hz will run hot at 50 Hz—and could possibly burn up. If the unit is rated at 50 Hz, it will operate safely at 60 Hz. That 25-Hz power supply of yours was monstrous due to the size of the iron core of its power transformer. Units rated for 110–220 V have a dual primary wind-

(text continued on page 62)

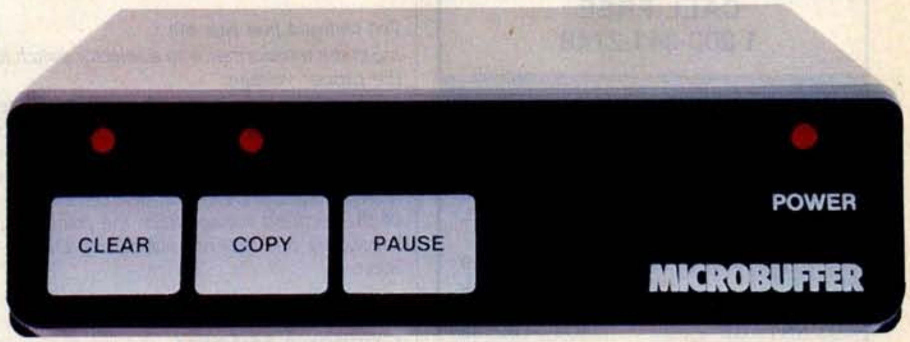
WAIT REDUCTION MADE EASY.

You know how hard it is to wait for the printer to finish before using the computer again. It's wasteful! Counter productive!

The solution: simply install Microbuffer™ printer buffer into the system, in seconds. And you can print and process simultaneously.

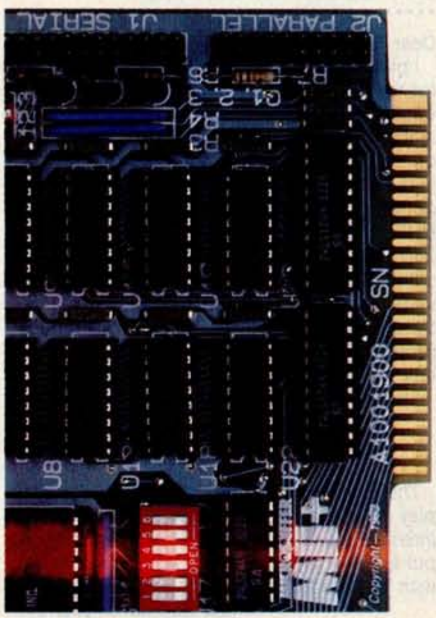
With one swift command, all printing data is dumped to the Microbuffer—it handles the printer and frees the computer for other functions.

Presto! Instant wait reduction.



Microbuffer II and II+ for the Apple II, II+, and IIe computers.

Microbuffer II comes in either a serial or a parallel version with 16K or 32K of RAM. Microbuffer II+, available with 16K, 32K or 64K, has both serial and parallel capabilities, so you can control two different printers at once. The Microbuffer II+ has on board high resolution graphics routines for 37 popular printers, and all include expanded graphics capabilities and text formatting in addition to the inherent benefit of letting you use your computer while your printer is working.

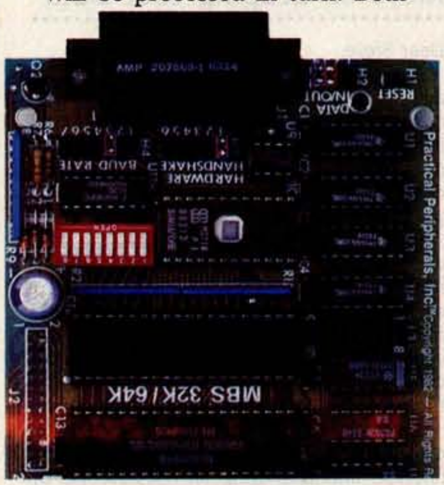


Microbuffer In-line for virtually any computer/printer combination.

These are stand-alone units that install In-line between virtually any computer and printer.

Besides printer buffering, the In-line serial interface (MBIS) can be used to efficiently transmit data from the computer to almost any device using a serial RS-232C interface. The parallel Microbuffer In-line (MBIP) is built exclusively for parallel interfacing, and works exceptionally well in virtually any parallel computer and any parallel printer.

Each of the stand-alone models have controls for making multiple copies (up to 255). With the pause control, printing may be halted at any point and continued later—it will pick up right where it left off. Even while you are printing copies of a document, additional files can be sent to the buffer and they will be processed in turn. Both come with either 32K or 64K of RAM, and are easily upgradable up to 256K for processing greater amounts of data.



Microbuffer/E for Epson printers.

Fully compatible with Epson MX, FX, RX, and IBM-PC series printers, these easy-to-install boards simply plug inside the printer.

For parallel interfaces, the Microbuffer models MBP-16K and MBP-64K are available.

For serial interfacing, Microbuffer models MBS-8K and MBS-32/64K are available. The MBS-8K supports both hardware and software (X-ON/X-OFF) handshaking; the MBS-32/64K supports three handshaking configurations (hardware, software X-ON/X-OFF and ETX/ACK).

SO WHAT ARE YOU WAITING FOR?

PRACTICAL PERIPHERALS

31245 La Baya Drive
Westlake Village, CA 91362 USA
(213) 991-8200 • TWX 910-336-5431

(text continued from page 60)

ing in the transformer with a selector switch for the proper voltage.

The voltage ratio is not substantially affected by small changes in frequency. Running a 50-Hz supply on 60 Hz will yield the same output voltages, so equipment operation is not affected. Your computer and disk drives run off of the rectified voltage from the transformer secondary and will not notice any change.—Steve

More on the Carrier-Current Modem

Dear Steve,

In regard to your article "Build a Power-Line Carrier-Current Modem" in the August 1983 BYTE (page 36), I have some questions. What is the minimum separation required for mark and space frequencies? Do you have any kits or circuit boards available? Thanks for your help.

Brent Lowensohn
Woodland Hills, CA

EXAR Application Note AN-01 gives several guidelines for designing with its XR-2206 modulator and XR-2211 demodulator. One of these relates to minimum bandwidth: "For any given pair of mark and space frequencies, there is a limit to the baud rate that can be achieved. When maximum spacing between the mark and space frequencies is used (where the ratio is close to 2:1) the relationship mark-space frequency difference (Hz) ≥ 83 percent (maximum data rate in baud). For narrower spacing, the minimum ratio should be about 67 percent."

Thus, the minimum spacing for 300 baud would be 0.67 × 300 = 200 Hz, and this is the separation used in the 103-type modem format. Because, in the carrier-current modem, adequate bandwidth was available and a higher center frequency was used, the 5-kHz separation was a convenient choice.

The power-line carrier-current modem is not available as a kit, and no circuit boards have been configured.—Steve

More on Scoping Your Data

Dear Steve,

I just read the December 1983 "Ask BYTE," and on page 560 you seem to give some bad advice to Mr. Chuck Gollnick of Pullman, Washington, regarding the use of an oscilloscope to determine the data rate, parity, and stop-bit characteristics of data coming from an RS-232C port.

Specifically, you recommend the use of a character with lots of consecutive 1s to determine the data rate. This would work great if RZ signaling was used. But RS-232C uses NRZ-L signaling; what is thus needed is a character with *alternating* 1s *and* 0s to make it possible to see distinct opposite-polarity pulses. For example, the character 01010101 = U would be useful.

I have successfully determined the stop-bit characteristics of Baudot signals from a radioteletype interface using an oscilloscope by watching the display for extra-length bits. If you see a bit 1.5 times longer than the shortest one seen, you know it is 1.5 stop bits. By slowing the sweep so that one or two characters are seen on the display, you may also be able to come up with the stop-bit characteristics.

Robert French
District Heights, MD

You are correct. The transmission of alternating 1s and 0s will simplify the measurement of data rate using an oscilloscope. A series of Us is a good choice. Your method of determining stop-bit characteristics is sound and should work on an ASCII signal (7 data bits) as well as the Baudot (5 data bits). Thank you for your correction and clarification.—Steve

Cleaning Disk Drives

Dear Steve,

I recently noticed the large number of ads for disk-drive cleaners. This sparked two questions I'd like to have answered. How much attention do disk drives require, and what type of cleaner is best for them? Thank you for your help.

Brian Gragg
Claremont, CA

The iron-oxide coatings used on most disks are somewhat abrasive. The in-out motion of the read/write head of the disk drive against this rotating medium produces a self-cleaning action and minimizes the buildup of oxide and dirt. Unless a poor-quality medium is used, head cleaning is not required often and can be accomplished with a cotton swab and some isopropyl alcohol, as well as the many head-cleaning disks available. Some head-cleaning disks are quite abrasive and should be used on an as-needed basis rather than at regular intervals.—Steve

E-Z Color In Kuwait

Dear Steve,

I plan to buy the E-Z Color Graphics Interface for my TRS-80 Model I. I am not certain, however, whether it can be used with a TV set here in Kuwait because the TV system here is based on the PAL color system and not the NTSC, as in the United States. Can the composite-video output from the TMS9918A chip be fed to a UHF modulator and the modulated RF to a 256-line PAL color TV set?

If the TMS9918A is not suitable to drive a PAL system, is there a similar chip that could be substituted in your E-Z Color Graphics Interface project in the August 1982 BYTE, "High-Resolution Sprite-Oriented Graphics," page 57?

Thank you for your time and assistance.

M. I. Saleem
Safat, Kuwait

The Texas Instruments TMS9918A Video Display Processor used in the E-Z Color Graphics Interface is designed for a composite-video output to the NTSC format and is not compatible with a PAL TV system. A similar chip, the

(text continued on page 64)

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(text continued from page 62)

TMS9929A, is pin compatible except for four pins and outputs luminance and color-difference signals that can be combined through a video encoder (such as the National Semiconductor LM1889) to produce a 625-line PAL composite-video signal. This signal can be fed through a modulator to your color TV or additional circuitry added to use the modulator feature of the LM1889.

The video-encoder circuit requires modification of the E-Z Color Card and the addition of extra components.—Steve

Hardware Training Program

Dear Steve,

I would appreciate your comments on the value of hardware training programs. Over the last few years I have done some work with software, but I would now like to investigate hardware design. Any information you have would be appreciated.

Michael R. Forry
Newport Beach, CA

The Heathkit hardware training courses are an excellent means of learning electronic hardware operation and design. Heath's documentation is famous for being clear and thorough, and the hardware breadboard trainers give you the "lab" work so necessary to support the theory. You can proceed at your own pace and tailor your studies to your particular interests.

In addition to the Heathkit courses, other schools offer at-home training in electronics. Two of them are NRI Schools, McGraw-Hill Continuing Education Center, 3939 Wisconsin Ave., Washington, DC 20016 and National Technical Schools, 4000 South Figueroa St., Los Angeles, CA 90037. Write them for further information.—Steve

Basic Video

Dear Steve,

I'd like to ask a couple of questions on everybody's favorite topic—video monitors. What do references to column widths mean in ads for monitors? Some just list monitors, but others advertise 40-, 60-, or 80-column monitors, as if they're talking about printers. I'm thinking of adding a monitor driver to my Radio Shack Color Computer, connecting it to a monochrome monitor, and using it with the Telewriter word-processing program. Because Telewriter's highest resolution provides an 85-character line, do I need an 85-column monitor (I've never seen one advertised), or do I need to worry about such things at all, considering that the program uses the high-resolution-graphics mode to draw the letters on the screen?

I've seen three green-screen monitors in the $100 price range. Can you comment on and/or recommend any of these, or are all $100 monitors pretty much equal?

With monitors available in the $100 price range, is it worthwhile considering converting a TV into a monitor by bypassing the tuner and other circuits, or is that more trouble than it's worth?

Duff Kennedy
Santa Barbara, CA

With all the letters pertaining to video monitors that I've recently received, it must be everybody's favorite subject.

Column width is a simplified means of relating the video bandwidth of monitors. Many computers are designed to be used with a TV set and display only about 40 characters per line. This occurs because a TV set's bandwidth is restricted (TV channels are only 6 MHz apart, and the video bandwidth is about 3.5 MHz) and cannot clearly display more than this number. Monitors advertising 40-column width are comparable to a TV set.

Word processing requires an 80-column line to completely fill a standard sheet of 8½- by 11-inch paper, and monitors that can display this

(text continued on page 66)

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Tallgrass Technologies Corporation

(text continued from page 64)

many characters need increased bandwidth. Whether they are advertised as 80- or 85-character displays is not important; the ad is telling you that they have the bandwidth to display a full line.

Rather than comment on the $100 monitors, I refer you to the October 1983 Consumer Reports. *Pages 537–540 feature an article on choosing a monitor and include comparisons of several monitors in the $100 price range.*

Finally, it is more trouble than it is worth to convert a TV into a monitor, especially if proper grounding and isolation techniques are not used. The risk of electric shock or an unwanted ground loop fed back into your computer can more than offset the cost of a good monitor.—Steve

Multiprocessing Help

Dear Steve,

I want to build a multiuser, multiprocessor, CP/M-oriented computer in which each user has a microprocessor and 64K bytes of RAM. I know enough about CP/M to write the BIOS (basic input/output system), and that once a bootstrap loader is written to load CP/M from disk to memory and to transfer execution to CP/M, I am home free. But because I have never used a multiprocessor computer, the concept is unclear to me as to what is going to happen when two users try to access the same disk or file simultaneously.

Once I physically configure the system, however, how can I use it to write the CP/M and bootstrap loader and save it on a floppy disk starting on sector 0, track 1? Also, can I be sure that the automatic power-up sequence in the floppy-disk controller will load the bootstrap loader in at location 80 hexadecimal and transfer execution there?

My main problem is that in this part of the world I can't get any book I need or pop into the local computer store for questions. I would really appreciate your help on this.

Tariqul Hasan
Dhaka-2, Bangladesh

In a multiuser CP/M system, each user is assigned a user code number from 0 to 15. The user numbers are assigned using the built-in CP/M function called USER. Once a user number is assigned, the user can access only files on the disks with that user number. It is not necessary to set aside disk space for each user because the user number is assigned to the file when it is put on the disk. When a cold start is performed, each user is assigned to user 0 and can access only programs in that user area until a different user number is assigned with the USER command.

When a system operates with CP/M, the instructions for initiating the system usually come with the microprocessor hardware or with the CP/M software you receive with the microprocessor. If these instructions do not come with the system you purchase, it would be a good

(text continued on page 68)

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Circle 306 on inquiry card.

(text continued from page 66)

idea to purchase a reference guide that shows you how to write a bootstrap loader. A good manual on the subject is The Programmer's CP/M Handbook *by Andy Johnson-Laird. For information on translations and book distributors outside the U.S., write to Osborne/McGraw-Hill, 2600 Tenth St., Berkeley, CA 94710.*

In general, the bootstrap loader for a system resides in a PROM or an EPROM that is bank-switched into the memory address space starting at address 0000 hexadecimal. When a hardware reset is performed, the microprocessor looks at this address for its first instruction. If the bootstrap were not in firmware, a boot program would have to be written each time the system was reset. The program must load the CCP (command control processor), BDOS (basic disk operating system), and BIOS from disk and then transfer control to the cold-boot entry point in the BIOS. Hardware manufacturers usually offer this firmware with the CP/M system they are selling.

For further information on this subject, you should purchase the manuals for the particular system that you intend to buy.—Steve

Communication Without Wires

Dear Steve,

You are no doubt extremely familiar with most input and output devices. My project involves the transmission of data from one computer to another (I am using two VIC-20s). The catch is that I will try to achieve this without using wires, i.e., transmitting data without having the two machines connected.

I realize that connecting computers and peripherals by infrared light has already been accomplished, therefore I am considering using the radio spectrum as a means of transmission.

My best bet would probably be to utilize the RS-232C interface for my actual transmission and reception. The concept would involve (from what I understand) converting the parallel signal to a serial, and then to an analog, which could be transmitted over a carrier wave to the receiving unit.

This is purely an idea. I have no working knowledge in the area and can only guess. I would value greatly your reflections on the subject. Thank you very much.

Dallas Kachan
Blind River, Ontario, Canada

Your idea of transmitting computer data via the radio spectrum is a form of radioteletype, which has been in use for years with a 5-bit code known as Baudot. Early devices were mechanical in nature and connected by wires. Radio transmission was achieved by connecting these mechanical units to a modulator for transmitting and a demodulator for receiving. Recently, the U.S. Federal Communications Commission approved the transmission of ASCII over the airwaves, which stimulated the application of computers to this form of communications.

The concept of radioteletype is analogous to Morse code, except that marks and spaces replace the dots and dashes. Where Morse code uses timing to distinguish dots from dashes, radioteletype uses frequencies to distinguish marks from spaces. Data is converted into a serial stream, modulated into audio tones, and then transmitted. On the receiving end, these tones are demodulated and decoded into data.

This system operates much as a modem connects two computers via a telephone line. In the February 1981 BYTE, I wrote an article on controlling a Big Trak computerized toy tank (page 44). I used a pair of inexpensive citizens band walkie-talkies to send data via the airwaves using a modem. A small, inexpensive modem, described on page 26 in the March 1983 Circuit Cellar article "Build the ECM-103, an Originate/Answer Modem," simplifies the project by reducing the number of components involved.—Steve

Advanced Video

Dear Steve,

In an "Ask BYTE" letter from D. K. Broberg ("Calculating Bandwidth Revisited," November 1983, page 602), the argument was made that the video bandwidth required of a video pixel stream can be obtained not as the inverse of the pixel rate but as the inverse of half the pixel rate. The reasoning was that driving alternating pixels fully on and fully off represents the worst-case demand for bandwidth, so the inverse of the two-pixel period yields the frequency of interest.

This argument is not correct. If the video-stream pixels could be accurately represented by sine waves or contiguous half-cycles of sine waves, Broberg would be quite right. However, a harmonic structure is associated with any kind of waveform other than sines, and a pixel stream requires a better representation than sines in order to preserve edge definition in the image. Ideally, the pixel stream would show instantaneous jumps from the amplitude level for one pixel to the amplitude for the next. At worst, this would result in a square-wave period equal to two pixel times. However, the bandwidth is not 1/(two pixel times). Fourier analysis shows that a square wave contains all odd harmonics. To get an acceptable picture, it is necessary for the video amplifiers to pass the third harmonic, which is at 3/(two pixel times). For a pixel time of 100 nanoseconds, this requires a video bandwidth not of 5 MHz, but of 15 MHz.

Robert P. Colwell
Pittsburgh, PA

Thank you very much for your response to D. K. Broberg's letter. The harmonic content of square waves is often overlooked in digital analysis when only levels are of concern. As you correctly point out, however, third-harmonic distortion should be kept low, and a video-amplifier bandwidth sufficient to pass these fre-

(text continued on page 70)

(text continued from page 68)
quencies should be used. A general rule would be to use as high a bandwidth as possible but settle for any monitor that you visually judge to have a satisfactory display.—Steve

Shugart SA-400s for Apples

Dear Steve,

I have an Apple II with one 5¼-inch Apple disk drive. I'd like to use my Apple with a Shugart SA-400 drive. I know these components are incompatible, but can you show me how to create a proper interface? Thank you.

CLAUDIO PUGLIESE
Buenos Aires, Argentina

A printed-circuit board and complete instructions for modifying a Shugart SA-400 disk drive for use with your Apple II can be obtained for $29.95 from R & D Electronics, 100 East Orangethorpe, Anaheim, CA 92801, (714) 773-0240.

Several traces on the SA-400 printed-circuit board must be cut and several jumper wires installed in addition to the interface-circuit board that connects between the Apple II cable and the 34-pin edge connector on the SA-400.

It is important to note that the SA-400 and this modification draw about 450 milliamperes from the Apple II's +5-V supply. If your system has many expansion cards, you may want to consider a separate power supply.—Steve

Replacing 4116s with 4164s

Dear Steve,

I have an Atari 400 with the 16K-byte memory board. I would like to know if it is possible to change the 4116 memory chips to 4164 chips, add some jumpers, and have a 64K-byte board. Thank you for your help.

RANDY B. BUMGARNER
Taylorsville, NC

In theory, upgrading from the 4116 to the 4164 is as simple as adding a few jumpers if the memory system was originally designed to do this. In most cases, it is more complicated.

The 4116 used a three-voltage power-supply system that was changed to a single +5-V supply for the 4164. This left two extra pins that could be used for addressing. On the 4164, only one of these pins was needed to upgrade the chip to a 64K-byte part. The following chart shows the reassignment of the pins:

Pin	4116	4164
1	−5 V	N.C.
8	+12 V	+5 V
9	+5 V	A7

Pin 1 can be handled easily by cutting the −5-V trace on your board that goes to your memory array. Pin 8 can be reassigned by cutting the +5-V and +12-V traces to your memory array and jumpering the trace from pin 8 to the +5-V supply. The trace from pin 9 now will be your new address line, and all decoupling capacitors on this line in your memory array must be removed.

That was the easy part. Now the memory address multiplexing portion of your board must be modified to bring in the new address line A7. Because I am not familiar with the addressing used on the Atari board, I can only suggest that you look over that portion of the circuit carefully before making any changes. An error here will be disastrous. You also must be careful that your new 64K-byte memory does not conflict with any other memory already assigned in the system, for example, any ROM or memory-mapped I/O devices.—Steve

Real-Time Clock Thoughts

Dear Steve,

I'd like to suggest a project for your Circuit Cellar.

I lust after a real-time clock for my IBM PC, but all my expansion slots are full of other
(text continued on page 74)

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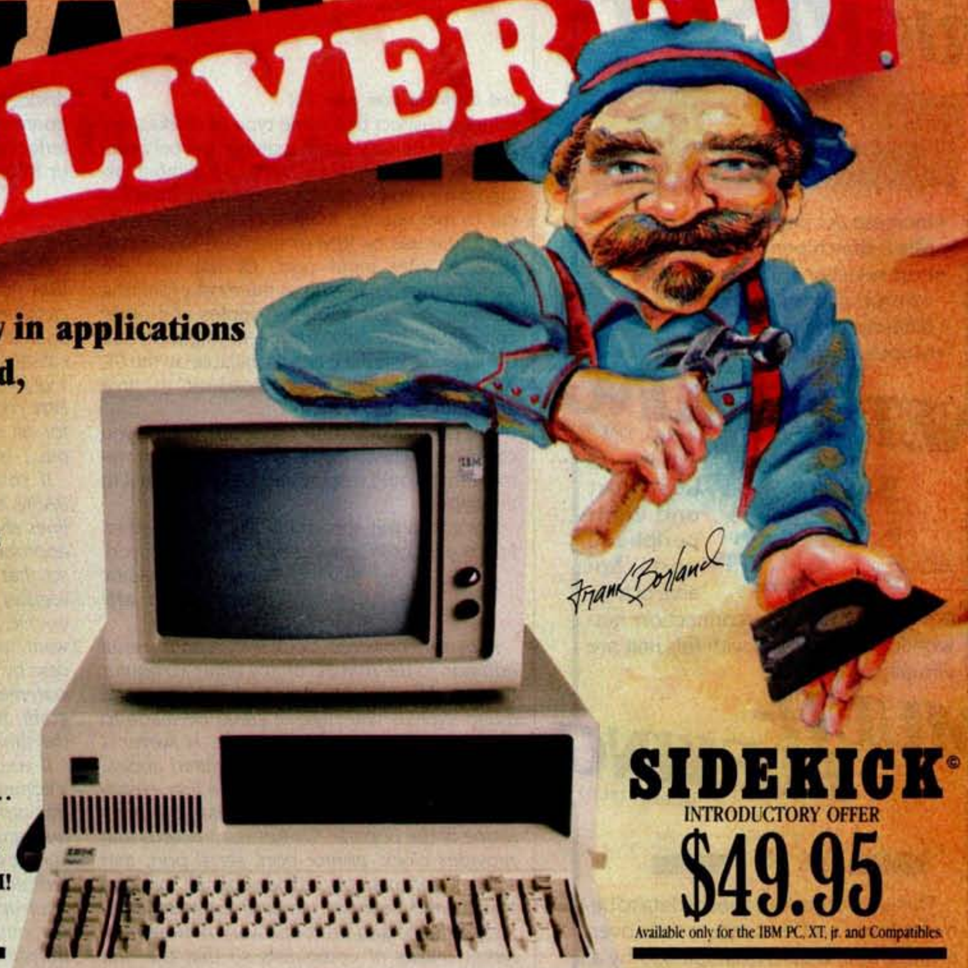

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(text continued from page 70)

things. I suspect that some type of clock/calendar would be easy to put together, the only consideration being how to interface it without taking up an expansion slot. Two possibilities occur to me: use the ROM socket(s) "reserved" for future use by IBM or interface to the cassette-recorder input port. Of the two, the cassette idea strikes me as the most promising because it might apply to Apples and other computers. The only drawbacks might be that the cassette interface is not available on the PC XT and that the clock must "broadcast" the time and date serially.

The project would be especially neat if you could use a cheap digital clock or watch movement that would display and be set external to the system.

If you can put something like this together, I think a lot of PC owners would be overjoyed.

THOMAS G. CASSIDY
Bloomington, MN

A battery-powered clock is indeed a useful addition to the IBM PC or any other computer that has date and time functions available. And a unit such as you suggest could be made to work through the cassette port. However, I believe this would have rather limited appeal for two reasons. First, because the first expansion board purchased by many IBM PC owners is one of the popular "six-function" boards that provides clock, printer port, serial port, and sockets for memory expansion all on one board; and second, because cassette data-transfer rates and protocols vary between different makes of computers so that the unit wouldn't be as universal as one would like.

Another approach, which I described in "Everyone Can Know The Real Time" in the May 1982 BYTE (page 34), is to interface the clock circuit through the RS-232C port. This has the advantage that the protocol is well established, and ICs are available to simplify design and construction of the necessary interface circuits.

Because the IBM PC has a software real-time clock written into its operating system, all that is needed to make use of an external hardware clock (once it has been set to the correct time) is to write a program to read the time from the serial port and output it to the PC's clock port whenever the computer is started up or reset. This can be written in BASIC and run automatically by calling it with an Autoexec program.—Steve

PC-Operated Cash Drawer

Dear Steve,

I am attempting to use my computer as a cash register in my business. My problem is interfacing an electronic stand-alone cash drawer with my IBM PC. I need to make a digital-to-analog (D/A) converter. Ideally, I would like to output a byte to the serial port of my computer and have that digital signal converted to a voltage that would, in turn, trip a relay to unlock the cash drawer.

Can you supply me with any information about how I can build or purchase such a device? I know where I can get an electrically operated cash drawer; the problem is the interfacing. I would greatly appreciate any advice or information.

JASON E. GAPCO
White Plains, NY

Probably the easiest way to interface your IBM PC to your cash register is by using the cassette port, which provides a 6-V DC power source rated at 1 ampere for driving a tape-cassette motor. Connect your relay to pins 3 and 1 of the cassette interface connector (the 5-pin DIN connector next to the keyboard connector on the rear panel). Pin 3 is +6 V DC, and pin 1 is common.

If your cash-register program is written in BASIC, the relay can be activated by adding the lines shown in listing 1 to your program in the appropriate place. This will set up your program so that function key 10 will open the cash register any time it is pressed. You can, of course, choose any other function key if you want, and you can provide more restricted access by using the KEY(10) ON and KEY(10) OFF statements as needed throughout your program. You also may need to play around with the timing loop to get the correct delay.

If your program is in assembly language or a compiled language, you can still use this port by outputting a 1 to bit 3 of port 61 (hexadecimal) and holding it for the required time. This can be done by modifying your program or by redirecting the INT 16 (hexadecimal) keyboard interrupt to a custom program that performs the output if the key just pressed is F10 or transfers to the normal keyboard if it isn't. A method for doing this is suggested in the book 8088 Assembler Language Programming: The IBM PC *by David C. Willen and Jeffrey I. Krantz (Howard W. Sams & Co.).*—Steve

Listing 1: *Additional lines to activate the relay.*

```
1 ON KEY(10) GOSUB 10000: KEY(10) ON
.
.
.
10000 OON=1
10010 OFFF=0
10020 MOTOR OON                  'Activate relay.
10030 FOR T=1 TO 10: NEXT  'Wait for drawer
                                 to open.
10040 MOTOR OFFF                 'Turn relay off.
10050 RETURN
```

A Senior Project

Dear Steve,

I am a senior in electrical engineering at Howard University. My idea for a senior project is to design and construct a system that will continuously monitor (in the home) a person's body temperature, blood pressure, respiration, etc., and transmit this data via radio throughout the household to a remote radio receiver that is interfaced with a personal computer. The

(text continued on page 76)

Answer: Smith-Corona

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Question: What printer company offers print quality that challenges printers costing hundreds of dollars more?

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(text continued from page 74)

personal computer will then process and store this data for subsequent retransmission via telephone lines to a family physician. The telemetry link is an important part of this system because the person being monitored would be able to move about the house unencumbered by wires. I find a project like this very interesting but quite challenging. Therefore, I would appreciate your answers to the following questions:

1. What type of transducers are available to monitor body temperature, blood pressure, respiration, etc.? Who manufactures such devices?
2. What ICs are available for conditioning the transducer outputs? Other than amplification and buffering, what signal conditioning is necessary to modulate an RF (radio frequency) carrier?
3. Once the analog signals from the transducers are properly "conditioned," should they be converted to digital signals and then transmitted via RF or transmitted in their analog form and then converted to digital signals on the receiver/computer end?
4. What form of carrier modulation should I use? AM, FM, pulse-width modulation? And what carrier frequency do you suggest (in the home environment)?
5. With a view toward making the transducer/signal conditioner/transmitter unit as small as possible and battery operated, are there any low-power ICs that contain a complete transmitter and receiver on a chip? National Semiconductor's LM1871 Radio Control Encoder/Transmitter and LM1872 Radio Control Receiver/Decoder seem likely candidates, but they are generally used for control of hobby servos.

I hope you can share your insights and shed some light. Thank you.

Robyn L. King
Washington, DC

The project you selected is, as you say, very interesting and challenging. The questions you asked also are very challenging and could take many pages to answer. Instead of answering them directly, I will try to give you a selection of reference materials where you can find the answers yourself (after all, it is your project).

Several sources can be reviewed to find the type of transducers you need. EDN (Electronic Design News) *and* Electronics *magazines often carry articles on medical electronics. A review of these magazines should yield all the information you need. For example, an article in a September 1980* EDN *discusses the Hughes HLSS-0533 heart-rate monitor chip that employs the photoplethysmographic monitoring technique. The March 20, 1980* EDN, *page 122, had a special report on sensors and transducers, and an April 1977* Electronics *had an article on a silicon transducer to measure blood pressure.* Electronic Products *is another good source of reference material. An article in the November 1982 issue (page 49) discusses advances in signal conditioning.*

Transmitting and receiving these signals can become a project in itself. I have taken the approach of "not reinventing the wheel" several times and used commercially built devices like walkie-talkies to do the job. You can find discussions of these techniques in two of my articles: "Handheld Remote Control for Your Computerized Home," July 1980 BYTE (page 22) and "A Computer-Controlled Tank," February 1981 BYTE (page 44).

I hope these references will be helpful in your senior project.—Steve

A Kaypro 10/S-100 Combo

Dear Steve,

As an author's portable word processor, the Kaypro 10 with an Epson FX-80 printer seems to be a good choice. For everything else, an 8086 with several IBM-compatible slots is advisable.

The Kaypro 10 has a parallel printer output, two RS-232C ports, and one light-pen input jack.

If I want to use the Kaypro screen, keyboard, and large disk, but also want to use a Semidisk or RAM Disk and an 8086 for the bulk of internal processing, what sort of hookup makes sense?

Sam Timac
Ft. Vermilion, Alberta, Canada

As I read your letter, I get the impression that even though you say "IBM-compatible slots" you are really thinking in terms of an S-100 bus system with an 8086 microprocessor rather than an IBM PC. The S-100 bus offers a wide selection of boards to run with the 8086, including several Semidisk, or RAM Disk, boards, but is in no way compatible with IBM hardware.

The Kaypro 10 does look good as a portable word processor, and if you like the relatively small screen (compared to a full-sized terminal), it might be used as a terminal for an S-100 system. Because S-100 systems are designed to be run with remote terminals rather than built-in displays, you should have no trouble at that end, and the Kaypro can easily function as a terminal with the proper software. Your dealer should be able to recommend a communications program that will configure the computer as a suitable terminal. The physical connection between the two computers will be through the RS-232C ports.—Steve ■

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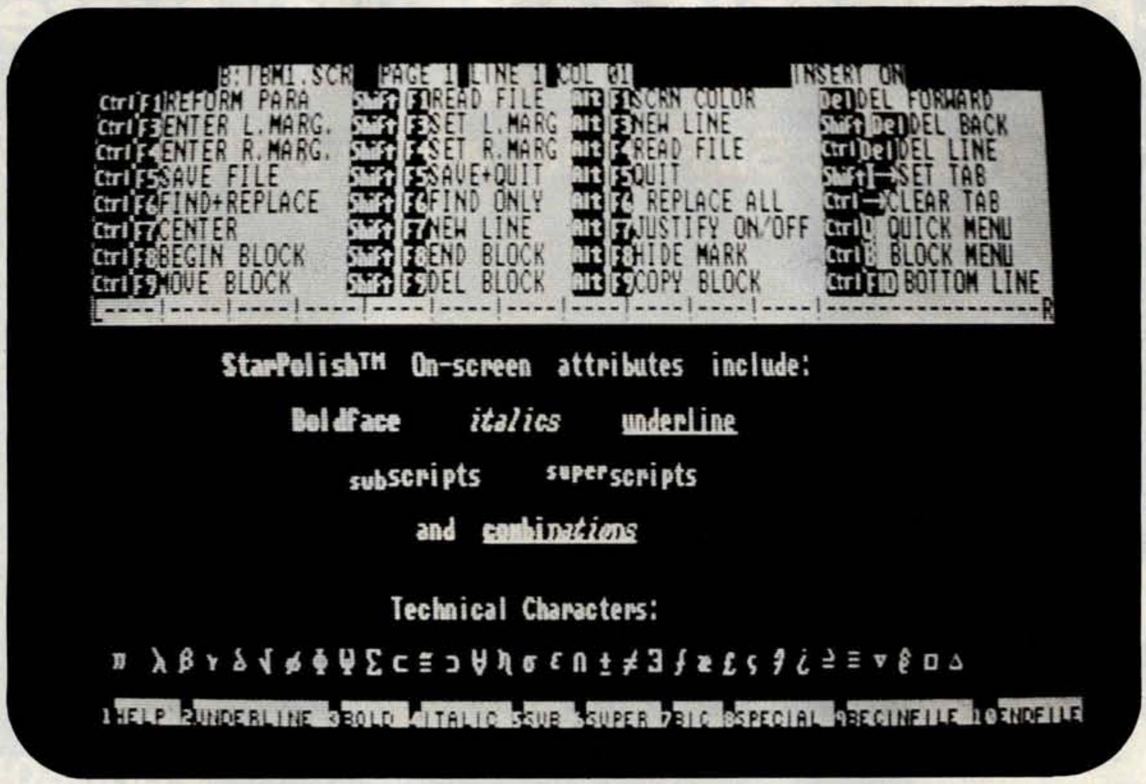

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LEARNING WITH LOGO
Dan Watt
BYTE Books/McGraw-Hill
New York: 1983
208 pages, $22.95

THE TOLL FREE
MICROCOMPUTER INDEX
Richard J. Volz and
Gene E. Thompson
Spokane Technical Press
Spokane, WA: 1983
360 pages, $14.95

LEARNING WITH LOGO
Reviewed by Tim Barclay

ILLUSTRATED BY WILLIAM GIESE

When teachers ask what they should be doing with microcomputers at the elementary school level, we say Logo, and the second thing we say is, get Dan Watt's book, *Learning with Logo*. As a part of the MIT Logo Project, Watt was responsible for the pilot study in Brookline, Massachusetts, schools. Before working on Logo, he was an elementary school teacher at the middle school level, and prior to that he was a curriculum developer with the Elementary Science Study, a federally supported curriculum-development project of the late 1960s. It is this depth of teaching experience combined with his thorough understanding of Logo that he brings to his book, and it shines through. The book is a successful combination of Logo programming, Logo philosophy, and teaching strategies. Although there are other books that deal with one or another of these aspects of Logo, none that I know of encompasses all three, not to mention with such success.

The book is written for an Apple using the Terrapin/Krell versions of Logo but includes appendixes that list necessary modifications for Apple Logo and TI Logo users. A separate edition of the book, *Learning with Apple Logo*, is also available; editions for Logo on Atari, Commodore, and Texas Instruments are in preparation.

A LEARNING ADVENTURE

Learning with Logo is challenging and rewarding for children and adults alike. The initial chapters of the three-part book are written with 10- to 13-year-olds in mind, but in no way does this introduction insult the intelligence of the novice adult embarked on a new adventure. The ideas are also accessible to younger children with the help of a teacher; in fact, the author includes several teaching hints within each chapter for this purpose.

The basic graphics commands for drawing on the screen are all introduced in this first section as well as the necessary commands for saving procedures and pictures on disk and for going to the editor to define your own new procedures. Anyone who completes the first portion of this spiral-bound, easy-to-use book befriends the Logo turtle and learns how to draw designs and pictures on the screen.

The second section of the book introduces more sophisticated programming concepts that use graphics, words, and lists. The uses of variables and conditionals are also included. These abstract concepts, which can be so mystifying when first encountered in algebra, come as simple solutions to real needs that every Logo learner encounters while writing graphics programs. It is an example of what Seymour Papert, the head of the MIT Logo Project, is talking about when he refers to setting up natural learning environments. That means providing a context in which students can explore, try new ideas, and find their own solutions as problems arise.

Watt shows the reader examples of some of the complex designs that can be drawn using recursion, such as rotating polygons, growing squares, and spirals. He explains the procedures that he used to create these shapes and suggests further investigations.

In addition to these more advanced graphics programming ideas, the author introduces the use of words and lists, explaining how to write interactive programs in a chapter called "Conversa-

(*text continued on page* 80)

(text continued from page 79)
tions with the Computer: Activities with Numbers, Words and Lists." As is true throughout the book, in his presentation of new commands and concepts Watt braids several modes of presentation together. They include:

- examples for the reader to try on the microcomputer that use commands needed to work with lists
- explanations of what the examples are doing
- cartoon sequences that graphically present the ideas
- "explorations"—suggested problems to try on your own
- "helper's hints"—more detailed explanations and teaching suggestions

By the end of this chapter, the reader is able to write procedures for conversations with the computer and quiz programs that are carefully designed using multiple subprocedures. For the person willing to work through these steps, understanding and fluency can develop.

The third section of the book builds upon the skills that have been developed in the first two sections. Each of the four chapters in this section takes a single programming project and develops the many procedures that make up the final program. The first project is an interactive computer game called Shoot, in which the player tries to hit a target with the turtle. Next is Quickdraw, which is described as a "Turtle Drawing Activity for Young Children." A chapter on animating the turtle follows, accompanied by a project called Racetrack, and last is a chapter on writing poetry called Poet. These later sections are appropriate for both older readers working independently or for younger users with assistance nearby.

TEACHERS ALSO BENEFIT

Learning with Logo is designed to be used with a preprogrammed disk of procedures ($15.95) that includes the aforementioned Shoot, Quickdraw, Racetrack, and Poet. Watt intends his audience to learn these procedures gradually, initially by just using and seeing them in action, later by studying and changing them. The disk also enables beginning learners to experience Logo in a more exciting way than they otherwise could. As an alternative to buying the disk, you can get a copy by typing the procedures listed in the appendix of the book.

A motto of Logo is "no threshold, no ceiling." This means that the language is easily accessible to young children yet is still a powerful and sophisticated language. For instance, many 4-year-olds are using Logo, as are students at MIT. The low-threshold part lies in the turtle graphics. If you have used Logo at all you have undoubtedly experienced the delight of drawing designs or solving geometric problems. But a question teachers often ask is, what next? Right-
(text continued on page 82)

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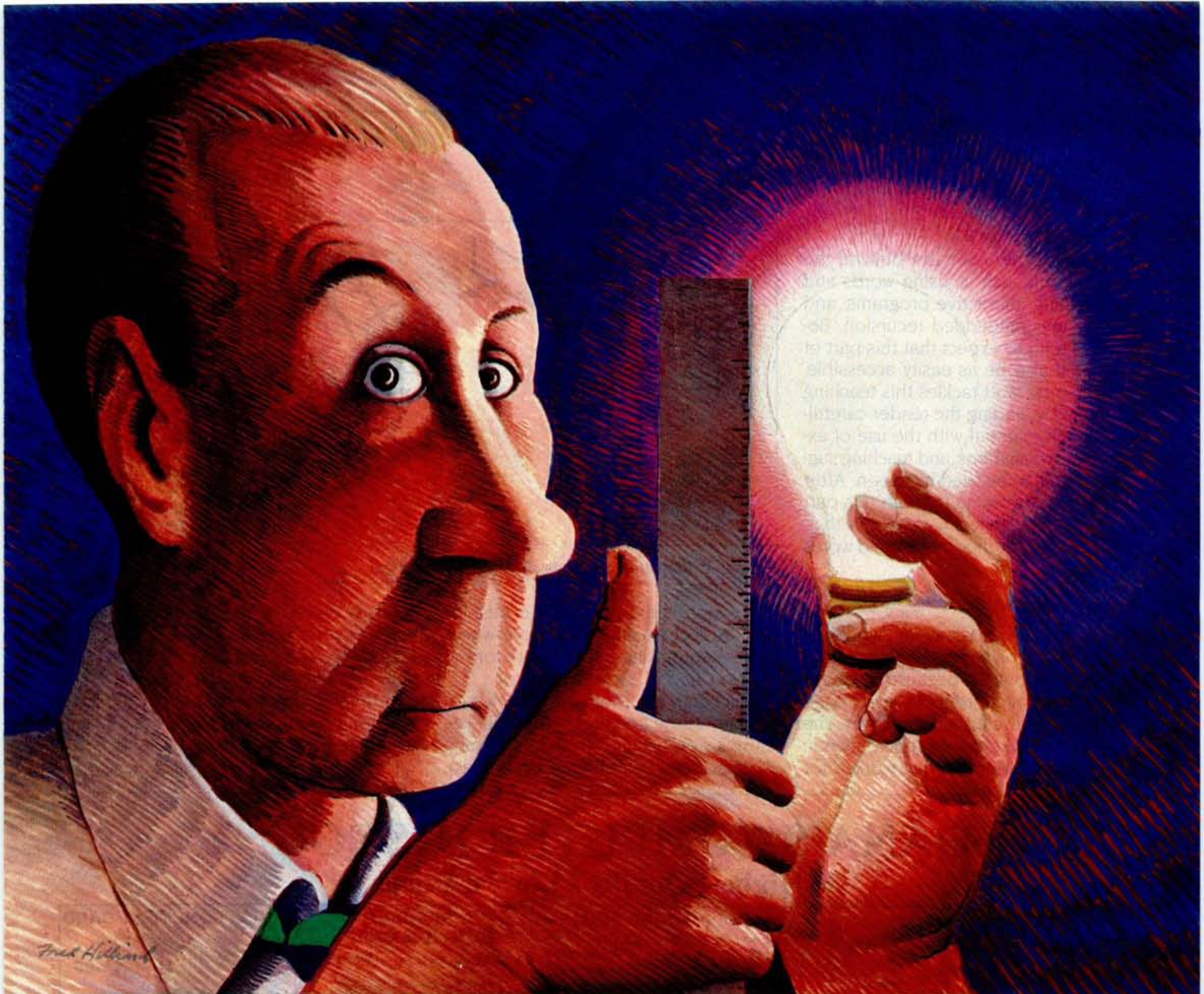

(*text continued from page* 80)

fully so, for there is more beyond the turtle world, such as using words and lists, writing interactive programs, and getting into embedded recursion. Beginners tend to expect that this part of Logo will also be as easily accessible, and it is not. Watt tackles this teaching problem by leading the reader carefully through material with the use of examples, explanations, and teaching suggestions, all to be tried hands-on. After reading and working through this part of the book, teachers have told us that, for the first time, they understand words and lists.

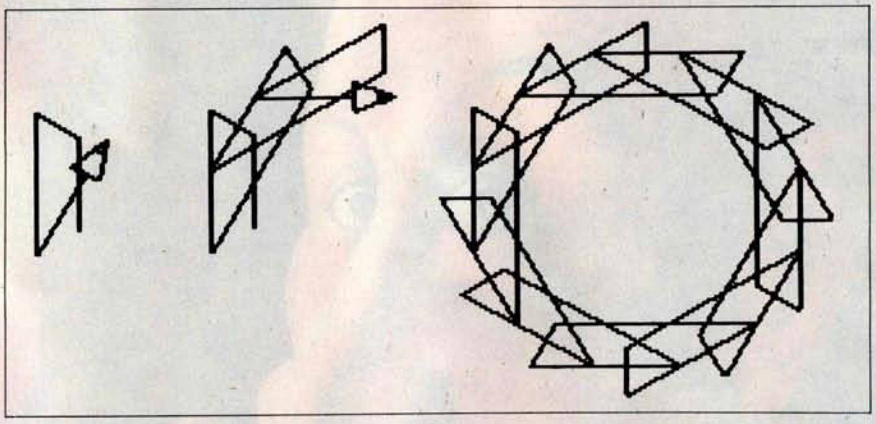

Figure 1: *Repeating a random shape creates a design.*

Figure reprinted with permission from McGraw-Hill Book Company

Minor Criticism

One potential pitfall when writing a book on Logo is how to sequence concepts and activities. Because there are any number of approaches, every Logo teacher will develop a favorite way. The author acknowledges this phenomenon by admitting "Here is what worked for me, you should do what works best for you." And one section in his book where Watt's sequencing did not work for me was in Chapter 3 on Quickdraw.

Quickdraw is a program that lets you perform turtle graphics with single-key entries. For instance, instead of typing FD space 20 Return (a total of six keys), you just type F. With F, B, R, and L as single keys for FORWARD 20, BACK 20, RIGHT 30, and LEFT 30, respectively, you can move and turn the turtle by predetermined increments to make graphics designs. Quickdraw has some other useful procedures for saving and re-

(*text continued on page* 84)

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(text continued from page 82)
drawing a set of commands, but it does not include any other graphics commands.

One very practical use for Quickdraw is for young children who cannot type the longer command words. Another use is to speed up graphics drawing. What I find inappropriate, however, is the series of suggested drawing activities using Quickdraw. These drawings (see figure 1) really beg for the REPEAT command. Without the REPEAT command, you have to enter the sequence of commands for the random shape (FFLLFLLLLFFFLLLLLFF) and then type them in repeatedly twelve more times. There is something to be said for motivating the learning of a new command by creating a need for it, but that does not seem to be part of the author's scheme here. This example seems to highlight the challenge of trying to balance easy access against interesting output.

Just as Logo uses turtle graphics as an entry into understanding programming, so also the author has included graphics in this book to clarify language and computer concepts. For this he has used a series of cartoon characters who act out the processes being carried on inside the computer. But the cartoons of a Logo elf, robot primitives, mailbags, mailboxes, and trash cans do not seem to help. Rather than being worth a thousand words, the cartoons require all the intense study that a page of print can demand if you are to understand the concepts being presented. They are easily skipped over, however, so you can ignore them and concentrate on just the words. This is a minor criticism about an otherwise marvelous book.

Anybody planning to teach Logo should have his or her own copy available in the classroom for quick reference. The more you refer to Dan Watt's book, the more enamored with it and with Logo you will become.

THE TOLL FREE MICROCOMPUTER INDEX

Reviewed by Maria V. Peeler

One problem with promising too much is that it's hard to live up to it. In this case, the product is slightly less than the promise.

That's the core of the discrepancy with *The Toll Free Microcomputer Index*. The authors use so much space in the first 14 pages glorifying the book's virtues—how it will save money, time, and headaches; how it will save the cost of a professional research service or consultant, the cost of microcomputer-magazine subscriptions, the cost of training the neophyte computer enthusiast—that the simple usefulness of the book is buried, leaving the reader a little shortchanged in the end.

TAKE A LOOK

Neophytes don't become wise com-
(text continued on page 86)

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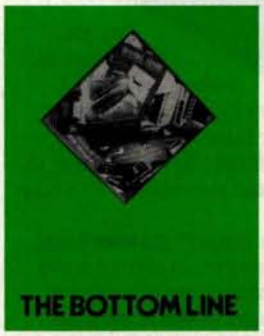

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(text continued from page 84)
puter buyers by calling 1-800-numbers; businesses can't completely bypass consultants or research services by calling 1-800-numbers; and most of us who buy computer magazines do so to enjoy articles, learn a little, and find out who has the lowest price on a Hayes modem this month—not to find out which companies have toll-free numbers.

That doesn't mean that this book isn't worth a look. It just means that *The Toll Free Microcomputer Index* is not the superbook its authors proclaim it to be. Taken in that light, it can be a helpful manual—especially to computer dealers, consultants, and myriad other individuals who tend to rely on information and merchandise from national rather than local sources.

COLORFUL CONTENTS

The Toll Free Microcomputer Index consists of two parts. The White Pages are an alphabetized database holding over 500 records on companies that maintain toll-free lines. The Orchid Pages consist of an alphabetized listing of keywords pertinent both to specific brands and large general categories. The two sections more or less correspond to a telephone book's white and yellow pages and function similarly.

The foreword to the Orchid Pages promises an index to the Keyword Index (which gives the name of the company and a one-line description), a Catalog Index, Information Index, and Location Index. Don't bother looking for the last three. They aren't there. According to the authors, funding ran out and they hope to include those indexes in the next edition.

OVERSIGHTS

A few oversights exist. For example, it has a list for Morrow Inc., but it describes it only under Morrow Micro Decision Computer Systems and makes no mention or cross-reference to Morrow's hard-disk manufacturing.

Despite the exclusion of three indexes, the oversights, and the overpraising in the stiff, textbook prose of the first 14 pages, the book looks professional. The cross-references, although not exhaustive, are at least accurate and adequate for its limited database. It is well printed on good quality paper, has a pleasant cover, and has few errors or typos. The book is available to user groups or clubs at a discount. ■

Tim Barclay, director of the Computer Resource Center at Technical Education Research Centers, 8 Eliot St., *Cambridge, Massachusetts* 02138, *writes frequently for its newsletter,* Hands On. *He also conducts teacher workshops on using microcomputers in education.*

Maria V. Peeler (7002 37*th* SE, *Lacey*, WA 98503) *is a technical writer and a public-information officer at the Washington State Utilities and Transportation Commission.*


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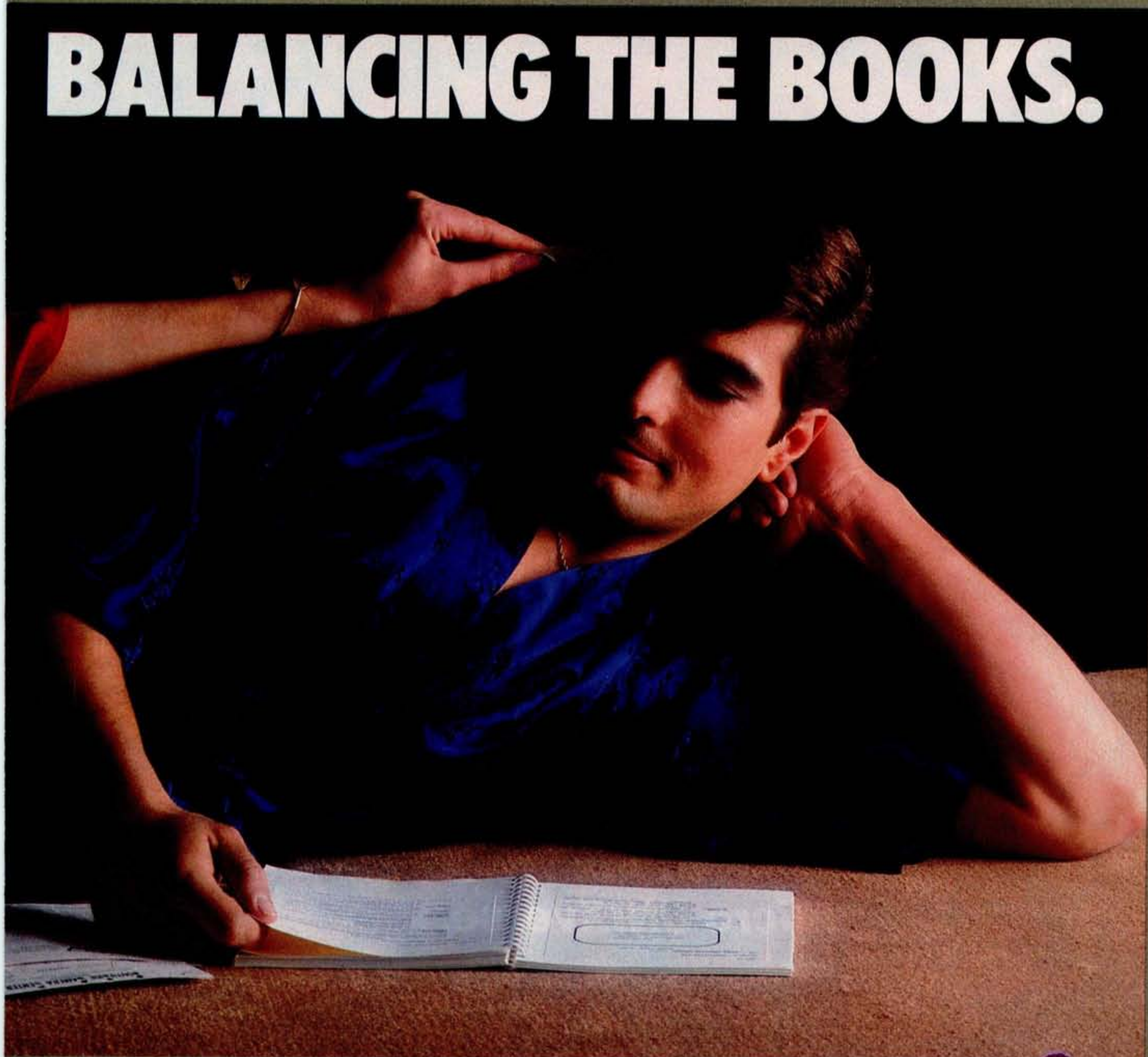

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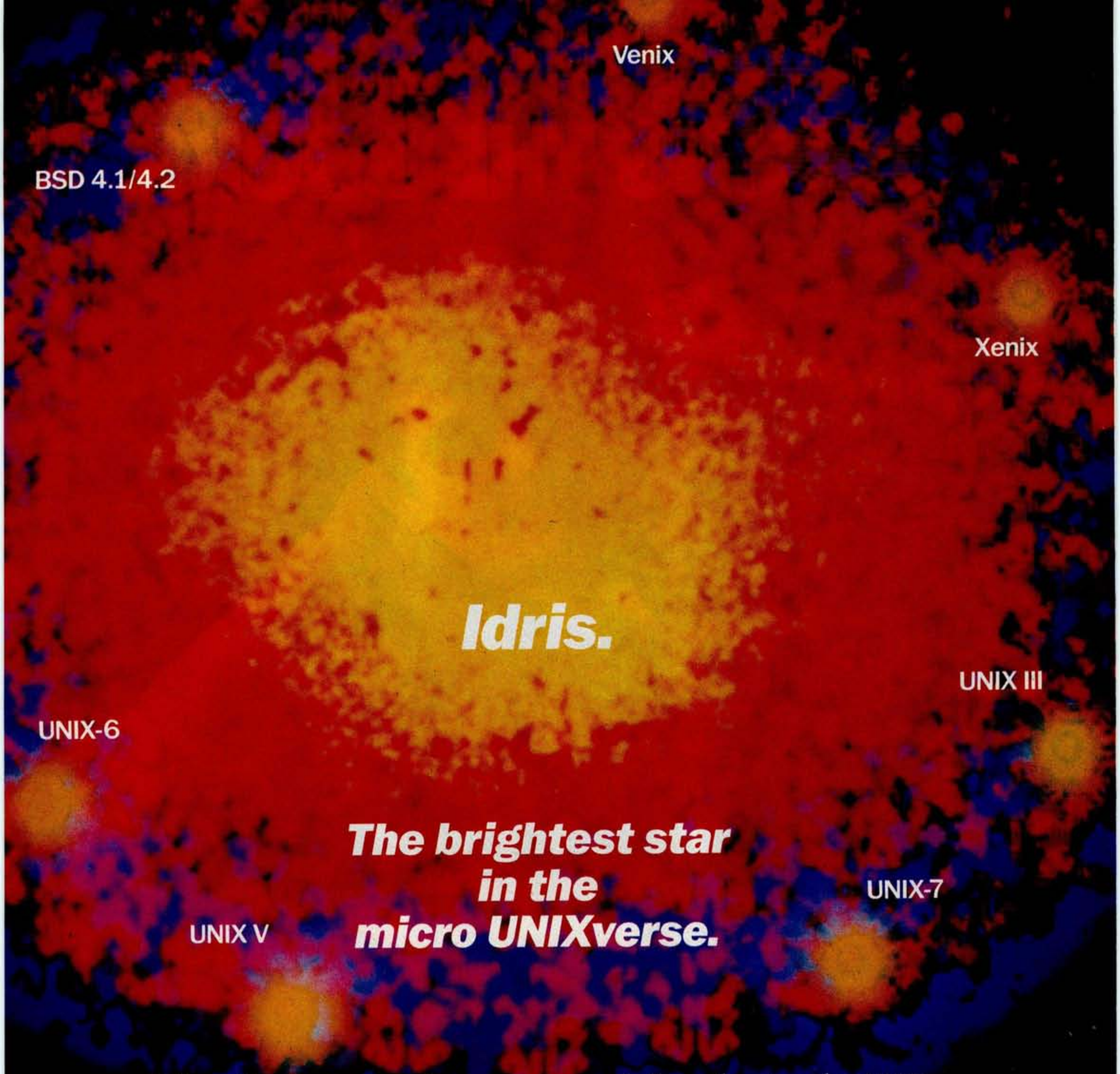

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● CHICAGO BBS ON ART AND TECHNOLOGY. The Center for Advanced Studies in Art and Technology (CASAT) at the School of the Art Institute of Chicago has set up a bulletin-board system (BBS) for artists and scientists to exchange information and ideas concerning the uses of technology in the arts. Research projects under way include sound synthesis and image processing. You can up- or download Apple high-resolution images to the system. CASAT's bulletin board is (312) 443-3744.

● 50 FIGS ON TREE
The FORTH Interest Group (FIG) announces the formation of the 50th chapter in Berkeley, California. FIG, a nonprofit organization, serves more than 4000 users of the FORTH computer language. It also sponsors the FIG-Tree, an on-line FORTH database (a 300-bit-per-second BBS) at (415) 538-3580. Membership is $15 a year ($27 foreign) and includes a subscription to *FORTH Dimensions*, a bimonthly newsletter. Contact the FORTH Interest Group, POB 1105, San Carlos, CA 94070, (415) 962-8653.

● ARTISTIC GRASS ROOTS
Art, Computers and Education (ACE) is a grass-roots group of artists, teachers, technicians, software developers, and art educators that meets to discuss issues in the arts and in art education involving the use of computers. Its newsletter contains interviews, software reviews, and reviews of arts peripherals. A $5 membership fee per school year entitles you to receive the ACE newsletter. For details, write to ACE, 3155 Avalon Court, Palo Alto, CA 94306.

● HUG IN CONN
The Connecticut Heath Users Group (CONNHUG) meets at 7 p.m. on the first Wednesday of each month at the Heathkit Electronic Center in Avon, Connecticut. The club maintains a bulletin board at (203) 674-8915. By providing a forum for information exchange, CONNHUG aims to educate in the area of computer science, particularly Heath/Zenith computers. For further details, contact CONNHUG, 395 West Main St., Avon, CT 06001, (203) 678-0323.

● GET INSIDE IRIS
The IRIS Users Group (independent of Point 4 Data Corporation, which owns the IRIS license) produces a quarterly newsletter, *Inside* IRIS, that contains educational and informative articles for more than 20,000 users. A BBS using the IRIS (interactive real-time information system) operating system is on line at (303) 44X-CLUB. A membership fee is $35 a year and includes the newsletter. For further information, call Doc Gordon at (303) 449-7637, Chauncey Taylor at (303) 663-1400, or write the IRIS Users Group, 1531 North Lincoln Ave., Loveland, CO 80537.

● ASK THE ORACLE
Oracle Network Headquarters' Silicon Valley Interchange RCP/M (remote CP/M) bulletin-board system is a nonprofit public-domain system operating 24 hours a day. Running on a CompuPro 816 with a 40-megabyte hard-disk drive, Oracle can accommodate more than 2500 on-line files of news releases, communications, utilities, data on 16-bit computers, and items of interest to users of Apple, Osborne, IBM PC, and CompuPro. The 300- or 1200-bps system's number is (408) 732-9190. Registration is required. Send a six-digit password and a $25 annual membership fee to Oracle Network Headquarters, Silicon Valley Interchange RCP/M, Attn: Registration, POB 532, Cupertino, CA 95015.

● "WORKSTEADER'S" FACT SOURCE. The National Association for the Cottage Industry is a nonprofit association that provides the home-based business-person with access to information supporting "worksteading" as a financially viable alternative. It sponsors quarterly regional conferences and periodic seminars. A related newsletter, *Mind Your Own Business At Home*, is available. Contact the National Association for the Cottage Industry, POB 14460, Chicago, IL 60614, (312) 472-8116.

● HAWKEYE AREA ATARI USERS GROUP. Eastern Iowa Atari owners have banded together to form Hawkatari, a users group that meets monthly and produces a newsletter. A library of public-domain software is maintained and members are encouraged to submit their programs. New members are welcome to join for $6 a year. Contact J.K. Wiese, Hawkatari, 2565 22nd Ave., Marion, IA 52302.

● ACES MEET IN THE SUNSHINE STATE. The Jacksonville Atari Computer Enthusiasts (JACE) is an independent users group that meets regularly and produces a newsletter that contains reviews, program listings, classified ads, and news. A $10 membership fee entitles Atari owners to become members. Sample newsletters are $1 each. Contact JACE, 1187 Dunbar Court, Orange Park, FL 32073.

● HOW TO EXPORT SOFTWARE. World Software Markets (WSM) are covered in *The WSM Newsletter*, a monthly publication from World Education Markets Inc. It provides readers with information about overseas export and licensing opportunities of software. This includes trends and developments in home, business, and school microcomputer markets. For details, contact WSM, Garrett Park, MD 20896-0255.

● A SOURCE FOR COMPARATIVE PRICING. *Computer Price Alert* is billed as a national survey of computer and software prices. Each issue reports the three lowest prices on certain materials as the result of a scan of several hundred discount and mail-order firms. It includes a listing of vendors who don't advertise elsewhere, thus keeping overhead expenses down. A one-year subscription (20 issues) is $48; a trial subscription (12 issues) is $36. Club discounts are available. For details, contact *Computer Price Alert*, POB 574, Cambridge, MA 02238, (617) 354-8116.

● BRIEFS FOR COMPUTER BUFFS. Owners of any brand of computer who live in the District of Columbia will benefit from the resources outlined in a monthly newsletter entitled *Home Computer Briefs*. It features articles on training, repairs, and other services; a word-processing column; a calendar of events; reviews of microcomputer books; and a column for readers to share experiences. The information selected for the contents of the newsletter is designed to help disgruntled users tap the full potential of their equipment. A one-year subscription is $18. Contact *Home Computer Briefs*, Suite 1739, 3421 M St. NW, Washington, DC 20007, (202) 965-4428.

● NORTH COUNTRY EDUCATORS UNITE. *North Country Micro* is produced five times a year and brings together almost 1500 educators in the

(continued on page 92)

CLUBS & NEWSLETTERS *is a forum for letting BYTE readers know what is happening in the microcomputing community. Emphasis will be given to electronic bulletin-board services, club-sponsored classes, community-help projects, field trips, and other activities outside of routine meetings. Of course, we will continue to list new clubs, their addresses and contact persons, and other information of interest. To list events on schedule, we must receive your information at least four months in advance. Send information to BYTE, Clubs & Newsletters, POB 372, Hancock, NH 03449.*

(continued from page 91)
Franklin/Essex/Hamilton area of northern New York state. They work on common problems and keep up on modern classroom technology via editorials, applications of existing software to education, reviews of hardware and software, and updates on what other school systems are doing regarding computer education. *North Country Micro* contains bibliographies for further study; subscriptions are free. To inquire, contact Kirk Peterson, Paul Smith's College of Arts and Sciences, Paul Smiths, NY 12970.

● CALIFORNIAN COMMODORIANS. The Orange County 20-64 Users Club meets at 1 p.m. on the fourth Saturday of each month to discuss news items and see presentations. Separate libraries for the VIC-20 and the C-64 are maintained for the members. A $24 annual membership includes a subscription to the computerized newsletter. For details, contact Burt Bonem, 11212 Barclay Dr., Garden Grove, CA 92641, (714) 539-5909.

● THE USERS GROUP FOR PCjr The User's Group offers IBM PCjr owners up-to-date information, new products, and support via a newsletter and program exchange. The User's Group will publish a list of approved products based on its testing standards of reliability, ease of use, and pricing. The membership fee is $15 annually. For details, contact Brian Gratz, The User's Group, 4620 50th St. A-9, Lubbock, TX 79414, (806) 799-0327.

● MACINTOSH USERS UNITE National Apple Pie is a clearinghouse for information and software exchange for users of the Apple Macintosh and Lisa computers. The bimonthly newsletter, *MacinTouch*, is free for members seeking information on seminars, meetings, workshops, new products, developments, and hands-on assistance. Annual membership is $19. For details, contact National Apple Pie, Wayland Square, POB 3198, Providence, RI 02906.

● RURAL RUCUS Computer users who are farmers and ranchers living in remote areas can now ask high-tech vendors questions about computers, thanks to a newsletter produced by the Rural Computer Users Society (RUCUS). Articles range from improving gross revenue and methods of scheduling to programs for the school-age reader. The focus of the newsletter is to help novices figure out how to best use their computers for business purposes. Send for information from RUCUS, POB 233, Hamilton, VA 22068.

● INVEST WISELY The American Association of Microcomputer Investors (AAMI) is an independent nonprofit organization that provides information to investors on how to use their microcomputers for profit in the stock, options, and commodities markets, bonds, real estate, and other investment opportunities. *The AAMI Journal* is produced bimonthly and contains reviews of investment software and on-line stock-market databases. A quarterly directory updates investment software. Computer programs, software discounts, and study guides are also available to members. For further information, contact AAMI, POB 1384, Princeton, NJ 06542, (609) 921-6494.

● WHEN OPPORTUNITY KNOCKS. New members of the Commodore Club receive a copy of a booklet entitled, *Cash from Your Computer!* Members exchange software, programming tips, and information. The bimonthly newsletter, *I/O*, contains technical columns, computer applications, and other topics related to the Commodore. Annual dues are $15 and include a newsletter subscription. Send a self-addressed, stamped envelope to Joe Kamenar, 225J Dunbar Lane, Horsham, PA 19044.

● SOFTWARE IS AN ISSUE *Software Issues* is an independent quarterly newsletter for people involved in the design, development, purchase, maintenance, or use of computer software. It addresses the development of quality computer programs, design and documentation methods, user interfacing, testing techniques, computer literacy, and more. An annual subscription is $12. Contact GDW Associates, POB 14258, Clearwater, FL 34279. ■

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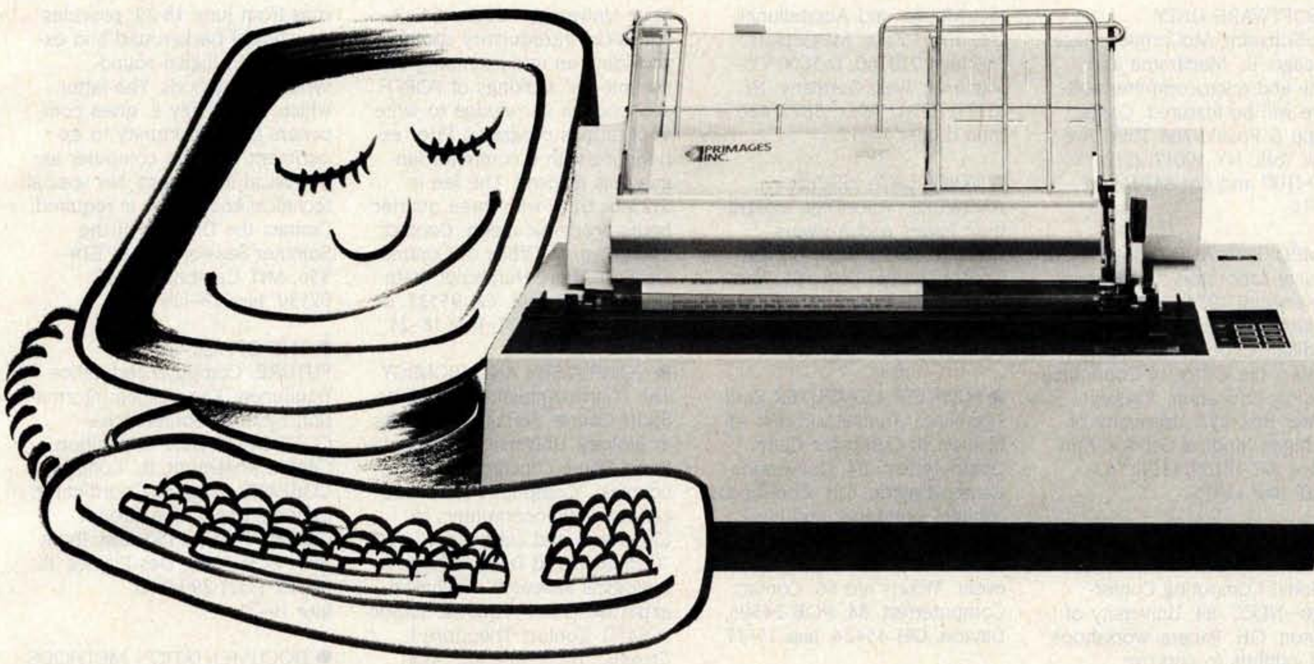

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● SOFTWARE ONLY
Info/Software, McCormick Place, Chicago, IL. Mainframe and mini- and microcomputer software will be featured. Contact Clapp & Poliak, 708 Third Ave., New York, NY 10017, (212) 370-1100 and 661-8410. *June 12–14*

● MEDICINE AND COMPUTERS
Clinical Laboratory Computers Symposium 1984, Towsley Center, University of Michigan Medical School, Ann Arbor. Contact the Office of Continuing Medical Education, Towsley Center Box 057, University of Michigan Medical School, Ann Arbor, MI 48109, (313) 763-1400. *June 13–15*

● NECC NUMBER SIX
The Sixth Annual National Educational Computing Conference—NECC '84, University of Dayton, OH. Papers, workshops, and exhibits to improve computer-based classroom instruction. Contact Lawrence A. Jehn, Computer Science Department, University of Dayton, Dayton, OH 45469, (513) 229-3831. *June 13–15*

● PC IN SPOTLIGHT
PC-World Exposition, McCormick Place West, Chicago, IL. Contact Mitch Hall Associates, POB 860, Westwood, MA 02090, (617) 329-8090. *June 13–15*

● BYTE HOSTS COMPUTER SHOW, BYTE Computer Show, Convention Center, Los Angeles, CA. Seminars, product displays, and technical conference sessions are some of the highlights of this show sponsored by BYTE and *Popular Computing* magazines. Contact the Interface Group, 300 First Ave., Needham, MA 02194, (800) 325-3330; in Massachusetts, (617) 449-6600. *June 14–17*

● COMPUTING GERMAN STYLE, International Computer Show, Cologne, West Germany. Seminars, workshops, and hardware and software exhibits. Contact Messe- und Ausstellungs-Ges.m.b.H Köln, Messeplatz, Postfach 210760, D-5000 Cologne 21, West Germany; tel: (0221) 821-1; Telex: 8873 426 a mua d. *June 14–17*

● VOICE/DATA ISSUES, ANSWERS, Voice/Data Integration: Issues and Answers, Newport Beach Marriott, CA. Contact Bernie Ilson, 65 West 55th St., New York, NY 10019, (800) 638-6590; in New York, (212) 245-7950. *June 15*

● MIDWEST COMPUTER FAIR
The Ninth Annual Midwest Affiliation of Computer Clubs' Computerfest '84, Convention Center, Dayton, OH. Commercial exhibits, computer and electronics fleamarket, seminars, and mini-courses highlight this event. Tickets are $6. Contact Computerfest '84, POB 24505, Dayton, OH 45424. *June 15–17*

● TECHNICAL WRITING
Writing for the Computer Industry, Plymouth State College, Plymouth, NH. Topics: how to write computer-related text for an international audience, electronic documentation, training and linguistic style, and how to integrate text and graphics. Contact Dr. Sally Boland, 5 Reed House, Plymouth State College, Plymouth, NH 03264, (603) 536-1550. *June 16*

● ACADEMIC COMPUTING
The Seventeenth Annual Association for Small Computer Users in Education Conference, Western Kentucky University, Bowling Green. Contact Dr. Dudley Bryant, Western Kentucky University, Bowling Green, KY 42101, (502) 745-0111. *June 17–20*

● INTRO TO FORTH PROGRAMMING, People, Computers, and FORTH Programming, Humboldt State University, Arcata, CA. A hands-on, introductory course providing an understanding of the internal workings of FORTH and enough knowledge to write applications programs. Prior experience with a computer language is advised. The fee is $125 or $175 with three quarter hours academic credit. Contact Claire Duffey, Office of Continuing Education, Humboldt State University, Arcata, CA 95521, or call (707) 826-3731. *June 18–21*

● COMPUTERS AND BIOLOGY
The Fourth Annual Notre Dame Short Course Series: Computers in Biology, University of Nevada-Reno. Three concurrent short courses: "Computers in Bioeducation," "Microcomputers in Classroom and Laboratory," and "Computerized Data Analysis in Biological Research." Technical expertise is not required. Tuition is $450. Contact Theodore J. Crovello, Biocomputing Short Course Coordinator, Department of Biology, University of Notre Dame, Notre Dame, IN 46556, (219) 239-7496. *June 18–22*

● ELECTRONIC OFFICE CONCEPTS, Office Information System Software, Massachusetts Institute of Technology, Cambridge. The concepts behind the design of multifunction office workstations, including technologies, human factors, software, and applications generators, will be studied. Contact the Director of the Summer Session, Room E19-356, MIT, Cambridge, MA 02139. *June 18–22*

● DIGITAL MUSIC TECHNIQUES, Experimental Music Studio, Massachusetts Institute of Technology, Cambridge. Two complementary sessions: "Techniques of Digital Audio Processing" and "Workshop in Computer Music Composition." The former, which runs from June 18-29, provides a technical background and experience in digital sound-synthesis methods. The latter, which begins July 2, gives composers the opportunity to experiment with the computer as a musical instrument. No special technical knowledge is required. Contact the Director of the Summer Session, Room E19-356, MIT, Cambridge, MA 02139. *June 18–July 27*

● THE OFFICE OF THE FUTURE, Computerized Office Equipment Expo/Office Information Systems Conference—COEE/OIS, O'Hare Exposition Center, Rosemont, IL. Contact COEE/OIS Program Coordinator, Cahners Exposition Group, Cahners Plaza, 1350 East Touhy Ave., POB 5060, Des Plaines, IL 60018, (312) 299-9311. *June 19–21*

● DOCUMENTATION METHODS
How to Document a Computer System, Sheraton Commander Hotel, Cambridge, MA. A series of documentation procedures will be presented. The fee is $155 prepaid. Contact Technical Communications Associates, Suite 210, 1250 Oakmead Parkway, Sunnyvale, CA 94086, (800) 227-3800, ext. 977; in California, (408) 737-2665. *June 20*

● TECHNICAL PROGRAM IN PRC, The First International Conference on Computers and Applications, Fragrant Hill Hotel, Peking, People's Republic of China. More than 100 technical papers will be delivered. Contact IEEE Computer Society, POB 639, Silver Spring, MD 20901, (301) 589-8142. *June 20–22*

● COMPUTING IN NE FLORIDA
The Great Southern Computer Show, Veterans Memorial Coliseum, Jacksonville, FL. Hardware, software, peripherals, accessories, and word- and data-processing exhibits complemented by workshops and seminars. Contact Great Southern

(continued on page 96)

IF YOU WANT *your organization's public activities listed in BYTE's Event Queue, we need to know about them at least four months in advance. Send information about computer conferences, seminars, workshops, and courses to BYTE, Event Queue,* POB 372, *Hancock*, NH 03449.

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(continued from page 94)
Computer Shows, POB 655, Jacksonville, FL 32201, (904) 356-1044. *June 21–23*

● COMPUTERS IN MEDICAL PRACTICE—MEDCOM 84, The First National Conference on Computers in Medical Practices, Masonic Memorial Temple, Nob Hill, San Francisco, CA. Twenty educational sessions plus exhibits and an investment-planning seminar. Contact MEDCOM 84, 1803 Golden Gate, San Francisco, CA 94115, (800) 468-2211; in California, (800) 445-2121 or (415) 931-0910. *June 23–25*

● GRAPHICS STANDARD COURSE, Introduction to GKS, Hyatt Regency Hotel, Austin, TX. A course on the Graphical Kernel System (GKS) standard. The fee is $495. Contact Nova Graphics International Corp., 1015 Bee Cave Woods, Austin, TX 78746, (512) 327-9300. *June 25–26*

● COMPUTATIONAL METHODOLOGY, Conference on the Forefronts of Large-scale Computational Problems, National Bureau of Standards, Gaithersburg, MD. The interdisciplinary application of large-scale computing technology will be addressed. The focus is on complex problems that test the limits of traditional experimental and computational methodologies. Registration is $275. Contact Wm. L. Schrader, FF '84, Newman Laboratory, Cornell University, Ithaca, NY 14853, (607) 256-3455. *June 25–27*

● MICROS IN EDUCATION Stanford Institute on Microcomputers in Education, Stanford University, Stanford, CA. An intensive session that provides the background necessary to serve as a school or district resource person. Hands-on programming, word processing, and administrative computing. Contact Stanford Institute on Microcomputers in Education, POB K, Stanford, CA 94305, (415) 322-4640. *June 25–July 27*

● COMPUTERS IN DENTAL PRACTICE—DENTCOM 84, The First National Conference on Computers in Dental Practices, Masonic Memorial Temple, Nob Hill, San Francisco, CA. Twenty educational sessions plus exhibits and an investment-planning seminar. Contact DENTCOM 84, 1803 Golden Gate, San Francisco, CA 94115, (800) 468-2211; in California, (800) 445-2121 or (415) 931-0910. *June 26–28*

● SOFTWARE, SYSTEMS, STRATEGIES, The 1984 Coronado Invitational Conference on Software, Systems, and Strategies: The Next Five Years, Hotel del Coronado, San Diego, CA. Contact Gnostic Concepts Inc., Suite 300, 951 Mariner's Island Blvd., San Mateo, CA 94404, (415) 345-7400. *June 26–28*

● PC IN BIG APPLE PCExpo, Coliseum, New York City. IBM Personal Computer hardware, software, and vendor exhibits. Daily seminars. Contact PCExpo, 333 Sylvan Ave., Englewood Cliffs, NJ 07632, (201) 569-8542. *June 26–28*

● FEDERAL COMPUTING EXPO Government Computer Expo—GCE84, Sheraton Washington Hotel, Washington, DC. Workshops, exhibits, and technical programs focusing on end-user computing and applications. Contact U.S. Professional Development Institute, 1620 Elton Rd., Silver Spring, MD 20903, (301) 445-4405. *June 26–29*

● LOGO CONVOCATION Logo '84 Conference, Massachusetts Institute of Technology, Cambridge. Four main themes, Logo Learning, Learning Environments, Technical Forecasts, and Images of Future Work. Product exhibits. Contact the Special Events Office, Room 7-111, MIT, Cambridge, MA 02139. *June 26–29*

● FORTH PROGRAMMING TIPS Using FORTH Effectively, Humboldt State University, Arcata, CA. A hands-on, advanced course on the generation and internal operations of a FORTH system. A mastery of an introductory FORTH course or a minimum of six months using FORTH and a knowledge of assembly language and operating-system principles are prerequisites. The fee is $150 or $200 with three quarter hours academic credit. Contact Claire Duffey, Office of Continuing

(continued on page 101)

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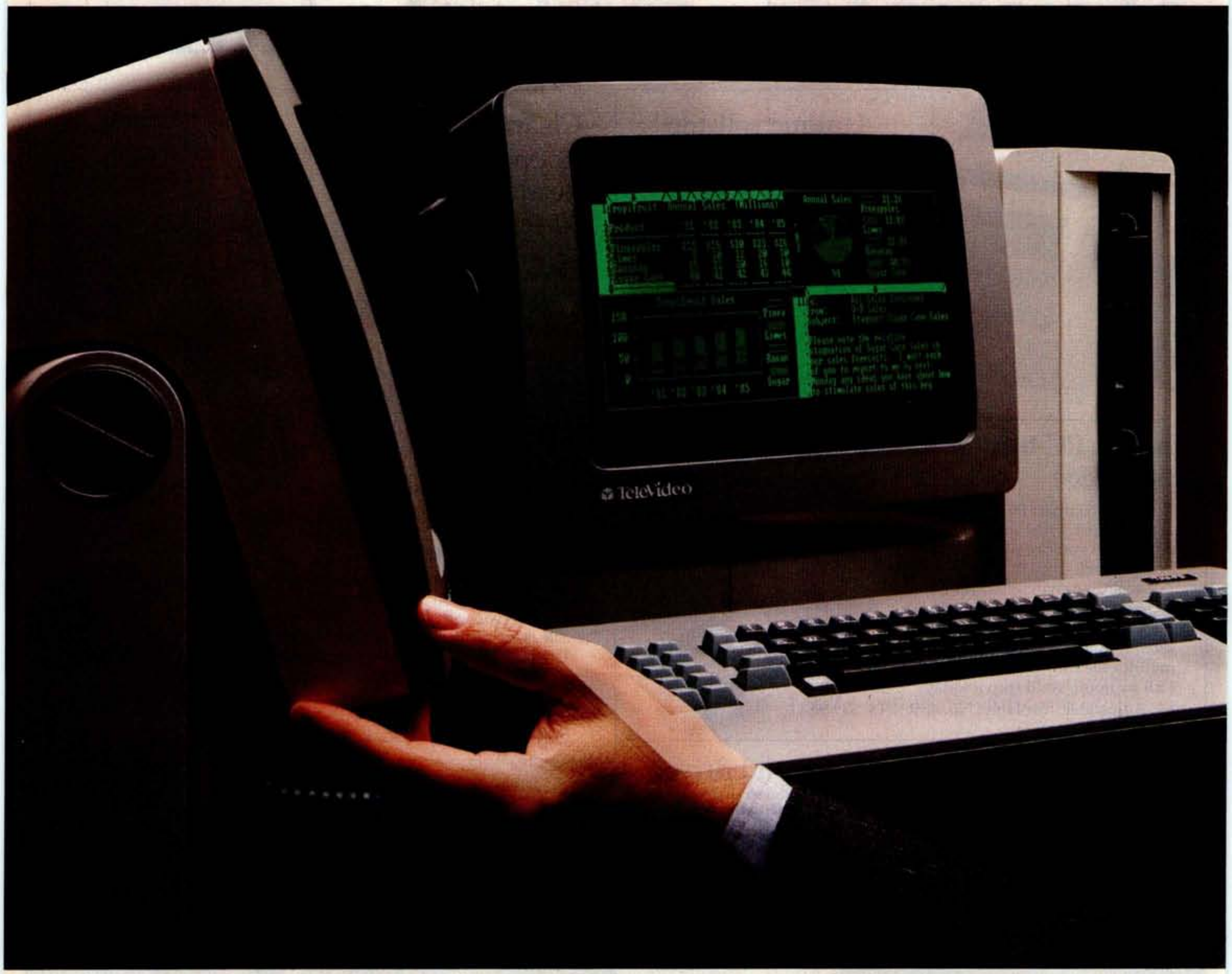
The best hardware for



TeleVideo versus IBM. Make a few simple comparisons and you'll find there is no comparison.

RUNS IBM SOFTWARE.

With the TeleVideo® IBM Compatible line—PC, XT and portable computers—you'll get the most out of all the most popular software written for the IBM® PC—more than 3,000 programs.

Because every TeleVideo Personal Computer offers the highest level of IBM compatibility on the market

THE BEST HARDWARE FOR THE BEST PRICE.

Features	Tele-PC	IBM PC	Tele-XT	IBM XT
Monitor	YES	OPTIONAL	YES	OPTIONAL
Screen Size	14"	12"	14"	12"
Tilt Screen	YES	NO	YES	NO
Quiet Operation	YES (NO FAN)	NO	YES	NO
Memory	128K	128K OPTION	256K	256K OPTION
Graphics Display (640 x 200 resolution)	YES	OPTIONAL	YES	OPTIONAL
Printer Port	YES	OPTIONAL	YES	OPTIONAL
Communication Port	YES	OPTIONAL	YES	YES
MS™-DOS/BASIC®	YES	OPTIONAL	YES	OPTIONAL
System Expansion Slot	YES	YES	YES	YES
RGB and Video Port	YES	OPTIONAL	YES	OPTIONAL
Typical System Price	**$2995**	**$3843**	**$4995**	**$5754**

compatibles. the best software.

and has the standard—not optional—features you need to take full advantage of every job your software can do.

Study the chart at the left. It proves that TeleVideo—not IBM—offers the best hardware for the best price.

Note that TeleVideo's ergonomic superiority over IBM extends from fully sculpted keys and a comfortable palm rest to a 14-inch, no glare screen that tilts at a touch.

THE BEST PORTABLE FOR THE BEST PRICE.

Features	TPC II	COMPAQ
High Capacity Storage	YES	NO
2nd Disk Drive	YES	OPTIONAL
Quiet Operation (No Fan)	YES	NO
Ergonomic Display	YES	NO
Communication Port	YES	OPTIONAL
International Power Supply	YES	NO
MS™-DOS 2.11	YES	NO
Graphics Display	YES	YES
Typical System Price	**$2995**	**$3710**

THE BEST MICROCHIPS.

What is perhaps most impressive about the TeleVideo IBM PC Compatible can be found deep within its circuitry. We use the same 8088 central processing unit that runs an IBM PC. But we also employ new VLSI (Very Large Scale Integration) microchips that are designed and built exclusively for TeleVideo.

These interface more efficiently with the powerful 8088 and yield numerous benefits.

For example, our tiny custom chips do the work of many of the larger, more expensive circuit boards in an IBM PC. So we can offer a computer system that comes in one attractive, integrated case, is ready to run and occupies less desk space. A computer that edges out IBM's added-cost component system for reliability, ease of service and purchase simplicity.

Fewer circuit boards to cool also allowed us to eliminate the noisy, irritating fan IBM and most other PCs force you to put up with. And TeleVideo compatibles accept any IBM hardware options without modification.

THE BEST LINE.

But the Tele-PC is only one element of the TeleVideo IBM PC Compatible line.

The TeleVideo XT is the best hardware for users of popular IBM XT software who would appreciate an extra 10 megabytes of storage capacity along with the advantages listed on the preceding chart.

As the chart above demonstrates, our portable IBM compatible computer, the TPC II, is far and away better hardware than COMPAQ.™ Better hardware—standard—at a better price.

THE BEST MANUFACTURER.

The TeleVideo IBM PC Compatible line is made by the world leader in multi-user computer systems and the number one independent manufacturer of terminals.

Our compatibles are available at participating ComputerLand and Entré (call 800-HI-ENTRE) dealers or you may call 800-538-8725 for the dealer nearest you. In California, call 800-345-8008.

Before you invest, make a few simple comparisons. You'll find that TeleVideo—not IBM or COMPAQ—has the best hardware for the best software. At the best price.

IBM is a registered trademark of International Business Machines. MS is a trademark of MicroSoft Corporation. GW Basic is a registered trademark of MicroSoft Corporation. COMPAQ is a trademark of COMPAQ Computer Corporation.

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Circle 23 on inquiry card.

(*continued from page* 96)
Education, Humboldt State University, Arcata, CA 95521, (707) 826-3731. *June 26–29*

● MEDICINE AND COMPUTERS
Annual American Society of Computers in Medicine and Dentistry Conference, Lodge at Vail, CO. An introduction to computers for doctors and dentists and a forum for expanding the use of computers. Contact Arlene Rogers, ASCMD, POB 21483, Upper Arlington, OH 43221, (614) 421-8487. *June 28–30*

July 1984

● WORKSHOPS FOR EDUCATORS, Compuworkshops Computer Seminars for Educators, various locations in California. Among the seminars offered are "Authoring Tools and Word Processing for Educators," "BASIC Programming for Educators," and "Designing Educational Courseware." Each course is $50. Contact Compukids of Seal Beach, Rossmoor Shopping Center, 12385 Seal Beach Blvd., Seal Beach, CA 90740, (213) 430-7226; in West Los Angeles, (213) 473-8002; in Tarzana, (213) 343-4008; and in Rancho Bernardo/San Diego, (619) 451-1742. *July–August*

● SME CONFERENCES & EXPOS, Conferences and Expositions from the Society of Manufacturing Engineers, various sites in the U.S. and around the world. A calendar is available. Contact the Public Relations Department, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0777. *July–August*

● C, UNIX COURSES
Courses in C Language and UNIX, Concord, MA, Somers Point, NJ, and College Park, MD. Three five-day courses are offered: "C Programming Workshop," "Advanced C Topics Seminar," and "UNIX Workshop." Contact Joan Hall, Plum Hall Inc., 1 Spruce Ave., Cardiff, NJ 08232, (609) 927-3770. *July–August*

● DBM SEMINARS
Digital Consulting Associates' Classes and Seminars, various sites in the U.S. Seminars and classes on dBASE II, Lotus 1-2-3, database administration, and other microcomputer topics. Contact Digital Consulting Associates Inc., 339 Salem St., Wakefield, MA 01880, (617) 246-4850. *July–August*

● DATABASE SEMINARS
SoftwareBanc Seminars, various sites in the U.S. and Canada. Such seminars as "Problem Solving with 1-2-3," "dBASE II," and "Exploring UNIX" are planned. Contact SoftwareBanc Inc., 661 Massachusetts Ave., Arlington, MA 02174, (800) 451-2502; in Massachusetts, (617) 641-1241. *July–August*

● EFFICIENT COMPUTING TECHNIQUES, Microcomputers: Techniques for Improving Your Computer Efficiency, Valley Inn and Tavern, Waterville Valley, NH. Four intensive two-day seminars: "Microcomputers: Programming in BASIC," "Introduction to VisiCalc," "Micro Database Applications," and "Engineering and Management Applications." Tuition is $495, or $679 with meals and lodging. Contact New Hampshire College, Resource Center, 2500 North River Rd., Manchester, NH 03104, (603) 668-2211, ext. 175. *July–September*

● MANAGERIAL SEMINARS
Computer Competence Seminars, Boston University Metropolitan College, Boston, MA. A series of hands-on presentations tailored for managers who know little or nothing about computers and for those who wish to sharpen their computing skills. On the docket are "PCs for Improving Financial Analysis and Decision Support" and "Personal Computers for Sales and Marketing Professionals." Fees range from $225 to $595. In-house programs can be organized. Contact Joan Merrick, University Seminar Center, Suite 415, 850 Boylston St., Chestnut Hill, MA 02167, (617) 738-5020. *July–September*

● RAINBOW SEMINARS
All-Hands-On, Boston, MA, Chicago, IL, New York City, and San Francisco, CA. A series of applications seminars featuring the DEC Rainbow 100. Contact Carol Ericson, BUO/E50, Educational Services, Digital Equipment Corp., 12 Crosby Dr., Bed-
(*continued on page* 102)

EVENT QUEUE

(continued from page 101)
ford, MA 01730, (617) 276-4572. *July–September*

● DEC SEMINARS
Technical and Management Seminars for Professionals, various sites in the U.S. Subject areas: system-performance management, networking, personal computing, applications design and programming, real-time applications design, and management development. On-site seminars can be arranged. Contact Educational Services, Digital Equipment Corp., Seminar Programs BUO/E58, 12 Crosby Dr., Bedford, MA 01730, (617) 276-4949. *July–September*

● HIGH-TECH TUTORIALS
Tutorial Short Courses from Hellman Associates, various sites in the U.S. Among the courses offered are "VLSI Design," "Digital Control," and "Error Correction." Fees are generally $895. Contact Hellman Associates Inc., Suite 300, 299 California Ave., Palo Alto, CA 94306, (415) 328-4091. *July–October*

● PROFESSIONAL EDUCATION
Seminars from the Institute for Professional Education, various sites in the U.S. Programs in statistics, management, simulation and modeling, personal computers, and computer science. Contact the Institute for Professional Education, POB 756, Arlington, VA 22216, (703) 527-8700. *July–December*

● COMMODORE DISSECTED
Commodore College '84, Brandon University, Manitoba, Canada. Workshops on graphics, sound, file handling, disk techniques, and 6502 machine language. Contact Faculty of Education, Brandon University, Brandon, Manitoba R7A 6A9, Canada, (204) 728-9520. *July 1–6*

● PC SHOW IN LONDON
The 1984 PC User Show, Novotel, London, England. Devoted to the IBM Personal Computer. More than 100 exhibits. Contact Geoff Dickinson, EMAP International Exhibitions Ltd., 8 Herbal Hill, London EC1B 1PA, England; tel: 01 837 3699. *July 3–5*

● WOMEN AND COMPUTING
The Third Annual National Conference of the Association for Women in Computing Conference, Holiday Inn Center Strip, Las Vegas, NV. The conference theme is "Choice or Chance in Computing Careers." Contact Patricia Timpanaro, AWCC '84 Registration, 40 Main St. Number 206, Stoneham, MA 02180. *July 8*

● NCC
The 1984 National Computer Conference—NCC, Convention Center, Las Vegas, NV. Professional-development seminars, more than 650 exhibits, and nearly 100 technical sessions. Contact the American Federation of Information Processing Societies Inc., 1899 Preston White Dr., Reston, VA 22091, (703) 620-8926. *July 9–12*

● FIBER-OPTIC METHODS
Fiber and Integrated Optics, San Diego, CA. Course topics: single- and multimode fiber cabling, photo detectors, receiver and repeater technology, and optical-fiber sensors. The fee is $875. Contact Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-6106. *July 9–13*

● SPECIAL EDUCATION INSTITUTE, Microcomputers in Special Education: Today's Challenge, Lesley College, Cambridge, MA. Subjects: Logo, software evaluation, administrative applications, and model programs. Technical expertise not required. Contact Joy Nikkel, Lesley College, 29 Everett St., Cambridge, MA 02238, (617) 868-9600. *July 16–20*

● SIMULATION CONFERENCE
Summer Computer Simulation Conference—SCSC '84, Copley Plaza Hotel, Boston, MA. Technical sessions, papers, panel discussions, exhibits, and tutorials. Contact Charles Pratt, Simulation Councils Inc., POB 2228, La Jolla, CA 92038, (619) 459-3888. *July 23–25*

● SIGGRAPH
ACM SIGGRAPH '84, Minneapolis, MN. Technical papers, panel discussions, a design show, film and video presentations, and nearly 30 courses. Contact SIGGRAPH '84 Conference Office, 111 East Wacker

(continued on page 104)

NOW!

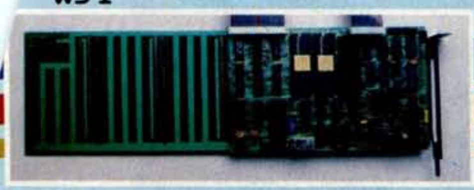
Choose From 3 Hard Disc Drive Systems That Convert Your IBM* PC To Perform Like The PC XT!

Maynard Electronics introduces three Winchester Hard Disc Drive Systems — the only drive systems to offer you 10 Mega-bytes of formatted capacity with complete internal installation! These systems offer the user countless benefits and features: capability of booting off the hard disc; additional functions while requiring only **one** card slot in your PC; and, use of available power, thereby preventing overheating problems which have affected other drives. Handling heavyweight data was never easier.

All three systems are quality engineered and work with DOS 2.0 without any special software drivers and also run with other operating systems designed to make use of the XT hard drive system. All you need is the IBM* DOS 2.0 Manual and you're ready to run!

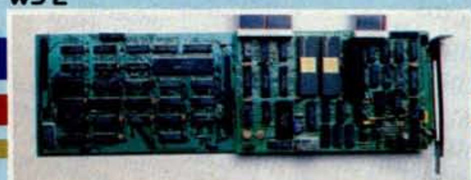
Each system is equipped with a low-power hard disc drive, complete software, cable, a SandStar™ Card and Hard Disc Controller Module. SandStar™ is the first family of modular peripherals created for the IBM* PC. Simple instructions for easy installation are included and all components are backed by an Unconditional One Year Parts and Labor Guarantee.

WS 1



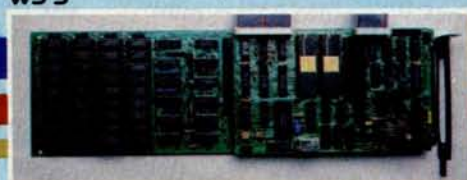
This System is equipped with the SandStar™ Multi-function card. In addition to the Hard Disc Controller Module, you can add up to three other SandStar™ Modules while using only **one** card slot. The following modules are available: Serial Port, Parallel Port, Clock Calendar, Game Adaptor, and Prototyping Module.

WS 2



This System is equipped with the SandStar™ Floppy Drive Controller Card. The Card can control, in addition to the Hard Disc Drive, two floppy drives mounted inside your PC and optionally two additional 5¼" or 8" drives mounted externally. This leaves three system slots for other expansion boards.

WS 3



This System is equipped with the SandStar™ Memory Card. In addition to controlling the Hard Disc Drive, the Memory Card allows you to add 64K bytes to 576K bytes of memory using only one card slot.

...expand your PC to perform like the PC XT, one of our Winchester Hard ...c Drive Systems is right for you. And if you have already made the ...e decision to install any of Maynard's SandStar™ Cards, the ...ndStar™ Hard Disc Controller Module may be purchased separately.

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(*continued from page* 102)
Dr., Chicago, IL 60601, (312) 644-6610. *July 23–27*

● INTERFACING TIPS FOR TEACHERS. Microcomputer-based Instrumentation for Schools, Middletown, OH. An introductory, hands-on workshop for college and secondary teachers. Contact Bill Rouse, 301 McGuffey Hall, Miami University, Oxford, OH 45056, (513) 529-2141. *July 23–August 2*

● MICROS IN EDUCATION Stanford Institute on Microcomputers in Education, Stanford University, Stanford, CA. See June 25–July 27. *July 30–August 31*

August 1984

● SCHOOL COMPUTER COORDINATORS. The Computer: Extension of the Human Mind, Center for Advanced Technology in Education, University of Oregon, Eugene. For individuals responsible for the use of computers and emerging technologies at the school and district levels. Pre- and post-conference workshops. Registration is $95. Contact Summer Conference Office, College of Education, University of Oregon, Eugene, OR 97403. *August 1–3.*

● SHOW FOR TARHEELS Great Southern Computer Show, Civic Center, Charlotte, NC. Hardware, software, peripherals, and accessories for the home and office. Seminars and workshops. Contact Great Southern Computer Shows, POB 655, Jacksonville, FL 32201, (904) 356-1044. *August 2–4*

● HOME AND OFFICE The First Annual Tampa Bay Computer Show & Office Equipment Exposition, Curtis Hixon Convention Center, Tampa, FL. Hardware, software, accessories, and peripherals for industry and home. Contact CompuShows Inc., POB 3315, Annapolis, MD 21403, (800) 368-2066; in Annapolis, (301) 263-8044; in Baltimore, 269- 7694; in the District of Columbia, 261-1047. *August 2–5*

● AI INVESTIGATED The National Conference on Artificial Intelligence, Performing Arts Center, University of Texas, Austin. Seminars, exhibits, and panel discussions. Registration for American Association for Artificial Intelligence (AAAI) members is $100; nonmembers pay $140. Contact Claudia C. Mazzetti, AAAI, 445 Burgess Dr., Menlo Park, CA 94025, (415) 328-3123. *August 6–10*

● COMPUTERS IN ENGINEERING. The 1984 ASME International Computers in Engineering Conference and Exhibit, Hilton Hotel, Las Vegas, NV. More than 60 panel discussions and paper sessions. Product exhibits. Contact American Society of Mechanical Engineers, 345 East 47th St., New York, NY 10017, (212) 705-7100. *August 12–16*

● MICROS & VOC ED Microcomputers and High Technology in Vocational Education Conference, Vocational Studies Center, University of Wisconsin, Madison. Concurrent sessions, formal classes, presentations, speeches, and videotaped programs. Preregistration fee is $55, or $65 at the door. Contact Dr. Judith Rodenstein, 964 Educational Sciences Building, University of Wisconsin, 1025 West Johnson St., Madison, WI 53706, (608) 263-4367. *August 13–16*

● COMPUTERS AND BIOLOGY. The Fourth Annual Notre Dame Short Course Series: Computers in Biology, University of Notre Dame, Notre Dame, IN. See June 18–22. *August 13–17*

● GRAPHICS & CONSTRUCTION. The Third International Conference and Exposition on Computers/Graphics in the Building Process, BP '84, Embarcadero Center, Hyatt Regency, San Francisco, CA. Tutorials, plenaries, and technical sessions will focus on the theme "The Building Process in Transition." Contact Conference Director, BP '84, Suite 333, 2033 M St. NW, Washington, DC 20036, (202) 775-9556. *August 19–23*

● PCB TECHNICAL SEMINAR The 1984 Printed Circuit Fabrication Technical Seminar, Boston, MA. Contact Donna Esposito, PMS Industries, 625 Sims Industrial Blvd., Alpharetta, GA 30201, (404) 475-1818. *August 27–29* ■

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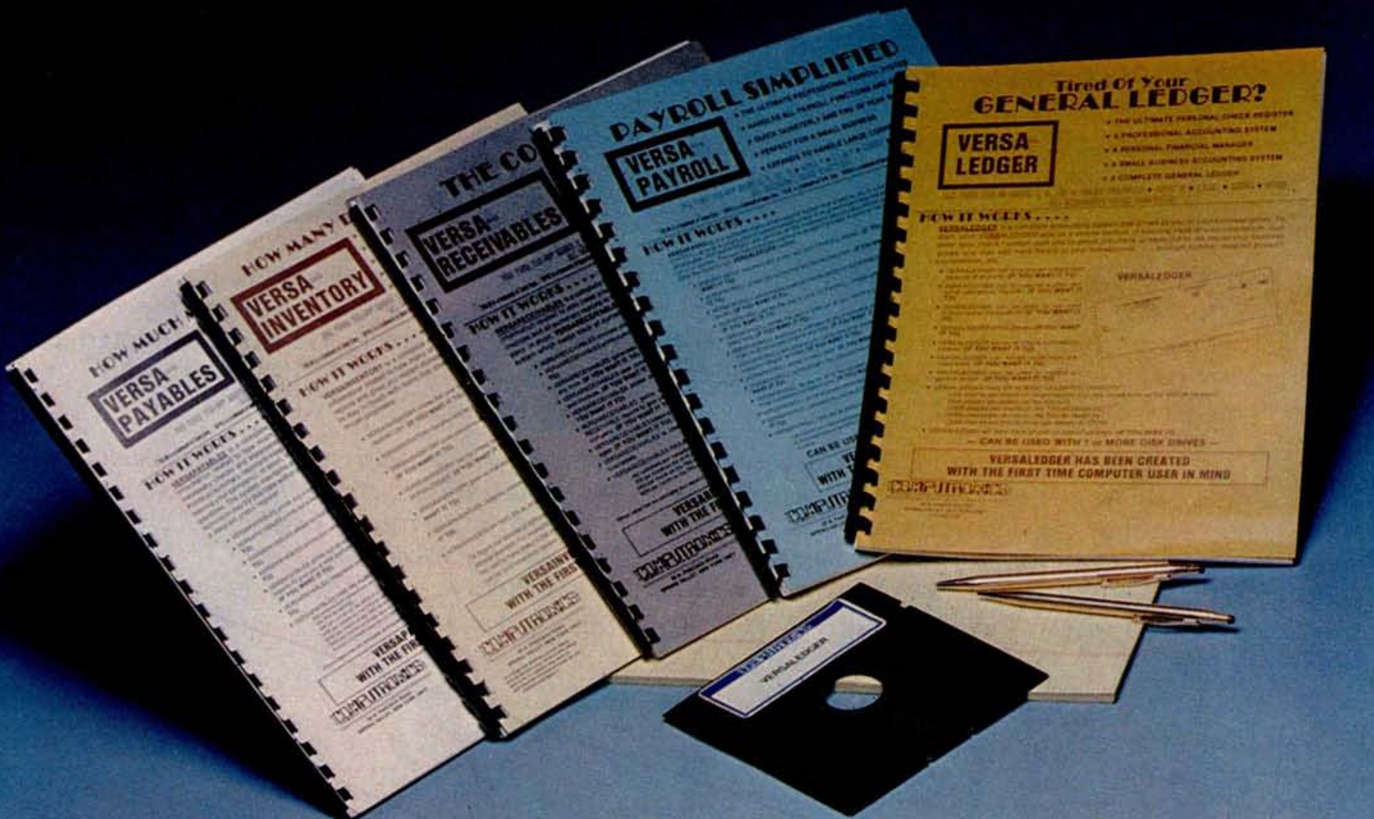

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VersaPayables™ is designed to keep track of current and aged payables, keeping you in touch with all information regarding how much money your company owes, and to whom. VersaPayables™ maintains a complete record on each vendor, prints checks, check registers, vouchers, transaction reports, aged payables reports, vendor reports, and more. With VersaPayables™, you can even let your computer automatically select which vouchers are to be paid.

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VersaInventory™ — $99.95

VersaInventory™ is a complete inventory control system that gives you instant access to data on any item. VersaInventory™ keeps track of all information related to what items are in stock, out of stock, on backorder, etc., stores sales and pricing data, alerts you when an item falls below a preset reorder point, and allows you to enter and print invoices directly or to link with the VersaReceivables™ system. VersaInventory™ prints all needed inventory listings, reports of items below reorder point, inventory value reports, period and year-to-date sales reports, price lists, inventory checklists, etc.

VersaLedger II™ — $149.95

VersaLedger II™ is a complete accounting system that grows as your business grows. VersaLedger II™ can be used as a simple personal checkbook register, expanded to a small business bookkeeping system or developed into a large corporate general ledger system **without any additional software.**

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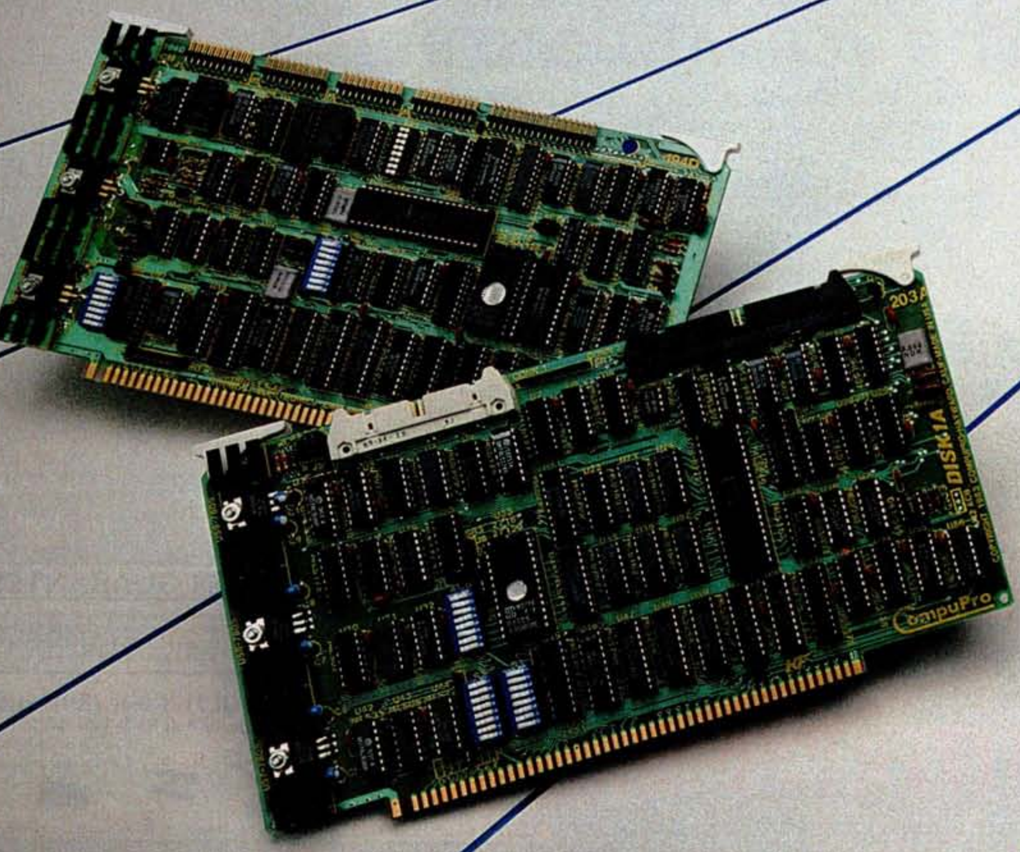
When it comes to answering your data storage needs, CompuPro has the essential components. Like our Floppy and Hard Disk Subsystems with Disk 3™ and Disk 1A™ controllers. They're the IEEE 696/S-100 products that will keep you and your system on the cutting edge of computing for years to come. Each reflects the most advanced technology available. And that's what you've come to expect from CompuPro. Because we've built our reputation on quality components like these for more than a decade.

DISK 1A™: Our high-performance floppy disk controller handles any combination of up to four 8" or 5¼" drives. The Disk 1A is perfectly suited for the highest level single or multi-user microcomputer system. It features state-of-the-art LSI architecture, high-speed DMA interface, and complete compatibility with CP/M-80™, CP/M-86®, CP/M-68K™, CP/M® 8-16™, MP/M™ 8-16™, and Concurrent CP/M™ 8-16™ operating systems.

DISK 3™: Our hard disk controller, which supports as many as four 5¼" Winchester drives, achieves new levels of performance for multi-tasking systems. The Disk 3's many features include transfer of each disk sector using high speed "burst mode" DMA, and a channel processor for independent seeking, reading and writing, as well as the capability to transfer large blocks of data between disk and memory with a single command. Compatible with the same operating systems as Disk 1A.




Ivan Chermayeff

Features

ALTHOUGH BYTE'S LOOK and organization change this month, the Feature section will continue to offer a range of topics: previews of innovative machines and software, techniques for using hardware and software, and in-depth explanations of how important technologies work. We welcome Steve Ciarcia to the Feature section effective this issue. The originality and diversity of Steve's popular construction projects rival those of some large manufacturing companies.

West Coast editor Ezra Shapiro opens the Feature section this month with a preview of the impressive Hewlett-Packard battery-powered portable computer, the HP 110. Small and light, the HP 110 packs powerful software into its ROM, including Lotus 1-2-3 and a text editor. The HP 110 accelerates the trend toward self-contained, truly personal (carry it with you everywhere) productivity tools.

Next, Steve Ciarcia completes his tale about turning the IBM PC into a personal minicomputer. "I know BASIC," Steve recently said, "and I don't want to learn any other high-level language." But Steve didn't resign himself to plodding through life at interpreter speeds. The Z8000 Trump Card lets Steve run BASIC and other software on the IBM PC at lightning speeds. This second and final part of the Trump Card article describes its software.

Ronald L. Greene follows with a lucid article that explains how macro substitution for the executable portions of words can make subroutine-threaded compilers produce faster code. Greene's article addresses reducing overhead in threaded interpreted languages and shows how to make FORTH run faster.

The monolith called the Department of Defense has given us Agent Orange and the F-111 bomber in recent years. As of January 1, 1984, it insists that Ada is the new computer language of the military-industrial complex. Whether this is bad or good, we offer this month the first installment of a two-part Ada primer written by Sabina H. Saib.

An interpreted version of Pascal will soon debut as Macintosh Pascal. Our product preview reveals that a company called Think Technologies produced this full implementation of the language combining BASIC's interactiveness and Pascal's structure to provide a powerful teaching language.

We've put John Bono to work on the hardware front, designing a low-cost printer buffer that you can build over a weekend. The result of John's effort is an article that'll help you build a device that frees your computer from periods of servitude to your printer.

In what may develop into a technique we'll all use some day, Keith H. Sueker explains how he receives radio-transmitted weather maps and displays the resulting data on a video monitor using his Apple computer. His article, called "Apple FAX: Weather Maps on a Video Screen," includes a screen photograph proving that the technique is a workable one. The hardware needed is inexpensive and the software relatively simple.

After last month's look at structured, incrementally-compiled BASIC, this month Rodolfo Cerati shows you how to write a spreadsheet in old-fashioned BASIC, in an article that reveals some interesting programming techniques.

—*G. Michael Vose, Senior Technical Editor, Features*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The HP 110

A light and powerful portable

IN THE BATTLE for dominance in the growing market for lightweight, battery-powered, briefcase-size portable computers, Hewlett-Packard has unveiled its new model, the HP 110. The unit is outwardly similar to many of its competitors—it's about the size of a metropolitan phone directory and has a flip-up LCD (liquid-crystal display) screen that lifts to uncover a typewriter-style keyboard. But two aspects of the design philosophy behind the 110 help set it apart from the crowd.

First, the 110's combination of abundant internal memory and silicon-based software makes it an extremely satisfactory traveling computer, freeing you from a large part of the dependence on disks and other cumbersome storage media. Second, the HP 110 was seen from the very first as the hub of an integrated system of components, an ideal that has been realized with the concurrent announcement of related products from Hewlett-Packard (see photo 1).

The guts of the computer are built around the Harris 80C86, a CMOS (complementary metal-oxide semiconductor) version of the popular 8086 microprocessor chip, running at 5.33 MHz (megahertz). Available memory consists of 272K bytes of CMOS RAM (random-access read/write memory), which you can divide between system RAM and electronic disk emulation, and a whopping 384K bytes of CMOS ROM (read-only memory). System RAM can range from a minimum of 96K bytes to a

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BY EZRA SHAPIRO

PHOTOGRAPHED BY PAUL AVIS

AT A GLANCE

Name
HP 110

Type
Portable computer with built-in 300-bps modem

Manufacturer
Hewlett-Packard Corporation
11000 Wolfe Rd.
Cupertino, CA 95014
(800) 367-4772

Processor
Harris CMOS 80C86

Memory
272K bytes CMOS RAM, user-definable as RAM or solid-state disk; 384K bytes CMOS ROM

Data Storage
RAM-based disk emulator; no internal drives

Size
13 by 10 by 3 inches; 9 pounds

Display
LCD, 16 lines by 80 characters; graphics resolution, 480 by 128 pixels

Power Supply
Rechargeable lead-acid batteries, rated 20 hours

Software Provided
MS-DOS 2.01, Personal Applications Manager, Lotus 1-2-3, Memomaker (word processor), terminal and communications packages

Price
$2995

Options
Thinkjet (HP 2225B) ink-jet printer, HP 9114 single 3½-inch disk drive, IBM PC/HPIL interface card with HPLINK software, various Hewlett-Packard interface converters

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maximum of 256K bytes. Onboard ROM contains an assortment of software, including HP's Personal Applications Manager (a shell-style user interface), MS-DOS version 2.01 (the operating system itself plus a collection of utilities for file management, directory maintenance, disk formatting, etc.), Lotus 1-2-3, Memomaker (a simple word-processing program), and a timer/alarm program. Also contained in ROM is the communications software to drive the computer's three output ports: an RS-232C serial interface, a proprietary HPIL (Hewlett-Packard Interface Loop) interface, and a built-in 300-bps (bits per second) modem that accepts a standard phone plug (see photo 2). There is no internal disk storage, but the battery-powered CMOS chips are essentially nonvolatile; that is, you can turn off the display and come back to the computer a week later and pick up exactly where you left off.

Hewlett-Packard manufactures its own CMOS ROM and RAM chips at Corvallis, Oregon, home of the division that has been producing hand-held computers and calculators for several years. Designers of the 110 took advantage of this facility to engineer two other CMOS chips for this project: an LCD controller with 8K bytes of display ROM, software fonts for the character generator, and bit-mapping for graphics; and another 8K-byte ROM chip, known as "the kitchen sink," that includes the timer, interrupts, serial port, and keyboard interface. These efforts resulted in a main printed-circuit board and an I/O (input/output) board with lower chip counts than you might expect. The final boards are not tightly packed; descendants of the 110 will have room for more interesting goodies.

The display is an 80-character by 16-line LCD, though the large expanse of plastic bezel around the screen suggests the possibility of a bigger display in the indeterminate future. In fact, HP engineers commented that they had looked at 24-line screens but had decided that product reliability and image quality were still too uncertain to make them acceptable at this time. You can select two character fonts: Hewlett-Packard's and an alternate set compatible with that of the IBM Personal Computer (PC). You can program the display in graphics mode as a grid of 480 by 128 pixels (picture elements). This is relatively high resolution, particularly for an LCD, and is suitable for most types of business graphics. Brightness (actually, darkness in this case) can be controlled with a single key on the right side of the keyboard. Characters and graphics are sharp, and screen updates are quite rapid.

The 110's keyboard is laid out in the standard Selectric format (i.e., the Return and Shift keys are in the old familiar locations) and has a full complement of computer keys: Control, Break/Stop, Escape/Delete, Caps Lock, and Print/Enter. A key labeled "Extend char" generates a non-ASCII (American National Standard Code for Information Interchange) character and is equivalent to the Alt key of the IBM PC. An additional row of keys along the top of the keyboard includes eight soft (determined by individual programs) function keys, two menu keys that generate or remove a map of the function keys from the bottom three lines of the screen, a Select key that chooses a highlighted option within a program, and four cursor-movement keys. There is no separate numeric keypad.

The rechargeable lead-acid batteries that power the 110 are rated at 20 hours of continuous use. In actual practice, the 110 can go for a week or more of sporadic use before the batteries become dangerously weak. The system is designed to preserve memory at all costs. The display is the major power drain, and the computer shuts it off at a preset interval of inactivity; you can choose an interval of anywhere from 30 seconds to 30 minutes. When the batteries reach 5 percent of capacity, the 110 refuses to turn on the display until they've been recharged. If the 110 is not used at all, you can expect a couple of months on a single charge.

The unit is a compact device with a high-impact molded plastic shell, measuring 13 by 10 by 3 inches (closed); its color is the typical nondescript off-white. It weighs in at 9 pounds. The basic package includes a plug-in recharger (similar to those used for other portable products) and a black vinyl carrying case with a handle and a wide, adjustable shoulder strap.

The HP 110 is tested to rather severe standards. However, the Hewlett-Packard quality-control staff stresses that these are goals rather than absolute guarantees for each machine: 0 to 50 degrees Celsius for operation, −25 to 55 degrees for storage, and 95 percent humidity for five days at 40 degrees. The units are also put through condensation, moisture absorption, and rapid temperature cycling tests. HP 110s have withstood altitudes of 50,000 feet and forces of 100 G on all axes. The fact that there are no sensitive internal

drives—no moving parts at all, with the exception of the keys and the lid hinges and latches—makes the 110 an extremely rugged computer. All units must pass FCC Class B limits on electromagnetic interference; Hewlett-Packard is working with the FAA to end the controversy over computer use on commercial airliners and to establish hard, published standards for portable computer radiation.

THE SOFTWARE

When you first open the HP 110, the screen is blank; pressing any key activates the display. The first time you use the computer, you will see Hewlett-Packard's Personal Applications Manager (PAM), modified somewhat from the original version distributed with the HP 150 touchscreen personal computer (see photo 3). Subsequently, turning on the display returns you to where you were the last time you used the computer. PAM is an operating-system shell; most file manipulation and system configuration is accomplished through PAM's main or subsidiary menus.

The initial PAM screen shows a number of important status items: date, time, remaining battery life, and space available on the electronic disk drive (called the A: drive). Most of the display is used to show the applications you can run. At the outset, these applications are those programs resident in ROM (called the B: drive); if at some point you load programs into the RAM disk, those programs are also displayed on the screen. Moving the cursor to a program and pressing either the first function key (Start Applic) or the Select key loads and runs the program. Data files are not listed.

The second function key (File Manager) leads to a secondary shell. The File Manager displays all the files in the default directory and a list of alternate directories. On this screen, the function keys enable you to print or delete a file or a directory, create a new directory (following MS-DOS path rules), choose a new directory to display, copy a file, rename a file, or format a new disk (more on this later in the section on peripherals). The File Manager serves as the shell for most of the MS-DOS maintenance commands.

The third function key (Clock Config) provides access to the clock configuration commands, letting you reset the time and the date. The fourth key (Reread Discs) rescans the directories and updates the PAM screen. The fifth function key (Datacom Config) leads to a menu for setting the parameters (communications rate, word length, stop bits, parity, protocol) for the HPIL interface and either the modem or the RS-232C serial port (you can't run these two outputs simultaneously).

The sixth function key brings up the system configuration menu (see photo 4). Here, you can allocate system memory and RAM-disk space, indicate the number of external disk drives plugged into the computer, select a read-after-write verification of disk action, set the display time-out interval, choose between a block or an underscore cursor, select the character set, determine the length of the warning beep, and configure the printer interface.

Pressing the seventh key, either from the main PAM menu or from any of the secondary menus, produces a menu for a series of detailed Help screens on all operations of the HP 110 (see photo 5). The eighth key returns you to the main menu from a secondary menu; if activated from the main menu, the key shuts off the display.

The four applications programs listed by PAM include Memomaker, Lotus 1-2-3, Terminal, and DOS Commands. Memomaker is a rudimentary word processor developed by Hewlett-Packard for quick notes, brief business correspondence, and ASCII program script files (such as the scripts PAM uses to trigger the alarm or run a program at a specific date and time). If you're accustomed to working with a full-fledged word-processing program, you might find Memomaker severely lacking in sophistication, particularly when it comes to formatted output.

Lotus 1-2-3, on the other hand, is a delight to use (see photo 6). Maximum system memory enables use of a spreadsheet with 2048 by 512 cells, certainly more than adequate for most modeling problems. Because everything

(text continued on page 414)

Photo 1: *The HP 110 links to two optional battery-powered peripherals, the HP 2225B ink-jet dot-matrix printer and the HP 9114 single 3½-inch disk drive.*

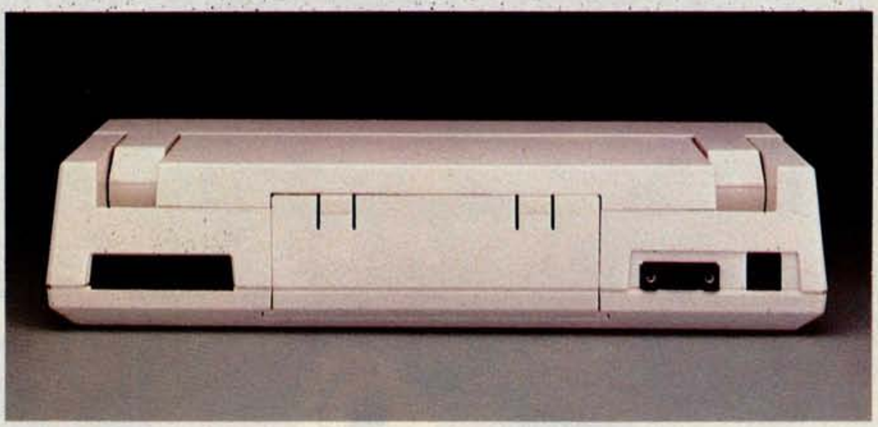

Photo 2: *The back view of the HP 110. Shown from left to right are the two connections for the HPIL serial interface, the socket for the plug-in recharger, a nine-pin RS-232C port, and a modular phone jack for the internal modem. The removable panel in the center provides access to the lead-acid batteries.*

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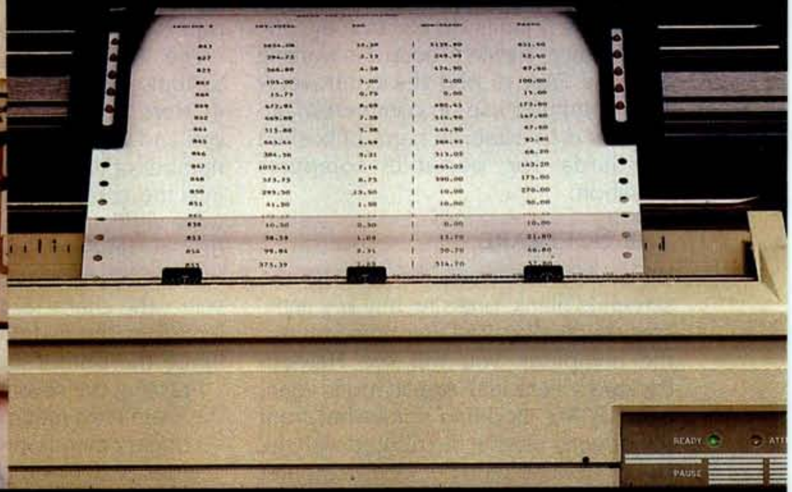

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Trump Card Part 2: Software

TBASIC and C compilers and an assembler

BY STEVE CIARCIA

Last month, we looked at the hardware of the Trump Card, a coprocessor board for use with the IBM Personal Computer (PC) or compatible computers. The presentation centered mainly on the Zilog Z8000's processor architecture, the support circuitry, and the interface between the Z8000 and the Intel 8088. But the power of the Trump Card can be unleashed only by the right software. This month, I'll describe the collection of software I've assembled for the Trump Card from several sources—most of it designed to support further program development. Let's first quickly review the features of the Trump Card.

WHAT IS THE TRUMP CARD?

The Trump Card (see photo 1) is a printed-circuit board that plugs into any I/O (input/output) expansion slot of an IBM PC, an IBM PC XT, or any computer compatible with them. It contains a Zilog Z8001 16-/16-bit microprocessor (the memory-segmented version of the Z8000) running at 10 MHz and up to 512K bytes of RAM (random-access read/write memory). The Trump Card communicates with the PC's built-in 8088 processor through a 256-byte FIFO (first-in/first-out) buffer.

A variety of software is available for the Trump Card. The most important, from my point of view, is the language system for its special version of BASIC. As you would expect, the Trump Card's TBASIC compiler excels at making user programs run fast, but it's also so easy to use that it makes some interpreted versions of BASIC look clumsy. The source language accepted by the TBASIC compiler is nearly identical with that of the IBM PC's Advanced BASIC interpreter (BASICA) and includes a few enhancements, such as compilation of programs larger than 64K bytes.

Other software included with the Trump Card follows:

- CP/M-80 emulator. The Trump Card can run programs designed to run under Digital Research's CP/M-80 DOS (disk operating system) by emulating the 8-bit Z80 instruction set and DOS calls. No special file headers or instruction-translation programs are required.
- C compiler. The source language accepted by this compiler follows that of Kernighan and Ritchie with a few minor differences (see reference 6).
- Screen editor. Incorporating many of the features normally found only in word-processing packages, the screen editor, called EE, enables you to write or examine ASCII (American National Standard Code for Information Interchange) text files for use either with the Trump Card or in the normal IBM PC environment.
- Y multilevel-language compiler. The unusual Y language system is essentially a structured assembler that enables Pascal-like control constructs and data types, arithmetic expressions with automatic or specified allocations of registers, and procedure calls with parameter passing.
- Debugger. With the debugger, you can examine and replace the contents of memory and registers, set breakpoints, or single-step through programs. Intended to aid in program development, the debugger is an integral part of Y.
- Semiconductor disk emulator. Under versions of PC-DOS equal to or higher than 2.0, Trump Card can allocate 128K to 387K bytes of its on-board RAM to function as a RAM disk or disk emulator. This memory is separate from the memory already existing on the PC's motherboard or other expansion boards and resides in the Z8000's separate address space. The Trump Card can run another function concurrently with the disk emulator.

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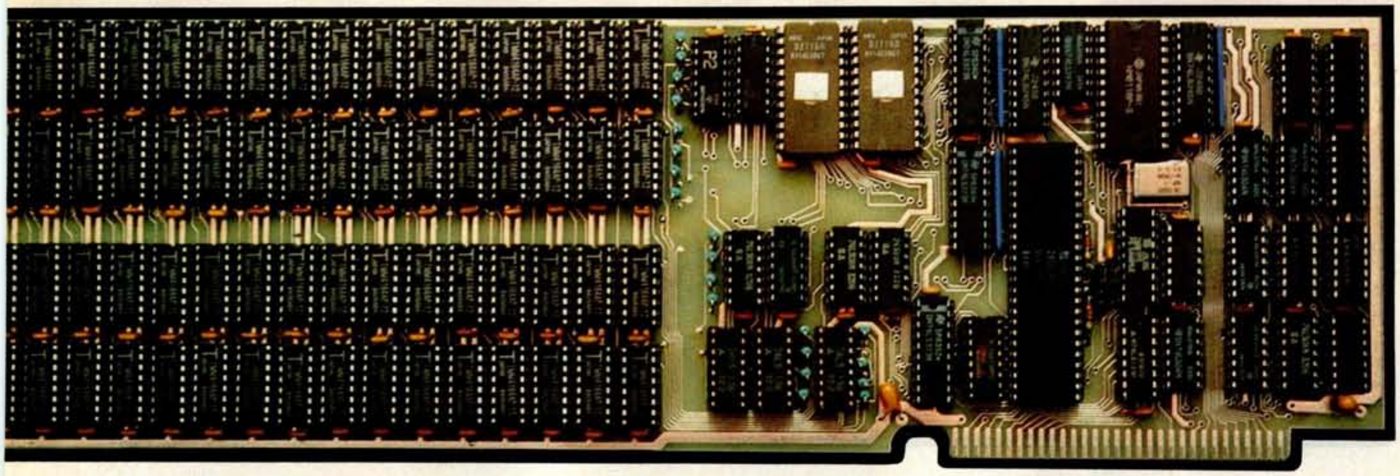

Photo 1: *The soldered prototype printed-circuit version of Trump Card.* RAM *sockets are at left.* EPROMs *are top center, and the* Z8001 *and support chips fill the remainder of the board.*

TBASIC *is a new version of the* BASIC *language that looks like an interpreter and executes like a compiler.*

(text continued from page 115)

BRINGING THE TRUMP CARD UP

To initialize the Trump Card, run a program called LDZSYS.COM from PC-DOS. When it has completed setting up the Trump Card and installing the device driver needed by PC-DOS to communicate with it, LDZSYS returns control to PC-DOS and the host 8088 processor, with the Z8000 awaiting further instructions. Example 1 in the text box on page 118 contains examples of this and other typical user commands (in italics) and the system's response (in roman type). The operation of the Trump Card is transparent to programs running on the host 8088. (If you think that you will always want the Trump Card's capabilities available, you can add a line containing LDZSYS to your PC-DOS AUTOEXEC.BAT file.)

To begin using the Trump Card, execute the "go" program, G.COM (G). When the Z8000 has control of the system, it returns with a colon prompt, as the fourth line of example 1 shows, indicating that the Z8000 is ready to accept commands. The text box also shows the command format for editing and compiling files and programs, which may be stored on the same disk used to boot PC-DOS.

INTERPRETERS VERSUS COMPILERS

As I said last month, a chief cause for my building the Trump Card was a feeling of frustration with the slowness of BASIC interpreters. I had, of course, considered using an off-the-shelf BASIC compiler to speed up my programs, but I did not relish all the overhead operations required by the compilers I had seen, such as Microsoft's BASIC compiler.

The typical compiler requires three separate operations to run a BASIC program. First, the program source code must be written using an editor program. Next, the ASCII program text from the editor is compiled into object code and stored in a disk file, which often takes several minutes. Finally, the special BASIC run-time processor is loaded from the disk to supervise execution of the object program. At last, the program does its thing.

Interpreters, for all their inefficiency of execution, do have one important benefit: you quickly can add a line to your program and type RUN to see its effect. But if you want to change a line in a compiled program, it's back to the editor and all the way through the process again. So when you finally have your debugged, compiled program, it may indeed execute 100 times faster than under an interpreted one, but it may have taken you 10 times as long to get it running right. I think this is one reason BASIC compilers are not in wider use.

To counter this criticism, compiler manufacturers suggest developing code on an interpreted BASIC first and then compiling it. Such a suggestion, while valid, ignores the reason for a compiler in the first place. If a hundredfold increase in speed is necessary to achieve a program's objective, it hardly makes sense that to write and test the original program you must wait 100 times longer each time you must run it.

The answer seemed relatively trivial to me—simply write a version of BASIC that looks like an interpreter and executes like a compiler. The result is TBASIC.

The Trump Card's TBASIC language system is a BASIC compiler that offers

significantly faster execution of BASIC programs than does a BASIC interpreter, while furnishing an operating environment much like that of an interpreter. TBASIC bridges the gap between traditional BASIC interpreters, which have built-in editors and are known for ease of use, and typical BASIC compilers, which produce rather efficient object code but can be difficult to work with. TBASIC's extremely fast compilation times and its capability for immediate-mode execution make working with it as easy as working with a friendly but slow interpreted BASIC, but the resulting programs run with the speed of a compiler. Unlike other compilers, the object code is not written into a disk file before execution (unless you request it). Therefore, no long delays are needed. When you load the file into the Trump Card, TBASIC compiles the program in a few tenths of a second.

Most programs that will run under the IBM PC's BASICA interpreter can be fed into TBASIC for compilation. You can use either the Trump Card's EE screen editor or the BASICA editor to write the programs. But if you then run the same program under both BASICA and TBASIC, depending upon the instructions you use, you will notice an increase in program performance by a factor of anywhere from 7 to 100. A listing of TBASIC's keywords is shown in table 1. TBASIC also supports most of BASICA's color and graphics commands (see photo 2).

Line numbers aren't required in the source code of programs written for TBASIC except where a line is to be referenced elsewhere in the program; for example, the destination of a GOTO or GOSUB statement would need a line number. Although not requiring them, TBASIC certainly allows line numbers on every line, so existing BASICA source code will run under TBASIC, to the extent that the program is compatible with TBASIC's syntax. Such programs can immediately benefit from the increase in performance provided by TBASIC.

The development of a program using a BASIC interpreter occurs in two modes: editing the program and running it. Developing a program with TBASIC involves three modes: editing, compiling, and running. Obviously, the only difference is compilation, which is invoked on the Trump Card by the DO command; once the program has been compiled, the familiar RUN command executes it.

Example 2 on page 118 shows some examples of the kind of interaction that occurs when you use TBASIC: how to enter a program using the EE editor, compile it, and run the compiled program. In the text box, input by the user is shown in italic type while the system's prompts and output are shown in roman characters.

During compilation of a program, error messages are issued each time an error is encountered. The line of the source file in which the error was detected is displayed; in some cases, an error message is also displayed. After an error is found and displayed, compilation continues and any other errors found also will be displayed. When the compilation has been completed, a list of any undefined symbols also may be output, in which case the program should not be run.

TBASIC Programs

Three methods can be used for entering program statements into the system for compilation under TBASIC. The first is to use the Trump Card's built-in EE screen editor, as mentioned previously (see photo 3). A second method is to enter the statements using TBASIC's direct-entry mode. The third choice is to enter and test the program using the computer's regular BASICA interpreter and then run it for effect using TBASIC. The three methods may be used interchangeably.

Example 3 shows an example of these functions with a minimally modified version of the Sieve of Eratosthenes program often used as a system benchmark (see references 4 and 5). A program called SIEVE.S was previously written in BASICA and stored as an ASCII file on the disk in drive B.

Suppose you want to run the program under both BASICA and TBASIC while recording how long it takes to be executed. You could use a stopwatch, but it's easier to add a few more program lines that record the starting and ending times automatically by calling the TIME$ function. It's possible to invoke the editor directly from TBASIC, as shown in example 3, to add two lines. And you can see that TBASIC took about 2 seconds to run the modified program as measured by the internal clock.

The program changes quickly were added and executed, and, when you left the editor with a QU command, the file SIEVE.S on drive B was updated to contain the TIME$-function statements. After running the slightly revised program under BASICA, you see that it takes 202 seconds, around 100 times as

(text continued on page 118)

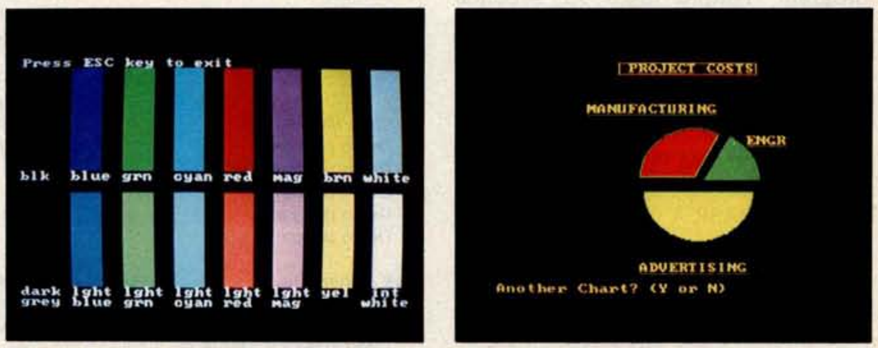

Photo 2: *Color (2a) and graphics (2b) tests demonstrate* TBASIC's *support of color/graphics commands normally associated with* BASICA.

Photo 3: *Programs in* BASICA *(3a) and in C (3b) can be written for Trump Card or the PC by using Trump Card's built-in* EE *editor.*

(text continued from page 117)

long. Now consider the aggravation of making changes in programs that take this long to run and waiting for the results each time. Perhaps you now understand why I built the Trump Card. If you're interested in how fast some

TBASIC *speeds up development and debugging as well as execution.*

other computers and BASIC systems executed essentially the same program, see table 2. Another program that demonstrates how TBASIC speeds things up is the simple looping benchmark shown in listing 1. The results are shown in table 3.

Not all programs run a hundred times faster in TBASIC. The Sieve program purposely uses integer arithmetic and avoids difficult floating-point calculations. But we can get an idea of floating-point performance from the simple benchmark routine of listing 2. In this program, TBASIC takes 3.2 seconds while BASICA takes 24.2. This benchmark shows the wide variation in performance you can expect from a different mix of statements.

Of course, most other BASIC compilers for the IBM PC also can demonstrate dramatic speed increases over interpretive BASICA. But I believe that TBASIC is different because it speeds up development and debugging as well as execution.

(You might be wondering if the installation of an Intel 8087 Numeric Processor Extension in the IBM PC would help speed up execution of BASIC programs. Under BASICA, it would have no effect whatsoever because BASICA is not written to use it. I did a quick informal test using Morgan Professional BASIC, which uses the 8087. Morgan BASIC took 12.8 seconds to execute listing 2.)

TBASIC'S EASE OF USE

TBASIC has many of the same convenience features for running programs that an interpreter has. You can use the commands RUN, RUN<*line number*>, GOTO<*line number*>, and GOSUB<*line number*> just as in BASICA. To stop a program from the console, you just hit

EXAMPLE 1

Computer Interaction	Comments
A>*LDZSYS*	Initialize Trump Card from PC-DOS.
A>	Control is returned to PC-DOS.
A>*G*	Turn control over to Trump Card.
:	(Trump Card's command prompt.)
: *EE<filename>*	Edit a file.
: *Z80EM<filename>*	Emulate Z80 and run CP/M-80 programs.
: *C<filename>*	Compile and run a C program.
: *Y<filename>*	Compile and run Z8000 structured assembly language.
: *BASIC<filename>*	Compile and run TBASIC programs.
: *//*	Exit from Z8000 command interpreter.
A>	Control returns to PC-DOS.

EXAMPLE 2

Computer Interaction	Comments
A>*B: (Return)*	Set the PC-DOS default drive to B. TBASIC will also use this drive as its default drive.
B>*G (Return)*	Type G to "go to" the Z8000.
:	The colon (:) is the Z8000 system command prompt, equivalent to the A> or B> prompt of PC-DOS.
:*BASIC (Return)*	Invoke TBASIC.
-	The hyphen (-) is the command prompt used by TBASIC; you may now invoke any TBASIC command.
-EDIT TESTFILE (Return)	Edit a new file using the EE editor.
T	You are now in the EE editor
EOF	in command mode.
E	Type "E" to enter text.
FOR I=1 TO 5 (Return)	Type in your BASIC program.
PRINT "Demo program" (Return)	
NEXT I (Return)	
(Escape)	Hit the Escape key to leave the Enter mode.
QU (Return)	Quit and save program on default disk B.
-	The "-" prompt shows that you are now back in TBASIC.
-DO (Return)	Compile the program by using the DO command (takes about 0.1 second).
-	Your program is now compiled.
-RUN (Return)	Type RUN to execute the compiled program.
Demo program	Compiled program output.
Demo program	
Demo program	
Demo program	
Demo program	
-// (Return)	The // command exits TBASIC. (The SYSTEM command could be used instead.)
:DIR (Return)	Call for a disk directory from the command interpreter.
DIRECTORY OF DRIVE B:	
TESTFILE	There's the source file you created with the EE editor.
:// (Return)	The // command exits the Z8000's B> command mode and returns control to PC-DOS.

EXAMPLE 3

Computer Interaction	Comments
B> *G (Return)*	Go to the Z8000 operating system.
: *BASIC SIEVE.S (Return)*	Get SIEVE.S from disk and compile it in about 0.2 second.
- RUN (Return)	Execute program in TBASIC.
1 ITERATION	
1899 PRIMES	The program produces output and ends.
-	Awaiting next command.
-EDIT (Return)	Call the editor from TBASIC prompt.
T	T indicates display from top of file; the complete Sieve file is displayed, ready to edit.

```
5 DEFINT A-Z
10 SIZE = 8190
20 DIM FLAGS(8191)
30 PRINT "Only 1 iteration"
50 COUNT = 0
```

60 FOR I = 0 TO SIZE	
70 FLAGS(I) = 1	
80 NEXT I	
90 FOR I = 0 TO SIZE	
100 IF FLAGS(I) = 0 THEN 180	
110 PRIME = I+I +3	
120 K = I + PRIME	
130 IF K > SIZE THEN 170	
140 FLAGS(K) = 0	
150 K = K + PRIME	
160 GOTO 130	
170 COUNT = COUNT + 1	
180 NEXT I	
190 PRINT COUNT;" PRIMES"	
E *(RETURN)*	Enter mode, allows text entry.
2 J$ = TIME$	Two lines are added to print the time.
200 PRINT J$, TIME$	
(Escape, Return)	Type Escape key to exit Enter mode.
QU (Return)	Finished changes. Leave editor and return to TBASIC.
- DO (Return)	The file is recompiled with the DO command, taking about 0.2 second.
- RUN (Return)	The program is run again with changes.
1 ITERATION	The program produces output.
1899 PRIMES	
01:01:25 01:01:27	
-	The prompt returns after execution ends.
-// (Return)	Exit TBASIC.
:// (Return)	Exit the Trump Card system.
B>*BASICA (Return)*	Get BASICA and run SIEVE.S.
LOAD "SIEVE.S"	(SIEVE.S was stored in ASCII format.)
RUN	
1 ITERATION	The program produces output.
1899 PRIMES	
01:05:35 01:09:01	

EXAMPLE 4 ....

Computer Interaction	Comments
B>*G (Return)*	Activate the Trump Card.
: BASIC (Return)	Enter TBASIC.
- /DIAG (Return)	Invoke subroutine-diagnostic mode.
- PRINT 2+3 (Return)	Directly add and print 2+3.
CExit;CImmxInit;Ki00000000;	The listing shows the compiler
CPrtInit;Ki00000002;Ki00000003;	subroutines that are executed to
b+;CPrtI;CPrtCR;R; 5	perform the function. CExit (call exit) jumps out of the console-input mode; CImmxInit calls for immediate execution with a flag integer-constant value of 0 set as Ki00000000. CPrtInit (call printer) directs printing to the console; the two integer values are expressed as Ki00000002 and Ki00000003, respectively; b+ calls a binary add routine; CPrtI prints the integer. CPrtCR finishes by sending a carriage return to the printer or console while R designates a return to the system. The computed value, 5, appears at the end.
- PRINT2.027+3.094 (Return)	Floating-point values produce a slightly different result.
CExit;CImmxInit;Ki00000000;	This time the constants are stored
CPrtInit;Kf01BA5E82;Kf46041982;	as floating-point numbers, and
CFltAdd;CPrtF;CPrtCR;R; 5.121	floating-point add and print routines are called instead.
-	

EXAMPLE 5 ....

:	Back in command interpreter.
:C (Return)	Call C compiler, the "-" is
-	the C compiler prompt.
-/DO BASICIO.C (Return)	Compile I/O routines.
-/DO CDEMO.C (Return)	Compile CDEMO.C program (listing 3).
-/IMAGE CDEMO E=MAIN (Return)	Save memory image of compiled program in a disk file called CDEMO.
-// (Return)	Get out of C compiler.
:	Back in command interpreter.
:CDEMO (Return)	Run compiled program.
C language	
C language	The program produces output.
C language	
C language	
C language	
:	Back in command interpreter.
:// (Return)	Get out of interpreter.
B>	Back to IBM PC-DOS command prompt.

Control-C. If possible, TBASIC will display the statement label nearest the point in the program where the stop occurred. Programs may contain STOP statements and may be restarted by a CONT command.

TBASIC also can execute statements and commands in immediate mode. You simply type the program line without a line number. (If you precede a statement with a line number, it will be compiled into the existing program.) You can get results like

```
-PRINT SQR(2)
1.414214
-
-PRINT 2*3
6
-
```

You can print out variables or run specific program lines that contain line-identifier labels. Immediate-mode statements and commands also may be included in program files.

TBASIC also has some commands useful in debugging and problem diagnosis that you probably have not seen before. You can examine the actual compiled machine-language object code with commands like /DIAG. If you give the /DIAG command before a program is compiled, a complete list of compiler subroutine calls will be produced. This can be demonstrated in the direct-execution immediate mode, as shown in example 4 for both integer and floating-point values.

C Compiler

For more ambitious program development, the Trump Card also supports a compiler for programs in the C language, as described by Kernighan and Ritchie (see reference 6). Programs need

The Trump Card also supports a compiler for programs written in the C language.

only slight modifications for compilation. Developing and running a C program is a three-step operation similar to the process used in TBASIC: editing, compiling, and running.

(text continued on page 120)

(text continued from page 119)

C compilers expect to find input and output routines in a subroutine library separate from the compiler. Kernighan and Ritchie describe a file called "stdio.h" that contains the I/O facilities. The Trump Card's C compiler uses a file of I/O routines called "basicio.c", which includes the following routines: "getchar", "putchar", "open", "close", "read", "write", "printf", "scanf", "lseek", and "creat".

The implementation of "scanf" and "printf" in the Trump Card's version of C differs slightly from that of Kernighan and Ritchie. In their implementation, the conversion characters "d" and "x" may each be preceded by an "l" to indicate a pointer to a "long" value rather than a pointer to an "int" value appears in the argument list. In this implementation, the uppercase conversion characters "D" and "X" are used for the same purpose. The conversion character "f" is used for floating point. The "scanf" routine assumes that the input values are separated by Space or Tab characters and that a Return character ends an input sequence.

The Trump Card's C compiler was designed with a user interface similar to that of TBASIC, and it's just as easy to use. Listing 3 shows a C program that is entered into the system using the EE editor in a manner such as that used for TBASIC. Example 5 shows how the program is compiled and run. Should you care to try the Sieve program in C, it is shown in listing 4 set up for 10 iterations. It runs in 3.2 seconds on the Trump Card, which compares quite favorably with versions of C running on 8-MHz MC68000 processors and with assembly-language versions on the IBM's 4.77-MHz 8088.

Y Multilevel Language

The Y language system compiles a multilevel language that can be best described as structured assembler code. It allows you to write programs using a mixture of Z8000 assembly language (in Zilog mnemonics), Pascal-like control structures, data types, arithmetic expressions with automatic or specified allocation of registers, procedure calls with parameter passing, and a descriptive compiler language. The different levels of constructs may, for the most part, be freely mixed.

The Y compiler generates code directly into memory with one pass and supports immediate execution of statements, conditional compilation, user-defined extensions to the language, and symbolic debugging. Most of the Z8000

Table 1: *Keywords for statements and functions available in the TBASIC compiler for the Trump Card. An asterisk indicates a new feature.*

Function	Statement	Command	Variable
ABS	BEEP	ALLOCATE*	CSRLIN
ASC	CALL	BLOAD	DATE$
ATN	CLOSE	BSAVE	ERR
CALLINTS*	CIRCLE	CONT	INKEY$
CDBL	CLS	DIAG*	TIME$
CHR$	COLOR	DISP*	
CINT	DATA	DO*	
COS	DATE$	EDIT	
CSNG	DEF FN	KILL	
CVI	DEF SEG	LIST	
CVS	DEFtype	MAP*	
CVD	DIM	NAME	
EOF	END	NEW	
EXP	FIELD	REGIONS*	
FIX	FOR...NEXT	REGS*	
HEX$	GET	RESET	
INP	GOSUB	RUN	
INPUT$	GOTO	SAVE	
INSTR	IF	SYSTEM	
INT	INPUT		
LEFT$	INPUT#		
LEN	LSET		
LOC	LET		
LOF	LINE		
LOG	LINE INPUT		
LPOS	LINE INPUT#		
MID$	LOCATE		
MKI$	LPRINT		
MKS$	LPRINT USING		
MKD$	ON ERROR		
OCT$	ON GOSUB		
PEEK	ON GOTO		
POINT	OPEN		
POS	OUT		
RIGHT$	PAINT		
RND	POKE		
SCREEN	PRINT		
SGN	PRINT USING		
SIN	PRINT#		
SPACE	PRINT# USING		
SPC	PSET		
SQR	PUT		
STR$	PRESET		
STRING$	RANDOMIZE		
TAB	READ		
TAN	REM		
VAL	RESTORE		
	RESUME		
	RETURN		
	RSET		
	SCREEN		
	SEEK*		
	SOUND		
	STOP		
	TIME$		
	WAIT		
	WHILE...WEND		
	WIDTH		
	WRITE		
	WRITE#		

Table 2: *Comparison of Sieve benchmark results (one iteration) on other computers running Microsoft-derived BASIC interpreters (times measured in seconds).*

Apple II	Apple III	TRS-80 Model II	IBM PC (BASICA)	IBM PC (TBASIC with Trump Card)
224	222	189	206	2.4

Table 3: *Execution time in seconds for the looping program of listing 1 on several interpreters.*

Apple II	IBM PC (CBASIC-86)	IBM PC (BASICA)	IBM PC (TBASIC with Trump Card)
101	275	80	0.9

Table 4: *A listing of the standard* CP/M-80 2.2 *functions. Those marked with an asterisk are supported by the Trump Card Z80 emulator.*

Function	Supported?
0 System Reset	•
1 Console Input	•
2 Console Output	•
3 Reader Input	
4 Punch Output	
5 List Output	•
6 Dir Console I/O	•
7 Get I/O Byte	
8 Set I/O Byte	
9 Print String	•
10 Read Con Buffer	•
11 Console Status	•
12 Version Number	•
13 Reset Disk Sys	•
14 Select Disk	•
15 Open File	•
16 Close File	•
17 Search For 1st	•
18 Search For Next	•
19 Delete File	•
20 Read Sequential	•
21 Write Sequential	•
22 Make File	•
23 Rename File	•
24 Login Vector	•
25 Current Disk	•
26 Set DMA Address	•
27 Get Alloc Addr	
28 Write Protect	
29 Get R/O Vector	•
30 File Attributes	
31 Disk Params Addr	
32 User Codes	
33 Read Random	•
34 Write Random	•
35 Comp File Size	•
36 Set Random Rec	•

mnemonics are implemented; those that are not can be used via the WORD pseudo-operation, as in the following: LDCTL REFRESH,R3 = WORD 07D3B.

The TBASIC and C compilers are written in Y. Each of the compiler subroutines is a Y file that has been compiled into assembly-language code. A full explanation of Y is beyond the scope of this article, but listing 5 shows some Y code for your inspection. Y is an advanced tool for the experienced programmer.

CP/M-80 Emulator

The Trump Card supports a software emulator for CP/M-80 version 2.2, which allows the Trump Card to execute assembly-language programs for the 8-bit Z80 microprocessor.

The Z80 program must be transferred to a PC-DOS (or MS-DOS) floppy disk. (This can be done by linking a Z80-based computer and an IBM PC through a serial RS-232C connection, either through a direct cable or through a modem.) Once the Z80 program is on the IBM-format disk, its filename extension must be changed from ".COM" to ".CMD", which is consistent with the CP/M-86 convention and avoids the problem of trying to run a Z80 program under IBM PC-DOS.

The emulator normally resides on a disk in drive B and is used in a manner very much like that of the other Trump Card software we've looked at. Nearly all the normal CP/M-80 system calls are supported by the emulator, with a few exceptions as shown in table 4. The standard CP/M-80 BIOS (basic input/output system) calls dealing with the disk, punch, and reader devices are not supported by the Z80 emulator; the remaining BIOS calls are supported.

In Conclusion

The Trump Card is a board-level hardware approach to upgrading the performance of your IBM PC (or a compatible system). Aside from its function as a

(text continued on page 122)

Listing 1: *A simple* FOR...NEXT *loop benchmark program in* BASIC.

```
100 FOR A=1 TO 10
115 FOR J=1 TO 10
120 FOR T=0 TO 200
130 GOSUB 200
140 B=1
150 NEXT T
155 NEXT J
160 NEXT A
170 PRINT "DONE"
200 RETURN
```

Listing 2: *A simple* BASIC *benchmark program for floating-point division.*

```
60 A=2.71828
80 B=3.14159
100 FOR I=1 TO 5000
120 C=A/B
320 NEXT I
```

Listing 3: *A demonstration program for the C compiler.*

```
main()
{
    int count,step;
    count=1;
    step=1;
    while (count <= 5)
        {
        printf(" C language\n");
        count=count+step;
        }
}
```

(text continued from page 121)

Z8000 development system, it provides many popular system enhancements in a single package: add-on memory, execution of Z80 programs, a separate editor, and language compilers. It was designed to solve my specific personal problem—I wanted a better BASIC that wasn't slow or cumbersome—and to support the PC in other ways: as a language and RAM-disk peripheral. If you're like me, these characteristics will be the most important ones to you.

In the process of building the Trump Card, however, I've found that it has potential I never imagined. Besides the software I've described, I expect that object-code translators for Z80-to-Z8000 and 8088-to-Z8000 conversions will soon be available, along with other utilities such as a print spooler. You also eventually will see Bell Laboratories' UNIX operating system for the Trump Card.

NEXT MONTH

Whimsy is in vogue, as Steve designs a musical telephone bell. ■

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Listing 4: *The Sieve of Eratosthenes benchmark in C.*

```
#define true 1
#define false 0
#define size 8190
#define sizepl 8191
   char flags[sizepl];
main(){
   register int i,prime,k,count,iter;
     printf("10 iterations\n");
   for (iter = 1;iter <= 10;iter ++){
       count=0;
       for(i = 0;i <= size;i ++)
            flags[i] = true;
       for(i = 0;i <= size;i ++){
            if(flags[i]){
                 prime = i + i + 3;
                 k = i + prime;
                      while(k <= size){
                      flags[k] = false;
                           k += prime;
                           }
                      count = count + 1;
                 }
            }
       }
   printf("\n%d primes",count);
}
```

Listing 5: TBASIC *subroutines written on the Y multilevel-language compiler.*

```
[5a]
if SWITCH=0 or CNT>100 then begin
SWITCH:=1; GODOIT(2, VAL&OF)
end
else begin
   R3:=^ABC; R5:=@R9[2]; R1:=CNT/2
   LDIR @R3,@R5,R1
end

[5b]
COLOR: PROC ...passed flag, then other params
depending on flag
  ...if flag bit 2=1, then set border color (if text
mode)
  ...if bit 1=1, set background color (text) or
palette (graphics)
  ...if bit 0=1, set foreground color (text) or
background color (graphics)
  save R6,R7
  POPL RR6,@RR12
  if BIT R7,2 not zero then begin
     POPL RR2,@RR12
     if SCRMODE<=1 then SETBORDER(R3)
  end
  if BIT R7,1 not zero then begin
     POPL RR2,@RR12
     if R0:=SCRMODE<=1 then SETBG(R3) else
if R0=2 then
SETPALET(R3)
  end
  if BIT R7,0 not zero then begin
     POPL RR2,@RR12
     if R0:=SCRMODE<=1 then SETFG(R3) else
if R0=2 then
SETGRAPHBG(R3)
  end
  restore R6,R7
  RET
SOUND: PROC ...passed duration
(in 1/18.2 secs) and frequency
  ...make sound
  POPL RR4,@RR12  ...duration
  POPL RR2,@RR12  ...frequency
  EXB RL3,RH3; EXB RL5,RH5
  R3:->BX; R5:->CX
  AH:=4  ...sound
  EXTCALL(SPSCRINT)
  RET
```

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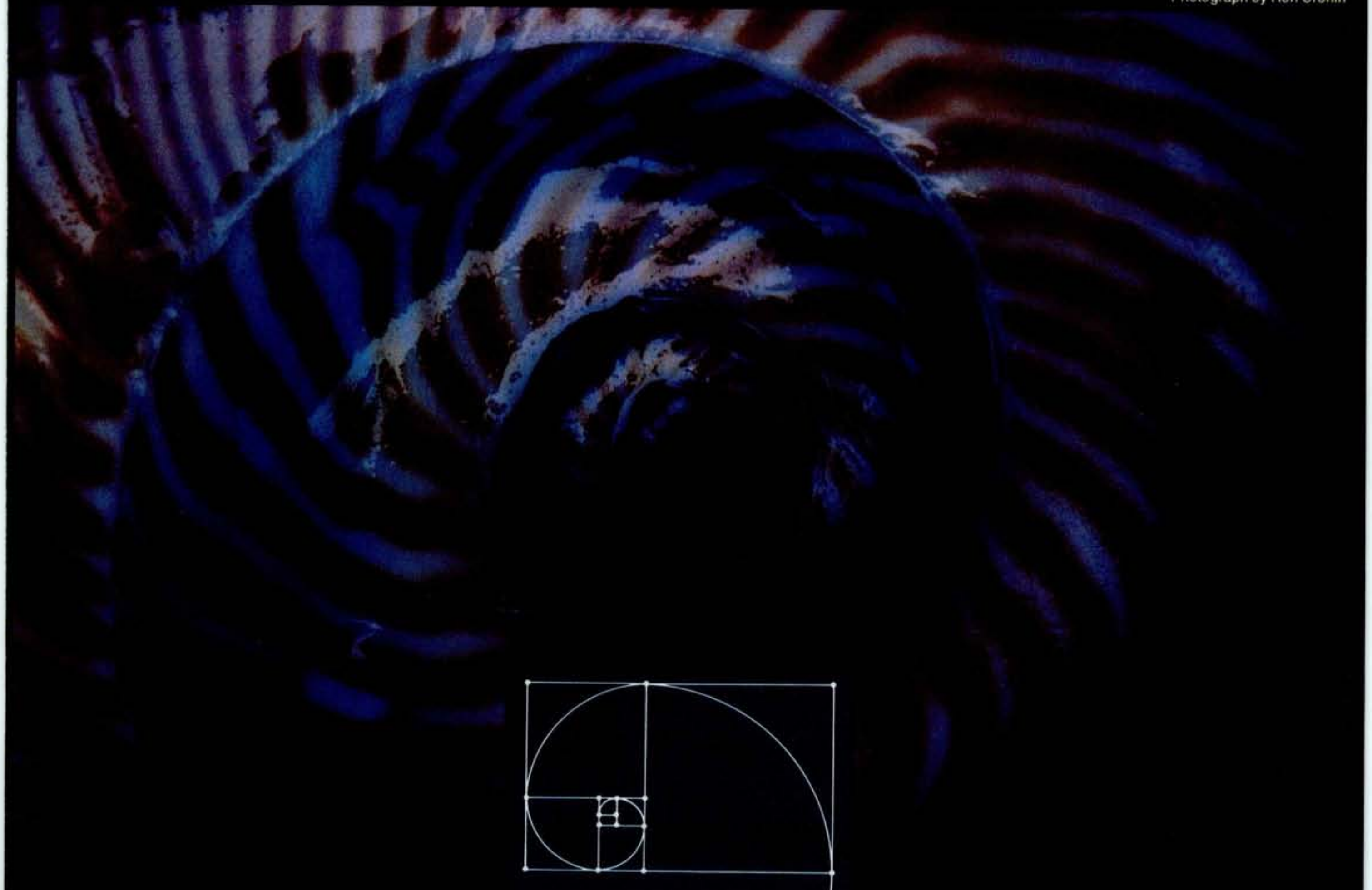

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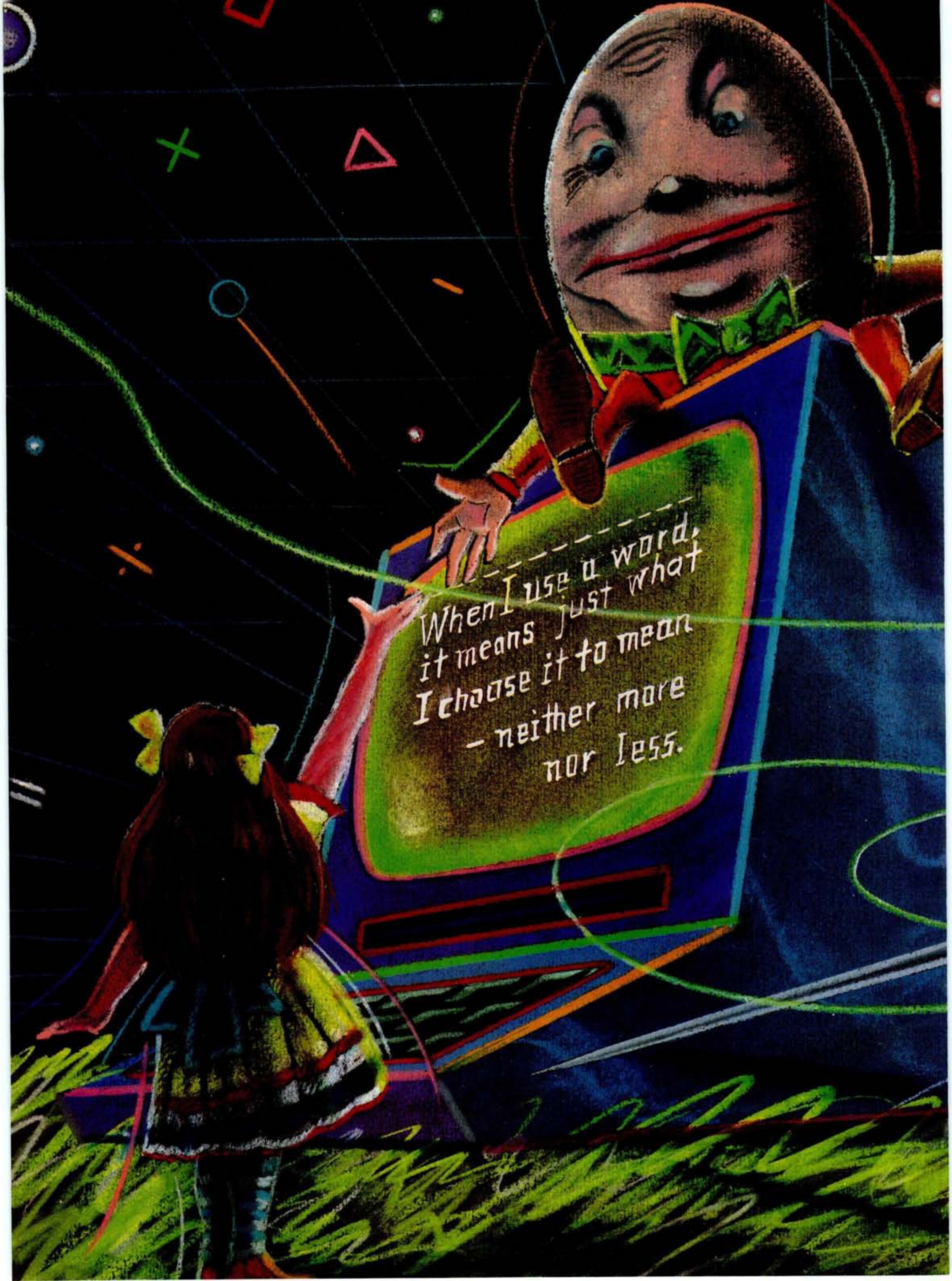
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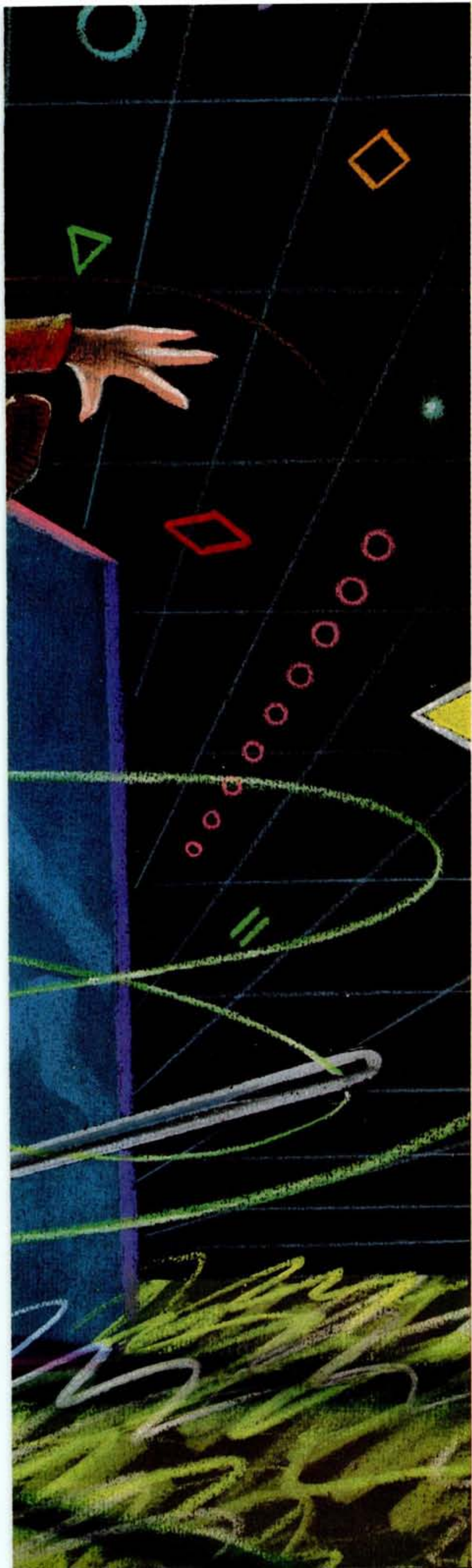

ILLUSTRATION BY ANDRZEJ DUDZINSKI

FASTER FORTH

Reducing overhead in threaded interpretive languages

BY RONALD L. GREENE

Threaded interpretive languages (TILs), of which FORTH is the most well known, possess a number of characteristics that make them nearly ideal microcomputer languages. One useful feature of a TIL is that, like BASIC, it can be used in an interpretive mode in which the computer immediately acts on commands. This is a major advantage when you're debugging programs. But a TIL can have many more immediately executable commands available to it than BASIC does, and you can create additional commands, thus adding to the power of the language.

A second desirable trait of a TIL is that it can be used in a compile mode. As with other compiled languages, such as Pascal or FORTRAN, programs written in the source code of the TIL can be compiled into machine code once and for all rather than retranslated each

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Previously debugged words need not be recompiled when errors are found in subsequent source code.

(text continued from page 127)
time they are run. But unlike the more common compiled languages, the compiler used in a TIL is incremental; that is, it compiles portions of code at a time under the interactive control of the programmer. In practice this means that you can name, compile, test, and debug small, logically related blocks of code (called "words" in TIL jargon) before you proceed to the next block. Previously debugged words need not be recompiled when errors are found in subsequent source code. Because of this, a TIL can produce programs that execute faster than most interpretive languages.

Other languages can be programmed using this modular technique to some extent through the use of functions, subroutines, and procedures. However, to debug one of these subprograms, you must write a main program to call it, and typically both must be compiled, linked, and executed repeatedly. A new TIL word, by contrast, can be compiled and then executed immediately using the interpretive mode; there is no need to write a main program to call it. In addition, the compilation step is almost trivial compared to other compiled languages because each new word is composed of previously defined (i.e., compiled and debugged) words.

Finally, a TIL can be extended. As mentioned above, new commands (words) can be constructed from previously defined words. These new words have the same power as the older ones; that is, they can be executed interpretively or used in the compile mode to define still other words. In fact, typical TIL programs consist of short, progressively defined new words. You enter the final word or words of the program to perform the required task.

These characteristics result in a language that is well suited to program development. In addition, if a TIL is implemented with care at the machine level, it can produce very efficient code.

The next section of this article will examine two approaches to implementing FORTH, the most common TIL. The usual method is very efficient in its use of memory and at the same time produces quite respectable execution times. The other technique is less memory efficient (though still superior to most common compiler languages) but can result in significantly shorter execution times.

IMPLEMENTING THREADED CODE

Several years ago in BYTE, Terry Ritter and Gregory Walker discussed four approaches to the implementation of threaded interpretive languages (see reference 5). I group three of the methods—direct-threaded, indirect-threaded, and token-threaded—under the generic name of "pointer-threaded" code. Pointer-threaded code is the most common method for implementing a TIL. The technique is also discussed in detail by R. G. Loeliger (see reference 3).

Most of this article is devoted to a form of subroutine-threaded code, which is the fourth approach Ritter and Walker cover. It allows the programmer to specify whether a given operation of the language is used as a subroutine or as a macro. I'll examine the advantages and disadvantages of the macro/subroutine approach in relation to the pointer-threaded technique. I use the syntax of FORTH for my high-level examples, but the techniques can be applied to any TIL. My low-level examples use 8086/8088 assembly code, but, again, they can be adapted to other processors.

All TILs have at their roots a set of executable, machine-language primitive operations called words. Examples from FORTH are such arithmetic operations as +, −, and * and such stack manipulation operations as DUP, DROP, and ROT. Additional (secondary) words are defined using these primitives or previously defined secondary words. All words, whether primitive or secondary, are kept in memory in a "dictionary." Each dictionary entry consists of a header (made up of the number of characters in the name), ASCII code for the characters of the name or part of the name (often the first three characters), and a link address for getting to the previous (or the next, depending on the implementation) dictionary entry. After the header comes the body of the word. The body of a primitive word consists of executable machine code that performs the operation. The body of a secondary word varies according to the type of threading used.

In pointer-threaded code the secondary word consists of a sequence of addresses, each of which is a pointer (direct or indirect) to either a primitive or another secondary word (see figure 1). Thus, it is necessary to provide a simple, "inner" interpreter that gets the pointer, jumps to the proper address, and then either executes the machine code if the routine is a primitive or continues the process of interpretation if the routine is another secondary word. Usually there can be as many levels of secondary routines as you like, but the interpreter must eventually get to the machine code of a primitive before it can start back down the ladder of interpretation. The execution speed of such an arrangement is critically dependent on the efficiency of this inner interpreter, which not only has to get the address of the next word to be executed but has to save the current address in order to continue with the flow of the program after execution of that routine.

If you are familiar with assembly language but not with the structure of a TIL, you may wonder, "Why write a special interpreter to save return addresses and jump to new routines when the processor contains the instructions to do just that in hardware, through subroutine calls and returns?" The answer is that a pointer-threaded compiler/interpreter has a smaller overall memory requirement than one that uses subroutine threading. I will return to this point shortly.

Figure 2 illustrates the organization of subroutine-threaded code. The form for the primitives is basically the same as in pointer threading, except that they end with a return from subroutine instruction (RET in 8086/8088 mnemonics). Pointer-threaded primitives, in contrast, end with more involved code that gets the interpreter to the pointer of the next word to be executed. The major difference lies in the secondary words. Subroutine-threaded secondary words are made up of executable subroutine calls to the starting addresses of primitives or other secondary words. Since these primitives or lower-level secondary words are terminated by a return instruction, the processor hardware or microcode itself controls the flow, without the need for the inner interpreter. The result is smaller overhead and faster execution.

A modification of the above scheme allows the execution overhead to be reduced even further. Very short words, consisting of a few bytes of code, need not be treated as subroutines at all. Instead, the subroutine call can be replaced by a macro substitution of the

entire executable portion of the word, thus eliminating the overhead of the subroutine call and return completely. We'll look at how to implement this plan next.

Threading Code with Subroutines or Macros

In order to add the possibility of macro substitution to the subroutine-threaded compiler/interpreter, you must include additional information within the header of each word. First, there must be a way for the compiler to determine whether the word is to be used as a subroutine or a macro. One simple way to do this is to use the high-order bit of the character-count byte as a flag. The bit is checked during compilation of the word. If, for example, it is a 0, the compiler writes code for a subroutine call to the address of the first executable statement of the word. On the other hand, if it is a 1, the compiler copies the executable code byte by byte (except for the RET). In order to reliably copy the required code, the number of bytes in the executable portion of the word being referenced must be stored. This is done by devoting an additional byte to the header. If you like, you could use the high-order bit of this byte (rather than the character-count byte) as the subroutine/macro flag.

Even if a given word is to be used as a macro in the compile mode, its executable code should be terminated by a RET statement. This is because pure subroutine threading is the best way of handling the interpretive mode of the TIL. Also, note that any word to be used as a macro should be written to contain only one RET statement—at the end.

With this scheme, you control whether a given word is to be used as a subroutine or as a macro. All you need do is define two additional primitives for the language—perhaps SUBROUTINE and MACRO—which clear or set the flag bit.

Comparison of Threading Techniques

To get a concrete understanding of the tradeoff between memory and execution speed, let's look at some specific examples of primitives and secondary words as used in the two threading schemes discussed above. In Chapter 3 of *Threaded Interpretive Languages*, Loeliger calculates the overhead for a primitive and a secondary word in terms of processor cycles. Folllowing his lead, I have translated his (indirect-threaded) inner interpreter for a "generic computer" into one applicable to an 8086/8088 microprocessor; the routines are shown in listing 1. For ease of comparison, the labels in the listing are the same as those used by Loeliger. The correspondence between his generic registers and my choice of 8086/8088 registers is given within the listing. Because most of the new personal computers using Intel microprocessors use the 8088 rather than the 8086, I have calculated the total number of 8088 clock periods for execution of the routines in listing 1, where the results are also given. Each execution of a primitive in this pointer-threaded language performs a call to the routines NEXT, RUN, and RETURN; thus, the number of 8088 machine cycles required is:

primitive cycles = NEXT + RUN + body + RETURN
= 82 + body (pointer-threaded)

For simple primitives such as DROP or + (addition), which require four cycles each, the amount of overhead is enormous—20 times what is required for the operation itself. The machine code of other primitives, of course, takes longer than four cycles; however, most will be significantly shorter than 82 cycles.

The overhead for a secondary word depends on the number and kind of words in the definition of the secondary. As Loeliger notes, each call to the secondary word requires a NEXT-RUN-COLON combination on entrance and a NEXT-RUN-SEMI combination on exit. Lower-level secondary words in the definition will need these calls as well. In addition, any primitives within the definition use 82 cycles in overhead. The secondary word with the least amount of overhead is one that is made up of primary words. For example, the word 2DUP defined as a secondary word requires:

(text continued on page 418)

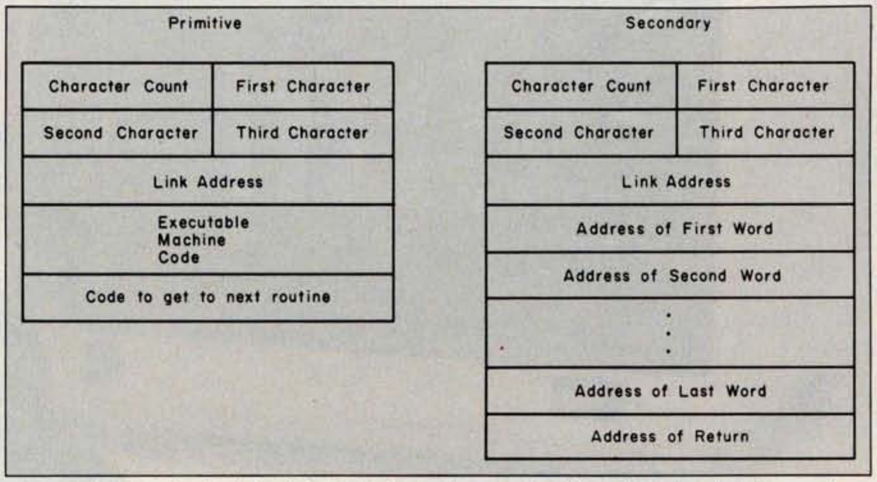


Figure 1: *Organization of primitive and secondary words of a pointer-threaded interpretive language.*

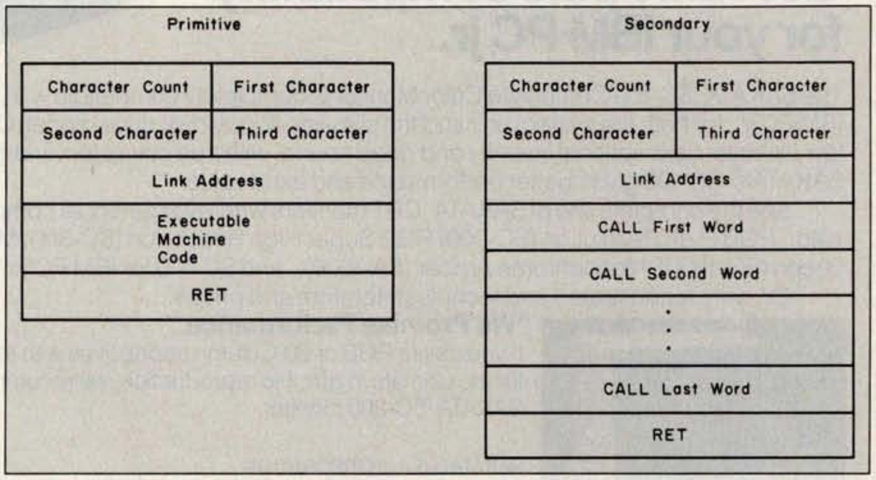
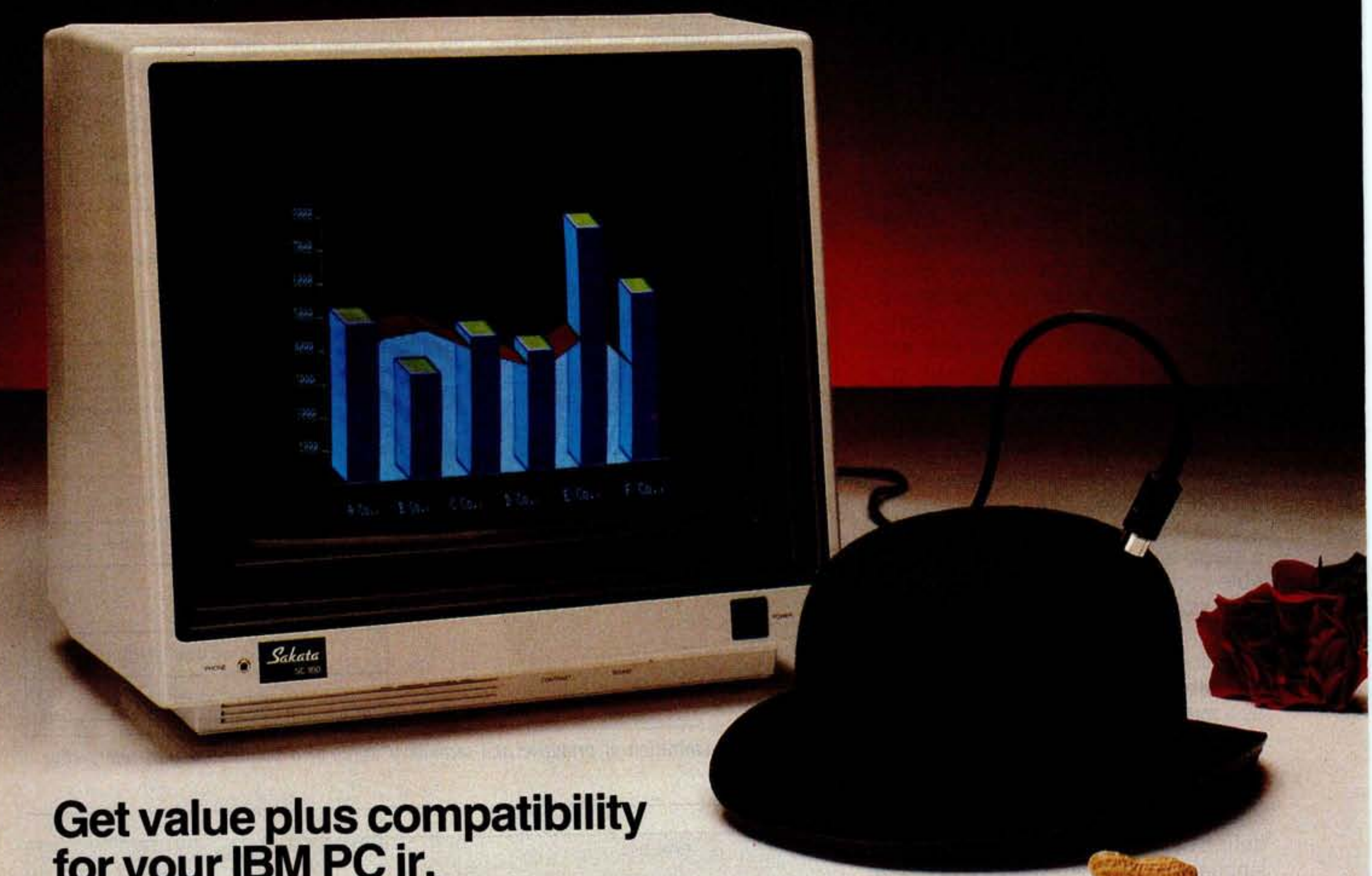


Figure 2: *Organization of primitive and secondary words of a subroutine-threaded interpretive language.*

THE SAKATA CONNECTION



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AN ADA LANGUAGE PRIMER

BY SABINA H. SAIB

PART 1 of this two-part article presents a brief overview of the Ada language and its history, as well as small examples of programs that demonstrate Ada's features. I have assumed that BYTE readers are familiar with programming languages, so I have not defined such concepts as variables, loops, functions, and arguments.

The following examples are intended to help you explore Ada's features. Each program focuses on a specific feature of the Ada language. The only drawback to this approach is that it sometimes sacrifices utility for exposition. The examples and the format of this article are a direct steal from James Joyce's two-part article, "A C Language Primer" (August and September 1983 BYTE). You can compare this article with his to compare the two languages.

To reinforce what you learn, I recommend that you enter each program into a computer, assuming, of course, that you have access to an Ada compiler. After a program runs successfully, experiment with omitting or changing parts of it. Introducing deliberate errors can provide a controlled exposure to Ada's sometimes cryptic error messages and can give you valuable experience in interpreting compiler diagnostics. Such messages are not the fault of the Ada language but of the compiler designs available today. As is the case with many language compilers, errors can have a cascading effect: many errors are actually the result of one original error.

This article does not pretend to explain everything you will want to know about Ada. My goal is to get you started with some key constructs and conventions in Ada.

Augusta Ada Lovelace, Lord Byron's daughter. The language was named after the countess, who is considered to be the world's first programmer.

Ada was designed by Jean Ichbiah at CII Honeywell Bull in France in 1978. Ichbiah improved the language in a second version, which was presented in 1980. It was based on Pascal with many features borrowed from more modern, but experimental, languages. Ada became an ANSI (American National Standards Institute) standard language in 1983 and is expected to remain unchanged until 1988. It is also a military standard and, as of this year, is used in many military applications.

Ada has many goals. Its primary reason for existence is to replace the use of assembly language in small computers dedicated to specialized applications such as signal processing, process control, and communications. Furthermore, Ada is intended to make programs much more portable, readable, maintainable, and reliable than programs written in other languages.

Someday Ada and its support tools will be available on many computers. Currently, there are only three true Ada compilers available: the New York University (NYU) Ada/Ed for the Digital Equipment Corporation (DEC) VAX; Rolm Ada and Ada Environment for the Data General Eclipse and the Rolm 3200; and Western Digital Ada for the Western Digital Microengine. There are also numerous partial compilers for Intel 8086-/8088-based computers, for Zilog Z80-based computers, and for Motorola 68000-based computers. A true Ada compiler has passed more than 2000 tests provided by the Ada Joint Program Office. After passing the tests, the compiler is issued a certificate of validation good for one year.

No dates have been established for validation of the microcomputer-based compilers, nor for validation of compilers based on larger computers. I expect that several more validated compilers will be available in 1984, and that at least one will be a microcomputer-based Ada compiler.

As with any language, good programming style is important. Ada provides facilities to help "readability," but it is up to the programmer to use these features. Indentation and naming conventions can help to make a program more readable, and their use should be encouraged. On the other hand, nesting can be avoided, and unstructured constructs can be forbidden.

Ada has more protection against common programming errors than most other languages. Often, when you get a pro-

(text continued on page 132)

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PHOTO COURTESY OF CULVER PICTURES

(text continued from page 131)

gram to compile, it runs the first time, which should help programmer productivity immensely. Like Pascal, Ada has many checks that it performs during execution. If a program is not time-critical, these checks should be left in. If the checks are burdensome, or if you are running benchmarks, they can (and should) be turned off.

Ada Program Structure

This is the smallest possible complete Ada program:

```
-- tiny1.ada --
-- The smallest Ada program
procedure smallest is
begin
  null; -- a comment
end smallest;
```

Comments in Ada begin with two hyphens (--) and end at the end of each line. No special character is needed for the end of a comment as in Pascal or C. This program has three comments: the ones in the first and second lines, which take up whole lines, and the one after the null statement, which takes up the rest of the line after the semicolon. This program is named **smallest** and does nothing. Any executable code would have been placed between the **begin** and **end** for the procedure.

To compile and execute this program on the NYU Ada/Ed system, the command is **$ada tiny1**.

Normally, Ada programs are in a file whose name ends in **.ada** . If the compilation is successful, the system presents a series of messages listing the time spent in compilation, binding, and execution. After finishing, the **$** prompt is displayed.

It is possible to compile a program without executing it and to create a library of programs for later binding.

Because Ada is a free-format language, we could have written this program in a more compact form, such as

```
-- tiny2.ada  The smallest Ada
-- program rewritten
procedure smallest is begin null;
end smallest;
```

In fact, if we left out the comments, the **smallest** program could be written on a single line as

```
procedure smallest is begin null; end smallest;
```

However, this is poor style and is not recommended.

Packages

Ada programs consist of *packages* of subprograms and a main program. You should structure a large program as a number of packages that contain related small subprograms.

In the following example, the program **small** calls a subprogram, **do_nothing**, that doesn't do anything.

```
-- Small1.ada
-- Smallest Ada program with
-- a subprogram in a package
package example is
-- subprogram specification
  procedure do_nothing;
end example;
package body example is
  procedure do_nothing is
  -- subprogram implementation
  begin
    null;
  end do_nothing;
end example;
with example;
use example;
-- main program uses subprograms
-- in package example
-- main program
procedue small is
begin
  do_nothing;
end small;
```

The package named **example** has one subprogram named **do_nothing**. A package in Ada has two parts, each of which can be compiled separately. (The main program also can be compiled separately.) The first part of the package is called the *package specification*. It merely lists the names and parameters, if any, of the subprograms in the package. Data items and data types can also be placed in the package specification. The second part of the package is called the *package body*, which contains the complete Ada code for the subprograms listed in the specification of the package. Our example has just one subprogram that does not do anything.

A main program that uses a package normally names the package in **with** and **use** statements just before the first statement of the program. To call a subprogram in a package, the program just states the name of the program. Any arguments are placed within parentheses after the name. A semicolon follows every statement and serves as a statement terminator rather than as a statement separator (as in Pascal).

This main program calls the subprogram **do_nothing** in the package **example**. The subprogram does nothing and returns control to the main program, which does more nothing before finishing execution.

You could nest the subprogram **do_nothing**, instead of putting it in a package, as in the following example.

```
-- Small2.ada
-- Smallest Ada program
-- with a nested subprogram
procedure small is
  -- nested subprogram
  procedure do_nothing is
  begin
    null;
  end do_nothing;
begin
  do_nothing;
end small;
```

The text of the subprogram is placed in the declaration part (before the **begin**) of the main program. This has an advantage in that the program text is smaller for our do-nothing example. However, this approach has serious disadvantages over using the package form. When nesting is used, the main program is no longer small. It usually takes longer to compile than when programs are placed in a separate package. Other users of subprograms placed in nested programs must include the text of the subprogram in their program, so there is much less sharing of software. Nesting also usually results in large data spaces accessible by all parts of the program. This is the usual Pascal approach to programming.

As demonstrated in the following example, Ada has a method of separate compilation that avoids long compilation time and long main-program text.

(text continued on page 134)

Ada for Microcomputers

BY MARK J. WELCH

A number of companies have developed, or are preparing, compilers for Ada or for subsets of Ada. As of January 1984, only three compilers had been approved by the Department of Defense, which holds the trademark to the name "Ada." A New York University implementation runs on the DEC VAX 11/780; a Rolm/Data General version runs on Rolm and Data General minicomputers; and GenSoft, formerly a Western Digital subsidiary, has developed a validated compiler and development system for Western Digital's WD-1600.

Of the three validated compilers, only GenSoft's version runs on a microcomputer. Although developed for the WD-1600, which is no longer produced, the compiler can be used on Digicomp Research's Delphi-100, which uses the same processor chip set. The Delphi-100 with a complete Ada development system would cost about $15,000 to $20,000. GenSoft is currently deciding whether to port the compiler to other processors or develop an entirely new version of the compiler.

Other vendors have announced either compilers that will be submitted for validation soon or subsets of Ada that will later be expanded to include the full language. Several of these run on microcomputers (see table 1). Many are cross-compilers that take advantage of the speed and memory of mainframes to produce code that can be run on microprocessors in dedicated systems—mostly for the military.

Alsys is developing compilers for the 8086 and 68000 processors, which the company hopes to submit for validation by the end of this year. The compilers need at least 1 megabyte of memory and a 10-megabyte hard disk.

Irvine Computer Sciences Corporation (ICSC) has developed Ada compilers for the 68000 and the Z8000. The 68000 compiler runs under Unisoft's implementation of UNIX and is available from Unisoft for $3500. The Z8000 version is available from Zilog for its System 8000.

RR Software is selling Janus, a subset of Ada. The vendor says the product will be expanded to the full Ada language by the end of the year. Available for computers using MS-DOS, CP/M, CP/M-86, or Concurrent CP/M-86, Janus costs from $300 to $1100, depending on development tools included.

RR Software has also introduced PASTRAN, a Pascal-to-Ada translator to increase the speed of program translation. It costs $100 for CP/M, CP/M-86, and MS-DOS. Nontranslatable features of Pascal are flagged.

SofTech is retargeting its Ada Language System for the 8086 under a contract with the U.S. Air Force Systems Command. SofTech also sells an Ada-to-Pascal translator. The company hasn't discussed any commercial plans for the product.

SuperSoft announced an Ada subset in early 1982 and had planned to have a full version late that year. However, it has decided not to expand its compiler. SuperSoft is selling a $300 CP/M-80 version, called SuperSoft-A, which it says includes about 65 percent of Ada's features.

Telesoft has a $3030 Ada Development Kit for the IBM Personal Computer (PC). The kit produces interpreted p-code. Telesoft submitted its $4435 compiler for the Motorola 68000 for validation in February.

Intellimac Inc. released an Ada shell that enables eight people to use Telesoft-Ada on Intellimac's 68000-based IN/7000 compiler family.

Mark J. Welch is a BYTE staff writer. He can be contacted at POB 372, Hancock, NH 03449.

Producer	68000	8086	Z8000	Z80	Other
Alsys 400 No.1 Totten Pond Rd. Waltham, MA 02154 (617) 890-0030	yes	yes			
Digicomp Research Terrace Hill Ithaca, NY 14850 (607) 273-5900					Delphi-100
GenSoft 319 South Craig St. Pittsburgh, PA 15213 (412) 621-0235					WD-1600 Delphi-100
Intellimac 6001 Montrose Rd. Rockville, MD 20852 (301) 984-8000	multiuser shell for Telesoft Ada (68000)				
Irvine Computer Sciences Corp. 18201 Sky Park Circle Suite L Irvine, CA 92714 (714) 250-1366	yes (Unisoft)		yes (Zilog)		
RR Software POB 1512 Madison, WI 52701 (608) 244-6436		$500 (MS-DOS CP/M-86, CCP/M-86)		$300 (CP/M)	
SofTech 460 Totten Pond Rd. Waltham, MA 02154 (617) 890-6900		yes (USAF)			
SuperSoft 1713 South Neil St. POB 1628 Champaign, IL 61820 (217) 359-2112				$300 (48K, CP/M)	
Telesoft 10639 Roselle St. San Diego, CA 92121 (619) 457-2700	$4435	$3030 (IBM PC)			
Unisoft 2405 Fourth St. Berkeley, CA 94710 (415) 644-1230	$3500				

(text continued from page 133)

```
-- Small3.ada
-- Smallest Ada program with a
-- separately compiled subprogram
procedure small is
  -- nested subprogram
  -- separately compiled
  procedure do_nothing is separate;
begin
  do_nothing;
end small;
separate (small)
-- subprogram implementation
procedure do_nothing is
begin
  null;
end do_nothing;
```

Although this approach avoids the problem of a long main program, it still has the data space problem and the sharing problem common to nesting. Therefore, I believe that almost all Ada subprograms should be placed in packages instead of using nesting or separate compilation and nesting.

Displaying a Message

Ada has several packages common to all compilers. Two of these are the **standard** package and the **text_io** package. The **text_io** package contains subprograms to display a message on the standard output device, which is usually your terminal.

```
-- hello1.ada
-- Greet the world
-- Introduce output in Ada
with text_io;
-- use of text_io package
use text_io;
procedure hello is
begin
  put ("Hello, world!");
  new_line;
end hello;
```

The message displayed by this example is the statement **Hello, world!** It is written as a character string within parentheses in the call to the **put** subprogram, which is in the **text_io** package. After the **put** subprogram, there is a call to the **new_line** subprogram, which positions the cursor at the beginning of the next line.

When using the **put** subprogram without a **new_line** call, the next output request puts the subsequent output on the same line on the display. Thus, we could write the message as follows:

```
-- hello2.ada
-- Greet the world
-- in another version
with text_io;
-- use of text_io package
use text_io;
procedure hello is
begin
  put ("Hello");
  put (" , ");
  put (" ");
  put ("world");
  put (" ! ");
```

(text continued on page 428)

BY G. MICHAEL VOSE

MACINTOSH PASCAL

An interactive interpreter transforms Pascal into a language as easy to learn as it is expeditious to use

Pascal's evolution has mirrored the growth of the microcomputer industry—both seek to bring usable, learnable computer power to a generation of inquisitive, educated people looking toward the next century. Niklaus Wirth created Pascal to make learning computer programming an easy but still rigorous task. Even before Carl Helmers called six years ago in this journal for the widespread adoption of Pascal, colleges and universities worldwide were beginning to embrace the language as a primary tool for teaching programming.

Apple Pascal was released in 1979 and was one of the first microcomputer implementations. Pascal became the primary programming language within Apple Computer Inc. for the development of new products. With this strong tie to Pascal, there was a good chance that Apple would be instrumental in the adoption of significant new Pascal products. The first of these new products is the recently announced version for the Macintosh.

The version of Pascal that Apple Computer offers for its new Macintosh is called Macintosh Pascal. Although it will be marketed by Apple, Macintosh Pascal was created at Think Technologies Inc. (420 Bedford St., Lexington, MA 02173) by Melvin Conway, who conceived the project and wrote the prototype interpreter; Andrew Singer and John Hueras, who designed the product for the Macintosh; and Peter Maruhnic and Terry Lucas, who wrote the Macintosh version. Running initially on the Macintosh only, Macintosh Pascal will be available for Apple's Lisa running under the MacWorks operating system. Think Technologies promises separate versions of the language for all major educational microcomputers in the next 18 months. Macintosh Pascal will retail for $125.

Editor's Note: This article is a BYTE *Product Preview. It is not a review. We think this new product is significant and therefore offer this advance look at a prerelease version. An independent in-depth review, with appropriate benchmarks, will appear in a subsequent issue.*

A NEW BREED

An interactive interpreter is the most innovative feature of Macintosh Pascal. Programmers can write source code in Macintosh Pascal and run it immediately without going through a separate compilation step. Students can run individual commands to understand their functions. Using the Macintosh user interface—with its multiple windows, mouse, and data integration—makes Macintosh Pascal programming easy and efficient. New programmers can learn the language more quickly and effectively when they can interact with a program at the source-code level. Macintosh Pascal's program-development tools, including single-step execution, use of breakpoints, and an Observe window to track the alteration of variables, further enhance this process (see "Macintosh Pascal's Development Tools" later in the text).

Macintosh Pascal is a full implementation, not a subset, of Pascal, and it emulates as closely as possible both the ANSI (American National Standards Institute) standard Pascal and LisaPascal. The following paragraphs describe the major differences between Macintosh Pascal and LisaPascal and Macintosh Pascal and ANSI Pascal.

Macintosh Pascal varies slightly from LisaPascal, particularly in the way the latter uses extensions to the language definition. Also, the scope anomalies of LisaPascal are errors in Macintosh Pascal. The Macintosh version differs in other significant ways, including:

- use of up to 255 significant identifier characters
- no support of compiler commands or nested comments
- simpler rules for *integer* and *longint* arithmetic
- additional *real* data types: *longreal*, *extended*, and *computational*
- requirement of the *otherwise* statement within a CASE construct
- no support of the *external* directive
- no support of user-defined units or segmentation
- no support of the functions

exit	*halt*	*heapresult*
mark	*release*	*memavail*
pwroften	*moveleft*	*moveright*
scaneq	*scanne*	*fillchar*

• support of the *pack* and *unpack* procedures

The Macintosh Pascal manual lists other minor differences between the two.

Macintosh Pascal conforms most closely to the ANSI standard for Pascal and is closer to that standard than is LisaPascal. Macintosh Pascal's major departures from the ANSI/IEEE 770X3.97-1983 standard include:

• the special symbol @ is an operator and never treated as a ^
• only the standard file variables INPUT and OUTPUT can be used as program parameters
• all quoted character strings are STRING data types, but Macintosh Pascal's compatibility rules are nonetheless compatible with the standard's
• support of the word symbols *otherwise, string,* and *uses*
• support of the underscore character within an identifier
• all *integer* and *real* data type operands are converted to *extended* before real arithmetic is performed; the result is always *extended*
• support of predefined *libraries*
• support of a set of string procedures and functions
• support of the *pointer* and *sizeof* functions for LisaPascal compatibility

The Macintosh Pascal manual lists other minor differences from the ANSI standard, including errors not automatically detected and reported, in an appendix.

Macintosh Pascal also supports the graphics functions of the Macintosh QuickDraw program. Macintosh Pascal can take advantage of QuickDraw's functions by including the QuickDraw libraries. This is done with the *uses* clause; for example, *uses* QUICKDRAW1, QUICKDRAW2.

Macintosh Pascal also supports IEEE numerics conventions using the Pascal library SANE (Standard Apple Numeric Environment). The SANE package is the first implementation of IEEE numerics on a microcomputer.

Programming in Macintosh Pascal

Because the language is interpreted, programming in Macintosh Pascal is very similar to using interpreted BASIC.

(text continued on page 138)

G. Michael Vose is a BYTE senior technical editor. He can be contacted at POB 372, Hancock, NH 03449.

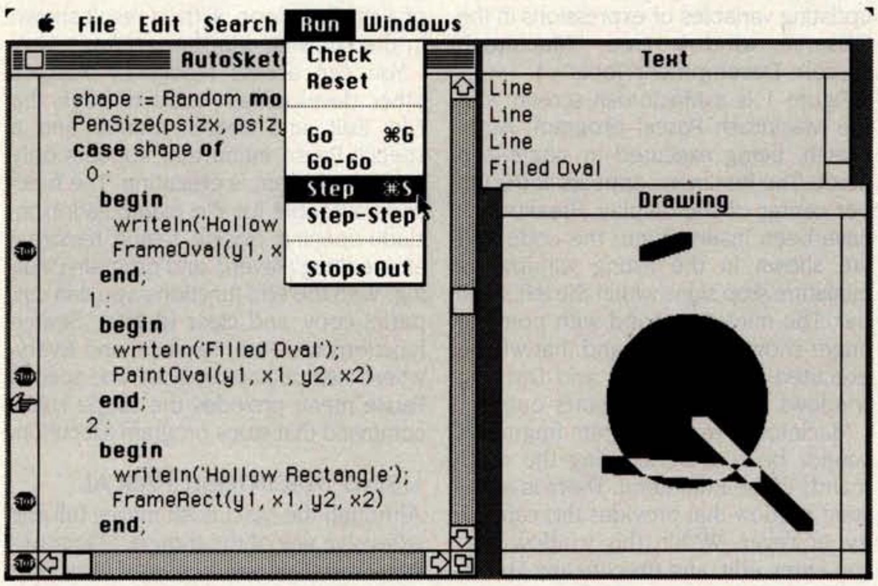

Figure 1: *The Macintosh Pascal AutoSketch program. The Run menu appears in the upper center of the screen. At the right are the Text and Drawing windows. The listing window, on the left, shows breakpoints indicated by stop signs; the finger points to the next instruction to be executed in single-step mode.*

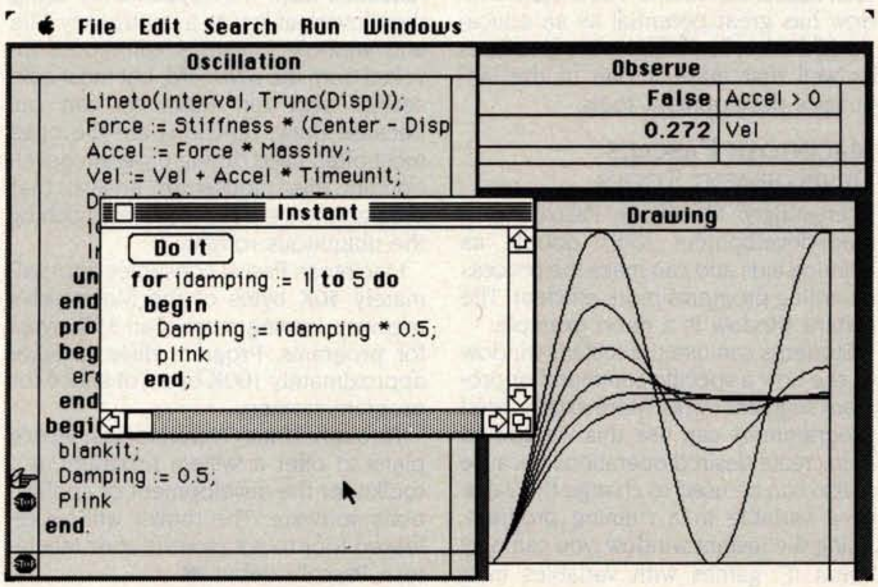

Figure 2: *The Oscillation program. The Observe window in the upper right shows the value of variables or expressions. The Instant window enables execution of code fragments and the changing of variables during program execution.*

(text continued from page 137)
You type in or load from disk the code you plan to run and then run it. Because Macintosh Pascal program lines are precompiled with the entry of a carriage return, errors are detected and reported immediately. Macintosh Pascal is thus even friendlier than traditional interpreted BASIC in detecting errors.

Where BASIC uses the RUN command to start program execution, Macintosh Pascal uses GO or ⌘-G, Apple's Cloverleaf command key followed by G in the manner of the Control-X keystroke sequence. Macintosh Pascal also enables execution of a program with breakpoints (called Stops) placed within the code (GO-GO), or single-step execution of the code with (STEP-STEP) or without (STEP or Cloverleaf-S) breakpoints. The GO-GO and STEP-STEP commands run a program with breakpoints, pause briefly at each Stop, and then continue, updating variables or expressions in the Observe window (see "Macintosh Pascal's Development Tools").

Figure 1 is a Macintosh screen with the Macintosh Pascal program, AutoSketch, being executed in single-step mode. The Run menu appears at the upper center of the display. Breakpoints have been inserted into the code and are shown in the listing window as miniature stop signs within the left scroll bar. The miniature hand with pointing finger shows the command that will be executed next. The Text and Drawing windows show the program's output.

Macintosh Pascal program fragments cannot be run alone using the commands in the Run menu. There is an Instant window that provides this capability, however. Within this window, you can enter, edit, and execute any Macintosh Pascal statement. The Instant window has great potential as an educational aid but has additional capabilities as well that make it one of the language's development tools.

Macintosh Pascal's Development Tools

Interestingly, Macintosh Pascal's program-development tools double as learning aids and can make the process of writing programs more efficient. The Instant window is a good example.

Students can use the Instant window to see how a specific command or program segment works. More experienced programmers can use this window to help create desired operations because it also can be used to change the value of a variable in a running program. Using the Instant window, you can play "what if" games with variables in a program while it is running.

This intraprogram interactivity is the guiding philosophy behind the language's program-development tools. Besides the Instant window, you can use an Observe window to watch the value of variables and expressions change as a program executes; the Text and Drawing windows to see the text and graphics output, respectively, of the current running program; or the Clipboard window, which provides access to the Clipboard system utility, used to move text or graphics from one window or program to any other program or window.

Figure 2 shows a Macintosh Pascal program called Oscillation in a display that includes the Instant and Observe windows. The Observe window, in the upper right corner, shows that the value of the *Accel* > 0 expression is false, while the value of the variable *Vel* is 0.272. The Instant window enables the execution of a single *for* loop, with its result shown in the Drawing window.

You can access Macintosh Pascal's other development tools through the File, Edit, and Search menus, and a special Pause menu that appears only while a program is executing. The functions available for file manipulation include opening, closing, saving, restoring after editing (Revert), and program printing. With the edit functions, you can cut, paste, copy, and clear (delete). Search functions are Find, Replace, and Everywhere (search and replace). The special Pause menu provides the single HALT command that stops program execution.

Using Macintosh Pascal

Although the Macintosh makes full and extensive use of the mouse, Macintosh Pascal enables you to select many of its functions from the keyboard by using the Cloverleaf key as a control key. File and window functions cannot be invoked from the keyboard, but most edit, search, and run functions can be. Because these functions are the ones most often used during program development, this "mousetrap" ensures that programmers are not hindered much by the ubiquitous rodent.

Macintosh Pascal consumes approximately 50K bytes of the Macintosh's memory, leaving more than 35K bytes for programs. Program disks provide approximately 100K bytes of space for program storage.

Through Think Technologies, Apple plans to offer a system programmer's toolkit for the development of applications software. The toolkit will be released four to six months after Macintosh Pascal's debut. ■

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MC6860	24	0-600bps Digital MODEM	7.95
MC68000L8	64	MPU 16-Bit (8MHz)	49.95
MC68488P	40	General Purpose Int. Adapter	9.95
MC68652P2	40	Multi. Protocol Comm. Controller	24.95
MC68661PB	28	Enhanced Prog. Comm. Int.	9.95
MCM68764	24	64K EPROM (450ns)	24.95
SY6522	40	Peripheral Inter. Adapter	7.95

8080A SERIES

TMS5501	40	Synchronous Data Interface (SIRC)	14.95
INS8080A	40	CPU	2.95
INS8154	40	128 Byte RAM 16-Bit I/O	13.95
8156	40	RAM with I/O Port and Timer	6.95
INS82C06	20	Octal D Flip Flop Tri-State (74C374)	2.49
DP8212	24	8-bit Input/Output (74S412)	2.25
DP8214	24	Priority Interrupt Control	2.95
DP8216	16	Bi-Directional Bus Driver	1.95
DP8224	16	Clock Generator/Driver	2.25
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DP8228	28	System Cont./Bus Driver (74S428)	3.49
DP8238	28	System Controller (74S438)	4.49
INS8243	24	I/O Expander for 48 Series	3.95
INS8245	18	16-Key Keyboard Encoder (74C922)	4.49
INS8246	20	20-Key Keyboard Encoder (74C923)	4.95
INS8247	28	Display Controller (74C911)	8.95
INS8248	28	Display Controller (74C912)	8.95
INS8250N	40	Asyn. Comm. Element	10.95
DP8251	28	Prog. Comm. I/O (USART)	4.49
DP8253	24	Prog. Interval Timer	6.95
DP8255	40	Prog. Peripheral I/O (PPI)	4.49
DP8257	40	Prog. DMA Control	5.95
DP8259	28	Prog. Interrupt Control	6.95
DP8275	40	Prog. CRT Controller	29.95
DP8279	40	Prog. Keyboard/Display Interface	8.95
DP8303	20	8-Bit Tri-State Bi-Directional Trans.	3.95
DP8304	20	8-bit Bi-Directional Receiver	2.95
DP8307	20	8-bit Bi-Directional Receiver	2.95
DP8308	20	8-bit Bi-Directional Receiver	2.95
DP8310	20	Octal Latched Peripheral Driver	4.95
8741	40	8-bit Univ. Peripheral Interface	29.95
8755	40	16K EPROM with I/O	24.95

DISK CONTROLLERS

INS1771-1	40	Single Density	16.95
FD1791	40	Single/Dual Density (Inv.)	29.95
FD1793	40	Single/Double Density (True)	29.95
FD1795	40	Dual Density/Side Select (Inv.)	29.95
FD1797	40	Dual Density/Side Select True	29.95

SPECIAL FUNCTION

DS0025CN	8	Dual MOS Clock Driver (5MZ)	2.49
DS0026CN	8	Dual MOS Clock Driver (5MZ)	1.95
INS2651	28	Communication Chip	8.95
MC3470P	18	Floppy Disk Read Amp System	4.95
MM58167AN	24	Microprocessor Real Time Clock	8.95
MM58174AN	16	Micro. Compatible Time Clock	7.95
COP402N	40	Microcontroller w/64-digit RAM and Direct LED Drive	5.95
COP402MN	40	Microprocessor w/64-digit RAM & Direct LED Drive w/N Buss Int.	5.95
COP470N	20	32-seg VAC Fluor. Drvr. (20-pin pkg.)	3.25
MM5369AA/N	8	Prog. Oscillator/Divider (60Hz)	1.79
MM5369EST	8	Prog. Oscillator/Divider (100Hz)	1.95

DYNAMIC RAMS

Part No.	**Pins			Price
1103	18	1024x1	(300ns)	.99
4027	**16**	**4096x1**	**(250ns)**	**2.49**
4116N-2	16	16,384x1	(150ns)	1.89 - 8/14.95
4116N-3	16	16,384x1	(200ns)	1.69 - 8/12.95
4116N-4	16	16,384x1	(250ns)	1.49 - 8/10.95
4164N-150	16	65,536x1	(150ns)	6.95 - 8/49.95
4164N-200	16	65,536x1	(200ns)	5.95 - 8/44.95
MM5261	18	1024x1	(300ns)	.49 - 8/1.95
MM5262	**22**	**2048x1**	**(365ns)**	.10
MM5270	18	4096x1	(250ns) MK4096	4.95
MM5280	22	4096x1	(200ns) 2107	3.95
MM5290-2	16	16,384x1	(150ns)	1.89 - 8/14.95
MM5290-3	16	16,384x1	(200ns)	1.69 - 8/12.95
MM5290-4	16	16,384x1	(250ns)	1.49 - 8/10.95
MM5298-3	16	8192x1	(200ns)	1.69

STATIC RAMS

1101	16	256x1	(650ns)	1.49
2101	22	256x4	(450ns) 8101	2.49
2102	16	1024x1	(350ns)	.89
21L02	16	1024x1	(450ns) L.P.	1.49
2111	18	256x4	(450ns) 8111	2.95
2112	16	256x4	(450ns) MOS	1.95
2114	18	1024x4	(450ns)	1.49 - 8/9.95
2114L	18	1024x4	(450ns) L.P.	1.95 - 8/13.95
2114-2	18	1024x4	(200ns)	1.75 - 8/11.95
2114L-2	18	1024x4	(200ns) L.P.	2.25 - 8/14.95
2147	18	4096x1	(70ns)	4.95
2148	18	1024x4	(70ns)	4.95
TMS4045	18	1024x4	(450ns)	3.95
TMS40L47-45	20	1024x4	(450ns)	2.95
5101	22	256x4	(450ns) CMOS	2.95
MM5257	18	4096x1	(450ns) 4044	4.95
HM6116P-3	24	2048x8	(150ns) CMOS	5.95
HM6116P-4	24	2048x8	(200ns) CMOS	4.95
HM6116LP-4	24	2048x8	(200ns) L.P. CMOS	5.49
HM6264P-15	28	8192x8	(150ns) CMOS	39.95
27LS00	16	256x1	(80ns) L.P.	9.95
7489	16	16x4	(50ns) 3101	2.25
74C920	22	256x4	(250ns)	3.95
74C921	18	256x4	(250ns) CMOS	3.95
74C929	16	1024x1	(250ns) CMOS (6501)	3.95
74C930	18	1024x1	(250ns) CMOS (6518)	3.95
74S189	16	16x4	(35ns) 93405	1.95
74S200	16	256x1	(80ns) 93410	3.95
74S206	16	256x1	(60ns) 93411	3.95
74S289	16	16x4	(35ns) 3101	2.25
82S10	16	1024x1	(50ns) O.C. (93415)	3.95
82S25	16	16x4	(50ns) O.C. (74S289)	2.25

PROMS/EPROMS

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2708	24	1024x8	(450ns)	3.95
2708-5	24	1024x8	(550ns) SM00246	2.95
TMS2516	24	2048x8	(450ns) 2716	5.95
TMS2532	24	4096x8	(450ns) NMC2532	6.95
TMS2564	28	8192x8	(450ns)	14.95
TMS2716	24	2048x8	(450ns) 3 voltage	9.95
2716	24	2048x8	(450ns)	4.95
2716-1	24	2048x8	(350ns)	5.95
2716Q-5	24	2048x8	(550ns)	4.49
2732	24	4096x8	(450ns)	6.95
2732A-3	24	4096x8	(300ns)	7.95
2732A-4	24	4096x8	(450ns) 21V	6.95
2732Q-4	24	4096x8	(550ns)	5.95
2758Q-A	24	1024x8	(450ns)	2.95
2764-4	28	8192x8	(450ns)	9.95
2764-3	28	8192x8	(300ns)	14.95
MM5204Q	24	512x8	(1us)	4.95
MCM68764	24	8192x8	(450ns)	24.95
27128	28	16,384x8	(450ns) 128K EPROM	59.95
74S188	16	32x8	PROM O.C. (6330-1)	1.49
74S287	16	256x4	PROM T.S. (6301-1)	1.95
74S288	16	32x8	PROM T.S. (6331-1)	1.95
74S387	16	256x4	PROM O.C. (6300-1)	1.95
74S471	20	256x8	PROM T.S. (6309-1)	5.95
74S472	20	512x8	PROM T.S. (6349-1)	4.95
74S473	20	512x8	PROM O.C. (6348)	4.95
74S474	24	512x8	PROM T.S. (DM87S296N)	4.95
74S475	24	512x8	PROM O.C. (6340)	4.95
74S476	18	1024x4	PROM T.S.	6.95
74S478	24	1024x8	PROM T.S.	8.95
74S570	16	512x4	PROM O.C. (6305)	2.95
74S571	16	512x4	PROM T.S. (6306)	2.95
74S572	18	1024x4	PROM O.C. (6352)	4.95
74S573	18	1024x4	PROM T.S. (82S137)	4.95
82S23	16	32x8	PROM O.C. (27S18)	2.95
82S115	24	512x8	PROM T.S. (27S15)	9.95
82S123	16	32x8	PROM T.S. (27S19)	2.95
82S126	16	256x4	PROM O.C. (27S20)	2.95
82S129	16	256x4	PROM T.S. (27S21)	2.95
82S130	16	512x4	PROM O.C. (27S12)	3.95
82S185	18	2048x4	PROM T.S. (TBP24S81)	9.95
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DATA ACQUISITION

DC10		Mostek DC/DC Convert. +5V to -9V	2.95
MC3470P	18	Floppy Disk Read AMP System	4.95
MC1408L7	16	7-bit D/A Converter (DAC0807LCN)	1.49
MC1408L8	16	8-bit D/A Converter (DAC0808LCN)	2.25
ADC0803LCN	20	8-bit A/D Converter (±1/2LSB)	4.95
ADC0804	20	8-bit A/D Converter (1LSB)	3.49
DAC0806	16	8-bit D/A Converter (0.78% Lin.)	1.95
ADC0809	28	8-bit A/D Converter (8-Ch. Multi.)	4.49
ADC0817	40	8-bit A/D Converter (16-Ch. Multi.)	9.95
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DAC1008	20	10-bit D/A Conv. Micro. Comp. (0.20%)	6.95
DAC1020	16	10-bit D/A Conv. (0.05% Lin.)	7.95
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DAC1222	18	12-bit D/A Conv. (0.20% Lin.)	6.95
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LM335Z		Temperature Transducer	1.40
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AY-5-1013A	**40**	**30K Baud Uart (TR1602)**	**3.95**

Digitalker™

DT1050 — Applications: Teaching aids, appliances, clocks, automotive, telecommunications, language translations, etc.

The DT1050 is a standard DIGITALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences. The "voice" output of the DT1050 is a highly intelligible male voice. Female and children's voices can be synthesized. The vocabulary is chosen so that it is applicable to many products and markets.

The DT1050 consists of a Speech Processor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

DT1050 Digitalker™ .... $34.95 ea.
MM54104 Processor Chip .... $14.95 ea.

DT1057 - Expands the DT1050 vocabulary from 137 to over 260 words. Includes 2 ROMs and specs.
Part No. DT1057 .... $24.95 ea.

INTERSIL

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FE0203D		3½ Digit LCD Display for 7106 & 7116	19.95
7106EV/Kit*	40	IC, Circuit Board, Display	34.95
7107CPL	40	3½ Digit A/D (LED Drive)	11.95
7107EV/Kit*	40	IC, Circuit Board, Display	29.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD	16.95
7201IUS		Low Battery Volt Indicator	2.25
7205IPG	24	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	24	Stopwatch Chip, XTL	14.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit*	16	Tone Generator Chip, XTL	7.95
7207AIPD	14	Oscillator Controller	5.95
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7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
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NEW PRODUCT! 74HC High Speed CMOS

74HC00	14	.59
74HC00	14	.59
74HC02	14	.59
74HC03	14	.75
74HC04	14	.59
74HCU04	14	.65
74HC08	14	.59
74HC10	14	.59
74HC11	14	.59
74HC14	14	.85
74HC20	14	.59
74HC27	14	.59
74HC30	14	.89
74HC32	14	.75
74HC42	16	.99
74HC51	14	.75
74HC58	14	.75
74HC73	14	.79
74HC74	14	.79
74HC75	16	.89
74HC76	16	.79
74HC85	16	1.59
74HC86	14	.69
74HC107	14	.59
74HC109	16	.79
74HC112	16	.79
74HC113	14	.79
74HC132	14	.99
74HC137	16	1.95
74HC138	16	1.09

74HC139	16	.99
74HC147	16	1.19
74HC151	16	.89
74HC153	16	.99
74HC154	24	2.49
74HC157	16	.89
74HC158	16	.89
74HC160	16	1.29
74HC161	16	1.29
74HC162	16	1.29
74HC163	16	1.29
74HC164	14	1.29
74HC165	16	2.79
74HC173	16	1.69
74HC174	16	.99
74HC175	16	.99
74HC192	16	1.39
74HC193	16	1.39
74HC194	16	1.09
74HC195	16	1.09
74HC237	16	2.95
74HC240	20	1.95
74HC241	20	1.95
74HC242	14	1.95
74HC243	14	1.95
74HC244	20	1.95
74HC245	20	2.49
74HC251	16	.89
74HC253	16	.99

74HC257	16	.89
74HC259	16	1.49
74HC266	14	1.19
74HC273	20	2.89
74HC280	14	3.95
74HC299	20	4.95
74HC366	16	2.39
74HC367	16	2.39
74HC373	20	2.39
74HC374	20	2.39
74HC390	16	1.49
74HC393	14	1.49
74HC533	20	2.39
74HC534	20	2.39
74HC595	16	3.95
74HC688	20	3.19
74HC4002	14	.59
74HC4017	16	2.19
74HC4020	16	1.39
74HC4024	14	1.59
74HC4040	16	1.39
74HC4060	16	1.39
74HC4075	14	.59
74HC4078	14	.69
74HC4511	16	2.69
74HC4514	24	3.79
74HC4538	16	2.39
74HC4543	16	3.49

74HCU04 is unbuffered. All others are buffered.

74C—C/MOS

74C00	14	.35
74C02	14	.35
74C04	14	.29
74C08	14	.35
74C10	14	.35
74C14	14	.69
74C20	14	.35
74C30	14	.35
74C32	14	.39
74C42	16	1.39
74C48	16	1.95
74C73	14	.79
74C74	14	.69
74C85	16	1.95
74C86	14	.39
74C89	16	5.95
74C90	14	1.19
74C93	14	1.19

74C95	14	1.39
74C107	14	.89
74C151	16	2.49
74C154	24	3.49
74C157	16	2.25
74C160	16	1.19
74C161	16	1.19
74C162	16	1.19
74C163	16	1.19
74C164	14	1.49
74C173	16	1.19
74C174	16	1.19
74C175	16	1.19
74C192	16	1.49
74C193	16	1.69
74C195	16	1.39

74C221	16	1.95
74C240	20	1.95
74C244	20	1.95
74C373	20	2.49
74C374	20	2.49
74C901	14	.59
74C903	14	.59
74C906	14	.59
74C911	28	8.95
74C912	28	8.95
74C915	18	1.19
74C917	28	8.95
74C922	18	4.49
74C923	20	4.95
74C925	16	5.95
74C926	18	5.95
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80C97	16	.69

LINEAR

TL071CP	8	.79
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TL081CP	8	.59
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LM301CN	8	.35
LM302H		1.95
LM304H		1.95
LM305H		.99
LM307CN	8	.45
LM308CN	8	.69
LM309K		1.25
LM309H		1.95
LM310CN	8	1.75
LM311CN	8	.69
LM312H		2.49
LM317T		1.19
LM317K		3.95
LM318CN	8	1.95
LM319N	14	1.95
LM320K-5		1.35
LM320K-12		1.35
LM320K-15		1.35
LM320K-24		1.35
LM320T-5		.89
LM320T-12		.89
LM320T-15		.89
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LM322N	14	1.65
LM323K		5.95
LM324N	14	.59
LM329DZ		.65
LM331N	8	3.95
LM334Z		1.19
LM335Z		1.40
LM336Z		1.19
LM337MP		1.15
LM337T		1.95
LM338K		6.95
LM339N	14	.69
LM340K-5		1.35
LM340K-12		1.35
LM340K-15		1.35
LM340K-24		1.35
LM340T-5		.79
LM340T-12		.79
LM340T-15		.79
LM340T-24		.79
LM341P-5		.75
LM341P-12		.75

LM341P-15		.75
LM342P-5		.69
LM342P-12		.69
LM342P-15		.69
LF347N	14	1.49
LM348N	14	.99
LM350K		4.95
LF351N	8	.60
LF353N	8	1.00
LF355N	8	1.10
LF356N	8	1.10
LM358N	8	.69
LM359N	14	1.79
LM370N	14	4.49
LM373N	14	3.95
LM377N	14	1.95
LM380CN	8	1.10
LM380N	14	.89
LM381N	14	1.79
LM382N	14	1.39
LM384N	14	1.79
LM386N-3	8	.89
LM387N	8	.89
LM389N	18	1.19
LM391N-80	16	1.19
LM392N	8	.69
LM398N	8	3.95
LM399H		5.00
TL494CN	16	3.95
TL496CP	8	1.19
NE531V	8	2.95
NE544N	14	2.95
NE550A	14	1.95
NE555V	8	.35
XR-L555	8	.59
LM556N	14	.69
NE564N	16	2.95
LM565N	14	1.19
LM566CN	8	1.49
LM567V	8	.99
NE570N	16	3.95
NE571N	16	2.95
LM703CN	8	1.19
LM709N	14	.49
LM710N	14	.69
LM711N	14	.79
LM723N	14	.55
LM733N	14	1.00

LM739N	14	1.95
LM741CN	8	.35
LM747N	14	.69
LM748N	8	.59
LM1310N	14	1.49
MC1330A1	8	1.95
MC1349	8	1.79
MC1350	8	1.49
MC1358	14	1.95
LM1456V	8	1.95
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LM2002T		1.95
ULN2003A	16	.89
XR2206	16	3.95
XR2207	14	2.95
XR2208	16	2.49
XR2211	14	3.95
LM2877P		1.95
LM2878P		2.95
LM2901N	14	.59
LM2902N	14	.89
LM2907N	14	2.49
LM3189N	16	1.59
LM3900N	14	.59
LM3905CN	8	1.19
LM3909N	8	.99
LM3914N	18	2.95
LM3915N	18	2.95
LM3916N	18	2.95
RC4136N	14	1.25
RC4151NB	8	1.95
RC4194TK		4.49
LM4250CN	8	1.29
LM4500A	16	1.95
NE5532	8	2.49
NE5534	8	1.69
ICL8038B	14	3.95
LM13080N	8	1.19
LM13600N	16	1.19
76477	28	3.95

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14 pin LP	.17	.15	.14
16 pin LP	.19	.17	.16
18 pin LP	.26	.24	.23
20 pin LP	.30	.27	.25
22 pin LP	.31	.28	.26
24 pin LP	.33	.30	.28
28 pin LP	.40	.37	.35
36 pin LP	.46	.42	.39
40 pin LP	.49	.46	.43

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8 pin SG	.30	.27	.25
14 pin SG	.43	.39	.37
16 pin SG	.47	.43	.41
18 pin SG	.53	.49	.47
24 pin SG	.69	.65	.61
28 pin SG	.81	.76	.72
36 pin SG	1.09	1.03	.97
40 pin SG	1.21	1.14	1.08

LP

SG

ST

WW

SOLDERTAIL STANDARD (TIN)

	1-9	10-99	100-up
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16 pin ST	.34	.32	.30
18 pin ST	.38	.36	.34
20 pin ST	.45	.43	.41
24 pin ST	.49	.46	.43
28 pin ST	.69	.67	.63
40 pin ST	.99	.95	.89

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-9	10-99	100-up
8 pin WW	.49	.45	.42
10 pin WW	.65	.62	.59
14 pin WW	.65	.62	.59
16 pin WW	.69	.65	.61
18 pin WW	.89	.85	.79
20 pin WW	1.09	1.05	.99
22 pin WW	1.25	1.19	1.15
24 pin WW	1.29	1.23	1.18
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JE520CM

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JE664-A EPROM Programmer. $995.00
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JM16A	2716, TMS2516 (TI)	25V	Intel, Motorola, Nat., NEC, TI, AMD, Hitachi, Mostek	$14.95
JM16B	TMS2716 (3-V's)	-5V, +5V, +12V	Motorola, TI	$14.95
JM32A	TMS2532	25V	Motorola, TI, Hitachi, OKI	$14.95
JM32B	2732	25V	AMD, Fujitsu, NEC, Hitachi, Intel, Mitsubishi, National	$14.95
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BUILD A PRINTER BUFFER

An inexpensive project for the parallel port

BY JOHN BONO

Personal computers have eliminated many of life's minor frustrations. Unfortunately, they also have created a unique set of new frustrations. For instance, have you ever debugged a program with a listing so old that even your handwritten modifications are modified? If you're like me, you don't want to stop debugging to wait for a new printout. Have you ever been connected to a computer via a phone line and wished you could get hard copy but your printer was too slow to keep up with the data transmissions? Perhaps you have a program that produces so much printed output that you wait until lunch to run it? Tying up your computer to print data is a waste of time and resources. If these situations sound familiar, a printer buffer may be the solution.

A printer buffer holds characters to be printed out until the printer is ready to accept them. It allows the computer sending the characters to dump the characters and go back to other tasks. In the meantime, the printer prints the characters at its relatively slow pace.

Software printer buffers do exist, but they have these drawbacks: they are highly hardware dependent, limited in buffer space, incompatible with some programs, and still slow down the computer somewhat.

The best solution is a hardware printer buffer external to your computer. These devices exist commercially, but they are relatively expensive. For that reason you should consider building one, as I did.

Photo 1 shows the completed printer buffer. It consists of only 24 chips, connectors, and a power supply. The entire unit cost less than $150 to build. The parts list for this project is specified in table 1.

How It Works

Figure 1 shows the flow of data from the host computer through the printer buffer and out to the printer. The computer sends a byte to the printer buffer interface. The microprocessor inside the printer buffer reads the byte and stores it in RAM (random-access read/write memory). This process continues until there are no more characters sent or until the buffer fills up. The buffer uses 64K bytes of RAM, which means that over 65,000 characters can be stored in the printer buffer. This translates to about 35 pages of printed material.

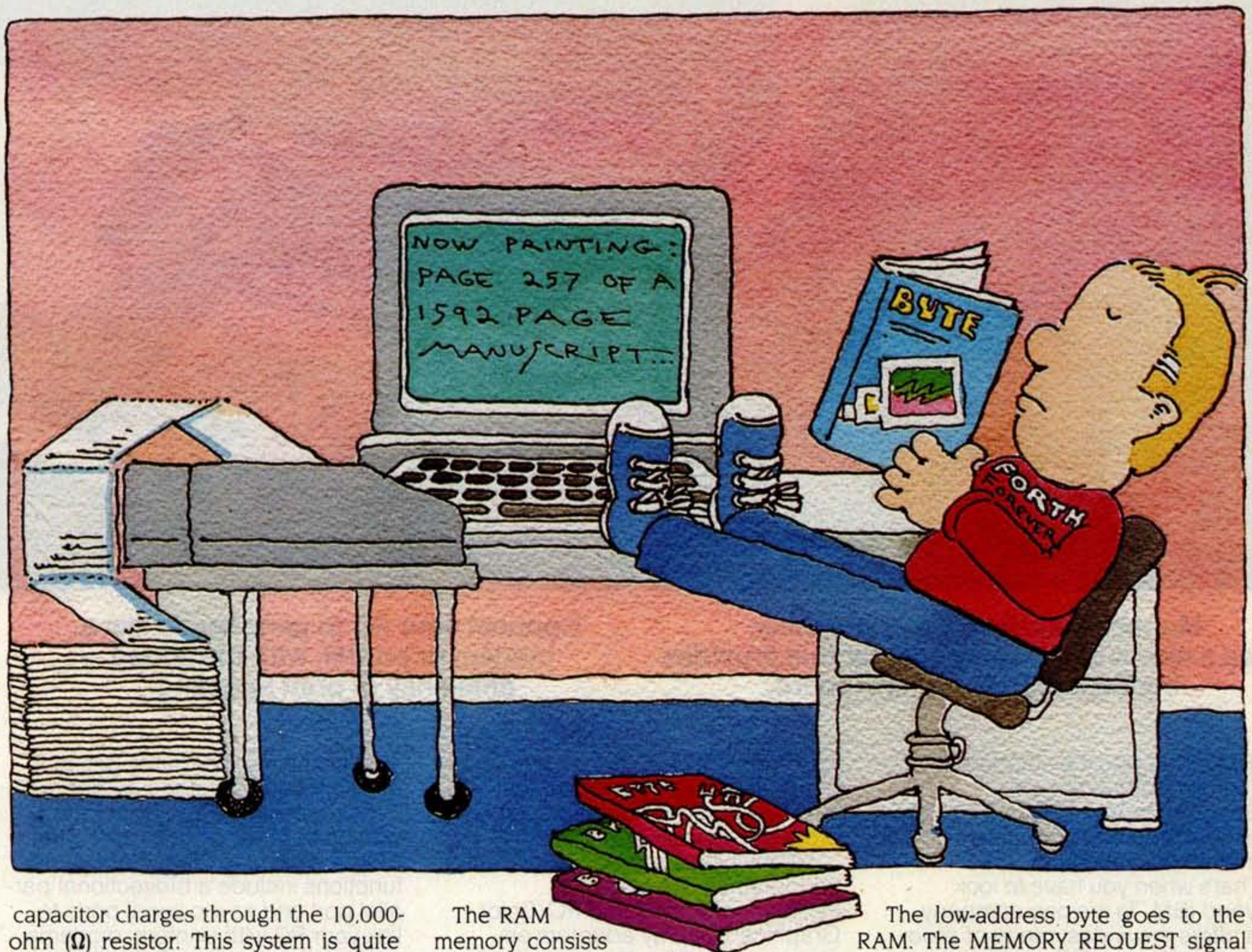
Output from the printer buffer takes place independent of input. The characters are taken from RAM in the same order as they are input. The microprocessor then sends the characters one by one to the printer interface. To the user, these two processes appear to take place simultaneously so that data can leave the computer and be printed as quickly as possible.

Figure 2 shows the block diagram for the printer buffer. The heart of the system is a Z80 microprocessor running with a 1-MHz clock. It executes instructions stored in an EPROM (erasable programmable read-only memory). The characters are input from the host computer into an 8-bit latch and are output to the printer through another 8-bit latch. The printer buffer includes 64K bytes of dynamic RAM. The RAM has a multiplexed address input and refreshing requirements, so additional support logic is required for its operation.

Getting Down to the Nitty Gritty

Figures 3a and 3b (pages 450 and 452) show the schematic diagram for the printer buffer. The 1-MHz clock is generated by IC1, an MC4024. Exercise special caution when buying this part because it is not CMOS (complementary metal-oxide semiconductor) as its 4000 series number might lead you to believe. Order only a MC4024, not just a 4024, and you won't have a problem. The 0.001 μF (microfarad) capacitor across pins 3 and 4 sets the frequency, and the connections to pin 2 adjust the frequency somewhat. In this application, the clock frequency is not at all critical—any clock rate between 0.5 and 2 MHz is acceptable.

IC2 is the Z80 microprocessor that runs the whole printer buffer. Pin 26 resets the processor when the 68-μF



capacitor charges through the 10,000-ohm (Ω) resistor. This system is quite simple, therefore, all the interrupt and direct-memory handshaking inputs are strapped to their inactive state. One thing I have found is that the Z80 has an annoying feature of letting its high-address bus float at certain times, which causes random chip selects and could destroy the contents of the RAM. To avoid this problem, IC5, a 74LS373, latches the upper-address byte and keeps it valid during the entire instruction cycle.

The EPROM memory resides at address locations 0 through 2047 (although 256 bytes is more than enough memory). The EPROM chip select is generated by IC11. This 74LS138 decoder is used as a 5-input OR gate determining whether the EPROM or the RAM will be selected during a given memory cycle. If the output of IC11 is low, the EPROM will be selected; if it is high, then the RAM will be selected.

The RAM memory consists of eight 4164 chips. All of the chip's pins are connected in parallel except for the data input and output pins (2 and 14). The interface from the Z80 to the RAM chips was the most challenging part of the design. The dynamic RAM works like this: a row address is provided, the row-address strobe (RAS) goes low, a column address is provided, the column-address strobe (CAS) goes low, and then data goes either in or out. The level of the READ/WRITE pin at the time of CAS determines the data direction. IC7 and IC8 are the address multiplexers for the RAM. When their *S* input is high, the low byte of the Z80 address is provided to the RAM-address input. When their *S* input is low, the high byte of the Z80 address goes to the RAM-address inputs.

The memory-access sequence starts with the Z80 putting out an address. The low-address byte goes to the RAM. The MEMORY REQUEST signal and either the READ or WRITE signal then occurs. These signals, with a RAM SELECT signal from IC11, are combined by IC4 to generate the RAS. Now, the RAM has the low-address byte. The RAS signal is delayed slightly by the buffers of IC14 and IC6 to allow for RAM-address hold time. Then the delayed RAS switches the address multiplexers IC7 and IC8 to provide the high-address byte to the RAM. The RAS is further delayed to allow for multiplexer settling time and then is fed to the RAM to provide CAS. When CAS goes low, the RAM either accepts or outputs the data byte depending on whether the Z80 is doing a READ or WRITE.

(text continued on page 446)

John Bono (23624 137th Ave. SE, Kent, WA, 98031) *is an electrical engineer with Boeing Aerospace Company's Electrical Technology Organization in Kent, Washington.*

ILLUSTRATION BY KIMBLE PENDLETON MEAD

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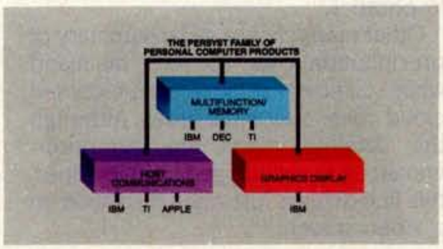

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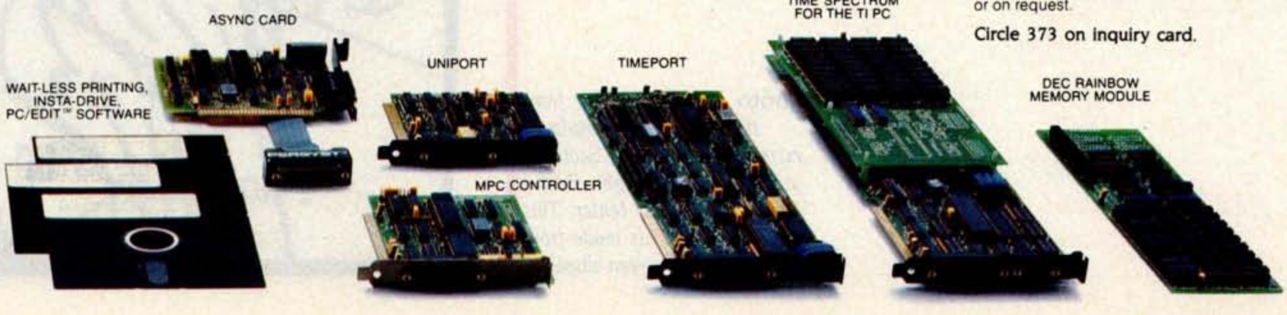

APPLE FAX: Weather Maps on a Video Screen

With a simple converter circuit, you can use your Apple to display facsimile weather maps

BY KEITH H. SUEKER

Behind the scenes, at television and radio stations and in hundreds of airports around the world, meteorologists ponder dozens of surface and upper-air weather maps several times each day. These maps display information about pressure, winds, temperature, and many other factors that forecasters use to predict the weather.

In this article I will describe a way to display real-time, radio-facsimile weather maps on the Apple II high-resolution video screen. With a short-wave receiver, a simple converter, and a short machine-language program, you can have a new window on the world.

Weather maps come in many forms and formats. Station NSS in Washington, DC, transmits a schedule of daily maps at 0000Z and 1200Z (7:00 a.m. and 7:00 p.m. EST). Some maps have a Mercator projection, some a polar projection. Some of the more interesting maps cover the northern hemisphere from Alaska to Gibraltar and include latitude and longitude lines as well as political and geographical boundaries. Many maps cover the North American continent from Mexico to the polar regions. State and provincial boundaries can be seen, along with major geographical features such as the Great Lakes and Hudson Bay. A sample display is shown in photo 1.

Other maps show a radar summary of precipitation over the U.S. mainland while still others show satellite-recorded cloud cover over large areas. Although the satellite maps are computer-enhanced to include geographical lines, this fine detail is lost when displayed on a video screen.

Photo 1: *Polar weather from the Alaskan Peninsula at extreme left center to Scotland at extreme upper right. Baffin Island is at upper center. This composite photo is made from five sequential screen displays.*

The content of these maps is not always obvious, and their complete interpretation is beyond my ability. Suffice to say that many maps show altitude contours for selected upper-atmosphere pressures, and that high- and low-pressure centers are often clearly shown.

FAX AND WX

Facsimile transmission (FAX) is widely used commercially for sending drawings over the common-carrier telephone lines. It is also used for transmitting weather maps (WX) to ships at sea on high-frequency radio circuits.

For mariners, weather is more than a matter of casual concern. It is vital for them to have as much forecast information as possible on wind velocity, wave heights, air and water temperatures, and other marine conditions. Sea-based aircraft pilots need forecasts of winds, cloud cover, temperatures, and other variables for marine operations. Weather information in the U.S. is collected by land and radio teletype circuits from a worldwide network of ground stations and ships at sea. Nearly every country in the world cooperates in this effort. Orbiting satellites provide additional inputs from specialized sensors. The resulting mass of data is assembled by the National Oceanic and Atmospheric Administration (NOAA) and fed into computers. NOAA's output is a daily stream of synoptic and forecast maps for almost anything you could want to know about the weather. The maps are transmitted nationally over FAX wire circuits and selected maps are also transmitted simultaneously on a number of high-frequency radio circuits through the facilities of the U.S. Navy Fleet Weather Service. Many other nations also transmit FAX maps, and their transmissions can often be received in this country.

FAX can be visualized as transmission of a television picture at a snail's pace. The original copy is scanned in a series of lines, just as in television. Instead of the 15.750-kHz horizontal-scan rate of television, however, a typical FAX scan rate is 2 Hz or 120 scans per minute. The luminance information of FAX transmissions requires only a kilohertz or so of bandwidth to resolve fine detail because the scan rate is so slow. The video of television is audio in FAX, the result of adapting picture transmission to the frequency and bandwidth limitations of telephone lines and long-distance radio circuits. Because a full FAX picture may require five minutes or more to transmit, FAX is not a winner for live action—except possibly for chess. But it has real utility for handling still pictures.

RECEIVING FAX

My personal involvement with FAX reception began several years ago when I acquired a surplus Western Union Deskfax machine for the princely sum of $15. This little machine uses a rotating drum covered with electrosensitive paper and forms an image by sparking a fine wire that advances slowly along the axis of the drum. To make Deskfax functional on radio weather FAX frequencies I had to convert it from 180 scans per minute to the standard 120 scans by building a precision 40-Hz power supply to drive the synchronous motors. Synchronizing pulses are sent at the start of each weather map, but FAX machines run "open loop"; i.e., they rely on a precise speed match between the transmitting and receiving scanners. Crystal-controlled motor drives provide the required accuracy.

The Deskfax machine also requires a receiving converter because the transmitted FAX signal is a continuous-wave carrier frequency shifted by the "video" information. Commercial FAX receivers employ automatic gain control (AGC) circuits with limiters and discriminators to recover the modulation and convert it to synchronizing pulses and a signal voltage that varies with pixel brightness in the original material. The signal voltage then drives whatever circuitry and mechanism is used to produce the received picture. For this project, I designed a much less elegant, but still functional, receiving adapter.

The Deskfax machine was a lot of fun to operate, but paper supply was a problem and the short drum could accommodate only enough paper for a small portion of each map. When I finally entered the computer age with the acquisition of an Apple II, it seemed logical to see if I could put FAX pictures up on the video screen.

APPLE HI-RES VIDEO

The high-resolution graphics (HGR) display of the Apple II is arranged as 192 lines of 280 horizontal pixels per line.

(text continued on page 148)

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An attempt to display the entire picture width on the video screen produces a vertically elongated picture.

(text continued from page 147)

Each line is organized as 40 bytes of 7 pixel bits per byte. The page is stored in RAM from hexadecimal 2000 to 3FFF (8192 to 16,375 decimal). The lines are not in a simple sequential order but jump around, presumably to make things easier for the character generator and the low-resolution graphics displays. This design feature makes screen addressing somewhat complicated.

An individual pixel may be displayed by setting high the corresponding bit of the byte in which the pixel resides. Bits 0 through 6 are displayed from left to right with bit 0 (the least significant bit) on the left. The highest bit of each byte must be a common value to assure proper display positioning. The procedure in generating the FAX display is to sample the received radio signal from the signal converter (see figure 1) 280 times for each half-second scan line, and to set each pixel bit high or low according to the signal level at that moment. This arrangement only distinguishes between black and white.

The transmitted picture resolution is better than 500 pixels per line, but this resolution is degraded by transmission conditions, sampling errors introduced by digitizing (accomplished at the game port on the Apple II), and the limitations of the simple receiving converter. In the vertical direction (successive scan lines), line spacing on the screen is such that lines are much farther apart than their spacing on mechanical FAX machines like my Deskfax. An attempt to display the entire picture width on the video screen produces a vertically elongated picture. For this reason, only about 20 percent of a scan line is displayed to preserve the proper aspect ratio.

HARDWARE

The receiver signal converter shown schematically in figure 1 is used for FAX reception with the Apple II. Audio output from the radio receiver is isolated and boosted in voltage by the input transformer, T1, an output transformer connected backwards. The impedance ratio is not critical. Diodes D1 and D2 rectify the signal and charge C1 to the peak voltage of the signal. Germanium diodes should be used for these rectifiers. Silicon diodes such as the 1N4148 can also be used, but they will require a considerably higher audio level from the receiver. Transistor Q1 acts as a level detector and its collector provides the computer with input using the game-controller socket. Nearly any type of NPN signal transistor will be satisfactory for Q1. The circuit is insensitive to layout and can be built on a breadboard, a printed-circuit board, or simply plugged into a prototype board. Audio leads to the receiver do not have to be shielded. The Apple's game port circuitry converts the analog signal from the radio receiver signal converter to the digital information used to display the map video image.

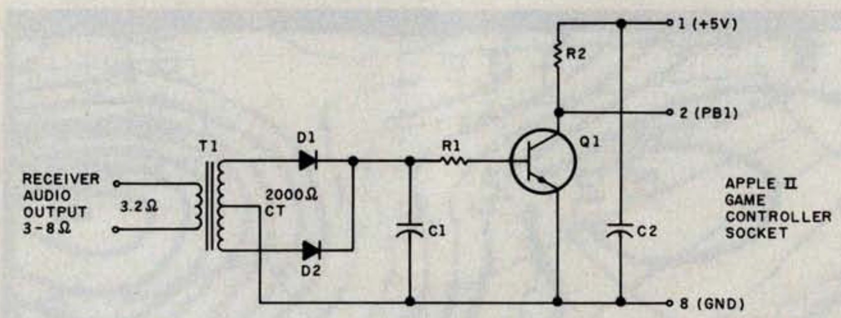
SOFTWARE

Listings 1 and 2 show the machine-language program for FAX picture reception and the few lines of the BASIC driving program that call it. The BASIC program simply sets the Apple II to full-page high-resolution graphics mode that clears the screen and calls the binary program. I chose to locate this program in the secondary high-resolution graphics page (HGR2) because it is not needed for the FAX display. The program can be relocated to run in any convenient location, however.

Let's examine screen addressing for a moment. The high-resolution screen has three symmetrical address divisions that I call "groups." These are each 64 lines long and have starting addresses of hexadecimal 2000, 2028, and 2050. Within each group there are eight "sets" of eight "rows" (or lines) each. Row addresses increment by hexadecimal 400 within each set, and set addresses increment by hexadecimal 80 within each group. This is the scheme the program follows in computing each new row address as the picture is drawn on the screen. There are probably more elegant ways of writing the program, so

(text continued on page 150)

Figure 1: *A schematic diagram of the FAX Converter.*



T1	Transistor-output transformer, 2000ΩCT/3.2Ω
D1, D2	Germanium diodes, 1N34 or equivalent
C1, C2	0.1 μF
R1	22,000 Ohms
R2	470 Ohms
Q1	2N4401, 2N3904, or similar type

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(text continued from page 148)
I offer this code simply as something that does the job.

In operation, the program sets starting addresses, waits one line, and then begins at "READ" by sampling the input flag on PB1. This appears as the highest bit of location hexadecimal C061. The bit is rotated left into the carry flag and then right into buffer location hexadecimal 4F05. The bit delay, hexadecimal 08, between samples determines the percentage of each line that is displayed, choosing the proper aspect ratio as described earlier. This process continues until 7 bits have been rotated into the buffer. At this point, the carry bit is set and rotated into the buffer to complete the byte. Finally, the byte is written into the next computed screen location and displayed immediately. Note that the screen refresh circuitry is continually reading the entire block of memory that comprises the high-resolution graphics page, although this action is transparent to the user.

The high-res screen has three symmetrical address divisions called groups.

When all 40 (hexadecimal 28) bytes have been written, the row is complete. The program then waits before starting the next row. The wait time is critical to insure precise synchronism with the transmitted line rate. At the end of each group, the program examines the keyboard flag at hexadecimal C000 to see if a key has been pressed. If so, the display is halted. This feature allows the picture to be restarted from the beginning by pressing another key, or to be held until a second key is pressed. If the first key is pressed during the last group formation (at the bottom one-third of the screen), the full picture will be held. It can be stored on tape or disk by exiting the program and entering "BSAVE (filename if disk), A$2000, L$1FFF."

The video display shows about 20 percent of a map's width, and the 20 percent displayed comes up at random each time the program is initiated. The restart feature is useful in moving to the more interesting parts of the map. After the display is complete, the program immediately begins a new display by overwriting the old one from the top. The screen is not cleared because it is useful to visually "tack" the new section onto the old one for continuity.

Listing 1: *The Facsimile driver program, written in 6502 assembly language.*

```
SOURCE FILE: FAXT
4F00:              BITS     EQU  $4F00    ;BITS PER BYTE COUNTER.
4F05:              BUFF     EQU  $4F05    ;BUFFER TO FORM DISPLAY BYTE.
C061:              FLAG     EQU  $C061    ;INTERFACE INPUT ON PB1.
FCA8:              WAIT     EQU  $FCA8    ;MONITOR SR WAIT.
4F10:              ROW      EQU  $4F10    ;ROW COUNTER.
4F11:              SET      EQU  $4F11    ;SET COUNTER.
4F12:              GRP      EQU  $4F12    ;GROUP COUNTER.
4F13:              SADL     EQU  $4F13    ;STARTING ADDRESS
4F14:              SADH     EQU  $4F14    ;OF CURRENT SET.
4F15:              GADL     EQU  $4F15    ;STARTING ADDRESS
4F16:              GADH     EQU  $4F16    ;OF CURRENT GROUP.
C000:              KBD      EQU  $C000    ;MONITOR SR KBD.
C010:              KBDSTRB  EQU  $C010    ;MONITOR SR KBDSTRB.
----- NEXT OBJECT FILE NAME IS FAXT.OBJ0
4000:                       ORG  $4000
4000:A9 08         START    LDA  #$08     ;START NEW PICTURE.
4002:8D 10 4F               STA  ROW      ;8 ROWS PER SET.
4005:8D 11 4F               STA  SET      ;8 SETS PER GROUP.
4008:A9 03                  LDA  #$03     ;3 GROUPS PER PAGE
400A:8D 12 4F               STA  GRP      ;FOR THE DISPLAY.
400D:A9 00                  LDA  #$00
400F:8D 13 4F               STA  SADL     ;SET LOW BYTE STARTING
4012:8D 15 4F               STA  GADL     ;ADDRESS FOR FIRST SET,
4015:8D 5D 40               STA  ADDL     ;GROUP AND ROW.
4018:A9 20                  LDA  #$20
401A:8D 14 4F               STA  SADH     ;SET HIGH BYTE STARTING
401D:8D 16 4F               STA  GADH     ;ADDRESS FOR EACH SET,
4020:8D 5E 40               STA  ADDH     ;GROUP AND ROW.
4023:A9 00         INIT     LDA  #$00     ;START A NEW LINE AFTER DELAY.
4025:AA                     TAX
4026:A9 29                  LDA  #$29     ;(THIS COMBINATION OF WAIT
4028:20 A8 FC               JSR  WAIT     ;TIMES KEEPS DISPLAY ROWS
402B:A9 AA                  LDA  #$AA     ;SYNCHRONIZED WITH SCAN
402D:20 A8 FC               JSR  WAIT     ;RATE OF FAX TRANSMISSIONS.
4030:A9 FF                  LDA  #$FF     ;DELAYS CAN BE CHANGED TO
4032:20 A8 FC               JSR  WAIT     ;MATCH A PARTICULAR APPLE
4035:A9 FF                  LDA  #$FF     ;CRYSTAL IF NECESSARY.)
4037:20 A8 FC               JSR  WAIT     ;DONE. READY FOR NEW ROW.
403A:A9 08         CHAR     LDA  #$08     ;SET BIT COUNTER FOR
403C:8D 00 4F               STA  BITS     ;SEVEN BITS PER BYTE.
403F:A9 00                  LDA  #$00     ;CLEAR BUFFER FOR NEW
4041:8D 05 4F               STA  BUFF     ;BYTE STORAGE.
4044:AD 61 C0      READ     LDA  FLAG     ;READ INTERFACE INPUT AND
4047:2A                     ROL  A        ;ROTATE INTO CARRY FLAG,
4048:6E 05 4F               ROR  BUFF     ;THEN INTO BUFFER.
404B:A9 08                  LDA  #$08     ;WAIT BEFORE SAMPLING
404D:20 A8 FC               JSR  WAIT     ;INTERFACE AGAIN.
4050:CE 00 4F               DEC  BITS     ;BYTE COMPLETE? IF NOT,
4053:D0 EF                  BNE  READ     ;TAKE ANOTHER SAMPLE.
4055:38                     SEC            ;IF DONE, SET HIGH BIT
4056:6E 05 4F               ROR  BUFF     ;IN BUFFER, THEN
4059:AD 05 4F               LDA  BUFF     ;READ BYTE INTO A.
405C:9D                     DFB  $9D      ;STORE BYTE FOR DISPLAY AT
405D:00            ADDL     DFB  $00      ;CURRENT SCREEN LOCATION WHICH
405E:20            ADDH     DFB  $20      ;WILL BE UPDATED LATER.
405F:E8                     INX            ;COUNT OFF BYTE AND
4060:8A                     TXA            ;CHECK TO SEE IF
4061:18                     CLC            ;DISPLAY IS AT
4062:E9 27                  SBC  #$27     ;END OF ROW? IF NOT,
4064:D0 D4                  BNE  CHAR     ;CONTINUE.
4066:CE 10 4F               DEC  ROW      ;ONE MORE ROW DONE.
4069:F0 0C                  BEQ  SETCHK   ;SEE IF AT END OF SET.
406B:AD 5E 40               LDA  ADDH     ;IF NOT, ADD $400 FOR NEXT
406E:18                     CLC            ;ROW STARTING ADDRESS
406F:69 04                  ADC  #$04     ;WITHIN SET AND PREPARE
4071:8D 5E 40               STA  ADDH     ;FOR NEXT ROW.
4074:4C 23 40               JMP  INIT     ;HERE WE GO - NEXT ROW.
4077:CE 11 4F      SETCHK   DEC  SET      ;END OF SET? IF SO, CHECK
407A:F0 22                  BEQ  GRPCHK   ;FOR END OF GROUP.
407C:AD 13 4F               LDA  SADL     ;IF NOT, FORM NEW ROW LOW
407F:18                     CLC            ;STARTING ADDRESS BY
4080:69 80                  ADC  #$80     ;ADDING $80.
4082:8D 5D 40               STA  ADDL     ;STORE FOR OUTPUT AND
4085:8D 13 4F               STA  SADL     ;UPDATE SET ADDRESS.
```

```
4088:AD 14 4F               LDA  SADH     ;DO SAME FOR HIGH BYTE.
408B:90 03                  BCC  NEWSAD   ;DON'T FORGET TO BRING IN
408D:18                     CLC            ;A POSSIBLE CARRY
408E:69 01                  ADC  #$01     ;FROM LOW BYTE ADDITION.
4090:8D 14 4F     NEWSAD    STA  SADH     ;STORE BASE AND CURRENT
4093:8D 5E 40               STA  ADDH     ;SET ADDRESS HIGH BYTE.
4096:A9 08                  LDA  #$08     ;RESET ROW COUNTER
4098:8D 10 4F               STA  ROW      ;AND
409B:4C 23 40               JMP  INIT     ;HERE WE GO - NEXT SET.
409E:CE 12 4F     GRPCHK    DEC  GRP      ;END OF PICTURE? IF NOT,
40A1:D0 16                  BNE  ZERO     ;GO DO RESETS.
40A3:AD 00 C0               LDA  KBD      ;DID THE BOSS PRESS A KEY?
40A6:30 03                  BMI  HOLD     ;YES, HOLD THE PHONE.
40A8:4C 00 40               JMP  START    ;NO, START ANOTHER GROUP.
40AB:AD 10 C0     HOLD      LDA  KBDSTRB  ;NOW WAIT FOR HIM TO
40AE:AD 00 C0     LOOP      LDA  KBD      ;PUSH ANOTHER KEY.
40B1:10 FB                  BPL  LOOP     ;NOT YET.
40B3:AD 10 C0               LDA  KBDSTRB  ;OK, WE'RE OFF AGAIN TO
40B6:4C 00 40               JMP  START    ;START A NEW PICTURE.
40B9:AD 15 4F     ZERO      LDA  GADL     ;FORM NEW LOW BYTE GROUP
40BC:18                     CLC            ;STARTING ADDRESS BY
40BD:69 28                  ADC  #$28     ;ADDING $28.
40BF:8D 15 4F               STA  GADL     ;STORE FOR BASE GROUP,
40C2:8D 13 4F               STA  SADL     ;SET AND
40C5:8D 5D 40               STA  ADDL     ;ROW ADDRESS.
40C8:AD 16 4F               LDA  GADH     ;DO SAME FOR HIGH BYTE,
40CB:90 03                  BCC  NEWGAD   ;REMEMBERING TO BRING IN
40CD:18                     CLC            ;A POSSIBLE CARRY FROM
40CE:69 01                  ADC  #$01     ;LOW BYTE ADDITION.
40D0:8D 16 4F     NEWGAD    STA  GADH     ;STORE ALL THE HIGH BYTE
40D3:8D 14 4F               STA  SADH     ;STARTING ADDRESSES
40D6:8D 5E 40               STA  ADDH     ;AS ABOVE.
40D9:A9 08                  LDA  #$08
40DB:8D 10 4F               STA  ROW      ;RESET ROW AND
40DE:8D 11 4F               STA  SET      ;SET COUNTERS.
40E1:AD 00 C0               LDA  KBD      ;ARE WE ON HOLD?
40E4:30 C5                  BMI  HOLD     ;YES, HOLD THE PHONE.
40E6:4C 23 40               JMP  INIT     ;NO, START A NEW GROUP.
40E9:00                     BRK

*** SUCCESSFUL ASSEMBLY: NO ERRORS
```

405E	ADDH	405D	ADDL	4F00	BITS	4F05	BUFF
403A	CHAR	C061	FLAG	4F16	GADH	4F15	GADL
409E	GRPCHK	4F12	GRP	40AB	HOLD	4023	INIT
C000	KBD	C010	KBDSTRB	40AE	LOOP	40D0	NEWGAD
4090	NEWSAD	4044	READ	4F10	ROW	4F14	SADH
4F13	SADL	4077	SETCHK	4F11	SET	4000	START
FCA8	WAIT	40B9	ZERO	4000	START	4023	INIT
403A	CHAR	4044	READ				
405D	ADDL	405E	ADDH	4077	SETCHK	4090	NEWSAD
409E	GRPCHK	40AB	HOLD	40AE	LOOP	40B9	ZERO
40D0	NEWGAD	4F00	BITS	4F05	BUFF	4F10	ROW
4F11	SET	4F12	GRP	4F13	SADL	4F14	SADH
4F15	GADL	4F16	GADH	C000	KBD	C010	KBDSTRB
C061	FLAG	FCA8	WAIT				

Listing 2: A BASIC *program to load the* Facsimile *machine driver.*

```
100 D$ = CHR$(4)
110 PRINT D$,"BLOAD FAXT.OBJO"
120 HGR
130 POKE 49234,0
140 CALL 16384
```

This program resulted in part from a desire to learn more about the Apple video display and to produce something useful in the process.

Reception

FAX weather maps are transmitted on numerous frequencies from many different locations worldwide. Among these are Washington, DC; Honolulu, HI; Bracknell, England; Guam; Tokyo, Japan; Canberra, Australia; Halifax, Canada; and Moscow, USSR. At my location transmissions from Washington are the most reliable (on frequencies of 3356 kHz, 4975 kHz, 8080 kHz, and 10,865 kHz). Many other frequencies and locations are available, however. A communications-type receiver with a beat-frequency oscillator (BFO) is required for reception. While a picture is being transmitted, the signal will sound like a short tone burst followed by a "skritch" sound. This is repeated twice each second. The tone burst should be tuned to zero beat so only the "skritch" is heard. A single sideband receiver is preferred but not essential.

Signals can arrive from different paths and may augment or interfere with each other.

The Fickle Ionosphere

Reception quality can be highly variable. Long-range radio reception depends on signal reflection from the ionosphere, and the density and height of the ionized layers can change rapidly. Signals can arrive from several different paths and may augment or interfere with each other. Multipath reception is often accompanied by differential time delays in transmission. The result is a smearing of horizontal details or the appearance of echo lines. Atmospheric or man-made electrical disturbances can also degrade picture quality. I mention these effects not to discourage the reader but, rather, to suggest that an element of uncertainty can add spice to the otherwise orderly world of digital computing. ■

References

1. Grove, Robert B. *Confidential Frequency List*. Park Ridge, NJ: Gilfer Associates Inc., pages 68–71.
2. Luebbert, William F. *What's Where in the Apple?* Chelmsford, MA: Micro Ink Inc., pages 12–14.

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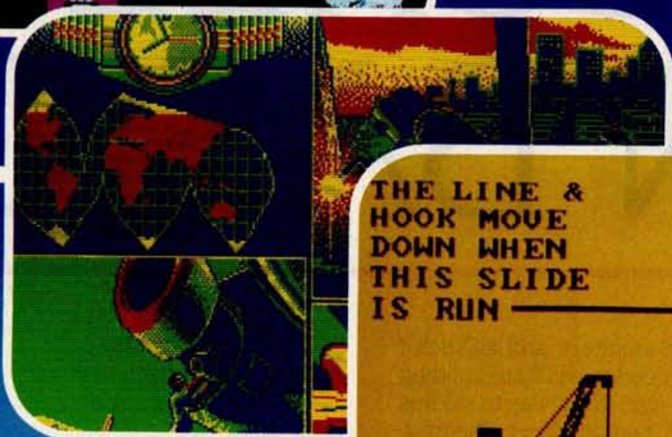

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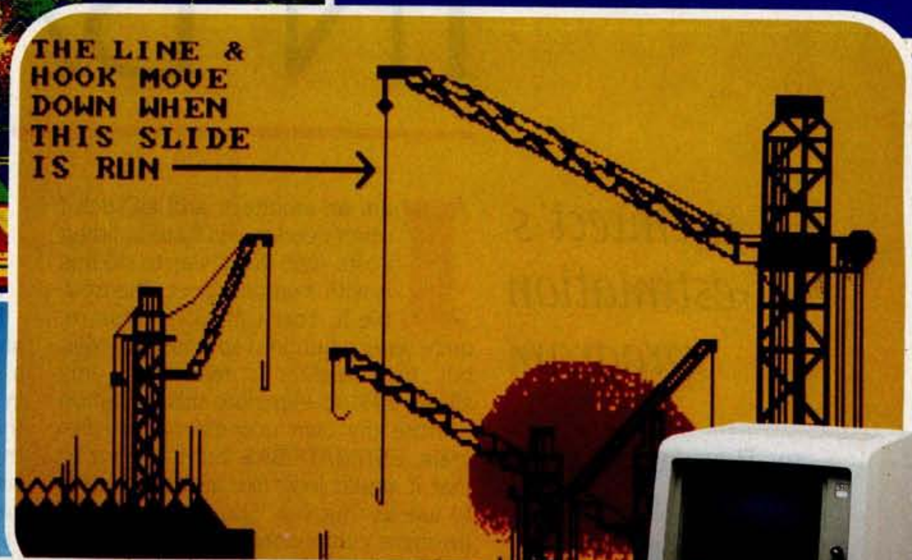

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SPREADSHEET IN BASIC

An architect's cost-estimation program

BY RODOLFO CERATI

I am an architect, and as such I often need to estimate building costs. One good way to do this is with a spreadsheet. The trouble is, cost estimates often require several hundred spreadsheet cells, but my CalcStar spreadsheet only allows 295. To eliminate this limitation I wrote my own cost-estimation program, ESTIMATE.BAS, but I wrote it so that it would look like and be as easy to use as CalcStar. Specifically, it uses the same cursor-control codes, instantly recalculates values, saves and recalls spreadsheet values on disk, and interfaces with a database.

I wrote the program in Microsoft BASIC-80, so it should be easily ported to other CP/M-80 computers. I also grouped the screen-handling functions in a series of subroutines so you can easily change them to match your screen's requirements. Finally, I included the ability to interface with a database program that I've written.

To run the program, you'll need: a microcomputer with a Z80 microprocessor and at least 56K bytes of memory, the CP/M 2.2 operating system, Microsoft's BASIC-80 interpreter, and a terminal with a directly addressable cursor, a clear-screen command, a backspace-and-character-delete command, and an erase-to-end-of-line command. A reduced intensity character display comes in handy, too.

USING ESTIMATE.BAS

Once you've typed the program in, save it and type RUN. You'll see a menu that looks like this:

B=build up a new estimate
E=edit an existing estimate
S=save values on disk
R=read values from disk
L=load another program
ESC=exit

Let's suppose that you type E to edit an existing estimate. You would then see a spreadsheet something like the one in figure 1. To move from cell to cell in this spreadsheet, you use the same control codes that you would use for cursor movement in WordStar. The current cell is indicated by angle brackets (**><**). Unlike other spreadsheets, though, my spreadsheet will not let you place just any kind of information in the cells. Instead, you are limited to entering the type of information called for in the column headings. For instance, you may only enter names under "Job type" and numbers under "Unit cost"; you may not enter formulas in any of the cells. Whenever you enter new numbers under "Unit cost" and "Quantity" and type the proper command, the program recalculates the percentages in the last column and the total value in the "Total value" row. If you want to add or delete rows, jump to a different page of the spreadsheet, or print the spreadsheet, type a semicolon and capital H (;H) for a list of the proper commands.

The other items in the menu are self-explanatory.

PROGRAM NOTES

I've included many remark statements in my program (see listing 1), but a few more words will help, I'm sure. The program is built around a two-dimensional array—ARR$—that contains the contents of each cell. The array is dimensioned for 100 rows by 7 columns. Four one-dimensional arrays—TP%, L%, PO%, and

MSK%—hold the screen-display and formatting parameters. Array TP% tells whether the cell is alphabetic or numeric, array L% tells the length of each column, array PO% tells the screen position of each cell in the spreadsheet, and array MSK% contains the strings used by the PRINT USING statements for formatting purposes.

The variables VMIN%, P%, VMAX%, PS%, SCR%, HZ%, and VP% contain the absolute position of the current cell in the main array and its relative position on the screen.

The program is sectioned into many subroutines to simplify programming and debugging. The most often used subroutines are at the start of the program to minimize the time the BASIC interpreter has to spend looking for them. The initialization and main menu subroutines are at the end.

The program occupies 15K bytes of disk space in compressed form and 18K bytes in ASCII (American National Standard Code for Information Interchange) form. If you want to save space, you can delete all of the remark statements, which are indicated with an apostrophe.

To adapt the program to other computer terminals, you only need to change the CRT (cathode-ray tube) routines in lines 60000 and 60020. If your terminal doesn't support reduced intensity, you can use reverse video instead. Or just place a null string ("") in variables W$(2) and W$(3).

To change the total number of cells in the main array, change MAX% in line 60060. To change the number of rows that are displayed, change the variables in line 60100. Finally, to change the screen-formatting parameters, change the DATA statements beginning in line 60220.

By now you have probably noticed that my program is not as flexible as CalcStar. It is, in fact, very specialized, but it has the same ease of data entry and display that commercial spreadsheets have. I've eliminated the flexibility of commercial programs in favor of a larger data capacity and a more compact program. I'm sure that you could adapt this program to your own purposes, especially if your applications are too large for conventional spreadsheets.

I can provide a copy of the program on disk in North Star double-density format for a nominal fee. Please write to me for details. ■

Rodolfo Cerati (Piazza Europa 26, 12100 Cuneo, Italy) is part owner of S & R Cerati Architects.

#	Code	Job type	u.m.	Unit cost	Quantity	Amount	%
1–	A/01	Excavations	m3	1.50	1,950.00	2,925.00	1.3
2–	B/01	Found. concrete	m3	14.50	130.00	1,885.00	0.8
3–	F/02	Steel bars	Kg	0.40	40,800.00	16,320.00	7.2
4–	S/03	R.concr. slabs	m2	25.50	2,780.00	70,890.00	31.5
5–	H/12	Exterior masonry	m2	28.50	1,350.00	38,475.00	17.1
6–	H/04	Int. walls (1)	m2	4.50	2,050.00	9,225.00	4.1
7–	H/02	Int. walls (2)	m2	6.75	385.00	2,498.75	1.2
8–	G/10	Plaster	m2	5.25	7,450.00	39,112.50	17.4
9–	L/01	Ext. finish	m2	6.50	1,850.00	12,025.00	5.3
10–	L/02	>Int. finish	<m2	2.50	6,200.00	15,500.00	4.5
11–	M/01	Marble floors	m2	52.50	195.00	10,237.50	4.5
12–	M/03	Synt. floors	m2	28.25	215.00	6,073.00	2.7
13–							
14–							
Total value ——————>>>						225,267.50	

type : text order : L–R Col.: 2 Row : 10
contents : Int. finish
edit : ________

Figure 1: *An example of a fictitious estimate spreadsheet. The cursor is at column 2 and row 10. The unit abbreviations are cubic meters (m3), kilograms (Kg), and square meters (m2).*

Listing 1: ESTIMATE.BAS, *a construction-costs estimate program with a spreadsheet-like data entry and display.*

```
1 '                 ############
2 '                 ESTIMATE.BAS
3 '                 ############
4 '
5 '       Construction costs estimating program
6 '       © 1983 — Rodolfo Cerati, Architect
7 '       Piazza Europa 26, 12100 Cuneo, Italy
8 '       Version 2.0 — date : June 13th, 1983
9 '
10 GOTO 60000:' <——Jump to initialization routine
85 '
86 '                 ##########
87 '                 Often used subroutines (lines 100–950)
88 '                 ##########
96 '
97 ' Print formatted value on screen
100 IF TP%(J%) THEN T=VAL(ARR$(I%,J%)):PRINT FNC$(PO%(J%),PS%)USING MSK$(J%):T:
    ELSE PRINT FNC$(PO%(J%),PS%)USING MSK$(J%):ARR$(I%,J%):
120 RETURN
248 '
249 ' Clear partial screen
250 FOR T%=1 TO GAP%:PRINT FNC$(O,T%+OFS%-1)W$(1):NEXT T%:RETURN
298 '
299 ' Calculate absolute row value in array (P%)
300 P%=VP%-(OFS%-1)+SCR%*GAP%:IF P%>MAX% THEN P%=MAX%:RETURN ELSE
    RETURN
318 '
319 ' Calculate position on screen
320 PS%=P%+OFS%-1-SCR%*GAP%:RETURN
348 '
349 ' Calculate bottom limit for screen display
350 VMAX%=VMIN%+GAP%-1:IF VMAX%>MAX% THEN VMAX%=MAX%
360 RETURN
396 '
397 ' Backspace one character
400 IF LEN(D$)=0 THEN RETURN ELSE PRINT CHR$(8)" "CHR$(8);
420 IF LEN(D$)=1 THEN D$="":RETURN ELSE D$=LEFT$(D$,LEN(D$)-1):RETURN
697 '
698 ' Get line
```

(listing continued on page 156)

(listing continued from page 155)

```
700 LINE INPUT;" ";C$:PRINT CHR$(13);:RETURN
709 ' get single character and echo it on screen
710 GOSUB 730:IF T%=13 or T%>31 THEN PRINT C$;CHR$(13);:RETURN ELSE PRINT"^"
    +CHR$(T%+64)CHR$(13);:RETURN
729 ' as above, but no echo
730 C$=INPUT$(1):T%=ASC(C$):RETURN
747 '
748 ' Waiting message
750 GOSUB 950:PRINT"Wait "W$(3);:RETURN
897 '
898 ' delete status line
900 PRINT FNC$(0,0)W$(1);:RETURN
947 '
948 ' Display program prompt
950 GOSUB 900:PRINT FNC$(0,0)" "W$(2);:RETURN
995 '
996 '                  ##########
997 '                  Print array
998 '                  ##########
999 '
1000 GOSUB 350:FOR I%=VMIN% TO VMAX%:PS%=I%+(OFS%-1)-SCR%*GAP%:
     PRINT FNC$(PO%(1),PS%)USING MSK$(1);VAL(ARR$(I%,1));
1020 IF ARR$(I%,2)<>" "THEN FOR J%=1 TO NN%:GOSUB 100:NEXT:PRINT
1040 NEXT:RETURN
1295 '
1296 '                 ##########
1297 '                 Print single item & recalculate total
1298 '                 ##########
1299 '
1300 GOSUB 300:GOSUB 320:IF HZ%>4 THEN T#=VAL(ARR$(P%,NN%))
1320 ARR$(P%,HZ%)=D$:I%=P%:J%=HZ%:GOSUB 100:IF HZ%<5 THEN RETURN ELSE IF
     HZ%=7 THEN 1360
1340 T1#=VAL(ARR$(P%,NN%-2))*VAL(ARR$(P%,NN%-1)):ARR$(P%,NN%)=RIGHT$(STR$
     (T1#),LEN(STR$(T1#))-1):J%=NN%:GOSUB 100
1360 TOT#=TOT#+VAL(ARR$(P%,NN%))-T#:GOSUB 1600:RETURN
1395 '
1396 '                 ##########
1397 '                 Print top title
1398 '                 ##########
1399 '
1400 PRINT FNC$(0,1)T1$ FNC$(0,2)T2$:RETURN
1495 '
1496 '                 ##########
1497 '                 Print title for total
1498 '                 ##########
1499 '
1500 PRINT FNC$(0,17)STRING$(79,45)FNC$(0,18)"Total ——————>>>"W$(1);:GOSUB
     1600:RETURN
1595 '
1596 '                 ##########
1597 '                 Print total value
1598 '                 ##########
1599 '
1600 PRINT FNC$(PO%(7),18)USING MSK$(7);TOT#:RETURN
1795 '
1796 '                 ##########
1797 '                 Print informations at bottom of CRT screen
1798 '                 using Micropro's Calcstar conventions
1799 '                 ##########
1800 PRINT FNC$(0,19)STRING$(78,45)FNC$(0,20)W$(1)FNC$(15,20)"type :"FNC$(0,21)W$(1)
     FNC$(11,21)"contents :"FNC$(0,22)W$(1)FNC$(15,22)"edit :"
1820 PRINT FNC$(35,20)W$(2)"order : ";:IF RD% THEN PRINT"T=B" ELSE PRINT"L=R"
1840 PRINT FNC$(50,20)"Col. :"FNC$(65,20)"Row :"W$(3):RETURN
1845 '
1846 '                 ##########
1847 '                 2nd cursor routines
1848 '                 ##########
1849 ' display 2nd cursor, i.e. brackets
```

(listing continued on page 457)

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Education

"BY THE YEAR 1984, there will be millions of general-purpose microcomputers in schools. . ."—Tom Dwyer, August 1980 BYTE.

Well, it's 1984 and there are about a million general-purpose microcomputers in schools, but many of them are still used as computerized page-turners and drill-and-practice sergeants. In 1980, when BYTE published its first education theme issue, the emphasis was on computer literacy and CAI (computer-aided instruction). Today, as computers reach students in all disciplines, the focus is moving from the computer as an object of study to the computer as a versatile learning tool.

Until recently, computers in education have been mainframes and minicomputers, administered and controlled by institutions and dispensed to users. As microcomputers get cheaper, more powerful, and easier to use, though, they are showing up on students' and teachers' desks. Computing power is being redistributed to the educational grassroots.

Software designed for education is still largely based on traditional learning materials, using the computer as a convenient delivery system that can give immediate feedback. A few innovative researchers and educators, however, are beginning tc explore the computer's real power, not only for computation, but for graphics, communications, and word processing.

Microcomputers are flooding American college campuses in record numbers. "A Computer on Every Desk" is a survey of schools that are trying to channel the tide to fit their educational goals.

Educational software suffers in the design loop: educators know what they want from software, but they can't write programs; programmers are not always versed in educational theory. The Rehearsal World, a programming environment developed at Xerox Palo Alto Research Center, is a first step toward a solution. In "Programming by Rehearsal," William Finzer and Laura Gould describe how a nonprogrammer can design and implement sophisticated software while the Rehearsal World writes Smalltalk code.

Learning software is only beginning to take advantage of the full power of computer graphics. Ann Piestrup of The Learning Company describes the design considerations behind TLC's powerful but playful interactive learning programs in "Game Sets and Builders."

Now more than ever, educators must be aware of the impact of computers on students and on the process of learning. How can computers best be introduced so that they will supplement, not supplant teachers? In this issue, Stephan L. Chorover ("Cautions on Computers in Education") and Joseph Weizenbaum (in the accompanying sidebar "Another View from MIT") offer warnings and suggestions to forestall the overzealous automation of learning.

An article by John Markoff on San Francisco's Exploratorium (with a text box on Telelearning's Electronic University), describes examples of alternate forms of off-campus education through the use of microcomputers.

Fred A. Masterson of the University of Delaware believes that programming languages can be useful pedagogic tools as well as programming tools. His "Languages for Students" describes the strengths and weaknesses of several popular, and some relatively unknown, languages for education.

There is now a great variety of microcomputers, minicomputers, and mainframes on many campuses. Naturally, all these machines need to communicate. One way is to use the Kermit protocol described by Frank da Cruz and Bill Catchings.

The possibilities for microcomputer applications in science and technology learning are endless. Examples in this issue include Nils Peterson's "Designing a Simulated Laboratory" and Robert P. Case's "Microcomputers in the Field."

Microcomputers are changing education—fast. Computing professionals and educators must work closely together to ensure that these changes are for the better.

—Donna Osgood, Associate Editor

A COMPUTER ON EVERY DESK

BY DONNA OSGOOD

A survey of personal computers in American universities

ACROSS THE COUNTRY colleges and universities are taking a serious look at the microcomputer as an essential part of the educational experience. A few dozen schools are already putting computers on students' desks, and hundreds more are exploring the possibilities. In several colleges, a personal computer is already as much a part of the cost of an education as tuition.

Why the move to micros? Plenty of reasons. Timesharing systems are overcrowded and expensive to upgrade. Students with an eye on the job market are beginning to demand "computer literacy" from their educations. And major computer manufacturers—most notably Apple, Digital Equipment Corporation (DEC), IBM, and Zenith—are wheeling and dealing to make their computers attractive.

The availability of personal computers is an obvious advantage. "Twenty-four hour access to a computer makes a tremendous difference in the way students view computing," says David Bray, dean of educational computing at Clarkson University. "Before, with our minicomputers and mainframes, students had to walk to the computer center and sometimes wait for hours to get to the computer. Some people are soured on computers that way."

Money is another powerful motivation for many schools. Faced with overburdened timesharing systems and rapidly increasing demands for computing, administrators look to micros to absorb and distribute some of the cost. In most cases, the student buys the hardware, often at a sizable discount from the manufacturer, and pays for it over several semesters or as part of tuition. This shifts some of the financial responsibility for computing to the students, though the cost of implementing a campuswide computer program is still considerable for the institution.

Clearly, hardware manufacturers see long-term advantages to having their machines in students' hands. Schools such as MIT, Carnegie-Mellon, Stevens Institute, and Brown have entered joint-research agreements with manufacturers and are doing extensive development in hardware, software, and network design. In some cases, the manufacturer gets proprietary rights to the products developed this way. Other advantages to the computer companies are not so immediate or tangible, but may well be important: students who use a particular machine in college may be loyal to the manufacturer later, as consumers and professionals.

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Students, faculty, and administrators are beginning to view the computer less as a computing machine and more as a broadly applicable tool for education and communication. "Our business is education, and we shouldn't lose sight of that," says Robert Golden of Rochester Institute. "Planning for computer use on campus has got to be curriculum driven, not just an afterthought to the selection of some hardware."

Most colleges either have plans to network microcomputers on campus or already have networks in place. Many schools will link the micros to larger computers for file storage or for terminal emulation. Networks can deliver electronic mail, student bulletin board and information services, and electronic library catalogs as well as communication among faculty, students, and staff.

Sociologists and psychologists are beginning to study the effects of widespread computer use on students. So far, the stereotype of the computer addict glued to a monitor screen and isolated from human contact just doesn't hold true. On the contrary, on many campuses the computer has brought together students who wouldn't otherwise have anything in common.

Private colleges and universities, with their greater financial and administrative flexibility, have been faster off the mark than their public counterparts. Even so,

only a handful of schools actually have large numbers of micros in student hands today, though several programs will start this September. No doubt some school administrators are holding back to watch and learn from the pioneers' mistakes. The 15 colleges and universities in the survey that follows are at the forefront of the movement.

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
Cambridge, Massachusetts

"Coherence" is the watchword for MIT's Project Athena, a $70 million joint research and development project with IBM and DEC. One of Athena's goals is to make hardware obstacles transparent to the user, so that a program produced on one part of the system is available to all other users. The entire university will rely on a single operating system and a comprehensive network.

IBM and DEC are supplying $50 million in equipment, staff, and maintenance to the project. DEC equipment and support will be centered in the School of Engineering, while the rest of the institute will use IBM machines. By dealing with two vendors, and possibly more later, MIT can preserve flexibility and transportability for future developments without being locked in to one vendor's product line.

In the first phase of the project, equipment on the DEC side will be 63 networked VAX minicomputers with four to six terminals each. IBM equipment in Phase 1 will be a distributed system of 500 PC XTs with 32-bit coprocessors, high-resolution bit-mapped displays, and local-area network interface cards. The PC XTs will be organized into several local-area networks, each supported by a file server (an IBM 4341) and a laser printer.

In Phase 2, beginning in 1985, the advanced workstations from both vendors (now under development) will be installed across campus. The workstations will have 32-bit processors, high-resolution bit-mapped displays, and networking capabilities. All Phase 1 software and curricular material should be transferable to the more advanced equipment.

Initially, Athena software will be based on Berkeley UNIX, version 4.2, with an editor, printing formatter, numerical analysis and graphics packages, a mail/file transfer program, and languages (C, FORTRAN, LISP, and Pascal). The system will evolve to accommodate new peripherals and software as well as improvements in the user interface.

The emphasis on coherence, which allows the transfer of information unimpeded by software and hardware considerations, brings its own restrictions. A set of rules is imposed on software design, limiting programming flexibility. Any group using the Athena network must agree to observe Athena's rules in its own programs.

MIT is investing $20 million over five years to support Project Athena. More than half of that money will fund faculty software-development efforts. "The educational value of Athena rests more in the software than the hardware," says Steven Lerman, the project's director. "We envision an environment where faculty prepare curriculum materials linked to the Athena system. What we hope will come out of this is an entire new generation of educational software for the technical curriculum."

Lerman anticipates applications in laboratory data acquisition and simulations, computation, and visualization. "The traditional means which we have to illustrate things in three dimensions are very limited—you can't control them, you can't rotate them and look at them from different directions at will. What we hope to do is create graphic environments in which students can explore the three-dimensional space and really get an intuitive gut feel for what's going on. Some students don't need this, interestingly enough, and some students desperately need it. Those that don't acquire it are seriously handicapped. The notion of a good architect or engineer who doesn't have that three-dimensional instinct is very hard to imagine."

Right now, says Lerman, "Educational institutions tend to provide a narrow band of ways to acquire information, principally the classroom and homework. Certain students seem to do well in one environment and not in another. I'm hoping that by creating a variety of software environments, we can extend the ways in which people can learn."

CARNEGIE-MELLON UNIVERSITY
Pittsburgh, Pennsylvania

By 1986, if everything goes as planned, all freshmen at Carnegie-Mellon University will be required to buy a very powerful personal computer that will become an integral part of their education. That computer will probably be the product of Carnegie-Mellon's joint research and development project with IBM, though the school is not under contract to buy the machines from IBM. Over the next few years, CMU will make the transition from what is now primarily a timesharing system to distributed personal computers.

According to James Morris, Director of the Information Technology Center at CMU, "Computers that are currently available at a price students can afford (about $3000) are not adequate to really make a difference to a student's education."

Specifications for CMU's machine are ambitious: it must have a bit-mapped display of a million pixels, a million instructions per second of processing power, a megabyte of real memory, and a virtual-address architecture with 32-bit address spaces. It must be connected to a local-area network as well.

Can they cram all that into a $3000 computer? "That is a very close call," says Morris. "Looking at what is currently available on the market, if you assume that the price will be cut in half over the next three years, it's plausible. The price will depend on the market developing, the competition developing,

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and a nontrivial discount from manufacturers, I would estimate." A prototype machine, an IBM PC with a National Semiconductor 16032 processor, will be available soon.

The computers will be networked in what Morris calls a "timesharing file system." It will encompass direct point-to-point communications and electronic mail but also will enable the user to browse through all the databases on campus. "It's the traditional kind of file sharing you find on timesharing systems," he says. Instead of hundreds of users, however, the system will handle thousands. "We're going to do that with large numbers of machines and local-area networks. The user doesn't have to worry about which machine is storing the file. Multiple copies of files will be kept on different machines, and there will be all sorts of computer system tricks to increase reliability and performance, but it will behave as one giant file system."

How will this tool change the way students work? "I can only speculate based on my experience at Xerox PARC [Palo Alto Research Center] over the last 10 years. If you provide people with a high-powered workstation and get them all connected into a common network and provide high-quality printing facilities, you drastically improve their ability to communicate with each other. People have seen fancy computers before. What they haven't seen before is a community of 5000 or 8000 people all wired together with this new communication medium."

CLARKSON UNIVERSITY
Potsdam, New York

In the fall of 1983, Clarkson University issued Zenith Z-100 microcomputers to all incoming freshmen. Each student pays $200 additional tuition a semester and a one-time maintenance deposit of $200. On graduation, the student surrenders the deposit and owns the computer.

David Bray, Clarkson's dean of educational computing, believes that if students are not computer literate when they leave the school, "then we are shortchanging them." When these students graduate in 1987, he says, nearly every professional in their fields will be expected to use a computer. Bray wants to be certain that Clarkson graduates will be prepared.

The computers have 192K bytes of memory, both 8-bit and 16-bit processors, and one disk drive. Clarkson has promised the incoming class a complete network by the time they are seniors and is working on the network design.

It's the logistics of learning that are changing at Clarkson, not the curriculum content. Laboratory and class demonstrations can use computer graphics to illustrate principles that cannot be clearly explained in a lecture. Some faculty members have established office hours when students can bring in their disks and discuss their work.

To Bray, word-processing capabilities are one of the most significant advantages the computer will confer. Already, he says, students are becoming more critical of what they write, and for the first time professors feel free to demand rewrites.

Bray believes that accessible micros are the key to getting the faculty involved in computing. Nearly all the Clarkson faculty have computers. Professors who would not use the timesharing facilities at the computer center will use desktop computers. Faculty members got Z-100s six months before the students did, and many attended classes and seminars to help them integrate the machines into their teaching.

Professors must be involved in developing computer software to integrate the computer into their classes. A faculty member who has programming questions, needs someone to write small routines, or needs computer help in a research project will latch onto a student for help. These one-on-one relationships between students and faculty members are emerging as a fringe benefit of the micro program.

The administrators' fear that students with micros would lock themselves into closets and become hackers was unfounded. In fact, according to Steve Newkofsky, acting dean of student life at Clarkson, the computer program has helped break down barriers between students in different fields by providing a common ground.

Five years from now, says Bray, "We will still be teaching chemistry, engineering, and so on. I don't think the educational process itself is going to change. Instead, we will be providing students with powerful tools and an effective educational assistant in the computer."

STEVENS INSTITUTE OF TECHNOLOGY
Hoboken, New Jersey

The Computers in Education program at Stevens has its roots in a decision made in 1978 to put new emphasis on computing and computers in the curriculum. By the fall of 1982, a pilot program was underway: all freshmen in the science and systems planning/management curricula were required to buy an Atari 800, at a 40 percent discount from the retail price. The computers were well received, and in the fall of 1983 the proprogram was expanded to include all incoming freshmen.

The new group, however, is getting a lot more computer for its money. The school contracted with DEC to buy 16-bit DEC 325s with 512K bytes of RAM and dual disk drives, which would have cost students about $1800. Through Stevens's special negotiations with DEC, however, students are getting an even sweeter deal: a Pro350 with dual floppy disks and a 10-megabyte Winchester disk, with software, for $1950. This 80 percent discount from the list price is based on an educational discount from DEC and contributions from Stevens.

Joseph Moeller, dean of educational development, emphasizes that

Stevens's approach to integrating the computer into courses is "curriculum driven." Computer use in early courses is designed to develop general computer skills that will be useful later. Moeller says, "The development of such a 'computer thread' throughout the curricula allows for a comprehensive approach to the effective integration of computer methods into the course structure."

A local-area network will eventually incorporate students' 350s. The net is already in place to link all the academic departments, VAXes, and the mainframe, and the next major expansion will bring in the students' computers. Dormitories are being refurbished to accommodate the computers, and a conduit is being installed for the network in the process.

Stevens has not yet finalized a total networking strategy because of the lack of standardization in networking technology. A research project under way with DEC will lead to development of a comprehensive local-area network solution for the entire campus.

Microcomputers are used across the curriculum. For example, interactive calculus programs help students through mathematical analysis classes. Chemistry courses include graphic simulations and drill and practice in chemical principles. In an introductory engineering graphics course, the computer is being used as an electronic drawing board and to integrate computer graphics capabilities into engineering graphics concepts. In the lab, computers will be used to collect data, interface with equipment, control procedures, and simulate experiments that might be impractical, expensive, or dangerous.

Applications in the liberal arts include a program in political science that analyzes voting systems and word-processing programs that students use to prepare their papers. Stevens is investigating the possibility of a joint project with AT&T to get Writer's Workbench, an editing program, running on the 350s.

Stevens is investigating the possibility of a joint project with AT&T to get Writer's Workbench running on the 350s.

"One of the most important benefits expected from this approach to computers," says Moeller, "is an increase in student involvement in project work—both independently and as part of teams. This was evident during the summer 1983 term, when approximately 30 faculty members and 20 undergraduate and graduate students formed software-development teams to prepare personal computer course materials for the fall semester. Many of the undergraduates were among those required to purchase Atari computers in 1982. Such activities have continued during the 1983–1984 academic year and are certain to increase, including both academic and research projects in the future."

Moeller believes the computers encourage better planning and less duplication from one course to another. Faculty involvement, central to the coordination effort, has led to an increase in interdisciplinary efforts by faculty members, he says.

Seventy-five percent of the full-time faculty is actively involved in the personal computer project. The institute supports an incentive program to encourage faculty members to buy and use computers. They can purchase the same DEC 350 system, with additional language capability, for $1500—paid over a period of three years—and will use computers in research and writing in addition to curricular activities.

"Within five years," says Moeller, "we'll see every student, every faculty member, and most of the staff with a desktop computer. This computer will have the capability of what is now a minicomputer with substantial stand-alone computing capacity hooked into a network to facilitate communications and professional activities. We are not going to stop having classes in classrooms with direct interaction between students and faculty. There will be a shift in the way faculty and students interact, and perhaps an increase in the kinds of learning that can take place. I expect that students will approach problems in ways which take full advantage of the computer resource at their fingertips and will be able to address more complex problems in more depth than ever before."

ROCHESTER INSTITUTE OF TECHNOLOGY
Rochester, New York

Rochester Institute is a larger and more diverse school than either Stevens or Clarkson. Computers from several manufacturers will be available to students through the bookstore at a discount, and the school will provide maintenance and training, but students are not required to buy personal computers.

Robert Golden, director of RIT's microcomputer task force, believes that fewer than a quarter of the 16,000 students will buy micros. He points out that no one machine would meet the needs of all the students, who major in such diverse fields as the fine and performing arts, hotel management and tourism studies, and engineering and sciences.

The computers getting the most emphasis at Rochester right now are DECs. The whole range of DEC micros is available through the bookstore at discounts of from 30 percent to roughly 60 percent on some special packages, with training and maintenance facilities already available. RIT is using some of its resouces to offer even larger discounts (as much as 82 percent) on some DEC packages for up to 200 faculty and staff members.

The school is developing an array of microcomputer uses in the classroom, from increased use of computer graphics in fine arts courses to a Survey of Computer Science course that uses computers as the primary mode of instruction. "We are just beginning the integration of computers into the classroom," says Golden, "but we see an incredible number of possible applications in the programs we offer here."

RIT has extensive timesharing facilities that are not yet overcrowded but could

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Every building on campus, including student housing, is wired to a digital PBX *network.*

(text continued from page 165)

be in the foreseeable future. Golden sees the school moving toward expanding the availability of micros on campus to meet the increasing demand for computing. He adds, "The path into the future is students having micros that can access larger computers or other micros through a network."

Although RIT is working with DEC on a limited Ethernet microcomputer network, the question of what networking scheme it will use for the entire campus is still open. Golden says, "There are technological issues that haven't been resolved. . . . There still doesn't seem to be the degree of compatibility between brands of micros that we need. The more you want to do, the more difficult it is. I've heard it said that the smart thing to do in computer networks is to wait . . . there's no great advantage in being the first."

RENSSELAER POLYTECHNIC INSTITUTE
Troy, New York

Rensselaer Polytechnic Institute, though similar in size and curriculum to Clarkson and Stevens, is not yet prepared to require students to buy computers, though they will be strongly encouraged. So far, few faculty members have instructional uses for personal computers, and the micros on campus are being used as intelligent terminals to the mainframe, for word processing, a little personal research, and games. Rensselaer traditionally has offered easily accessible and plentiful timesharing to students, but administrators feel that distributed processing will be the direction of the future.

Jim Moss, director of computer services at RPI, estimates that, of a total campus population of 6000, one thousand students already have personal computers. But until computers are an integral part of the instructional program, he says, and until a network is in place, Rensselaer will not require students to buy them. For now, there are two public microcomputer sites on campus to which students have free access. Every building on campus, including student housing, is wired to a digital PBX network, so that students with micros can access the campus mainframes or minis and eventually will be able to communicate micro to micro.

Moss stresses that an electronic information environment, not just a computing environment, will be important in the next decade. In the past, he says, the bulk of computing was geared to problem solving and calculations. Now the electronic movement and control of information is central, in the form of electronic mail, word processing, on-line libraries, and communication among faculty and students.

For several years, RPI has provided a unique scholarship program: 20 students a year are awarded a microcomputer in addition to their stipend. In a two-year study, psychologist Linnda Caporael has compared these students to a group who brought their own micros to college and to students with similar academic talents but without computers.

"There is this idea that computers are going to turn people into hackers or social isolates," Caporael says. "I was hardly prepared for the extent to which computer use was a social activity. Half of the students in our study reported that having a computer helped them to make friends. Most of the information students get about computers comes from people—nobody likes to read manuals, so they get information from each other. At RPI we have a microcomputer facility in a dormitory, which is damned inconvenient for faculty and staff, but great for students. I know students who own computers that go down there, because they've got a burning question and they know they can find somebody there to answer it."

So far, according to Caporael, students are using computers to replace typewriters and calculators. "There's not so much of what we call 'emergent use,' things the computer makes possible that wouldn't be happening otherwise. I think that will change over time. The niche for computing in education is there, but the software and applications just aren't there yet."

CASE WESTERN RESERVE
Cleveland, Ohio

Case Western Reserve studied and rejected the idea of a computer for every student, at least for the present. Instead, DEC Pro 350s in a computer laboratory and in clusters around campus serve many of the students' computing needs. Case's mainframe had been overburdened and due for expansion until the microcomputers distributed some of the load.

Freshman and sophomore computing students are the computer lab's primary users. Upperclassmen tend to outgrow the microcomputers and move on to the mainframe, according to Case vice-president Don Schuele. That, he says, is the trouble with requiring students to buy microcomputers. Schuele believes that the school should provide the facilities necessary for an education, but if a student wants the comfort and privilege of a personal machine, the school will make it easy to get one.

Case has found the computer lab to be cost-effective. Within two and a half years, the savings in time bought from the mainframe will cover the entire cost of the lab. "Three years down the road, if it turns out that the 350s are not right for us, we can sell them and buy new machines. It won't have cost us a penny," says Schuele.

(text continued on page 170)

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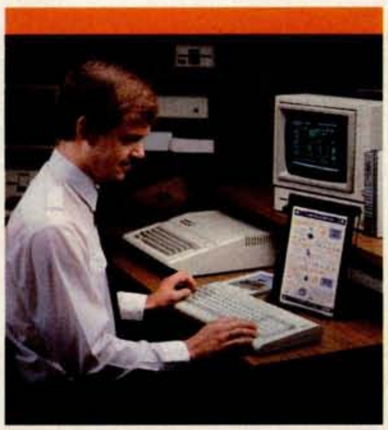

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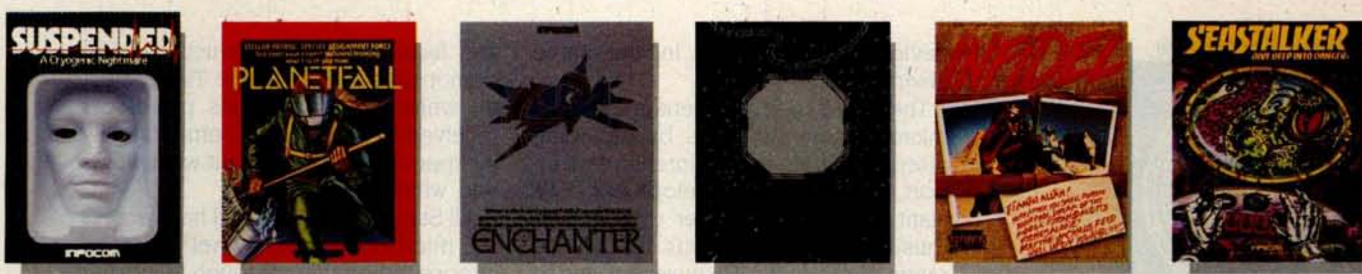

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(text continued from page 166)

STANFORD UNIVERSITY
Palo Alto, California

Stanford University may well provide a model for microcomputer programs in the heterogeneous environments of large universities. No single microcomputer could meet the needs of all Stanford faculty, staff, and students, and no program to impose a single standard across the campus could ever be successful. Yet, if the proliferation of personal computers on campus were ignored, the result would be chaos. Stanford's approach is a kind of guided evolution, using the university's resources to encourage ordered development.

"Standardization and control aren't the style of the institution," says Michael Carter, director of instruction and research information systems (IRIS). "Our solution to the problem is to be flexible and adaptable in getting all of those devices to be useful in the same environment."

The idea is to focus attention on a few microcomputer systems by providing discounts, training, maintenance support, and software development. "We want to focus the rather diffused enthusiasm on the campus for a wide range of products. What we're trying to do is select vendors and products that we think would be particularly useful in our academic and administrative computing environment, and then make them available to people," says Carter.

Through a program called Microdisk, Stanford will sell, service, and maintain microcomputers for faculty, staff, and students. So far, Microdisk has a contract with Apple and is negotiating with DEC, Hewlett-Packard, and IBM for equipment at academic discounts. Microdisk will offer a lab where prospective buyers can try hardware and software as well as consultants who will assure that they make informed purchases.

Carter intends to let the needs of the Stanford community guide the development of the microcomputer program. Questions that users ask through Microdisk are one source of information. "Our strategy is to learn as much as we can about where people want to go with their computing by providing support to questions," he explains. Experiments that get microcomputers to students and faculty, such as instructional and demonstration labs or the Tiro project (in which 150 humanities professors received IBM PCs) are a comparatively inexpensive way to find out what works and what doesn't.

All Stanford students will have access to microcomputers whether they choose to buy them through Microdisk or not. Clusters of the more popular computers will be distributed around campus for public use. Stanford plans a combination of broadband and baseband networking for voice, video, and digital links to all academic buildings, including student residences.

Faculty members will be encouraged to develop instructional software for the approved machines. IRIS will provide development hardware, professional and student programmers, and consulting to faculty software developers—provided they write software for machines widely available to students, through Microdisk or in the public clusters.

"What we're trying to do is enhance academic achievement by applying computer technology. Our best bet is to try to focus it a little here, nudge it a little there, lead a little bit over here. With so many really smart faculty members out there, I want to give them enough devices so that they know exactly what they want to do, and then fol-

(text continued on page 172)

(text continued from page 170)

low them, rather than control the way they use computers. The trick really is to remove the obstacles so that those people can lead the way."

UNIVERSITY OF MICHIGAN
Ann Arbor, Michigan

"We are putting tools in students' hands that before were available only to teachers and scholars," says Karl Zinn of the University of Michigan. "With modeling or simulation tools, students can do more thorough research than scholars used to be able to do with graduate assistants cranking things out by hand. Students now have the resources to do more original and creative work."

The first segment of the University of Michigan to implement an extensive microcomputer program is the College of Engineering, with its Computer-Aided Engineering Network (CAEN). Associate dean Daniel Atkins says, "We are building what we see as the absolutely essential computing environment, highly distributed, with networks connecting everything." Apple Lisas and Macintoshes, IBM PC XTs, and Apollo Engineering Workstations are distributed in "open computing clusters" across campus. Engineering students pay a usage fee of $100 per term.

"We are on a schedule that will essentially equip all our faculty, staff, and students with the appropriate workstation within a couple of years," says Atkins. There will be computers in research labs and in every faculty member's office, as well as a computer on every desk in some classrooms. CAEN is working with housing administrators to get computer clusters into dormitories.

So far, there is no plan to issue computers to individual students, though that may happen later. Students are free to buy personal computers, of course, and as a member of Apple's University Consortium, the school provides Macintosh computers at about half the retail price. "We're not sure how many of our students will buy Macintoshes," says Atkins. "Macintosh is still not a powerful enough machine for all the needs that engineering students have, but it is beginning to get very interesting."

Microcomputer clusters will be connected to the university network, UMnet, to allow access to a variety of mainframes and to permit file transfer for storage on mainframes. Eventually, UMnet will have connections in every dormitory room for personal computers, adequate dial-up capabilities for off-campus users, and archival storage for the entire network.

How will easy access to computing change the way students learn? "We are saturating the environment with computers," says Atkins, "and seeing what the students do with them. One of our criteria is that the machines support highly interactive graphics. This is a 'what if' environment for engineers, where they can have experience with many design iterations using a powerful industrial tool." When students in the technical communications course used Lisas to produce their papers, instructors noticed an enormous increase in the use of figures and graphics.

The key to the success of the program, Atkins says, is in convincing the faculty to make routine use of the computers. CAEN has provided each faculty member with an office workstation, and most professors are also buying computers to use at home. The college provides release time from teaching and student assistants to help an instructor develop applications. There is another motivation, according to Atkins: "The fact that the students have this environment readily available is creating pressure on the faculty from below. That was quite deliberate."

The College of Engineering is the testing ground for microcomputers for the rest of the university, and it is sharing information with deans of other colleges, the campus computing center, and the university's Center for Research on Learning and Teaching (CRLT). Atkins believes it will not be long before all University of Michigan students have ready access to personal computers.

Karl Zinn is heading a program within CRLT to introduce students to microcomputers, and he is enthusiastic about the Macintosh. Humanists react well to a screen that looks like a piece of paper,

(text continued on page 174)

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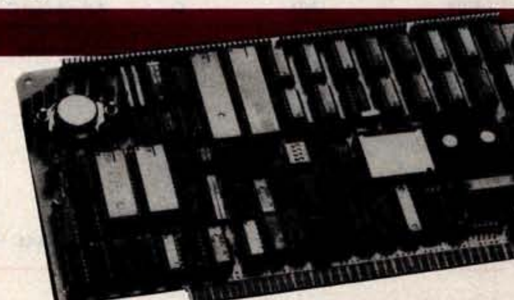

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(text continued from page 172)

he says. A small, transportable machine like Macintosh makes an unthreatening demonstration possible: you can bring the machine to the person, rather than bring the person into a special computer room filled with unfamiliar equipment.

Zinn stresses the importance of activities that shift the user's focus from the machine itself to the process of communicating with other people through the computer. For several years CRLT has helped students and faculty use its computer-based conferencing software, first on the UM timesharing systems, and now on microcomputers. Convenient access to microcomputers, Zinn says, expands personal and academic communication possibilities.

"Computer centers are more and more going to become information centers," says Atkins. "If we end up going in the direction of lots of isolated, noncommunicating computers, that's going to be a step backward. We have to build a network that allows access to databases, to the technical library, to national networks, to electronic communities of people doing research together. The challenge is not really that of acquiring lots of personal computers. The challenge is integrating them in a distributed environment."

DREXEL UNIVERSITY
Philadelphia, Pennsylvania

"Our approach to microcomputing has been to enhance undergraduate education. We picked a machine that we felt would support that aim. We are not trying to serve every possible goal that computers could serve on an academic campus." Brian Hawkins, assistant vice-president for academic affairs, feels that Macintosh is an ideal tool for Drexel students. Half of the university's students commute to campus, and

(text continued on page 176)


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(text continued from page 174)
every term a third of them work in business and industry as part of Drexel's cooperative education program. Hawkins believes the Macintosh is powerful, flexible, and portable enough to meet their needs.

As of this spring, all freshmen are required to have access to a Macintosh. Although most Apple University Consortium schools will not have large numbers of Macintoshes until fall of this year, Drexel received a large shipment of them in February. According to Apple sources, this commitment was based on Drexel's aggressive and well-publicized plan to get computers to all students.

Students can buy the computer from the university for $1000, with financing from the school if necessary, or they can work out independent arrangements. Disks and some peripherals will be available from the university bookstore at a discount.

A student advisory committee and a student-run users' group were in place before the computers were distributed on campus, running demonstrations and tutorials and raising student complaints and concerns. "We have been impressed with Drexel's planning," says Steven Weintraut of the Student Microcomputers Advisory Committee. "Every time we come up with a question, they have an answer."

Drexel freshmen are required to have access to a microcomputer.

There are no immediate plans to network the Macintoshes, partly because the student population is so mobile. Many will use the computer at home or at the job. "I can't hardwire that world," says Hawkins. "Certainly we have long-term plans for networks to support our academic program. Our approach for the first two years is based on the stand-alone capability of the machine. After that, we will network as needed."

Faculty training has run for more than a year to prepare for the onslaught of microcomputers. Applications and demonstrations, some of them designed on other computers, will be available immediately, and a software review center in the library will enable instructors to see what is already available in particular fields.

A fringe benefit of the microcomputer program, according to Hawkins, is the faculty's renewed interest in teaching methods. "Because of the change in technology, there seems to be a greater willingness to look at the educational technology as well as at how to best present concepts and ideas."

Drexel administrators share a concern voiced by educators at other schools: how will the computer change students' lives? Sociology professor Joan McCord is beginning a five-year study to measure changes in values, attitudes, stress, and time use among students and faculty. "You don't have to have an attitude toward the telephone, but you use it and it changes the way you approach problems. Just as the wide use of telephones changed lives, habits, and attitudes, so could the widespread use of computers."

BROWN UNIVERSITY
Providence, Rhode Island

Brown University is involved in a $50 million research and development project with IBM. In a few years, students and faculty may be using graphics-based, fully networked IBM "scholars' workstations" designed at Brown. In the meantime, a lab full of Apollo computers is changing the way students learn, and the Macintosh will probably be a hit on campus.

Microcomputers are just beginning their incursion into students' lives at Brown. There is no overall plan to get a computer to every student, but Brown's participation in the Apple University Consortium means that the Macintosh will be readily available. Bill Shipp, director of Brown's Institute for Research in Information and Scholarship, says, "The fact that a student or faculty member can have an affordable machine makes all the difference in the world. The average student will think of refrigerators and computers in the same thought."

English professor George Landow believes that easy access to computing can give liberal arts students some of

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the same research advantages that scientists have enjoyed. "With a scholar's workstation that could tie in to the university, or perhaps someday the Library of Congress catalog on line, someone doing research at a very sophisticated level could have a great many facts immediately available. One could teach students in the humanities to do the same kind of hands-on research that has been done for a long time in science courses."

Students in computer science courses at Brown are involved in a new sort of learning experience, one that may eventually be applied in other disciplines. In a lab equipped with 60 Apollo computers, students can watch dynamic graphic simulations of algorithms in operation. A typical lecture in this class includes a 20-minute "movie" illustrating an algorithm.

According to Bob Sedgwick, who teaches the class, more students learn advanced material faster with the simulations. Enrollment in the course is twice what it was last year. He found, however, that there was a limit to the information people could absorb in the visual form. "Every once in a while the entire class would say 'Stop!' and we'd have to freeze everything for about 15 minutes to explain what was going on. Eventually the students in the class got to accept it, though someone coming in from outside would be bewildered." Sedgwick looks forward to next year, when he'll work with students who already have experience with the medium.

The simulation system may be adapted for other computers, including the IBM workstation and possibly the Macintosh. "There is a question of performance," Sedgwick says. "I think we can do a lot on the Mac, but we can't do everything." What's important, says Bill Shipp, is to get people in different disciplines to think about the ways they work and the kinds of tools they use.

DARTMOUTH COLLEGE
Hanover, New Hampshire

Dartmouth has a long tradition of student computing. In the sixties, when the school developed its timesharing system, students were the principle users, and computing was a service provided freely to all. Even before the advent of personal computers, 95 percent of students used computers while at Dartmouth. The move toward personal computers will draw from and build upon the timesharing system already in place.

(text continued on page 181)

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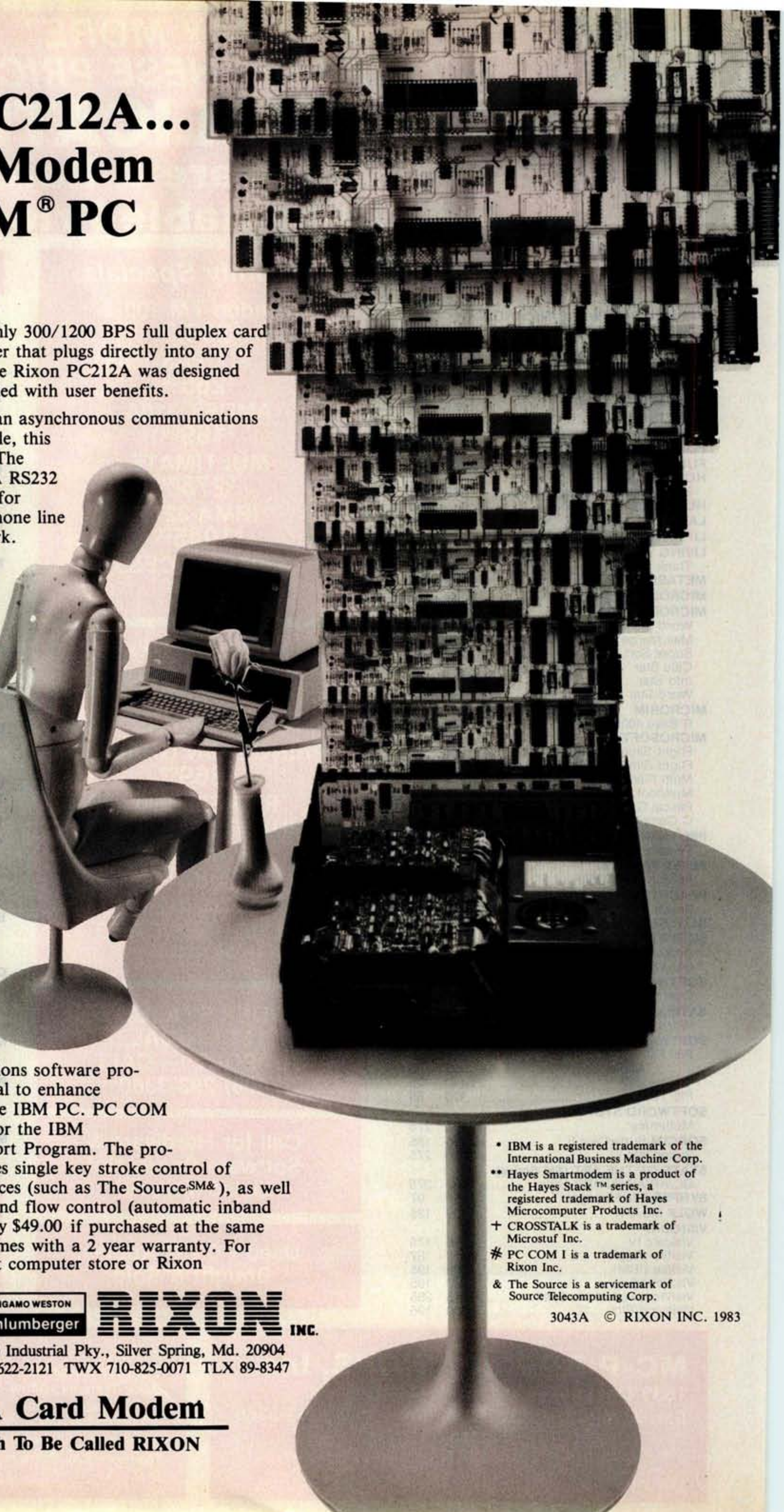

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Entering freshmen will be required to buy Macintoshes this September. "A personal computer will be one of the tools of the trade that every student has, like a textbook," says William Arms, vice-provost for computing and planning. Students can pay for their computers over time, as with any student cost, and financial aid will take the cost of the computers into account.

Macintoshes will be used both as free-standing computers and as terminals to the timesharing system, Arms says. Word and graphics processing, selected applications, and BASIC are the first priorities for the Macintosh as a stand-alone computer. For electronic mail, library access, and large programs, the Mac will serve as a terminal to the school's larger computers.

Although BASIC was developed at Dartmouth, Arms says that the comparatively crude versions of the language currently available are an embarrassment to the school. BASIC's original authors, John Kemeny and Tom Kurtz, have promised that a modern version will be available for the Macintosh by fall.

The high-speed communications network already in place at Dartmouth will be extended to all student dormitory rooms by September. Outlets in dorm rooms will link students' Macintoshes to each other, to computers in departments and administrative offices, and to the mainframes in the Kiewit Computation Center.

"The key to all of this is the faculty," says Arms. Many faculty members are already involved in software development, funded by a grant from the Sloan Foundation. When the Dean of Arts and Sciences surveyed the Dartmouth faculty, he found that a third had plans to use the computers in their courses within a year. The interested faculty were evenly distributed among the humanities, sciences, and social sciences divisions.

Many of the initial proposals for software development are based on materials already available on the timesharing system. Conversion projects in mathematics, writing, philosophy, art, social science, literature, psychology, music, and physical sciences are well under way. Every faculty member who

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expects to do curriculum work will have a Macintosh or a Lisa, some of which have been donated by Apple. Software developed at Dartmouth will be shared with other universities through the Apple University Consortium and the Sloan Foundation.

"We have a very simple ambition," Arms says, "and that is to be an outstandingly good liberal arts university. I would hate to see computing seen as something special, rather than simply as a good tool."

REED COLLEGE
Portland, Oregon

Reed is the smallest member of Apple's University Consortium. A college with a reputation for rigid academic standards, it may serve as a proving ground for the impact of large numbers of microcomputers on a student population.

Reed will provide Macintoshes to the academic community without cost to students. This is to be accomplished through donations from friends of the college and corporations. No one, however, will be required to use the computer. Richard Crandall, chairman of the Technical Resource Committee, says, "If a student finds a personal computer conducive to thinking, then it is welcome. If the personal computer is forced, it may not be welcome. If a liberal arts education is going to mean anything, it has to be supported with access, but not requirement."

In August of 1983, Reed published a five-year master plan for computing resources, covering the microcomputers, new mainframe and mid-sized computers, development of the Computer Center, and establishment of an Information Resource Center. The Information Resource Center will be a central location for printing facilities and graphics terminals. It will also be a place where people can meet to discuss their computer problems and techniques. "This should reduce some of the isolation that might be caused by many independent terminals," says Crandall.

The first Macintoshes that arrive at Reed will go to the Information Resource Center. After that, faculty members will get computers, then department and division support staff. Library workstations are the next priority, and individual allocations for students are last on the list.

Reed plans an icon-oriented network, which will link all the campus computers, from the mainframe to the integrated system level, to the Macintoshes. According to Crandall, "The Macintosh is ideal for this kind of network, because it's possible for an individual to visualize the entire Reed campus, academically and geographically." He adds, "Macintosh has many of the features we would have designed in if we had specified an academic computer."

DALLAS BAPTIST COLLEGE
Dallas, Texas

Dallas Baptist College is a small school, with only 1300 students. Dallas Baptist's microcomputer is small, too: in the fall of 1983 incoming freshmen were required to buy Radio Shack Model 100 portable computers.

The scope of the project at Dallas Baptist is certainly not small, however. The computers are used throughout the curriculum; in any freshman class, at least three assignments per term must make use of the computer.

Word processing is a primary concern at Dallas Baptist, according to Bill Moos, assistant professor of computer science. Students will have the opportunity to write more and will therefore learn to communicate better, he says. The word processor bundled with the Model 100, supplemented with third-party and in-house software, is adequate for students' needs, Moos says.

Computer literacy classes have been required at Dallas Baptist since 1982. Now that students have portable computers, introductory computer literacy is a hands-on course. Everyone learns

(text continued on page 184)

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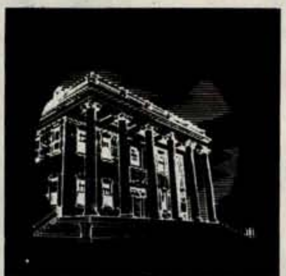
(text continued from page 182)

at least the rudiments of BASIC programming, and the more advanced BASIC course, though not required, is well attended.

The goal of the microcomputer program is to produce students who will have a competitive advantage in business and industry, both because they will be familiar with computers and because they will be more experienced communicators. "We wanted a general support tool so that students can increase their overall productivity," said Moos. "This is not just something more to learn. We feel our students will have a head start in business."



DREW COLLEGE OF LIBERAL ARTS
Madison, New Jersey

The head of Drew's computer initiative, Richard Detweiler, is a psychology professor. Why a psychologist? "We are not doing something for computer scientists, or even for people who are interested in computers," Detweiler says. "We are doing something which is important for people in today's world."

Detweiler sees two purposes for introducing the computer: to enhance education in the short term and to prepare students for the computer-driven world they will face when they graduate. "If students are to function successfully and make a contribution to the society in which they live, the ability to use the microcomputer or computers in general as tools, as problem solvers in an everyday way, is absolutely crucial. The only way to accomplish that is through a personal ownership kind of approach."

Drew will issue an Epson QX-10 with a 16-bit 8088 coprocessor to each freshman matriculating this fall. Rather than charge students directly for the equipment, however, Drew will allocate funds from tuition to the project over the next several years. Students will take the machines with them when they graduate.

Any faculty member who wants a computer can have one, and much of the administrative staff will be using the Epson. Current students can buy an Epson at a Drew-supported discount or use the computers that will be scattered across campus in public clusters.

Drew settled on the Epson QX-10 after considering many other machines, including the Macintosh. "We decided against the Macintosh because of its proprietary operating system and the fact that it would lock us in to Macintosh and Macintosh descendants. We did not want to be tied to a specific machine for the future," says Detweiler. He believes that the large body of public-domain software available for MS-DOS and CP/M will be an advantage to students.

By September, when freshmen begin using their computers, software will be in place for introductory courses throughout the academic disciplines. Word processing will be a built-in part of freshman writing courses, so faculty can demand refinements and rewriting wherever necessary. Detweiler believes that students can absorb the routine parts of learning, such as names and dates in history or vocabulary in foreign languages, through computer drills outside of class, freeing class time for higher-level learning.

"We are a liberal arts institution," says Detweiler, "and we believe that for people to be liberally educated they need to know how to use the computer as a tool." ■

Drew will issue Epson QX-10s to freshmen matriculating this fall.

The Apple University Consortium

By the end of 1984, twenty-three American universities will have bought 50,000 Macintosh computers for faculty, students, and staff. As members of the Apple University Consortium, these schools will get a big price break on the machines—students will pay about $1000 (plus tax) for a Macintosh at most Consortium schools.

One of the program's goals, according to Steve Jobs, chairman of the board of Apple, is to "help Apple discover new applications for its products." Software will be shared among Consortium members. "There will be a consortial spirit," says Drexel's Brian Hawkins. Consortium members, however, are not bound by contract to license to Apple the software they develop. In fact, some universities are planning to market their proprietary software and are beginning to consider in-house and third-party development schemes.

Most schools will have a full compliment of Macintoshes by September. For now, many colleges have enough machines for demonstrations and software development, but not enough to pass out to students. The exception is Drexel University (see page 174), where students received their computers in February and began using them for classwork with the spring term.

Apple's retail dealers in university towns have mixed reactions to the plan. They cannot match the Consortium's discount, and many feel they are losing business to the schools. Some retailers, however, see the program as a way to open previously untapped markets. In Provo, Utah, Brigham Young University has taken steps to protect the local dealers. Each student who buys a Mac signs over to the university the right to buy the computer if the student sells it within five years. "We are a small community, and we must be sensitive to dealers' needs," says BYU's Lynn McClurg.

No doubt a black market in Macintoshes will flourish for a time in many university towns. Already, ads are showing up in local papers, offering students a quick profit on the machines. Some will regret selling the computer, though. No school will sell more than one to a student, and, according to Hawkins, "A student who sells his or her Macintosh is committing academic suicide."

Apple University Consortium members are Boston College, Brigham Young, Brown, Carnegie-Mellon, City University of New York, Columbia, Cornell, Dartmouth, Drexel, Harvard, Northwestern, Princeton, Reed, Rice, Stanford, University of Chicago, University of Michigan, University of Notre Dame, University of Pennsylvania, University of Rochester, University of Utah, University of Washington, and Yale.

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Dick is a programmer. Dick is bored. Harried. Dick struggles with trace chores. Debugging routines. Nonexistent documentation. Hidden bugs. So Dick is four months behind schedule. And customers are upset when bugs slip through. They yell and make Dick upset. They make Dick's boss upset. Nobody is very happy.

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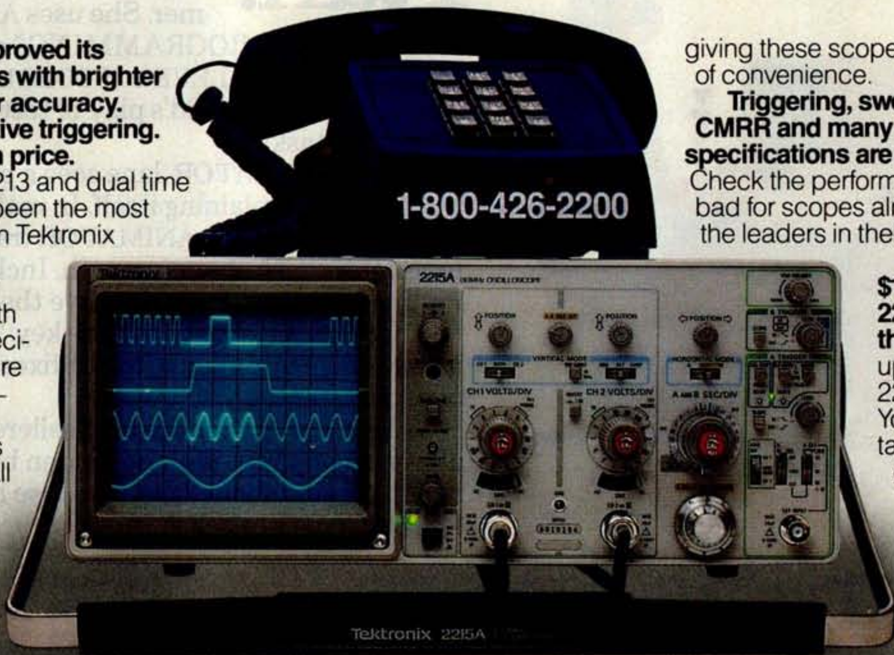

Now Tek has improved its 2213/2215 scopes with brighter displays. Greater accuracy. And more sensitive triggering. At no increase in price.

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A brighter display and new vertical amplifier design provides sharp, crisp traces. That makes the 2213A/2215A a prime candidate for tasks like TV trouble-shooting and testing, where fast sweeps are typical.

New features include 10 MHz bandwidth limit switch, separate A/B dual intensity controls (2215A only), and power-on light: additions customers have suggested for giving these scopes the final measure of convenience.

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CRT brightness	14 kv accel. potential	10 kv accel. potential
Vertical accuracy	3%, 0° to 50°C	3%, +20° to 30°C
Chop rate	500 kHz	250 kHz
Input capacitance	20 pF	30 pF
CMRR	10 to 1 at 25 MHz	10 to 1 at 10 MHz
Channel isolation	100:1 at 25 MHz	Not specified
A Trigger sensitivity (int)	0.3 div at 5 MHz	0.4 div at 2 MHz
TV triggering	1.0 div compos. sync	2.0 div compos. sync
Sweep accuracy (in 10X)	4%, 15° to 35°C	5%, 20° to 30°C
Delay jitter	20,000 to 1 (2215A) 10,000 to 1 (2213A)	10,000 to 1 (2215) 5,000 to 1 (2213)
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PROGRAMMING BY REHEARSAL

BY WILLIAM FINZER AND LAURA GOULD

An environment for developing educational software

PROGRAMMING BY REHEARSAL is a visual programming environment that nonprogrammers can use to create educational software. It combines many of the qualities of computer-based design environments with the full power of a programming language. The emphasis in this graphical environment is on programming visually; only things that can be seen can be manipulated. The design and programming process consists of moving "performers" around on "stages" and teaching them how to interact by sending "cues" to one another. The system relies almost completely on interactive graphics and allows designers to react immediately to their emerging products by showing them, at all stages of development, exactly what their potential users will see.

The process is quick, easy, and enjoyable; a simple program may be constructed in less than half an hour. The beginning set of 18 primitive performers, each of which responds to about 70 cues, can be extended as the designers create new composite performers and teach them new cues.

We were motivated to undertake this project by our desire to give programming power to those who understand how people learn; we wanted to eliminate the need for programmers in the design of educational software. Programming by Rehearsal is implemented in the Smalltalk-80 programming environment and runs on a large, fast, personal machine: the Xerox 1132 Scientific Information Processor (the Dorado).

COMPUTERS AND INTUITION

In the spring of 1980 our attention was focused on a topic we called Computers and Intuition. It seemed to us that newly available, high-resolution computer images, combined with interactive control over these images, constituted a new medium for the presentation of information and concepts. We were particularly concerned with the implications that this interactive computer graphics medium might have for education.

We were also thinking about how paradoxical it was that the computer was often viewed as an engine for improving cognitive and analytical skills, while it might turn out that because of its superlative dynamic graphics, its main new contribution to education might be in the enhancement of nonanalytical, intuitive thought.

Such ideas were certainly not new. Even 15 years ago, a few farseeing people proposed that computer graphics would have a profound effect on human learning. As Brown and Lewis wrote in 1968, "In the same way that books support man's linear and verbal thinking, machines will support his graphic and intuitive thought processes." (See reference 1.) Similarly, in 1969 Tony Oettinger wrote "Computers are capable of profoundly affecting science by stretching human reason and intuition, much as telescopes or microscopes extend human vision." (See reference 2.) It seemed that now we had both the software and hardware to realize these visions.

From these ruminations grew the design and implementation of a system called TRIP, which attempted to give students an intuitive understanding of algebra word problems through the manipulation of high-resolution pictures. (See reference 3.) TRIP, implemented in the Smalltalk-76 system (see reference 4) on research hardware, a Xerox Alto, took about two months to design and four months to implement. It was structured in the form of a kit so that

(text continued on page 188)

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In the Rehearsal World, only things that can be seen can be manipulated

(text continued from page 187)
teachers could add new time-rate-distance problems fairly easily; it included a diagram checker, an animation package, an expression evaluator, and an extensive help system. Members of the computing profession were impressed that we were able to bring to life such a complex, general, graphical, yet robust and helpful system in such a short time. Educators, however, were usually aghast that so much time and effort were needed to produce a single system and that the result was, in their view, so limited.

After we had pilot-tested TRIP and were thinking about what project to take on next, we realized that our interest had shifted up one level, from the actual design of educational software to the design of a "design environment" for educators. As our colleagues were busy building the Smalltalk-80 environment (see references 5, 6, 7, and 8), we undertook the task of extending and reifying that environment to allow curriculum designers who did not program to implement their own creative ideas.

Designer Control

The work described here is based on the belief that it should be possible to place the control of interactive computer graphics in the hands of creative curriculum designers, those with an understanding of the power of such systems but not necessarily with the ability or willingness to write the complex programs that are necessary to control the systems.

Design and implementation constitute two phases of a feedback loop. In most design situations, in which programming is a separate and specialized skill, the designer must somehow convey embryonic ideas to a programmer, perhaps by sketching on paper or talking. Then the programmer goes away to write a program so that something shows on the screen to which the designer can respond. This process introduces interruption, distortion, and delay of creative design.

In the creation of educational software it is particularly important that the design decisions be made by someone who understands how students learn and what they enjoy rather than by someone whose expertise is in how computers work. Too much of the educational software we see today has a lot of fancy graphics but little real learning content. We hope that if educators have more direct control of the computer, they will create high-quality software.

In the environment we describe here, the designer begins by sketching the description, not in words or on paper, but directly on the computer screen. This sketching is not free-form but is done with the aid of specially provided graphical entities. If the designer's ideas are rather vague, the process of sketching may help to define them; if the ideas are well defined, they can be quickly accepted, rejected, or improved. In either case, nothing is lost in the translation process, as the only intermediary between the designer and the product is a helpful, graphical computer system that gives immediate response. Since there is no waiting, the designer is involved in a collaborative, creative process in which there is minimal investment in the current production; thus a poor production can be rejected quickly and easily, and a good one pursued and improved.

The Rehearsal Metaphor

A large, supportive design environment needs a potent metaphor in which the unfamiliar concepts of programming will have familiar, real-world referents. Our goal was that the metaphor would serve as a guide to the designers without getting in their way.

Smalltalk is an object-oriented language. This means that all the basic elements of programming—strings, numbers, complex data structures, control structures, and procedures themselves—are treated as objects. Objects interact with other objects by sending messages. Logo is an example of a programming language with one object, a Turtle, which can be sent a limited number of messages such as FORWARD 20. Smalltalk has many kinds of objects that respond to a wide variety of messages.

Our immersion in Smalltalk led us to extend the object-message metaphor to a theater metaphor in which the basic components of a production are performers; these performers interact with one another on a stage by sending cues. We call the design environment the Rehearsal World and the process of creating a production Programming by Rehearsal.

Everything in the Rehearsal World is visible; there are no abstractions and only things that can be seen can be manipulated. Almost all of the designer's interactions with the Rehearsal World are through the selection (with a mouse) of some performer or of some cue to a performer. Assuming that a designer has the germ of an idea, the creation of a Rehearsal World production involves:

- Auditioning the available performers by selecting their cues and observing their responses to determine which are appropriate for the planned production. If a production involves getting the student to write stories using pictures, the designer might choose a text performer and a picture performer because the former responds to the cues *setText:* and *readFromKeyboard* and the latter responds to *growBy:* and *followTheMouse*.
- Copying the chosen performers and placing them on a stage.
- Blocking the production by resizing and moving the performers until they are the desired size and in the desired place.
- Rehearsing the production by showing each performer what actions it should take in response either to student (user) input or to cues sent by other performers.
- Storing the production away for later retrieval.

A Scenario

Static words and pictures on paper are a poor substitute for direct experience with a dynamic, interactive, computer design environment. Nevertheless, we shall try to give the flavor of what it is like to use the Rehearsal World through a simple scenario involving two novice designers, Laura and Bill. Suppose that these designers are interested in language curriculum and would like to

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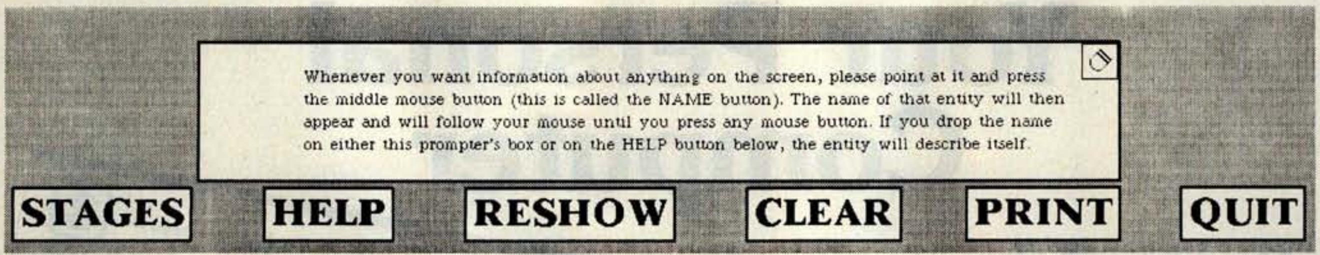

Figure 1: *The control panel and the prompter's box, showing an initial help message. The icon in the corner is an eraser.*

(text continued from page 188)
make some sort of word game. We'll follow their efforts, skimming over many of the details of their interactions with the Rehearsal World, with an eye to understanding some of the design decisions of Programming by Rehearsal itself. Although one person can manage both mouse and keyboard quite well, we'll assume that Laura is in charge of the mouse and Bill is typing on the keyboard. In what follows, the paragraphs describing the action of the designers have been italicized.

Bill and Laura know from their brief introduction to the Rehearsal World that all of the performers are clustered together in troupes waiting to be auditioned for parts in a production. They know also that the Rehearsal World includes a help facility that gives assistance and descriptive information about how to proceed.

Laura starts by selecting the HELP button from the control panel at the bottom of the screen (see figure 1). Selection of the HELP button causes the "prompter's box" to fill immediately with "procedural help" suggesting something that the designers might want to do next. When they select HELP initially, the procedural help message that appears explains that they can always obtain "descriptive help" about anything that they can see on the screen.

The fact that everything that can be seen is capable of self-description is an important component of the Rehearsal World and one that makes it accessible to nonprogrammers.

When they ask for descriptive help about the STAGES button, they learn that if they select the STAGES button, they will get a menu of troupes and productions. Laura selects the STAGES button which presents her with a menu of troupes and productions (see figure 2). She finds a Text performer in the Basic Troupe that she wants to audition to learn what it can do. Laura starts by asking it to describe itself and is told by the help system that if she selects the Text performer, she can edit the text that it displays. This editing is the default action of the Text performer. Laura and Bill spend a minute becoming familiar with the simple editor that the Text performer provides.

The Rehearsal World uses a three-button mouse for pointing at things on the screen. The SELECT mouse button causes a performer to execute its default action. The NAME button always causes the name of the entity to appear at the cursor point; if this name is dropped in the prompter's box, a description of the entity appears. Finally, the MENU button raises a pop-up menu for the performer, enabling the designer to send cues to it. In interacting with a finished production, only the SELECT button is used; that is, the NAME and MENU buttons are not needed by the student user.

Laura uses the MENU mouse button to see the category menu for the Text performer (see figure 3). Certain commonly used cues are at the top of this menu in lowercase, while others are grouped under categories in uppercase. Most of the cues and categories are shared by all performers. Only the

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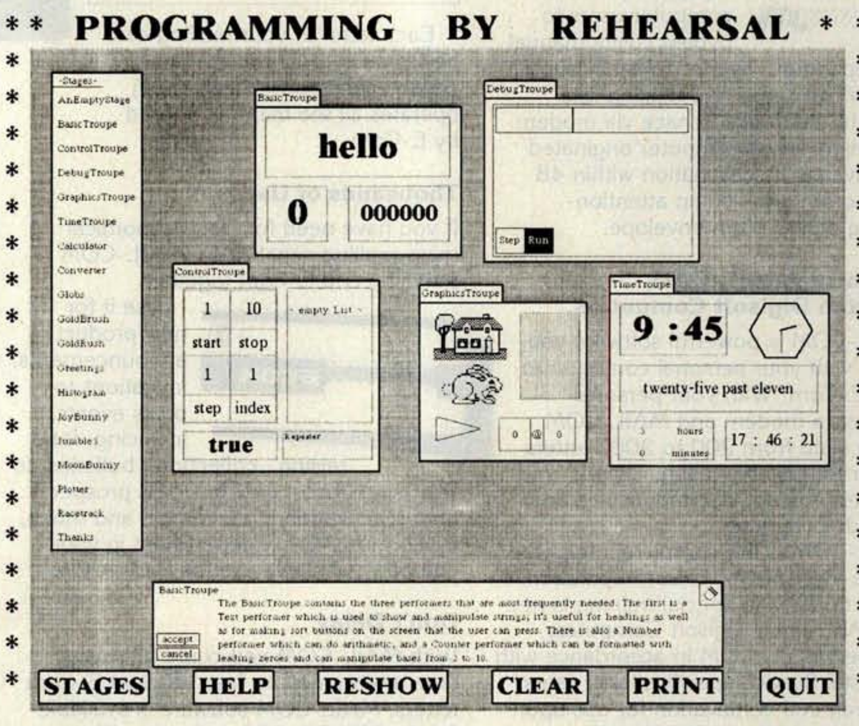


Figure 2: *The entire Rehearsal World theater, showing the* STAGES *menu at the left, all the available Troupes, and a descriptive help message about the BasicTroupe.*

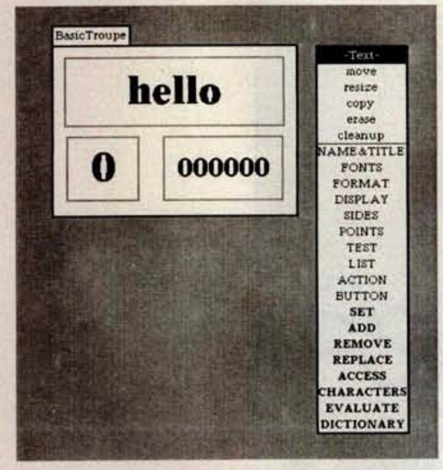


Figure 3: *A BasicTroupe, containing a Text, a Number and a Counter, and a category menu for the Text performer.*

(*text continued from page 190*)

categories at the bottom of the menu (in bold) are particular to the Text performer.

In its current prototype form, the Rehearsal World contains 18 primitive performers, each of which responds to a standard set of 53 cues and an average of 15 cues particular to that performer. To understand what this means, imagine a BASIC with a thousand reserved words. This complexity would be intolerable without a hierarchical organization and a simple way for the designer to browse that organization. The Smalltalk-80 system provides a window, called a Browser (see figure 4), whose visual structure reflects the hierarchical organization of the objects and methods in the system. In the Rehearsal World, functionality is organized around performers grouped together into troupes; the cues that each performer understands are grouped into categories. The result is that designers never have to scan too much information at a time, and, because each level in the hierarchy has a different screen appearance, they never lose track of where they are in that hierarchy.

Our novice designers proceed to rehearse the Text performer by sending it various cues. Laura tries move and resize and gets a pleasant surprise when the fonts change so that the text always fits within the performer's borders. She selects the SET category and gets a cue sheet showing the list of cues that have to do with setting text (see figure 5). Some cues, like setText:, take parameters that are indicated by parameter lines next to the cue. They use the help system to discover that they can type any string as a parameter to the setText: cue. Bill types 'goodbye' on the parameter line. When Laura selects the cue, "goodbye" appears in the Text performer.

They discover through rehearsal that the setJumbled cue produces a random permutation of the characters in the text. They enjoy looking at the different bizarre configurations that jumbling a word can produce and decide to explore no more, but to make a jumble game as their first design exercise. As often happens, interaction with the design environment itself leads to a creative idea.

One would not expect jumbling of text to be a basic capability of a programming language. A programmer who encountered a need for such a function would expect to write a simple routine. In a design environment, however, we expect to find a great deal of high-level functionality, chosen with care by the implementors of the environment, so that the designer's attention is not diverted from the design task itself.

Laura and Bill's initial idea for their simple production is to use two Text performers, one to be placed above the other on the stage. The top Text is to contain the word to be jumbled and the bottom one is to act as a soft button (a button on the screen which, when the student selects it with the mouse, causes something to occur). In this case its action will be to cause the jumbling of the top Text (see figure 6). Laura uses the copy cue to put a Text performer on an empty stage.

Any existing performer can be copied. Thus each performer acts as a prototype from which other performers can be generated; each new copy will have exactly the same characteristics as its prototype.

Laura and Bill use the resize cue to make the Text performer fill most of the top half of the stage, and then they copy it to make a second Text performer (exactly the same size as the first) in the bottom half of the stage. Bill types the word JUMBLE into it, as this is what they want the user to see. With the blocking thus completed, they decide to give each of their performers a mnemonic name that describes its purpose; they call the performers ***JumbledWord*** *and* ***JumbleButton****. Now they are ready to define the action of the bottom Text, which they want to act as a button.*

Any performer can become a button. By turning a performer into a button,

(*text continued on page 194*)

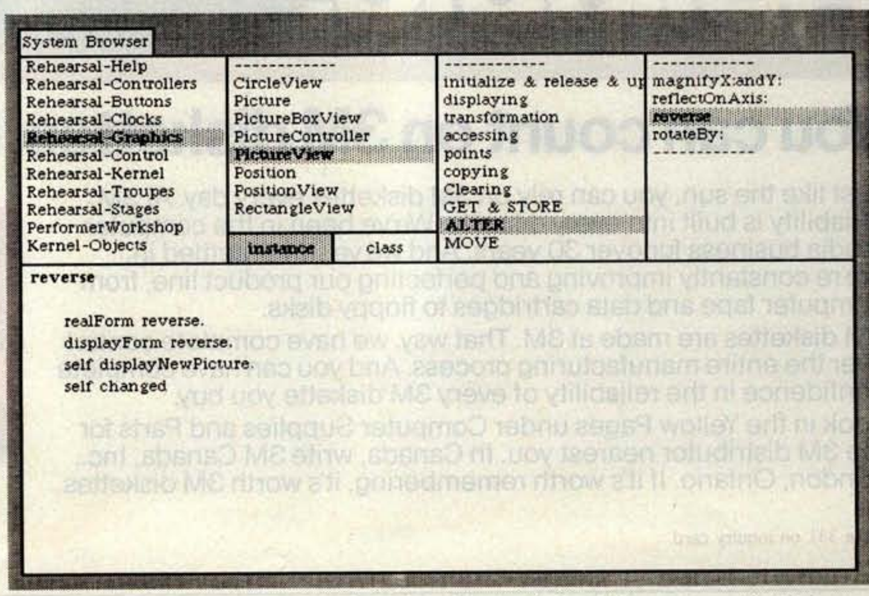


Figure 4: *A Smalltalk browser showing the* **Rehearsal-Graphics** *category, the* **PictureView** *class, its* **ALTER** *category, the message named* **reverse** *from that category, and the method associated with that message.*

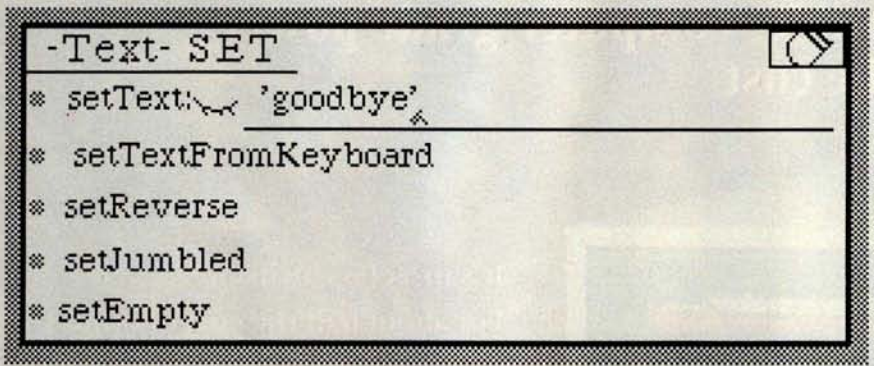


Figure 5: *A cue sheet for the* **SET** *category of a Text performer. The string 'goodbye' has been typed on the parameter line of its first cue.*

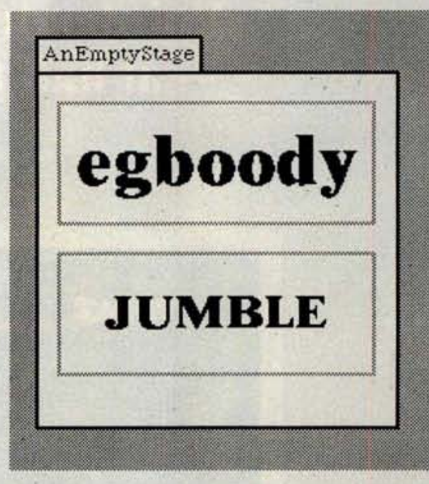


Figure 6: *A stage containing two Text performers, the top one showing a jumbled word and the bottom one acting as a button which the user can select to cause the jumbling to occur.*

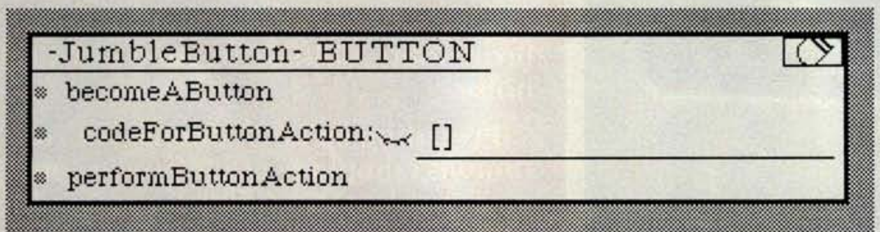


Figure 7: *The cue sheet for the* **BUTTON** *category of the performer named* **JumbleButton**. *The square brackets on the parameter line indicate that the designer should write some code between them.*

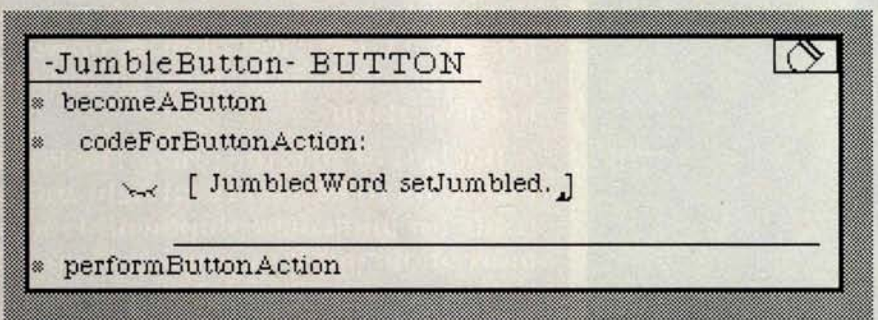


Figure 8: *The code, written by watching, which indicates what the* **JumbleButton** *should do whenever it is selected by the user.*

(text continued from page 192)

the designers get to decide what will happen when the user selects that performer. One of the categories on every category menu is BUTTON; its cue sheet contains the cue *becomeAButton (see figure 7).*

After Laura sends the becomeAButton is cue to the ***JumbleButton****, it no longer responds to selection by providing an editor; instead, it simply flashes. It is now a soft button on the screen, but it has no action. They must show it what to do.*

They do this by using the cue codeForButtonAction:|| to which every performer responds. Bill and Laura understand that they are expected to provide a block of code between the square brackets to describe the action that should occur when the user selects the ***JumbleButton****. The action they want is very simple; they just want the* ***JumbledWord*** *to receive the setJumbled cue. Bill knows that he does not have to type the code; instead the Rehearsal World will "watch" while they show it what to do.*

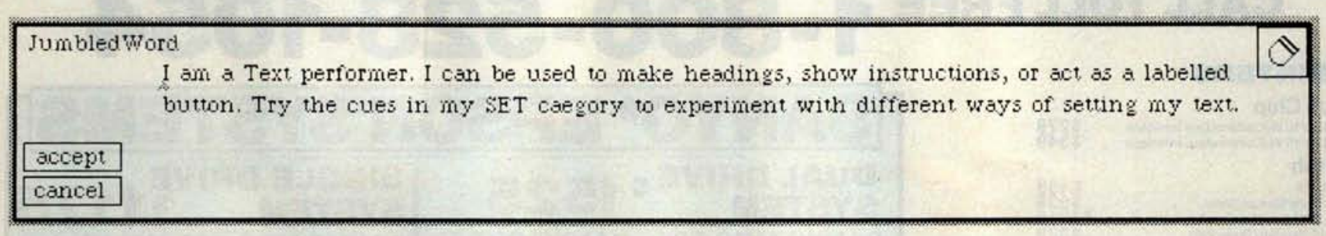
To the left of each parameter line is a tiny icon representing a closed eye. When Laura selects it, the eye opens to indicate that the system is indeed watching. Then Laura sends the setJumbled cue to the ***JumbledWord*** *by selecting it. The code* ***JumbledWord setJumbled*** *appears within the square brackets of the codeForButtonAction:|| cue of the* ***JumbleButton****, and the eye closes again (see figure 8).*

Two significant obstacles to learning a programming language are mastering the language's syntax and learning the vocabulary. In the Rehearsal World, the designers rarely have to know either the syntax or the vocabulary as most writing of code is done by watching. While the eye is open, the designers rehearse a performer and the system makes a record of this rehearsal. The Rehearsal World's ability to watch, in combination with a mouse-driven interface, means that the designers do remarkably little typing. The designers know whether or not the code is correct not so much by reading it but by observing whether the effect produced on the stage is the desired one.

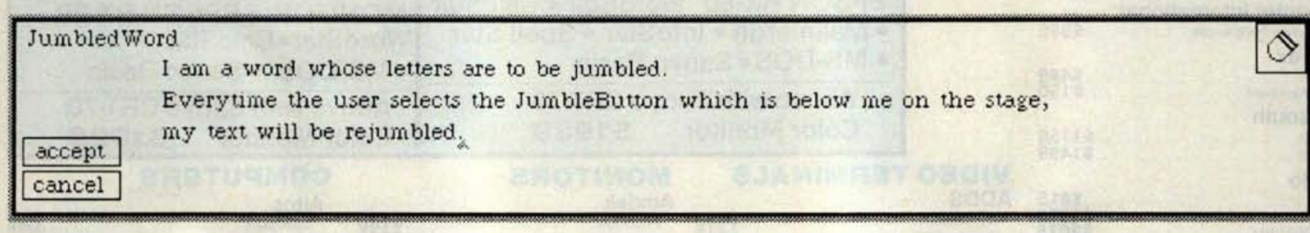
Immediately after Laura sends the codeForButtonAction:|| cue, she can select the newly defined button to see if it behaves as expected. Each time she selects the ***JumbleButton****, it flashes and the* ***JumbledWord*** *jumbles its text.*

In a traditional programming environment, the programmer moves back and forth between programming mode, in

(text continued on page 196)



(9a)



(9b)

Figure 9: *The default comment associated with every Text performer (9a) and the edited comment to be associated only with the performer named* JumbledWord *(9b).*

(text continued from page 194)

which typing code is the dominant activity, and running mode, in which testing takes place. In Programming by Rehearsal, the designer does not feel any shift from one mode to another.

Even though their production is very simple, Laura and Bill decide to document it. They have already given the two Text performers appropriate names: JumbledWord and JumbleButtton. They use the help system to get the default comment for the JumbledWord and edit it to be more specific (see figure 9).

As a designer creates new productions and new performers, the Rehearsal World becomes more complex. The default descriptive help messages can be changed by the designer by simply editing what appears in the prompter's box and selecting the ACCEPT button. This provides a quick and pleasant method for providing descriptive comments for productions, performers, and cues.

It takes our two designers less time to produce their first jumble game than it takes to read about it. Although they have some ideas about how to make the game more interesting and educationally worthwhile, they decide to store what they have implemented so far. It is the stage itself that must be instructed to do the storing. The stage has its own category menu and one of its categories is STORE. They store their efforts under the name Jumble1 (see figure 10).

No fixed set of functions provided in a design environment will ever be satisfactory; the designers will always run up against the limits of that set and wish for more capabilities. The fact that stages understand cues suggests one of the mechanisms for extensibility in the Rehearsal World: every stage can be

(text continued on page 198)

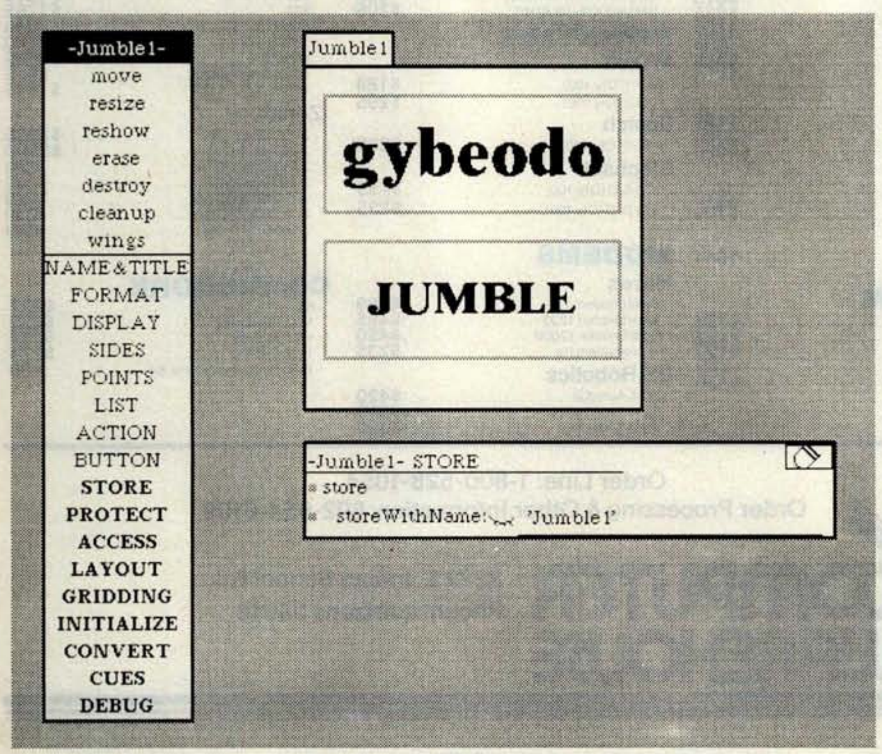


Figure 10: *A stage named* Jumble1*; it's a category menu and cue sheet for its* STORE *category.*

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```
LIST
10  REM #---ACRECO10---
20  REM #---CUSTOMER NAME AND ADDRESS LOAD PROGRAM---
60  DIM B$(15)/DIM C$(20)/DIM D$(20)/A6$(1.8)=''ZZ'
70  J=0/OPEN #0, ''CUSTMST.2''
80  GOSUB 400
90  J=G
100 GOSUB 400
110 N=0
120 !''LAST CUST # ENTERED WAS '' F,'' '', A$ '' '',B$
130 !
140!''TO END PROGRAM ENTER 9999 AT CUST #'
150 J=J$1
160 !''ENTER FOLLOWING''
170 GOSUB 520
180 INPUT ''CUT # '',F
190 IF F=9999 THEN 490
200 IF F =N THEN 220
210 N=F/GOTO 240
220 !''SEQUENCE ERROR-RETYPE''
230 GOTO 160
240 INPUT ''1ST NAME '', A$(1,8)
250 IF A$=A6$ THEN 380
260 INPUT ''LST NAME '', B$(1,15)
270 IF B$(1,2)=A6$(1,2) THEN 380
280 INPUT ''ADRS LIN1 '',C$(1,20)
290 IF C$(1,2)=A6$(1,2) THEN 380
300 INPUT ''ADRS LIN2 '',D$(1,20)
310 IF D$(1,2)^A6$(1,2) THEN 380
320 INPUT ''TEL # '',E$(1,8)
330 IF E$(1,2)=A6$(1,2) THEN 380
340 INPUT ''MO PMT AMT '',G
350 IF G=999 THEN 380
360 GOSUB 420
370 GOTO 150
380 N=N-1
390 GOTO 170
400 READ #0%96#J,A,F,A$,B$,C$,E$,G
410 RETURN
420 WRITE #0%96#J,A,F,A$,B$,C$,D$,E$,G
430 K=0/G=J
440 WRITE #0%96#J,A,F,A$,B$,C$,D$,E$,G NOENDMARK
450 RETURN
460 J=0
470 GOSUB 420
480 GOTO 140
490 REM #---CLOSE ROUTINE---
500 CLOSE #0
510 END
520 C$(1,20)=''                          ''/REM 20 BLANKS
530 D$=C$/A$=C$/B$=C$/E$=C$
540 RETURN
```

Basic

```
ACCOUNTS RECEIVABLE is a file.
    1 Uses       CUSTOMER NUMBER
    2 and        CUSTOMER NAME
    3 and        ADDRESS
    4 and        CITY STATE ZIP
    5 and        TELEPHONE NUMBER
    6 and        MONTHLY PAYMENT AMOUNT

ADD TO CUSTOMER FILE is a verb.
    1   Does     MESSAGE    ''What is the customer number?''
    2   and      INPUT      CUSTOMER NUMBER
    3   and      MESSAGE    ''What is the customer's name?''
    4   and      INPUT      CUSTOMER NAME
    5   and      MESSAGE    ''What is the street address?''
    6   and      INPUT      ADDRESS
    7   and      MESSAGE    ''What is the City State and Zip Code?''
    8   and      INPUT      CITY STATE ZIP
    9   and      MESSAGE    ''What is the customer's phone number?''
    10  and      INPUT      TELEPHONE NUMBER
    11  and      MESSAGE    ''What will the customer pay monthly?''
    12  and      INPUT      MONTHLY PAYMENT AMOUNT
    13  and      SAVE by CUSTOMER NUMBER in file ACCOUNTS RECEIVABLE
    14  and      REPEAT
```

plain english

```
IDENTIFICATION DIVISION.
PROGRAM—ID.
  TEST.
ENVIRONMENT DIVISION.
CONFIGURATION SECTION.
SOURCE—COMPUTER    RMC.
OBJECT—COMPUTER    RMC.
INPUT—OUTPUT SECTION.
FILE—CONTROL.
  SELECT AR—MASTER ASSIGN TO RANDOM ''/u/files/armast''
    ORGANIZATION IS INDEXED
    ACCESS MODE IS DYNAMIC
    RECORD KEY IS CUSTOMER—NUMBER.
DATA DIVISION.
FILE SECTION.
FD AR—MASTER LABEL RECORDS ARE STANDARD.
01  AR—REC.
    05 CUSTOMER—NUMBER                       PIC X(4).
    05 CUSTOMER—NAME                         PIC X(20).
    05 CUSTOMER—ADDRESS                      PIC X(40).
    05 CUSTOMER—CITY—STATE—ZIP               PIC X(40).
    05 CUSTOMER—PHONE                        PIC X(10).
    05 CUSTOMER—PAYMENT—AMOUNT               PIC 9(5).
WORKING—STORAGE SECTION.
PROCEDURE DIVISION.
RESIDENT SECTION 1.
STAR—UP.
  OPEN OUTPUT AR—MASTER.
LOOP.
  DISPLAY ''ENTER CUSTOMER NUMBER OR '' TO EXIT''
  ACCEPT CUSTOMER—NUMBER PROMPT
  IF CUSTOMER—NUMBER = ''  '' GO TO END—OF—JOB.
  DISPLAY ''ENTER CUSTOMER NAME''
  ACCEPT CUSTOMER—NAME PROMPT
  DISPLAY ''ENTER CUSTOMER ADDRESS''
  ACCEPT CUSTOMER—ADDRESS PROMPT
  DISPLAY ''ENTER CUSTOMER CITY STATE ZIP''
  ACCEPT CUSTOMER—CITY—STATE—ZIP PROMPT
  DISPLAY ''ENTER TELEPHONE NUMBER''
  ACCEPT CUSTOMER—PHONE  PROMPT
  DISPLAY ''ENTER CUSTOMER PAYMENT AMOUNT''
  ACCEPT CUSTOMER—PAYMENT—AMOUNT  PROMPT
  WRITE AR—REC INVALID KEY GO TO BAD—ADD.
  DISPLAY ''CUSTOMER RECORD SAVED''
  GO TO LOOP.
BAD—ADD.
  DISPLAY ''INVALID CUSTOMER''
  GO TO LOOP.
END—OF—JOB.
  CLOSE AR—MASTER.
  STOP RUN.
```

Cobol

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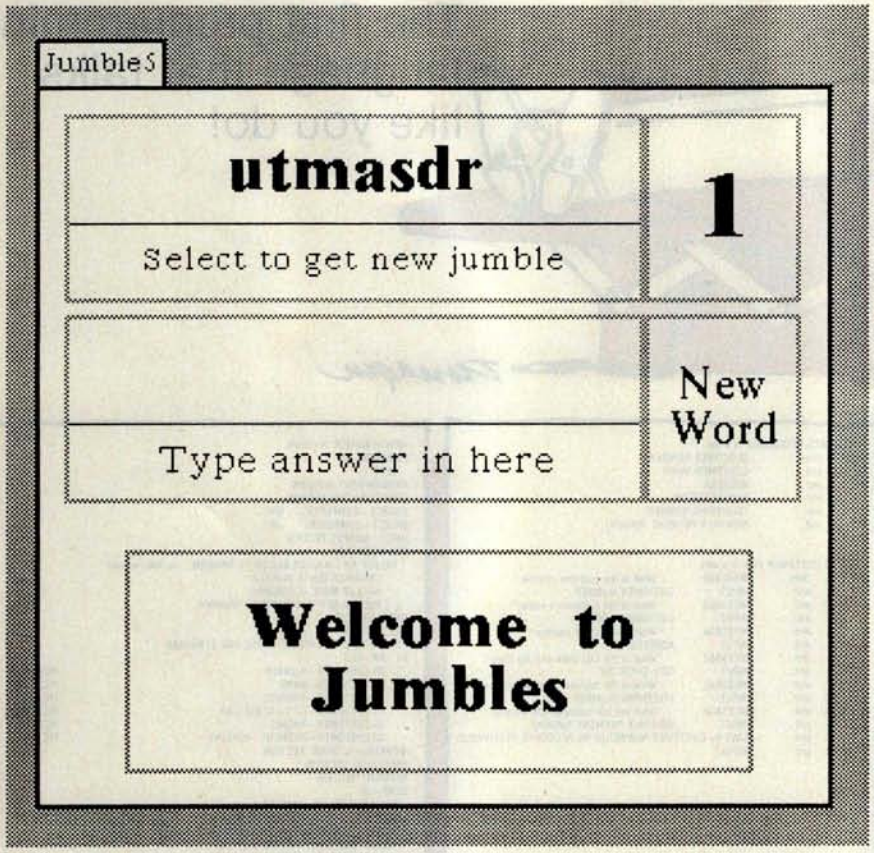


Figure 11: *An improved game named* **Jumble5**, *which evolved from* **Jumble1**.

(text continued from page 196)
converted into a new performer and every stage can be taught new cues. A designer who needs a new kind of performer can construct one by aggregating existing performers on a stage, teaching that stage some appropriate new cues, and converting the result into a new performer.

There are many circumstances in which the designers may wish to aggregate performers: several performers belong together as a logical and spatial unit; a group of performers are to be used repeatedly within a production or in several different productions; a production is very complex, and creating a new performer allows a factorization of the entire problem into smaller ones.

Bill and Laura's jumble game goes through four revisions until it finally becomes the one shown in figure 11. This improved game contains four Text performers and a Number performer. The large Text at the bottom is used simply to give feedback to the student. The Text labeled "New Word" has been turned into a button; its button action is to cause a new secret word to be chosen from a List and presented in jumbled form in the top Text performer. This performer has also been turned into a button; its button action is to rejumble itself. The number of rejumblings is shown by the Number performer next to it. The Text performer in the center of the stage is to be edited by the student who will type the answer there. Every time that Text is changed, it will cause the answer to be checked against the secret word and suitable feedback to be provided. It does this by means of its change action.

When a performer changes in some fundamental way, as when a Number performer changes its value or a Text performer changes its text, it executes its change action. The default change action of a performer is to do nothing, but the designer can define this action for any performer. Certain other performers have additional possible actions: the Repeater performer has a repeat action, the List performer has a selection action, and the Traveler performer has a move action.

In the Jumble5 game, Laura and Bill use a List performer to keep a list of secret words. Since they don't want the user to see the List, they place it in the wings (see figure 12).

While everything should be visible to the designers, not everything should be visible to the user of the production. Wings can hold performers waiting to appear on stage, data structures like the List of secret words, or temporary variables used in computations.

A very simple game grew and prospered as our designers implemented it, changing in response to their new understanding of what they were doing, and to the needs and interests of users and other designers who experimented with it. It became something real that people wish to play with and from which they can get some increased intuitive understanding of the rules underlying English orthography.

Beneath the Rehearsal World — Through the Trapdoor

The Rehearsal World in some ways may be thought of as a visible Smalltalk. Although our original intention was to remove the need for programming at the Smalltalk level, it is paradoxically true that the Rehearsal World provides an excellent entry point for an incipient Smalltalk programmer. Designers may drop through the trapdoor of the Rehearsal World; beneath they will find all the tools of the Smalltalk-80 programming environment. A Rehearsal World tool found there is called the Performer Workshop. It looks like a simplified Smalltalk browser and provides a mid-level mechanism for creating new primitive performers and defining new cues.

For each kind of performer there is a corresponding Smalltalk class that is a subclass of class **Performer**. The inheritance mechanism of Smalltalk allows the subclass to inherit the message interface of class **Performer**. Each production corresponds to a subclass of class **Stage**. When designers store a production, the Rehearsal World defines a new subclass of class **Stage**. Interest-

(text continued on page 200)

(text continued from page 198)
ingly, a stage is so much like a performer that class **Stage** is actually a subclass of class **Performer**.

When designers create new performers, the Rehearsal World defines a new subclass of **Performer** and writes the code for the appropriate additional methods that the class will need for layout and for cues. Because the code written by the Rehearsal World is indistinguishable from code written by a programmer, one can inspect it and modify it in either a Performer Workshop or a Smalltalk browser (see figure 4).

There are two important features of Smalltalk that are not present in the Rehearsal World. The first is the ability to create a hierarchy of objects. In Smalltalk, when one constructs a new kind of object—that is, a class—one usually constructs it by defining a subclass of the existing class that is most like the new class. In that way the new class can inherit a great deal of the desired behavior. In the Rehearsal World, there is no concept of class. A designer who wants a new production that is similar to an existing one can modify the existing production and store it under a different name. A major weakness of this method is that modifications made to the first production will not be automatically reflected in the modified one. In contrast, a modification made to a Smalltalk class will be automatically reflected in its subclasses.

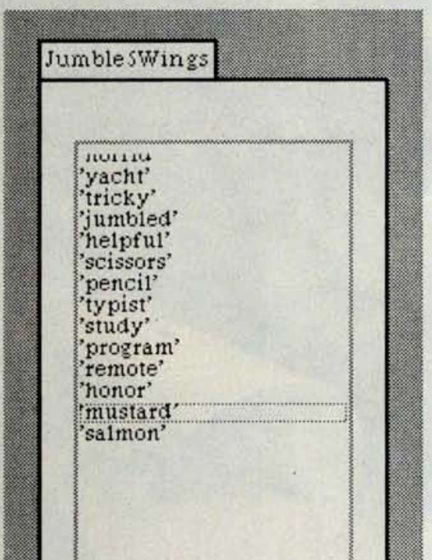


Figure 12: *The wings of the* Jumble5 *game, showing a* List *performer in which the current secret word is selected.*

The second difference between Smalltalk and the Rehearsal World is that in Smalltalk there is a distinction between a class and an instance of that class. The class is the abstraction; an object is always an instance of some class. A class may have any number of instances. Any changes to the class will be immediately reflected in all its instances. In the Rehearsal World, there are no abstractions, thus no classes. Everything is visible. Any performer can serve as a prototype and one gets new performers through copying. What is lost is the ability to have changes made to the original reflected automatically in the copies.

DEBUGGING

Ordinarily, the sooner a program gives evidence that something is wrong, the easier it is for the programmer to diagnose the problem. Designers in the Rehearsal World find that bugs manifest themselves very quickly because nearly all state information is visible and because the flow of control from performer to performer is fairly obvious to the eye. Even so, a situation will occasionally arise in which the designer cannot easily account for some behavior on a stage.

It seems appropriate in Programming by Rehearsal that help should come in the form of another performer, the Debugger performer (see figure 13). A Debugger, when placed on a stage, intercepts all the actions that performers execute, shows their code, and waits for the designer to tell it to go on. While the actions of the production are thus halted, the designers can investigate the cause of a problem using any of the normal Rehearsal World activities such as opening up cue sheets and sending cues. Additional actions that may be initiated are placed in the Debugger's queue for later execution.

ANIMATION AND MULTIPLE PROCESSES

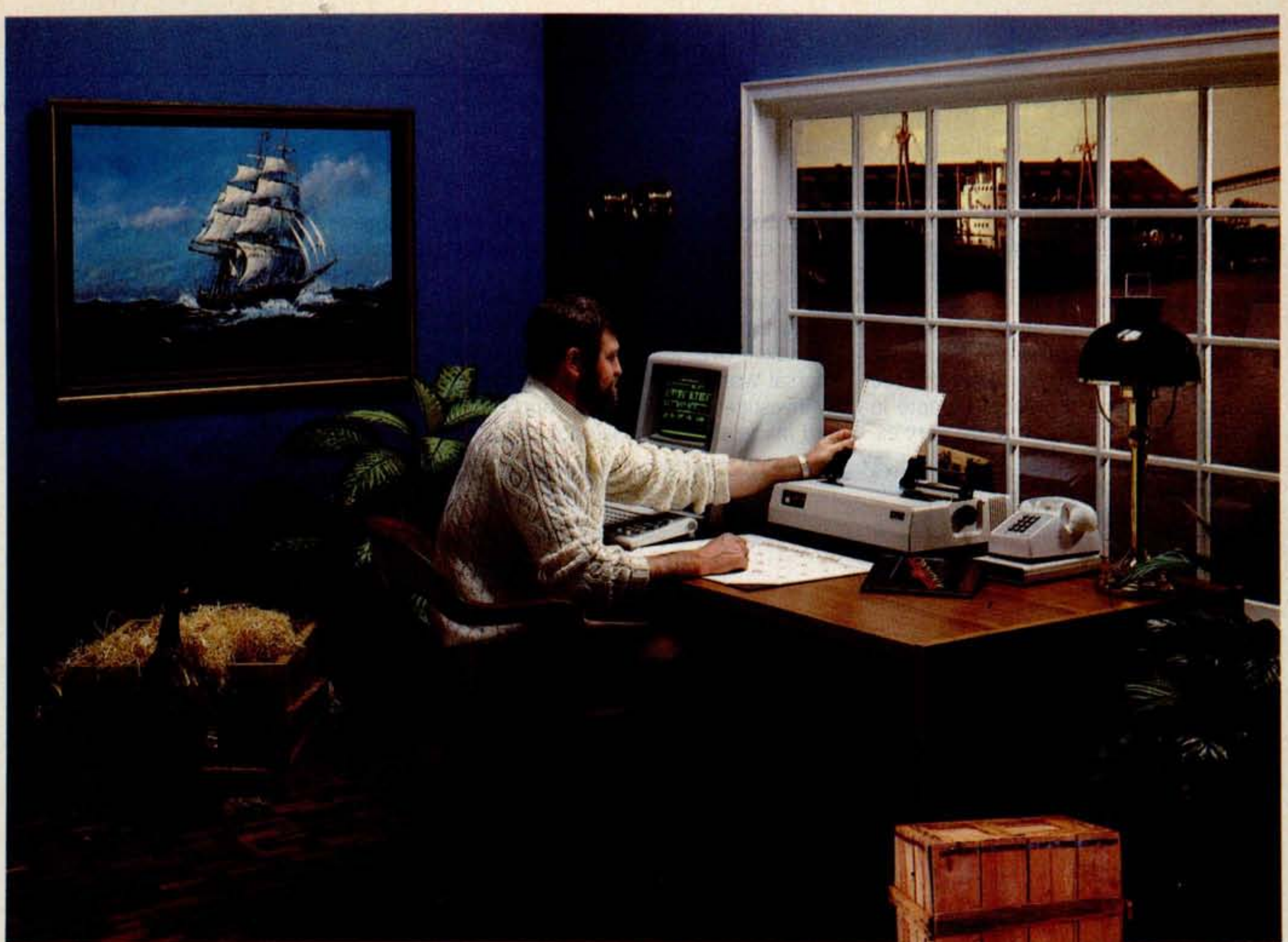
An intuitively pleasing, though incorrect, model for the Rehearsal World would be that each performer goes about its business independently of the others except when it needs another performer to answer a question or do something. Performers would be like people in the real world, capable of independent action but interacting through requests. Animation, you might think, would be easy because each performer would have its own rules for moving around on the screen. In this model, which we call the one-process-per-performer model, each performer would essentially have its own processor for its private use. Trouble comes when performers have to share resources and coordinate that sharing. Several schemes for dealing with these problems have been developed over the years.

Our own solution to the problems introduced by having one process per performer was to allow each user action to initiate a single independent process that either runs to completion or, as with animation, continues in an infinite loop. A single production can, at any given time, have any number of different processes running in it. (Beyond that, there can be several stages on the screen at a time, each running its own processes.) This one-process-per-user-action model has so far proven to be both intuitive and powerful, though we see it as an area where further research is necessary.

DESIGNERS AT WORK

Since the Rehearsal World is a prototype system, very few designers have had a chance to experiment with it. The first one to actually use the system was Joan Ross, a curriculum designer from the University of Michigan. Joan created many interesting productions using the Picture and Turtle performers. She helped us to debug the system and to understand how to improve it on all levels as we prepared for a pilot study.

We spent a month responding to the
(text continued on page 202)



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(*text continued from page* 200)

issues that Joan raised as a result of her experiences and then invited Dan Fendel and Diane Resek, curriculum designers and faculty members of the Mathematics Department at San Francisco State University, to visit for three days to see what they could create in the Rehearsal World. They are very experienced designers, familiar with the power of interactive computer graphics, but they are not programmers.

We gave them a tour of the system and within 45 minutes Dan and Diane had taken over and were using the Rehearsal World themselves. They started by investigating a simple production we had made about probability and soon suggested and implemented some improvements. They found out how it worked by looking at the button actions and change actions of the performers, both on stage and in the wings. By the end of the first afternoon, they had turned it into a game that bore only a slight resemblance to our original exploratory activity. In the process, they had auditioned Texts, Numbers, Lists, and Repeaters to discover their capabilities, dealt some with the blocking of the stage, written a fair amount of code by watching, and understood about button actions, change actions, and repeat actions.

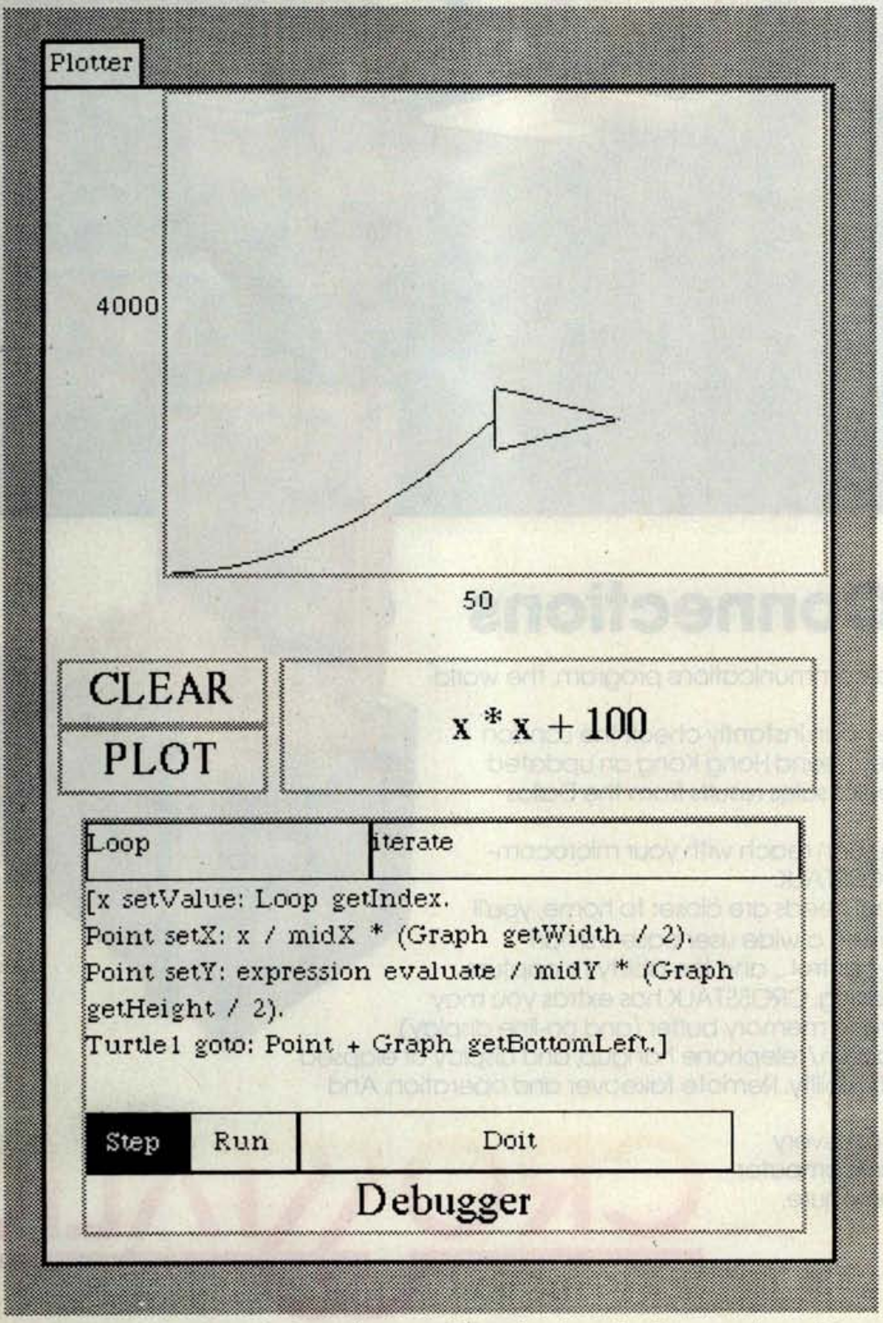


Figure 13: A *stage on which a Debugger performer has been placed temporarily so that the designer may observe the code for each successive action.*

Dan and Diane spent an hour the next morning away from the machine, designing with words and a pencil. In the course of this design session, they refined their embryonic ideas for a fraction game through discussion of both the pedagogical issues and the fantasy through which they should be transmitted. They also considered which Rehearsal World performers they would need in their proposed game. The fantasy involved a cave filled with gold dust. They envisioned the ceiling of the cave as an irregular set of stalactites; they saw the floor as tiled. The student's problem would be to sweep a vertical broom through this cave, one floor tile at a time, trying to collect as much gold dust as possible without ever allowing the broom to touch the ceiling. The broom would stretch or shrink by a certain fractional amount which the student would specify before each move. For example, if the student edited the fraction to read 2/1, the broom would become twice as tall when it moved.

They had other design criteria as well. They wanted the game to configure itself differently every time the START button was selected, and they also wanted to make it easy for a designer to specify an easy cave, with broad floor tiles and very little variation in the ceiling, or a hard one. They wanted to have a score that was expressed as a percentage of the available gold dust; they wanted some sort of disaster to occur if the student made the fraction too large and the broom touched the ceiling. They decided to call their production GoldRush (see figure 14).

We found this description quite overwhelming for an initial project, as we

(*text continued on page* 204)

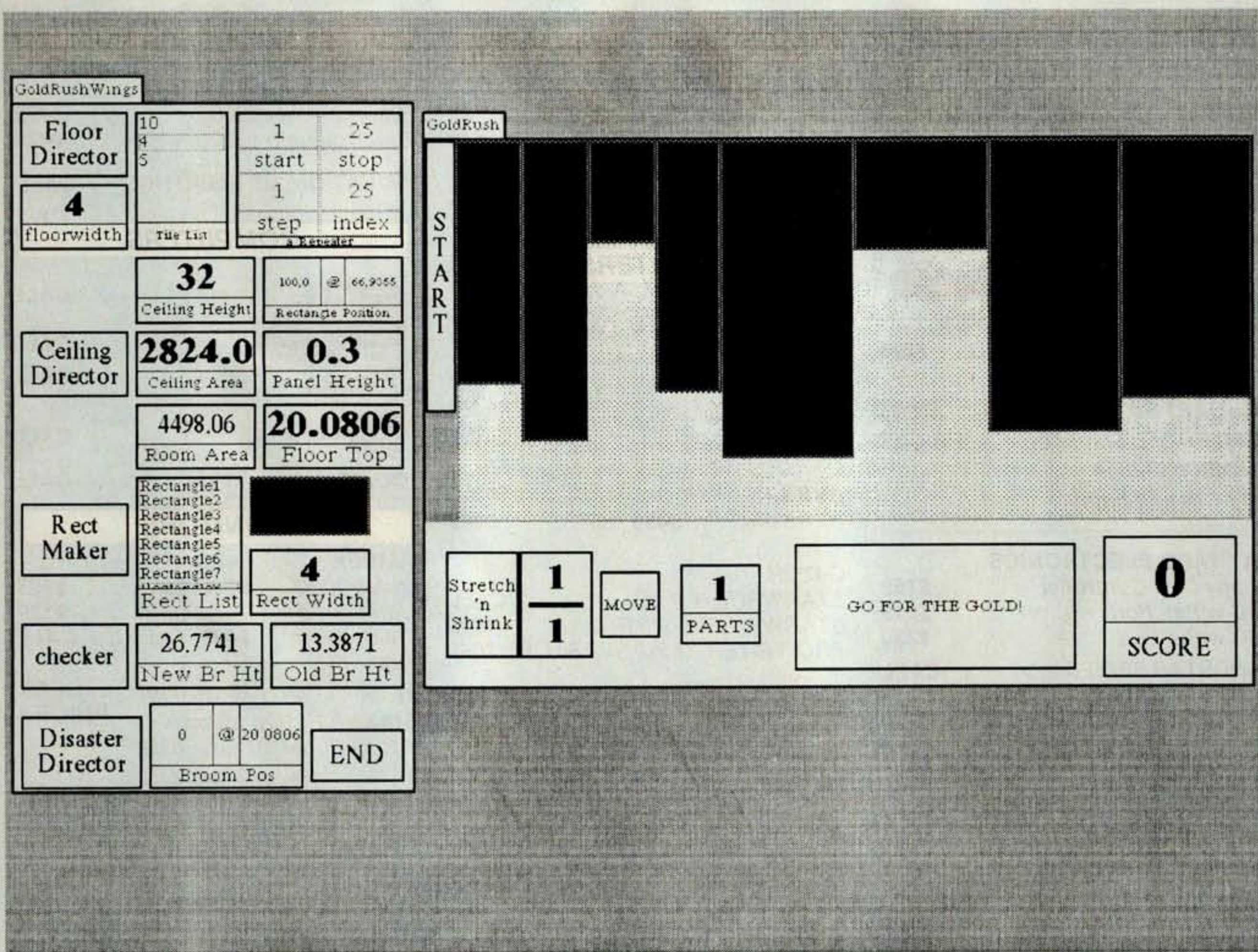


Figure 14: *The GoldRush game and its complicated wings, showing more performers backstage than are on stage.*

(text continued from page 202)
had expected them to embark on something at the level of the Jumble Game described earlier. Rather than starting with a toy example for practice, they were embarking on a real-world task after only one day's experience. We worried that they had chosen something too difficult for them to accomplish in the remaining two days.

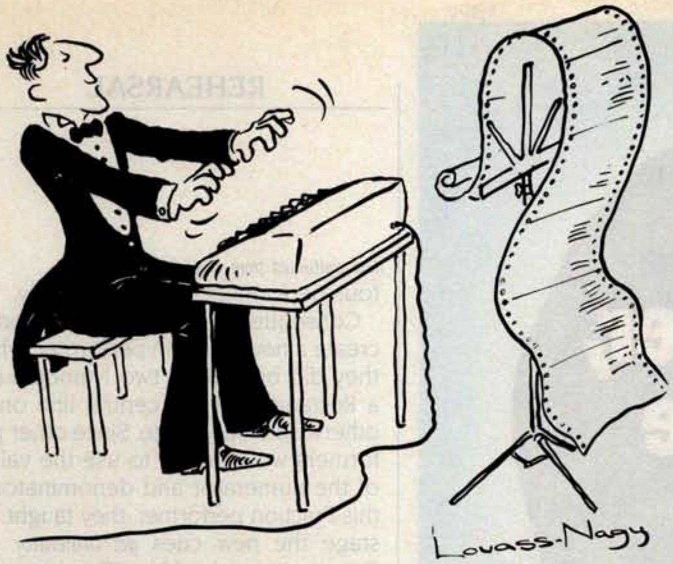
By lunch time they had figured out how to use the Turtle to draw the floor. They said, "We need a Floor Director to be in charge of drawing the floor," and placed a button in the wings labeled FloorDirector for that purpose. They used this same strategy to make a CeilingDirector, a Checker to test whether or not the broom was touching the ceiling, and a DisasterDirector in charge of what should happen when it did. Certain performers had become, if you will, visible procedures. They invented this strategy on their own, led to it by the Rehearsal World's emphasis on buttons.

Next to these directors in the wings, they placed the performers that would be needed by the directors to accomplish their tasks. These performers fulfil the role of variables; since everything in the Rehearsal World must be visible, all variables must be represented by performers. By grouping their performers in a logical manner, they could debug their program easily by selecting a button, like the CeilingDirector, and simply watching what happened, both on stage and in the wings.

Their next task was to implement the broom (for which they used a Rectangle), the START button, and the MOVE button. The action of the START button was simply to cause the FloorDirector and the CeilingDirector to perform their button actions. The action of the MOVE button was first to move the broom and then to ask the Checker to determine whether or not the broom was touching the ceiling. If it was, it asked the DisasterDirector to perform its action; if it wasn't, the Checker computed the score. That they had not yet even designed the disaster didn't matter; they were using top-down programming techniques, realizing that they could return later and replace the empty code block of the DisasterDirector with whatever they wanted.

By the end of the day, the FloorDirector and the CeilingDirector were both working properly and they could move the broom through the cave. They started to plan the randomness that they wanted to build into the button action of the START button.

The next day they made a fraction to be edited by the user, creating it from two Numbers and two Rectangles, one to act as the line between the Numbers, the other to act as a frame. This looked and worked fine, but they soon discovered that it was a great disadvantage to be dealing with four independent performers instead of a single unified one: whenever they decided that their fraction was the wrong size or in the wrong place, they had to resize or move
(text continued on page 206)



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(text continued from page 204)
four performers commensurately.

Consequently they felt the need to create a new Fraction performer, which they did by placing two Numbers and a Rectangle for the central line on an otherwise empty stage. Since other performers would need to use the values of the numerator and denominator of this Fraction performer, they taught this stage the new cues *get*Numerator, *get*-Denominator, and *get*Value. Then they told it to convert itself into a new performer named Fraction and promptly used it in their production.

By the end of the third day, they had a game that worked, that they could respond to, that they liked, and that still needed improvement.

An extra day of work was devoted to adding new features. A Number performer called Parts was added that could be edited by the user; its change action was to show the broom divided into the number of parts indicated. This additional piece of design arose from their interaction with the production; had they been working entirely from a paper sketch, this improvement might not have occurred to them.

They then invited others in our research center to play. Although it had been designed for third-graders, our colleagues found the game interesting and fun to play. They were impressed with the quality of the game and especially with the fact that the designers were nonprogrammers, yet had implemented something so complicated in only a few days.

Eventually we found some children of an appropriate age to be students; they also enjoyed playing the game and spent many hours trying to make a perfect score. Diane now plans to reimplement GoldRush at San Francisco State using the Rehearsal World design as a prototype but changing it to run on different hardware, which might include color and have a different pointing mechanism.

Research Questions

Our experiences with designers have given us confidence that our general ideas about how to make the power of computers accessible to nonprogrammers are correct. We believe that interactive, graphical programs could and

(text continued on page 208)

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(text continued from page 206)
should be built inside an interactive, graphical programming environment. We believe that for such programs, some sort of visual, spatial programming will eventually supplant the current process of writing lines of textual code. Nevertheless, we have many unanswered questions about the nature of visual programming.

An important aspect of the Rehearsal World is that everything is made visible; only things that can be seen can be manipulated. Thus, rather than thinking abstractly, as is necessary in most programming environments, a designer is always thinking concretely, selecting a particular performer, then a particular cue, then observing the cue's instant effect. We know that much of the initial accessibility of the system is due to this concrete, visual, object-oriented approach. What we don't know are its shortcomings.

As designers create increasingly large and sophisticated productions, they may find it a nuisance to have to instantiate everything (even temporary variables) in the form of a performer. There are problems with space on the screen and with visual complexity. Some of these problems are addressed by the ability to collapse a large set of performers into a single new one, which can be made very small while still retaining its original functionality. This helps not only with space but with factoring the production into significant pieces.

While beginning designers benefit from the concreteness, more experienced ones will benefit from being able to think in more general and abstract terms. They are led to think in general terms by the fact that all performers respond to a large set of common cues; they are led to think in abstract terms through the manipulation of Lists and Repeaters. Still, it may be difficult to build productions, for example, that need to access large amounts of data. At some point, the concreteness may become a barrier rather than an advantage.

We know that the "watching" facility is very important to beginners and makes it possible for them to "write" code without learning a language. But it's really very simple and is in no way "programming by example"; it employs

(text continued on page 210)


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(text continued from page 208)
no generalizations but merely makes a textual record of a performer being sent a cue, perhaps with parameters. Again, advanced designers might be led to think abstractly rather than specifically if the Rehearsal World provided a more powerful watching facility that was capable of some form of generalization.

In the Rehearsal World, button action and change action are the major mechanisms for expressing the interactions of all performers; a few performers, like the Repeater, the List, and the Traveler, have other special actions as well. Designers find these actions very natural and so far have had no difficulty describing their needs in these terms. However, the Rehearsal World does not provide designers with the facility to create new types of actions for new performers, and this may become a problem in the future.

The Rehearsal World supports multiple processes in such a natural way that our designers are not surprised by the existence of this facility as they interrupt whatever they're doing to do something else. However, we have little experience with designers using multiple processes in some production and expect a variety of conceptual and mechanical difficulties to arise.

Designers express actions in a procedural fashion, instructing a performer to send a cue under certain conditions. We are curious about how designers would deal with a constraint-based Rehearsal World in which the relationships between performers were expressed in terms of conditions that should always hold true (for example, that the value of a Number should always be twice that of another Number). We hope that researchers working on similar design environments will explore these questions. ■

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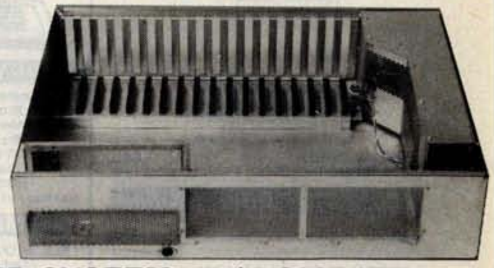

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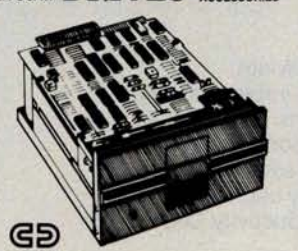

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GAME SETS AND BUILDERS

BY ANN PIESTRUP

Graphics-based learning software

ONLY RECENTLY ARE computer scientists and educators beginning to collaborate to create learning software that can fulfill the promise of the personal computer to transform education. A few educators have begun to think like computer scientists, and some programmers are beginning to understand children's learning needs.

Schools lag far behind business, science, medicine, and law in responding to changes in the culture. Children, for the most part, are getting a token exposure to the power of computing in schools, and only minimal exposure to the computer as a graphic, playful, interactive medium with which to learn concepts and skills.

Early educational software used in computer-aided instruction (CAI) has been primarily text-based. While useful for factual drill and effective at teaching what standardized tests measure, too often there is little in such software to engage the learner's imagination.

Much of the graphics-based "entertaining education" software now distributed for the home is like a slow video game, with a thin veneer of educational content and merely decorative graphics. The purpose of such programs is to teach a limited set of facts, such as math problems or spelling words. Many of these programs require only that a child press a single key, then passively watch while the computer does tricks—the computer has all the fun. Once the child learns the minimal content and exhausts the limited bag of graphic tricks, interest in the program is gone.

In contrast, powerful learning software programs, such as learning game sets and builders, use graphics to convey meaning, not to decorate the screen. They teach *learning strategies* and fundamental, generalized skills upon which others can be built.

POWERFUL LEARNING

Powerful learning is carefully sequenced, with content that offers real value to the child. It is playful, with features of a game and characteristics of literature (themes, characters, elements of surprise), and it has a simple, clear user interface.

In effective learning games, play can begin in a very few minutes. To achieve this, commands for getting in and out of programs and for reaching instructions and the menu should be straightforward and consistent. A simple user interface frees the user from the details of managing the game and allows the child to focus on playing, and therefore learning.

Designers of learning software must be constantly aware of the cognitive "load" the mind can absorb and must present a carefully measured amount of new information with a proportional amount of familiar information.

Powerful learning software can offer several approaches to the same material and thereby encourage the learner to think flexibly. This flexible thinking can carry over outside the context of the game. There are no single correct answers; there are patterns to find and alternatives to consider.

Fascination with concepts can be an intrinsic motivation, leaving the child free to operate at his or her learning edge. The best learning software offers options, such as editors that enable children to create their own games or to create original graphics or text. Games need to have a smooth flow, with no barriers between steps. Children should be able to choose their own pathways through a set of games and to play any game as many times as it poses a challenge.

MOTIVATION

With a whimsical story line, humor, and a warm, nonjudgmental tone, learning games can be endearing and delightful

(text continued on page 216)

Ann Piestrup is chairman and founder of The Learning Company (Suite 170, 545 Middlefield Road, Menlo Park, CA 94025). She holds a Ph.D. in educational psychology from the University of California at Berkeley.

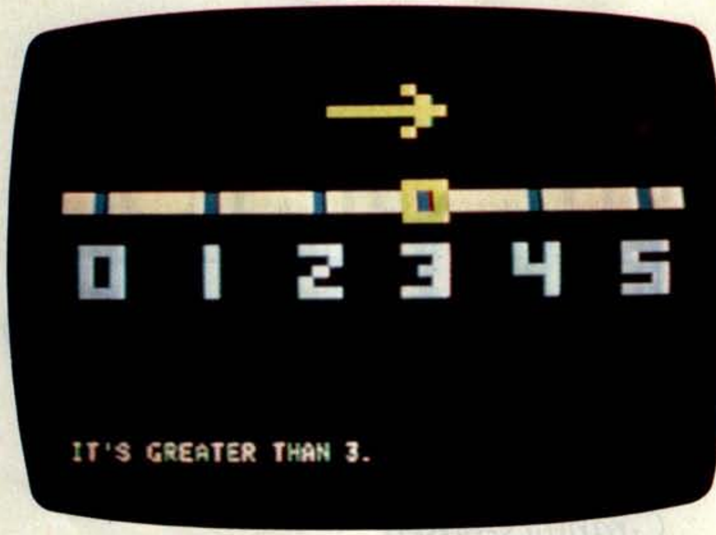

Photo 1a: *The first game in the Bumble set, Find Your Number, presents the concepts of numerals, number lines, and greater than and less than.*

Photo 1b: *Find the Bumble combines these elements in a 4 by 4 array. Columns and rows are highlighted as numbers and letters are plotted. Concepts are represented both in words and symbols.*

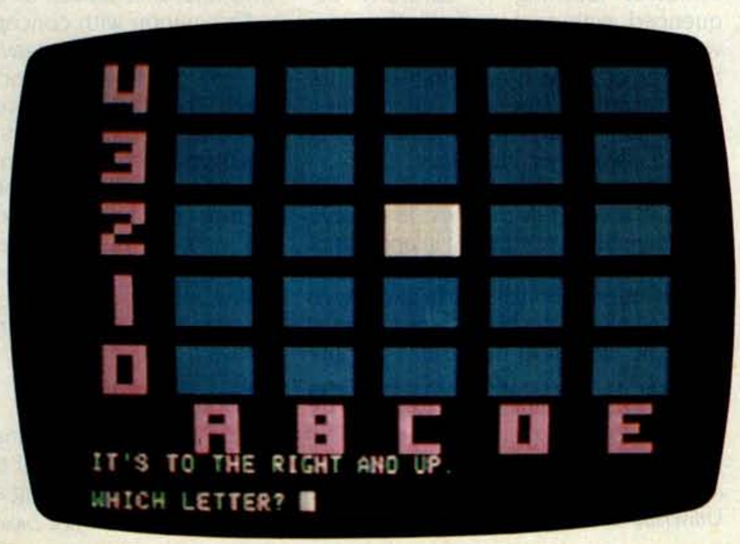

Photo 1c: *Butterfly Hunt offers a larger grid and removes arrow clues, leaving only text explanations. The horizontal axis is plotted first, then the vertical axis.*

(text continued from page 215)

to younger children. A theme character can tie programs together in a fantasy-evoking way. The best games are elegantly simple, so that a small input has a dramatic output.

Exciting games may offer an element of chance, or competition with an opponent or against the clock; there is a sense of risk and the unexpected. Within a game, children can be encouraged to play cooperatively, to seek joint solutions to a problem.

Learning games, like other software, books, and movies, convey values. Designers must be sensitive to the values that schools and parents want to teach. Good learning software interests both sexes and avoids gratuitous violence.

Learning Game Sets

A learning game set is a series of programs structured so that concepts and skills learned in earlier games form a foundation for later games. Learning game sets focus attention narrowly and offer manageable bits of new information, and they guide the learner with prompts throughout the learning experience. While working through the game set, children can learn complex skills and advanced concepts. In addition, they can learn strategies for approaching visual information.

All games in a set should have a unifying theme, which could include a character, story, and cohesive metaphor.

Bumble Games and Bumble Plots from The Learning Company (Menlo Park, California) are examples of learning game sets. These programs present a focused set of information and skills, such as using numerals, number lines, arrays, and grids (photos 1a through 1f). A fantasy character named Bumble from the planet Furrin guides the learning.

In these games, each time a child presses a key, some action is shown on the screen. The child can press another key within three seconds to make something else happen. The player sets the pace of the game and therefore has a sense of control over the medium.

Children playing games in the Bumble set work through fundamental concepts such as counting, greater than and less than, positive and negative numbers, columns and rows. When they can enter *x,y* coordinates fluently in a four-quadrant grid, they catch robbers in

moving cars, name coordinates for a sonar detector, and plot tic-tac-toe positions. Then they can plot their own graphics with a simple editor that is presented like a game.

These games encourage play because there is no way to lose. Children can cooperate or compete in guessing numbers and often transcend the issue of winning or losing by assuring that each child has a turn to play at alternate times when it is obvious that the next entry will win.

Children maintain interest in a program like Bumble Games for many months or even years. The concepts are very basic—how space relates to number. The concepts of row and column lay the foundation for beginning to use spreadsheets and to plot computer graphics. The programs also encourage children to build spatial awareness, to formulate strategies, and to experience success in learning.

Children can transfer skills learned in these games to new situations, such as finding points on a map from grid references. Thus young children can learn the skills that many of us struggled with in junior high school. Kindergarten children who can fluently plot graphics on a computer may present a challenge to the schools, but they show that computer learning games can teach important concepts in a playful, powerful way.

BUILDERS

A builder is a program with real-time, animated graphics, with which a user can put parts together to make something new. Nothing in text could simulate a builder program, with its functional graphics. Its purpose is to encourage learning by doing in an exploratory environment. A builder could teach a specific content, such as electronics, chemistry, biology, or music. Examples are Pinball Construction Set from Electronic Arts and our own Rocky's Boots.

Builders provide a metaphor to the real universe, with a defined and internally consistent geography, elements (often icons) such as building parts and connectors, and rules. For example, in Pinball Construction Set, the player uses icons to create a simulated pinball machine. The machine is a game board with movable bumpers and flippers.

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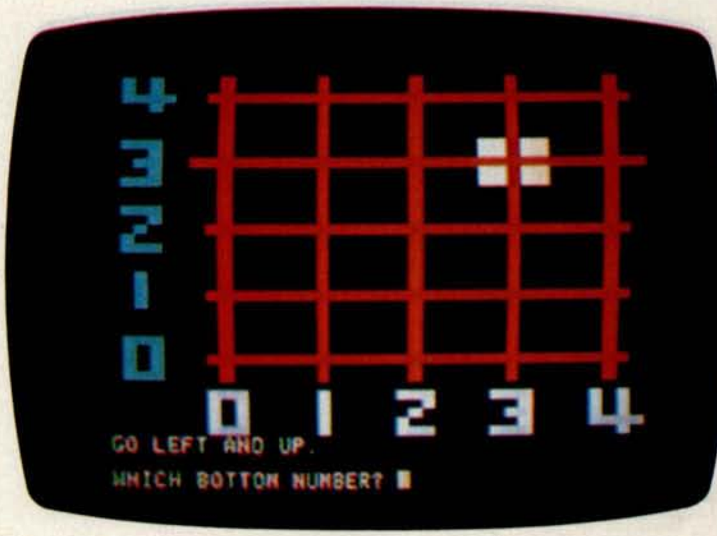

Photo 1d: *Visit from Space substitutes a grid for the array. For the first time in the set, numbers label both axes.*

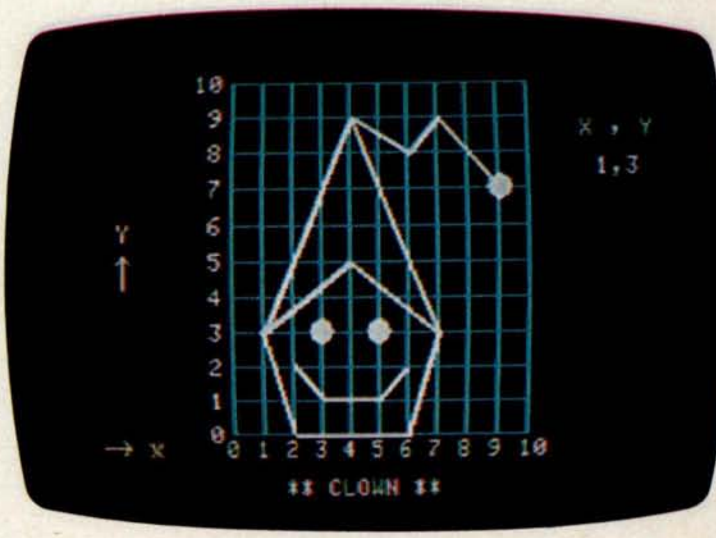

Photo 1e: *In Tic Tac Toc, children must enter numbers in x,y format. Columns and rows are no longer highlighted as points are plotted. Children must plot many coordinates on the same grid, using a game strategy.*

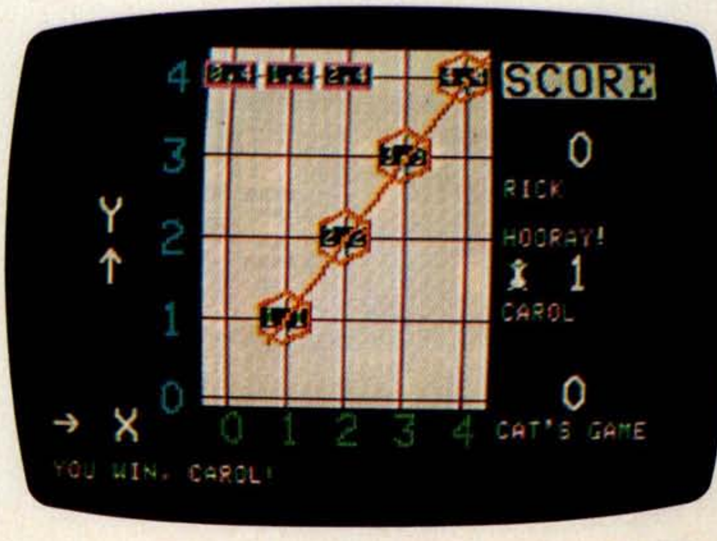

Photo 1f: *In Bumble Dots, children use standard pair notation to plot original graphics on a 10 by 10 grid. These graphics become the basis of a game.*

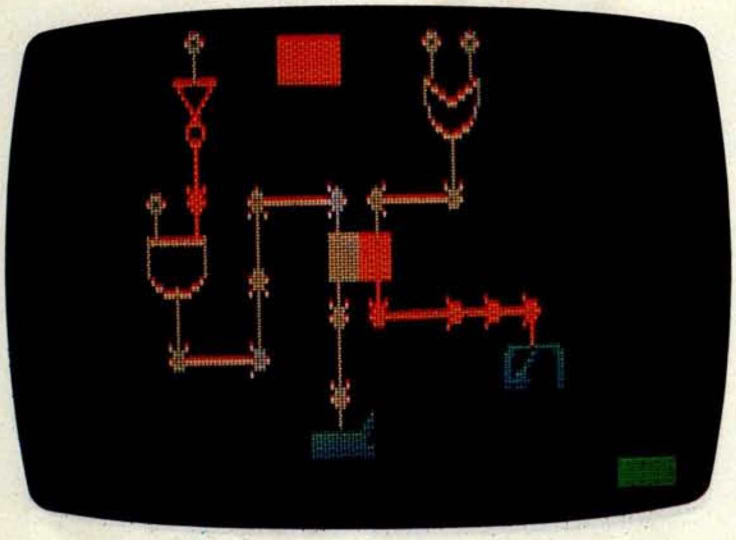

Photo 2a: *Players using Rocky's Boots can design machines using* AND, OR, *and* NOT *gates.*

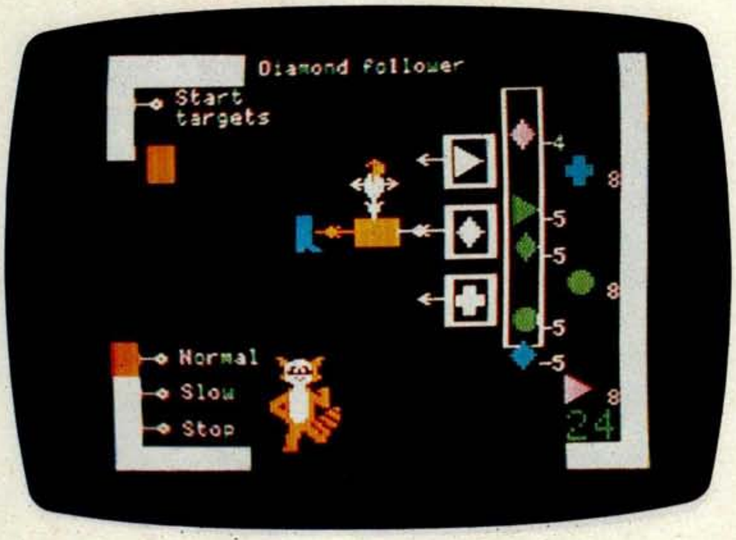

Photo 2b: *In the game room in Rocky's Boots, players build logical kicking machines to solve problems.*

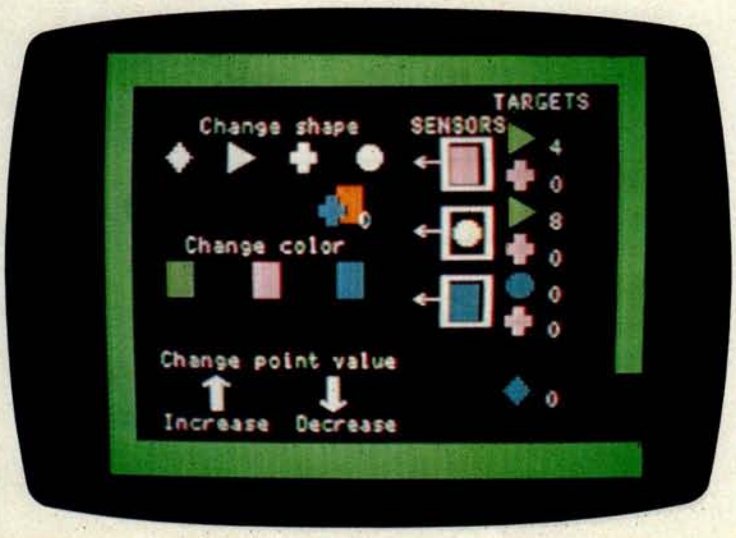

Photo 2c: *Rocky's Boots has a graphics editor that players use to create new games.*

(text continued from page 217)
which can act according to the rules of real pinball machines or according to rules modified by the player.

The internal geography of Rocky's Boots is represented as a set of rooms with doors and walls (photos 2a through 2c). The player uses elements such as wires, logic gates, and sensors to build simulated electronic devices according to the internal rules of Rocky's world and the broader rules of combinatorial and sequential logic.

Within the parameters set by a builder, players can recombine elements according to structuring rules. They can create games, generate novel solutions to puzzles, edit and rework their creations, and in doing so explore fully the properties of the elements and rules. The program designer creates tools that are open to the player's exploration. At the same time, the limits of the program's universe (of the physical space, its elements, and rules) help structure learning. This permits both freedom and focus within the same environment.

The exploratory character of a builder encourages invention and divergent thinking. An ordinary computer-aided instruction program, in contrast, requires single, predetermined correct answers from a passive user. The builder says, "Use your mind. Here are some examples—now go make your own." A child experiencing a builder environment can develop persistence, self-confidence, a sense of mastery, and the ability to make choices.

Successful builder programs must not be punitive or judgmental, as some CAI programs are. Rather than operating in a binary, right-wrong mode, they present an environment in which any action has a natural consequence. A badly planned or clumsy action will produce unsatisfying results—an inelegantly designed machine doesn't do much—but it is up to the player to judge the outcome. The player can redesign the machine, seek new solutions, and improve upon the design until he or she is satisfied. Thus, the learner deals not only with information but with knowledge and insight.

The player can gain insight by trying many approaches to the same problem. The program designer presents an abstract concept in a builder whose

elements make the concepts concrete. The player gains direct experience with the concepts, has time to think, to formulate and test hypotheses, approaching the building environment from many angles. The parameters of the builder focus attention on a small set of realities and allow the player to manipulate concrete objects in order to achieve a "felt" awareness of broader concepts. These new concepts are not empty words or mere labels but the beginnings of insight.

For example, the designer of Rocky's Boots wanted to convey logical concepts inherent in AND, OR, and NOT gates. He represented these as Tinkertoy-like parts with symbols used by electrical engineers. He added color and animation to model electric current flow. The player begins by working through structured tutorials, then combines and recombines elements, directly experiencing the abstract concepts of AND, OR, and NOT. After completing a series of puzzles, the player can create original games. Some people apply what they have learned in the context of the game to new situations in real life. These players have gained insight into very important concepts in electronics and logic.

Builders are simulations that can defy the laws of the physical universe. By suspending disbelief, the player can enter a special reality, then stand outside it to gain insight into the modeling process itself. For example, in Rocky's Boots, the presence of electric current in a wire or gate is represented in red, absence of current in white. Players use this color coding to understand the current flow in complex circuits, then some make the conceptual leap: this is a model, and like any model, it has limitations and is not a complete representation of reality. Children who can make this connection have learned an important principle in science: we are bound by our models.

A New Generation of Learning Software

Learning game sets and builders are new genres of educational software. Children using these programs explore powerful visual environments. Through their play with these tools, children can acquire not only skills and knowledge, but insights at a new level. ■

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CAUTIONS ON COMPUTERS IN EDUCATION

BY STEPHAN L. CHOROVER

Effects on the student-teacher relationship

"TO PROPHESY IS extremely difficult," says an old Chinese proverb, "especially with respect to the future." Nevertheless, the proliferation of personal computers in the educational environment seems certain to have a profound and far-reaching effect upon teachers, students, and the educational enterprise as a whole.

As a student of "psychotechnology," I am interested in the material and conceptual impact of sociotechnological change upon both the thought process and behavior of individuals, and the organization and development of human groups. What is the relationship between computer-based systems and the human social systems within which they develop or into which they are introduced? As an educator and psychologist, I am interested mainly in the human side of this question, as we make the transition to computer-based systems of instruction.

Only experience and time will tell whether or not the computerization of education will actually revolutionize the ways in which we teach and learn, but it will undoubtedly have many more or less profound effects upon how students and teachers relate to one another.

Among the questions that I would like to see addressed are these: How will the evolution of computer systems affect the fundamental form and content of the educational enterprise? What effects will it have on the personal and professional lives of students and teachers? How will it affect relations between, and patterns of interactions among, individuals and groups?

Carnegie-Mellon University is developing an integrated computer network. CMU President Richard Cyert wrote in *Science* (November 11, 1982) that: "An environment that is densely populated with computers represents a new type of world. We need to know the impact of such an environment on social interactions. We also must study the effects of decisions made by the process of communicating over a network, as opposed to face-to-face meetings. There are, in fact, a large number of issues that require study at the inception of the radical change we are making."

At Carnegie-Mellon, he reports, the task of studying these questions has been assigned to a committee of social and computer scientists.

SCHOOLS AS FACTORIES

Ostensible experts, including many of this year's political candidates, are inclined to issue alarms about the declining "efficiency and productivity" of American commerce and industry, especially as compared to that of the Japanese. Equally expert analyses of the present state of our educational system tend to reflect and reinforce this perspective. I have been unable to find a single example of a recent, officially authorized review of American public school education that is not predicated upon the view that we are falling woefully behind our principal competitors in the international race for industrial (text continued on page 224)

Stephan L. Chorover (Department of Psychology, MIT, Cambridge, MA 02139) is a neuropsychologist and professor of psychology at the Massachusetts Institute of Technology. He is the author of From Genesis to Genocide: The Meaning of Human Nature and the Power of Behavior Control (MIT Press, 1979) *and a frequent commentator on developments in the field of "psychotechnology."*

(text continued from page 223)
and commercial supremacy in the world. Once that premise is accepted it is easy to offer the conjecture that one reason for this sorry state of affairs is the failure of our educational institutions to provide a proper grounding in the skills required for national success and international leadership.

In the context of this conception of education, we should examine what the experts are telling us about the role of computers in education. In a recent paper entitled "Productivity and Technology in Education," Dr. Arthur S. Melmed, an official of the U.S. Department of Education, tells us that the problem of "how to improve productivity in education" will be "perhaps the central problem for education and educational research for the remainder of this decade." Failure to deal successfully with this problem, he continues, will have profound and far-reaching deleterious effects on our national economy. What is to be done? Here is his answer: "The key to productivity improvement in every other economic sector has been through technological innovation. Applications of modern information and communication technologies that are properly developed and appropriately used may soon offer education policy makers . . . a unique opportunity for productivity management."

Though some readers may think it strange to speak of education in such crassly materialistic terms, there is nothing new in the idea of the school as a kind of "factory." As early as 1916, Professor Ellwood Cubberly, Dean of Stanford's School of Education, proudly proclaimed our schools to be "factories in which the raw materials are to be shaped and fashioned into finished products" in accordance with "specifications for manufacturing (derived from) the demands of twentieth-century civilization."

Richard Cyert, in a Carnegie-Mellon press release of October 20, 1982, expressed his belief that the network of personal computers developed at Carnegie-Mellon "will have the same role in student learning that the development of the assembly line in the 1920s had for the production of automobiles. The assembly line enabled large-scale manufacturing to develop. Likewise, the network personal computer system will enable students to increase significantly the amount of learning they do in the university."

Displacement, Deskilling, and Alienation

My father would have said: "There is no free lunch." The improvement in productivity achieved in other economic sectors through the development and deployment of technological innovations always has effects upon the people whose productive activities are directly affected. Not all of the effects are reducible to measure and number. For the vast majority of men and women whose work lives have been significantly affected by automation—the principal mode of industrial innovation—the response has not been entirely salutary. All too often automation has led to worker displacement, deskilling, and alienation. What reasons do we have to believe that technological innovation (computerization) will follow a different course and lead to a different outcome in the field of education?

Though some may think it strange to speak in such terms, there is nothing new in the idea of the school as a kind of factory.

Let us imagine ourselves to be educational policy makers involved in trying to decide which way to turn in the helter-skelter transition toward computer-based systems of instruction. Let us assume that ours is an underfinanced public school system in an American city and that our teachers feel they are underpaid and overworked.

Let's assume that we are responsible for determining whether (and if so, how) to introduce computers into the elementary school and high school curricula. Let us suppose further that we are concerned with "improving our productivity" and that we are already keeping track of our system's "inputs and outputs" through the use of standardized academic achievement tests.

Into this situation comes a well-trained and well-meaning team of computer experts and cognitive scientists. Perhaps they have come from a major scientific/technological university or computer-development corporation nearby. In any event, they bear what appears to be a carefully crafted proposal; one that they and others have been working on for some time in the laboratory. They believe it is time for a field test.

Precisely what have they been working on? "Improved educational productivity," says one. "Computer-aided instruction," says another. "Computer-based learning," claims a third. They explain that the tutorial mode of teaching, using individualized instruction, is much more efficient than the classroom mode. They have designed a courseware package of both hardware and software, with which a student who has no prior computer experience can work in a self-paced manner. Subject matter is broken down into codable units and presented to the student at the appropriate time. Any information a student needs can be encapsulated in a computer program.

After an initial investment in the hardware and software, they point out, the system will be extremely cost-effective. Instead of teachers who are subject-area specialists, the school can hire relatively unskilled people to be "resource managers" and "system monitors," more commonly known as stockroom attendants and security guards. The university (or company) will provide all the expert assistance the school will need, including curricular material, lesson plans, and examinations. The school will be able to say "goodbye teacher," and good riddance to that skyrocketing professional payroll.

To the objections now arising, let me hasten to insist that what I have presented is more than a caricature. "Goodbye teacher" was, in fact, the title of an article written almost two decades ago by Professor Fred S. Keller, a behavioristically inclined psychologist who was one of the leading developers of an earlier system of automated instruction inspired by the work of B. F. Skinner. The so-called "Keller Plan" is one of the old theories that has died along with many other well-intended measures for increasing educational productivity through automation.

"Computer tutor" systems have the same form, content, and intended applications as that just described and are presently under development in many academic and corporate contexts. My scenario is based, in part, on a lecture presented recently at MIT by a visiting professor of cognitive science. The interpretation of the foreseeable effects of the computer tutor upon the quality of work life in the classroom (especially as it touches on the deskilling of the teacher's role) is taken directly from a conversation with him.

A Crisis in Education

What is to be done? I do not presume to say what researchers and systems developers in this field should do, or how educational policy makers ought to respond when confronted with proposals of this kind. Nevertheless, I am convinced that developments in the rapidly evolving field of computers in education are bound to have an effect on all of us who are part of the American educational system.

I hope that the problem of automation in education will give us a reason to stop, think, and reconsider the problem of sociotechnological transition in deeper and more humane ways. Meanwhile, let me suggest that the experience gained in many places thus far provides a provisional basis for saying

(text continued on page 226)

Another View from MIT

BY JOSEPH WEIZENBAUM

Joseph Weizenbaum, Ph.D., a Professor of computer science at the Massachusetts Institute of Technology, made the following comments in a telephone interview conducted by Donna Osgood, a BYTE associate editor, on the effectiveness of computers as learning tools.

We in the United States are in the grip of a mass delusion with respect to the education of kids with computers. The belief that it is very urgent that we put computers in primary and secondary schools is based on a number of premises, of which only one is true. The true premise is that the whole world is becoming increasingly pervaded by computers. But then people infer that in a world pervaded by computers, everybody must be "computer literate" in order to be able to cope with the world at all. A second inference is that a high degree of computer literacy assures one a good job, while computer illiteracy condemns one to life on the margin of the coming information society.

I think most people imagine computer literacy to consist largely of the ability to communicate with computers, to operate them and to be able to correctly interpret their output. Hence, computer literacy is generally interpreted to mean knowing a computer language or two, and probably involves facility with the computer's keyboard.

Another illusion is that computer-language learning is like other kinds of learning. That, of course, is best done very early in life, indeed, the earlier the better. This provides a lot of fuel for the pressure on the schools to begin computer training very early and to make it part of the school curriculum from kindergarten to grade 12.

Again, all of this is based upon the true assumption that the computer is beginning to pervade and will continue to pervade our society. I would like to draw an analogy to something else that is ubiquitous in our society—the electric motor. There are undoubtedly many more electric motors in the United States than there are people, and almost everybody owns a lot of electric motors without thinking about it. They are everywhere, in automobiles, food mixers, vacuum cleaners, even watches and pencil sharpeners. Yet, it doesn't require any sort of electric-motor literacy to get on with the world, or, importantly, to be able to use these gadgets.

Another important point about electric motors is that they're invisible. If you question someone using a vacuum cleaner, of course they know that there is an electric motor inside. But nobody says "Well, I think I'll use an electric motor programmed to be a vacuum cleaner to vacuum the floor."

The computer will also become largely invisible, as it already is to a large extent in the consumer market. I believe that the more pervasive the computer becomes, the more invisible it will become. We talk about it a lot now because it is new, but as we get used to the computer, it will retreat into the background. How much hands-on computer experience will students need? The answer, of course, is not very much. The student and the practicing professional will operate special-purpose instruments that happen to have computers as components.

The emphasis on learning computer languages early is misplaced. It is clear to me that computer languages are not like natural languages. I think they are more like mathematical languages or physics. They require a certain intellectual maturity, and when you have that intellectual or mathematical maturity, you can learn them relatively quickly. It isn't worth spending a lot of time on at an early age.

The counterargument that we should begin with baby steps early, like teaching BASIC to eight-year-olds, is going in exactly the wrong direction. BASIC is, from a pedagogic point of view, an intellectual monstrosity that we should start to eradicate and not attempt to use as a basis for anything.

I'm trying to argue that the introduction of computers into primary and secondary schools is basically a mistake based on very false assumptions. Our schools are already in desperate trouble, and the introduction of the computer at this time is, at very best, a diversion—possibly a dangerous diversion.

Too often, the computer is used in the schools, as it is used in other social establishments, as a quick technological fix. It is used to paper over fundamental problems to create the illusion that they are being attacked.

If Johnny can't read and somebody writes computer software that will improve Johnny's reading score a little bit for the present, then the easiest thing to do is to bring in the computer and sit Johnny down at it. This makes it unnecessary to ask why Johnny can't read. In other words, it makes it unnecessary to reform the school system, or for that matter the society that tolerates the breakdown of its schools.

(text continued from page 225)
what should not be done. Computer-based systems should not be introduced from the top down.

Too many schools still follow a well-established recipe for disaster: first, policy makers choose the hardware, then decide on the software. They then teach teachers and other staff how to use the system, and finally, everybody tries to figure out what the goals of system utilization are to be and whether the system already in place can help meet those goals.

Instead, teachers and students should be involved at all stages of the process, including the initial and difficult (often neglected) one of defining the educational values and goals that any such system is intended to serve.

> *Too many schools still follow an established recipe for disaster: first, policy makers choose the hardware, then decide on the software.*

It would be a very serious error to look only at the technical aspects of computers in education and to think only in terms of quantifiable productive efficiency. It is only in the context of a supportive educational community—a human environment conducive to learning—that the hazards of automation can be avoided.

What then needs to be done in the design of educational systems that will include the use of computers? Without attempting to give a comprehensive answer, as the details will vary from case to case, I would suggest that we must take it as our goal to draw people into an intimate and creative human context. The people who are on the receiving end of the innovations have to be involved in the transition. We are at a turning point, if you will, a kind of crisis. The Chinese character for "crisis" is made up of two other characters: "danger" and "opportunity." ■

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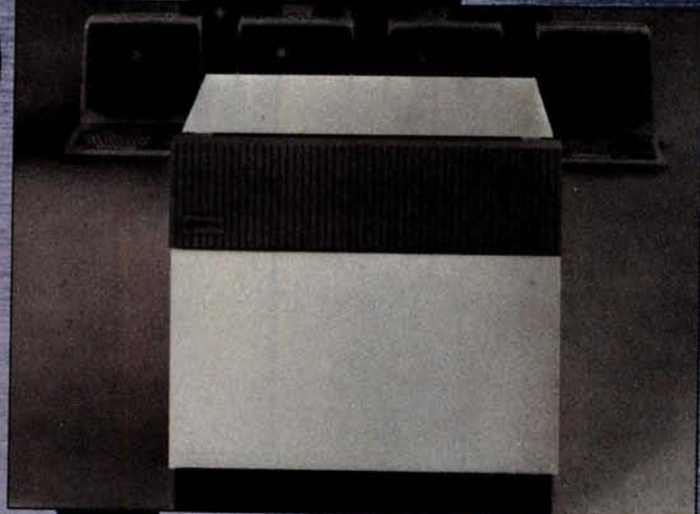

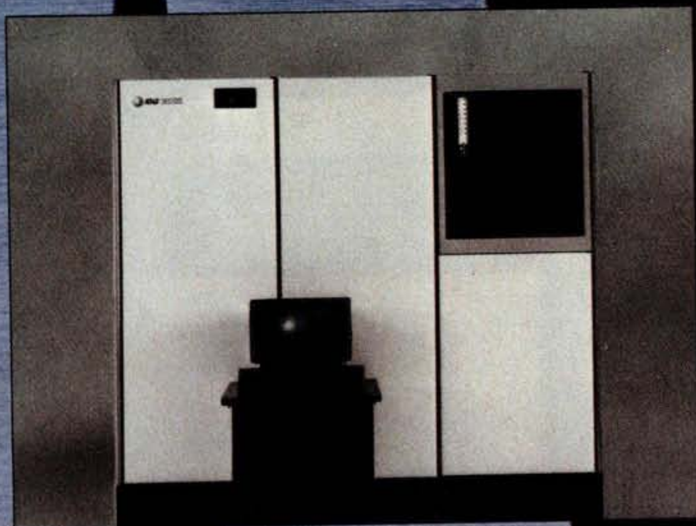

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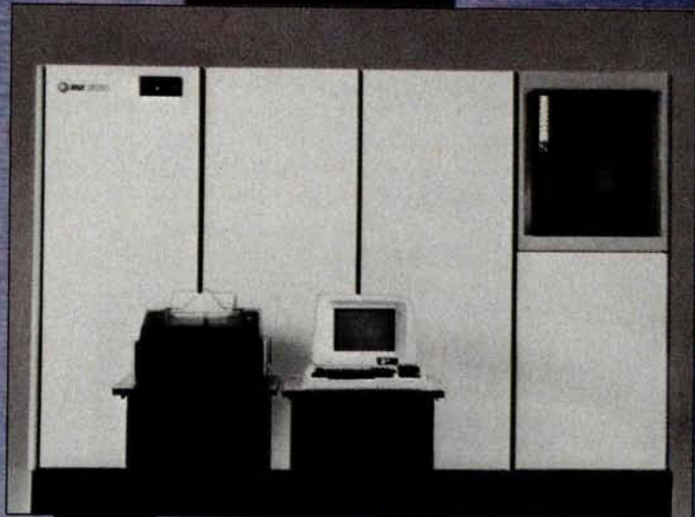

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LANGUAGES FOR STUDENTS

BY FRED A. MASTERSON

Evaluating programming languages for use in education

ONE OF THE MOST enlightened forms of computer-aided instruction (CAI) encourages students to use a programming language to explore problem domains, classes of related problems. In addition to enhancing computer literacy, such exploration helps students acquire strategies for learning about new problem domains. But all programming languages are not created equal; some are more appropriate for this application than others.

I have four requirements for a CAI programming language: simplicity, power, compatibility, and cognitive richness. "Simplicity" refers to the ease with which students can learn a programming language, at least to the degree that they can use it to solve simple problems. "Power" is a measure of the ease with which a programming language can be applied to complicated problems. Simplicity and power are relatively independent. Some programming languages are difficult to learn but provide relatively easy solutions to complex problems, while some simple languages do not.

The third requirement for a CAI programming language is that it be compatible with other computing applications. A programming language encountered in a CAI context may be the first computing experience for many students. There should be a positive transfer between a CAI programming language and such common computing applications as word processing, statistics packages, and other popular programming languages.

"Cognitive richness" measures the extent to which the programming language facilitates thinking about various problems. Cognitively rich languages provide easy ways to represent and test hypotheses about the rules governing problem domains. In contrast, cognitively poor languages may actually block reasoning about a problem domain by producing an antagonism between natural ways of thinking and the representations allowed by the language. This requirement is closely related to those of simplicity and power. Indeed, ease of learning and ease of application necessitate a rich notation for representing problems.

MAINSTREAM LANGUAGES: NEITHER SIMPLE NOR POWERFUL

Such mainstream programming languages as FORTRAN, ALGOL, and Pascal are widely distributed and widely used in academia and industry. The same languages tend to be popular in both settings, since industry hires the graduates of academia, and curriculum planners are sensitive to the needs of industry.

FORTRAN (Formula Translation), because it was the first high-level language, established a dominance that still prevails in physical science and engineering, though most versions of it lack overall coherence and well-designed flow-of-control commands. FORTRAN programs make heavy use of conditional branching statements that send control to different parts of a program, so that programs for all but the simplest tasks must be read in a zigzag fashion, instead of in a smooth flow from top to bottom. (However, RATFOR, a UNIX version of FORTRAN, and FORTRAN 77 incorporate ALGOL-like flow-of-control commands.)

ALGOL (Algorithmic Language) shows a higher degree of internal consistency and sophisticated control structures. As a result, it became a universal language for communicating algorithms in computer science. ALGOL control structures such as BEGIN...END, IF...THEN...ELSE, FOR...DO, and WHILE...DO set a precedent for future solutions to flow of control in programming languages. However, ALGOL lacks a standard set of commands for reading and writing data.

(text continued on page 234)

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(text continued from page 233)

Pascal, a descendant of ALGOL, is doing well in academia. Pascal is trim enough to run in the 48K- to 64K-byte memory limit that characterizes many of the personal computers commonly used in educational settings. It is small enough to be easily implemented, and its trimness makes its syntax and semantics easy to specify and relatively easy to grasp.

A major drawback to FORTRAN, ALGOL, and Pascal as programming languages for student use is that they are not interactive. In order to try even the simplest commands, a student must enter them in a source-code file, run a compiler to produce an object-code file, and then run a linker to make an executable program file. Consequently, experiments with one or a few commands consume disproportionately large amounts of time and effort. A much better environment would be an interactive one in which small sets of statements could be tested immediately.

A second major flaw in these programming languages is that all complex procedures must be broken down into steps that manipulate the contents of single memory locations in the computer. Although the computer is forced by its architecture to deal with memory locations one at a time, a programming language suitable for student use should disguise this limitation, making it seem that entire arrays or lists of numbers or characters can be manipulated by single commands.

The "one thing at a time" limitation is often built into programming languages as a limitation on the values of user-defined functions, which must be the contents of a single location in memory. Thus, functions cannot return arrays or lists as values—only single numbers or items. Subroutines in FORTRAN or procedures in ALGOL or Pascal must be used to compute more complicated data structures. As a result, procedure or subroutine calls are used much more frequently than functions. This is unfortunate, because a sequence of function applications can convey a clearer picture of a computation than an equivalent sequence of procedure or subroutine calls. For example, consider the problem of squaring each element of a matrix named MATRIX1 and then transposing the result. If SQUARE and TRANSPOSE could be coded as functions, a solution would be

```
MATRIX2 := TRANSPOSE (SQUARE
            (MATRIX1))
```

Since this is not possible in any of the aforementioned languages, the solution would have to look something like this:

```
SQUARE (MATRIX1,
  TEMPORARYMATRIX)
TRANSPOSE (TEMPORARYMATRIX,
  MATRIX2)
```

where the first argument of each procedure is the matrix to be operated upon and the second argument is the result of the operation. (In FORTRAN, "CALL" would precede "SQUARE" and "TRANSPOSE".) By comparison, the functional notation is considerably clearer.

BASIC: Simple But Not Powerful

A high degree of interactiveness is essential to the potential simplicity of a programming language. One of the best-known interactive programming languages is BASIC (Beginner's All-Purpose Symbolic Instruction Code). Successive lines of a BASIC program are typed directly to the BASIC system, and a program can be run immediately, without the delays interpolated by compiling and linking. In addition, most BASIC systems can execute single lines of commands outside of formal program definitions.

BASIC became *the* programming language for microcomputers during the middle to late 1970s because it was small enough to fit in the limited memories of early microcomputers. The price of this compactness was reduced performance.

Like FORTRAN, BASIC lacks adequate control structures. Many versions restrict variable names to no more than two characters, making the use of mnemonic names nearly impossible. However, BASIC's most egregious flaw is the absence of procedures or subroutines. Many manuals erroneously describe BASIC's "GOSUB" command as a subroutine facility. In fact, it is no more than an unconditioned branch from one to another block of code, with the ability to later return to the original block.

Fortunately, standards for an improved version have been drafted by the BASIC Committee of the American National Standards Institute (ANSI). The proposed standard allows multicharacter names for variables and ALGOL-like flow-of-control commands. The new standard also supports true subroutines with calling parameters and local variables.

APL and LISP: Powerful But Not Simple

All the languages we've looked at so far have only moderate power because they suffer from the "one thing at a time" limitation mentioned earlier. Restricting our search to readily available programming languages, two avoid this limitation—APL and LISP. Implementations of APL (A Programming Language) and LISP (List Processing language) are available for many mainframe and minicomputer systems and for some microcomputers. APL and LISP are highly interactive and extremely powerful, but their unusual notations have daunted many would-be users.

In some ways, APL and LISP are two of the best-kept secrets in computer software. While both have devoted users, neither has gained widespread acceptance, probably because of the notational problems mentioned above. Yet beneath those quirky notations lie programming systems that can be described as "futuristic" when compared to ALGOL, BASIC, FORTRAN, and Pascal.

APL and LISP let users think in terms of data structures. The data structures favored by APL are arrays (scalars, vectors, matrices, and arrays with more than two dimensions). In LISP, the data structures are lists (and the elements of a list may themselves be lists). Both APL and LISP enable the user to define functions that return entire data structures. Thus, embedded function applications can be used to clarify the hierarchical structure of a computation. Here is the APL command for the earlier example, squaring each element of a matrix and transposing the result:

```
MATRIX2 ← TRANSPOSE SQUARE
              MATRIX1
```

APL and LISP are also highly interactive. A function can be executed as soon as its definition has been entered. In addition, you can execute commands in "immediate execution mode" without embedding them in a function defini-

(text continued on page 236)

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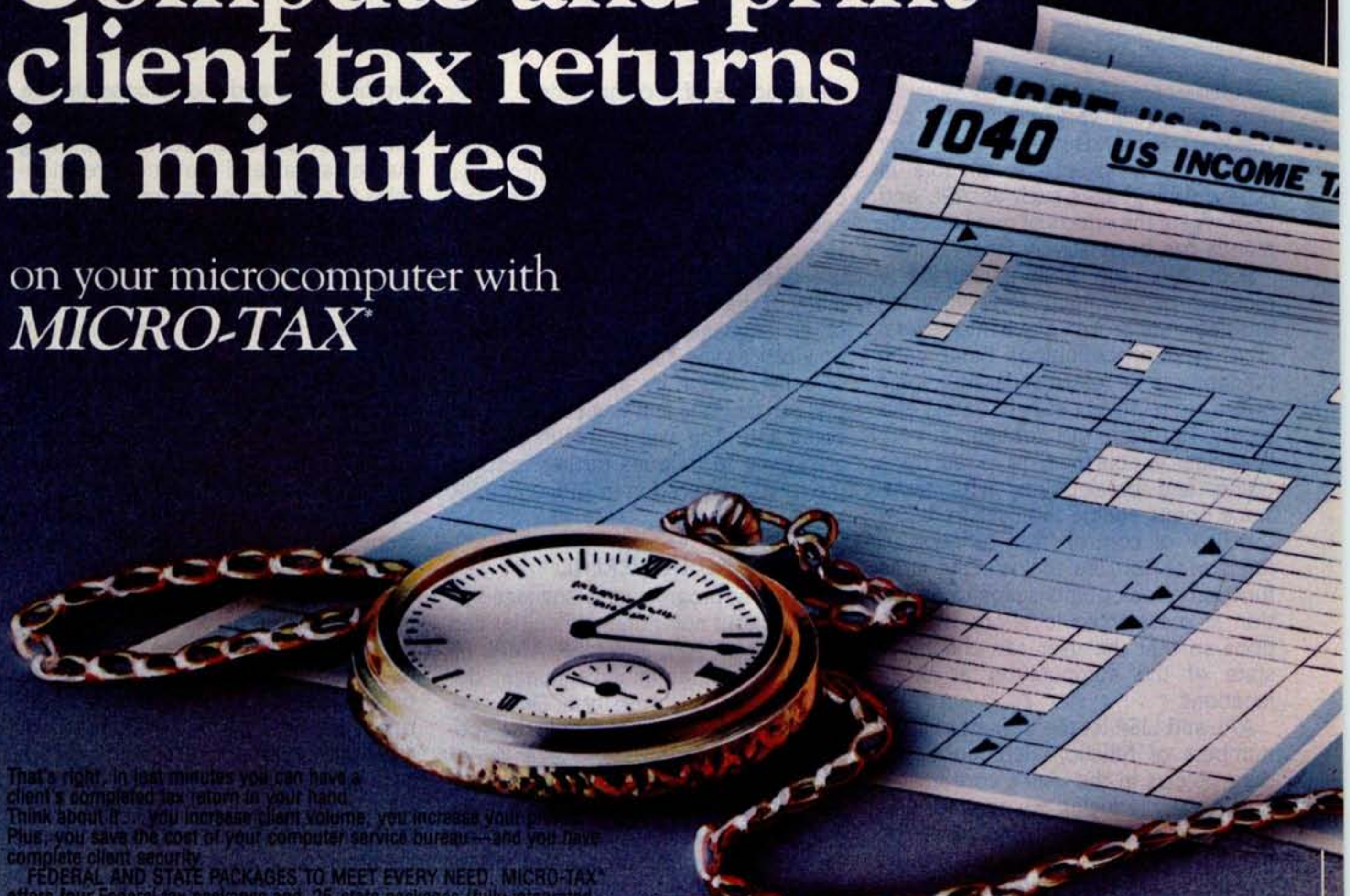

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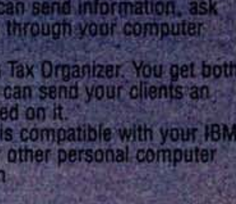

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(text continued from page 234)
tion. Thus, it is very easy to try out various commands to see how they work. This is especially valuable in powerful languages such as APL and LISP, where the effects of one-line commands can be relatively far-reaching.

Both APL and LISP encourage a modular programming style in which problems are broken down into several short function definitions. Since each function can be tested separately, logic errors are relatively easy to detect and rectify. To further aid debugging, both languages enable the user to set "trace points" and "break points" in functions. Trace points enable the user to follow the flow of control from function to function or from line to line in the same function. Break points suspend execution at preselected locations in functions so that the user can check the state of the computation at those locations.

APL and LISP let the user store large numbers of function definitions and data objects in the user's core image, thus greatly reducing the need for disk file save and retrieve commands. The user's core memory image is allocated dynamically, expanding when additional functions or structures are created and contracting when functions or structures are reduced or eliminated. Memory allocation is completely transparent to the user, so that "dimension statements" are not required to warn the system of future memory requirements. At any time, the entire memory image can be saved as a single disk file and retrieved later. Thus, the user can load an entire core image from disk, modify, delete, or add functions and data structures to that image, then save the entire core image back to disk.

APL and LISP are self-contained programming-language environments. They have coordinated facilities for memory management, error recovery, and I/O formatting defaults that enable users to customize the environment to fit special requirements.

Although both APL and LISP are interactive and powerful, they use offbeat notations and eccentric built-in editors. APL uses unusual characters and requires special terminals outfitted with APL keyboards. LISP has standard characters but uses reverse Polish notation and uses parentheses often to delineate the structure of a computation.

Neither APL nor LISP has structured commands for controlling iterations. Fortunately, both languages encourage programming styles that reduce the need for iteration, because both provide many commands that process entire data structures at once. Indeed, many of the applications of iteration in other languages involve the one-at-a-time processing of sequential elements of a list, vector, or array—processing that can be done in a single APL or LISP command. The use of recursive programming techniques further reduces the need for iteration in APL and LISP.

AMPL and Logo: Simple and Powerful

Fortunately, programming-language systems without notational difficulties can be based on APL and LISP. AMPL (A Modified Programming Language), developed at the University of Delaware, is a dialect of APL that avoids the special APL character set. [For a list of publications on AMPL, see the bibliography on page 238.] Logo, though inspired by LISP, does not rely as heavily on parentheses and allows the use of standard notation (in addition to reverse Polish) for arithmetic operators.

Despite notational simplification, AMPL and Logo retain many of the advanced features of their parent languages. In particular, both AMPL and Logo have the following features:

1. interactive, interpreted code
2. powerful primitives for creating and altering whole data structures
3. functional notation that often emphasizes the hierarchical structure of a computation
4. dynamic memory allocation
5. stored workspaces containing variables and function definitions
6. user access to system variables

The Logo programming language is a simple yet powerful tool that children can use to explore the worlds of geometry, mathematics, and physics. However, far from being just for children, Logo has many sophisticated features that will sustain the interest of advanced programmers.

We have used AMPL as part of an introductory college-level course in statistical data analysis. Our goals are twofold. First, and most important, we want to provide our students with a simple yet powerful tool for exploring mathematical and statistical relationships in sets of experimental data. Our second goal is to further the cause of computer literacy. This is the first exposure of most of our students to computers. Thus, it is extremely important that the experience be interesting and that it transfer to other computer activities. Perhaps the strongest motive behind the design of AMPL was to rid APL of its major eccentricities and thus increase its commonality with other computing notations and systems.

AMPL enables students to experiment with the grammar of algebra. There is a close correspondence between the structure of AMPL expressions and the equivalent algebraic expressions. Thus, each time a student interactively tries an AMPL expression, he or she learns a little more about the rules governing the evaluation of algebraic expressions. The end result of such learning can be dramatic. Students with poor math backgrounds, who otherwise would have difficulty grasping algebraic evaluation rules, learn the rules relatively easily by interacting with AMPL.

In addition to computing the values of statistics, students use AMPL to do sampling experiments. The experiments simulate coin tossing, sampling from continuous distributions, sampling correlation scatter plots, and so on. Such experiments give students a dynamic understanding of sampling variability and illustrate the basic logic of statistical inference.

Cognitive Richness: Languages to Think With

Cognitively rich languages let users think in terms of complete structures. APL and AMPL let users think in terms of whole arrays, and LISP and Logo let users think in terms of hierarchical list structures. While other languages support these types of data, they distract the programmer's attention to element-by-element processing details. Due to the built-in "one thing at a time" limitation, the net effect is to pull the programmer's perspective away from the whole structure.

The numerical array representations
(text continued on page 238)

(text continued from page 236)

of APL and AMPL make these languages ideal for representing problems in linear algebra and statistics. Arrays can be used in these languages to represent string data as well. For example, a book is easily represented as a three-dimensional array in which each two-dimensional slice represents a page of text. Simple commands can be used to access and rearrange pages, lines, columns, and individual characters.

The hierarchical list structures of LISP and Logo facilitate the representation of algebraic formulas and propositions in symbolic logic. List structures are also useful in natural-language programs, where they represent the grammatical parsing diagram of a sentence or, at a deeper level of processing, a propositional representation of the meaning of the sentence.

The ability to think in terms of whole structures comes as a delightful surprise to students who are used to "one thing at a time" languages. Data structures acquire an almost physical palpability as the user breaks them apart and reassembles them into new structures by means of simple commands.

Another contribution to cognitive power is the freedom these languages provide from disk file bookkeeping. All required procedures and data structures reside in a core workspace and are instantly accessible by name. In many other languages a source program may reside in one file, library procedures in another, and data in yet another. As a result, the user must move about from file to file to edit procedures and data. This is just one more source of distraction from the cognitive goals of a programmer.

Another conceptually powerful feature of APL, AMPL, LISP, and Logo is the ability to write recursive procedures; that is, procedures that call themselves. For example, a recursive procedure to determine the length of a list would apply itself to the list with one element removed and then add 1 to the answer. This recursive procedure is shorter and conceptually more satisfying than an iterative one that steps through the list counting each element in turn.

WANTED: RESPONSIVE, CUSTOMIZABLE LANGUAGES

The result of my survey of widely available programming languages is distressing. One might well ask why so few programming languages are suitable for CAI. And since CAI suitability should be synonymous with "human efficiency," why are there so few human-oriented programming languages?

We are at a new frontier of programming-language design. The old, inflexible, noninteractive programming languages have catered to the large-scale computing needs of science, business, and government. What we need now are flexible, interactive, powerful programming languages for the student and the personal computer user.

The requirements of large-scale computing could hardly be farther from those of most students and individuals. Cost-effective programming languages, in the context of economies of scale, demand *machine* efficiency at the expense of *human* efficiency. Machine-efficient programming languages tend to be inflexible and picayune, requiring several lines of code to accomplish even the simplest tasks. Programming becomes a tedious task prone to mistakes.

An analogy can be made to ground transportation. Businesses use large trucks to transport goods as cheaply as possible. Who would claim that individuals should use the same vehicles to go to work or go shopping? FORTRAN, ALGOL, BASIC and Pascal seem like trucks. We need more "automobiles" and "bicycles": responsive, customizable programming languages for CAI and personal computing. ■

AMPL, a modification of APL designed at the University of Delaware, allows standard ASCII characters, mnemonic command names, and a simple editor. It runs on the DECsystem-10 mainframe. A VAX 780 version is due for release this summer, and an IBM PC version is projected for 1985.

The author thanks Ken Cowan, Elizabeth Rust Kahl, Suzanne McBride, and Tony Stavely for their helpful comments on earlier versions of this article.

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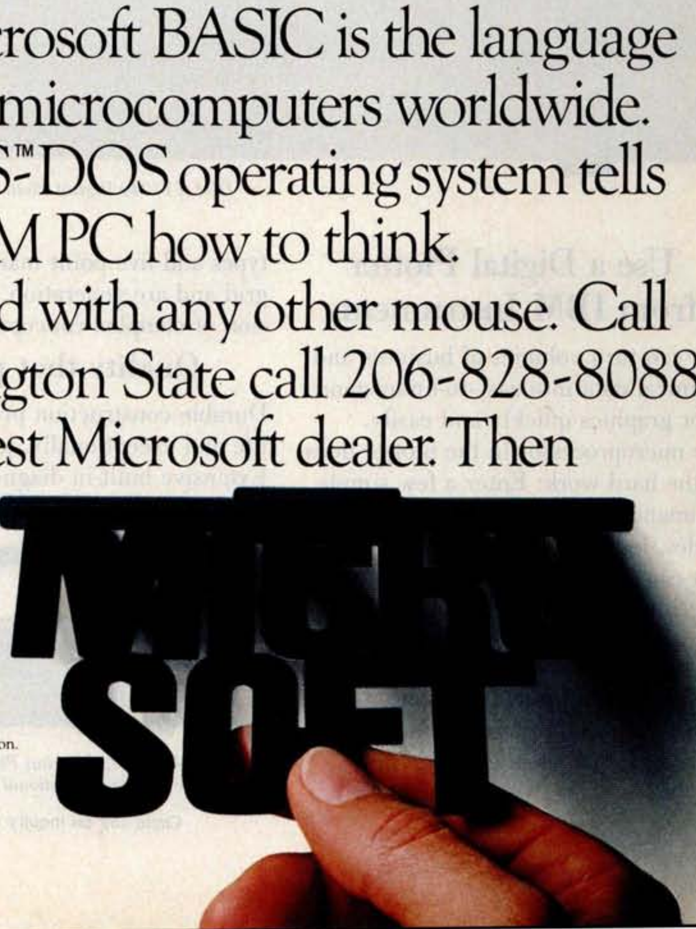

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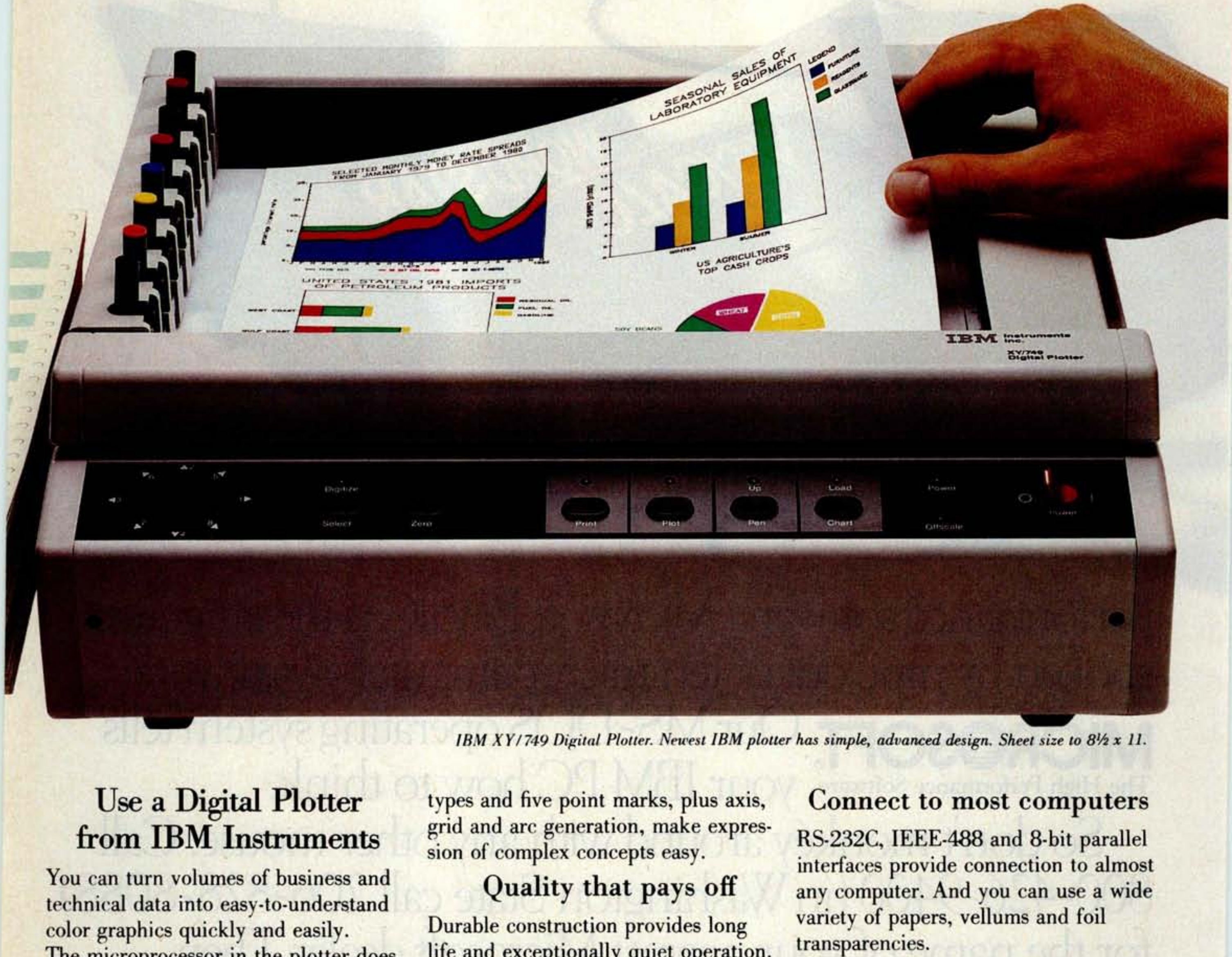

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MICROCOMPUTERS IN THE FIELD

BY ROBERT P. CASE

Practical considerations

PORTABLE COMPUTERS ARE perfectly suited for use in anthropological and zoological in-the-field data-processing applications. Portables were designed, however, for use in friendly environments. Taking a portable into potentially hostile environments requires more than the usual planning for system organization. Introduction of unfriendly elements like extremes of temperature and humidity, contamination by dust and other foreign matter, and general abuse in the field, can quickly reduce a computer to electronic junk. This article describes the special selection and the "hardening" of a portable computer system for use in a research project in Central America.

Throughout this discussion I have taken a cookbook-like approach based on the presumption that field scientists interested in this application will have modest exposure to computers. A step-by-step presentation should be the most useful for the reader.

WHY USE A SYSTEM IN THE FIELD?

Field scientists in anthropology, environmental sciences, and zoology conduct research primarily through funding provided by a variety of public or private agencies. Research funds are traditionally in short supply and the competition is always strenuous. A proposed project must promise much in the way of research, and once funded, it must deliver, especially if it is to receive future assistance. Most granting agencies monitor the research closely and require that the researcher provide preliminary reports on the progress made. Some of the advantages of an onsite computer should be readily apparent, given these conditions. I will draw upon experiences from my current project to illustrate various points.

The project is a three-year research program designed to investigate the pre-Columbian Mayan civilization of southern Mexico and northern Central America. My role is to direct laboratory and data-processing operations. A multiplicity of competing theories have been offered about the rise and fall of Mayan social, economic, and political organization, but very little has been done in the way of empirical testing. The primary objective of the project, then, is to collect and analyze sufficient data from our research area so that we can validate, modify, or reject some of these alternative theories.

We recognized from the beginning that it would be extremely slow and difficult to manually process such a wide variety of data; yet we wanted to be capable of doing some preliminary hypothesis testing in the field. So the decision was made to computerize data processing.

SYSTEM ANALYSIS AND DESIGN

After deciding to use a portable computer, the next step was to identify the specific tasks that the computer would perform. Software and, ultimately, hardware selection must be tailored to the user's needs.

In our case (and probably in the case of all research projects), the most critical need was for a database management system that could store, manipulate, and retrieve data. Second, we required the means to mathematically analyze our data. A third, but not essential, function included word-processing and hard-copy documentation capabilities.

The first consideration at this stage is whether it will be necessary to transfer data to a mainframe computer after returning from the field. We talked to the director of our university's mainframe facility to get some guidelines on the compatibility of different systems. Usually compatibility problems can be resolved by using special software. But this requires additional processing steps and should be avoided whenever possible. Also, many large data-processing (text continued on page 244)

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facilities have mainframe computers by more than one manufacturer, so there may still be a wide range of compatible microcomputers and software to choose from.

This brings us to the second step, selecting the software that will perform the specified tasks. A multitude of programs may exist for any given task, each with different strengths and weaknesses. Furthermore, these programs are designed to run on particular operating systems such as CP/M or MS-DOS. In effect, this stage of the system analysis involves simultaneously evaluating competing software/hardware configurations. That is, program X, which runs only on class X computers, must be compared to a similar program, Y, which runs only on class Y computers. If at all possible, get a demonstration of the different candidates. When evaluating similar programs, keep the following questions in mind: How well will it perform the tasks I need? How easy is it to learn and use? Has it been extensively tested and is it reliable? And, of course, how much does it cost? Based on this analysis, you should pinpoint the programs you require and be able to narrow down the selection of suitable hardware.

Your choice of a microcomputer is limited to the operating system your software will run on, but there will usually still be a number of portable computers to choose from (see "How to Choose a Portable," September 1983 BYTE, page 34). Important considerations include: the size, feel, and arrangement of the keyboard; the size and quality of the video monitor; the size of the memory; and the disk-storage capacity. The keyboard and monitor characteristics are a significant concern; a poor design in either can reduce input speed and accuracy. Another important factor is the amount of random-access read/write memory (RAM) and disk storage, which can place limits on data storage and processing. Naturally, mechanical reliability and cost are also important concerns.

Using these guidelines for our project we first examined database-management programs. On the basis of comparisons, dBASE II was chosen for its greater power and flexibility. We searched next for a suitable statistics package to fill our second requirement. At the time of the analysis (May 1982) there were only a handful of such packages. Our choice, Statpak, was designed to be interfaced with dBASE II and other popular database-management systems. Statpak requires MBASIC and so this was added to our list. One other criterion added to our list was a minimum of 64K bytes of RAM for dBASE II; this is less important today since most suitcase-size and many briefcase-size portable microcomputers match or exceed 64K bytes of RAM.

We were concurrently studying the portable systems then on the market. We concluded that our three-year research program would require a tremendous amount of disk storage. We investigated the Kaypro 10, the first portable to have a 10-megabyte Winchester hard disk. This system has the 64K bytes of RAM required for dBASE II, it uses the necessary CP/M operating system, and, as a further benefit, it comes with bundled software including MBASIC (required for Statpak) and WordStar (a word-processing package that fulfilled our third general requirement). Finally, the close proximity of the Kaypro plant to our base at San Diego State University was an additional advantage. Subsequently, the peripheral devices were evaluated, with the Prowriter 8510 printer (C.Itoh Electronics) and the 500-watt Grizzly Uninterruptible Power System (Electronic Protection Devices Inc.) being selected.

Upon completion of the system analysis and design we would normally have gone out and bought the specified equipment and software. In our case, however, an unexpected reduction in our National Science Foundation award made this impossible. We were not willing to give up easily, so we contacted each manufacturer, first by telephone, followed by a written proposal in which we solicited their sponsorship. Each one graciously accepted and we owe them much gratitude.

Field Conditions and Microcomputers

In spite of their portability, microcomputers imitate mainframes in requiring a relatively clean, climate-controlled room at home or in the office. Obviously, field scientists will not usually have such luxurious accommodations. It is imperative that you identify the potential environmental perils that await and take the necessary preventive measures. A system failure in a remote location is extremely difficult, if not impossible, to recover from.

The most serious climate-related problems for the computer are excessive heat and extreme humidity or aridity. Equally serious is the problem of the equipment being infiltrated by dust or insects. Finally, the source and quality of electricity used to power the system has to be considered; a blackout, brownout, or power surge can ruin your whole day, not to mention your project. These, in fact, constitute the environmental problems that we anticipated adversely affecting our anthropology project in Central America. We wrote in our proposal to Kaypro that we expected daily temperatures to reach the mid-90s with humidity exceeding 90 percent. We also noted that dust and insects would be a problem, as would an inconsistent power supply. Kaypro recognized that there were significant risks to the operation of a computer and that modifications were called for. One of their engineers, Ron Morgan, took on the task of constructing a climate-resistant Kaypro 10.

Morgan's objective was to have a completely sealed cabinet in order to prevent dust and moisture from affecting components. This created additional problems, such as cooling and the need for data backup. The solution to the cooling problem was to build a special heat sink mounted to the top of the cabinet. Whisper fans mounted over holes in the cabinet circulate air through the components, out through the heat sink, and back into the cabinet again. This closed cooling system is designed to maintain the interior of the computer at a normal room temperature.

Second, sealing the cabinet required that all vents and the floppy-disk port be closed. Both the hard-disk and floppy-disk drives were removed together with the standard fan. Two of the new, thinner, 10-megabyte hard-disk drives and a Toshiba floppy-disk drive were installed, with the Toshiba in line with, but backset from, the floppy-disk port. The port was then sealed by screwing a piece of plexiglass over it. It was Morgan's intention to use the sec-

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ond hard disk to back up the first, so status lights for each drive were attached to the clear plexiglass. To monitor internal conditions a small thermometer and humidity indicator were placed so that they would be visible through this port window.

The addition of a second hard-disk drive created problems. First, the power supply had to be modified. It was decided that the backup unit would normally be inactive. For files to be copied, a three-way switch mounted on the back panel would be used to power up the second drive. Beyond that, special firmware had to be created to allow communication between the hard-disk units, with one designated as primary and the other secondary. As an added precaution, provision was made for switching these designations in the event of primary-drive failure.

With these modifications, it was apparent that all data would be resident on the hard disks. This was viewed as an example of the "all your eggs in one basket" syndrome, an intolerable situation. Since we would probably have use of a climate-controlled building near the project site, we decided that we should also take along a Kaypro 4 computer. We realized that if this unit could be kept operational, there would be several important benefits, not the least of which was a backup for the Kaypro 10. Furthermore, by using the serial ports, the Kaypro 4 and 10 could be linked for uploading and downloading. This would provide an extra level of security since all data could then be backed up on floppy disks. Finally, the Kaypro 4 would give us a second data-entry station. Since this is the slowest aspect of any data-processing operation, a second workstation would prove quite valuable. One other emergency provision was made, that of the Toshiba floppy-disk drive sealed inside the Kaypro 10. If the Kaypro 4 were inoperable and the 10's performance degrading, we could remove the plexiglass window, power up the Toshiba disk drive, and download the data from hard disks to floppies.

From our perspective we had covered every reasonable contingency affecting the operational qualities of the computers. What remained was the worst possibility: a system failure. Ron Morgan assessed the various components within the Kaypros on two criteria: (1) high or low risk of failure, and (2) repairability or nonrepairability. Spare components of a high-risk but repairable nature were assembled and packaged for shipment. Repairing a computer in the field may seem like an impossible mission to anyone who has never looked inside a microcomputer. The Kaypros' modular design, however, makes replacing damaged boards eminently practical. Our parts kit consisted of a power-supply board, disk-controller board for both hard and floppy disks, LSI (large-scale integration) chips, fuses, and whisper fans. Naturally, an appropriate tool kit was assembled and I was given some training as well.

Having covered every conceivable angle concerning the computers, we next evaluated the environmental risks to the peripheral devices. The Prowriter 8510 is listed in the C.Itoh manual as being operational within a temperature range of 5° to 40°C (41° to 104°F) with relative humidity between 10 and 85 percent. This was judged to be adequate, so no modifications were needed. Of greater concern, actually, was the probability of the printer paper absorbing moisture from the air, which could potentially harm the printer as the paper passed through. This problem should be alleviated by keeping paper supplied in special storage except when the printer is used.

The second device, the Grizzly Uninterruptible Power System, was also deemed to be fieldworthy without modification. This essential tool "purifies" the electrical current and instantaneously provides up to 15 minutes of battery power to gracefully shut down in the event of a blackout. The only extra effort here was to make a dust cover to place over it when not in use, something we provided for all hardware.

Operational Procedures

Beyond mechanical modifications, adverse environmental conditions can be mitigated by thoughtful operational procedures. In fact, a well-designed, well-regulated operation is equally or more important than the hardware and software and can contribute much to the success or failure of any project. In essence, operational procedures should answer the questions of who, what, when, why, where, and how.

Who has access to the equipment and what their responsibilities are might not be applicable to a small project with a one-man data-processing operation. But if more than one person will be working with the equipment then it is always best to establish the lines of authority and to explicitly identify each person's role and duties.

When and where data-processing operations take place are two important considerations in softening harsh environmental conditions. Careful selection of the physical facility where the operation will be established can go a long way toward minimizing subsequent problems. Similarly, by scheduling our operational time for the early morning and late afternoon or evening, we will avoid the high-risk peaks in heat and humidity and, hopefully, avoid damaging the equipment.

The most elaborate planning should be accorded to how the work will flow through the system; this should be done in a step-by-step fashion so that nothing is overlooked. To begin with, the field forms on which the data is recorded should be designed so that they are easy to key into the computer. The cleaner the input document, the more accurate the data entry will be.

Inevitably, errors will be entered, either because the source document was wrong or the key entry person erred. Data validation techniques must be developed to catch as many errors as feasible. Some kinds of error-trapping methods are built into various programs while others, like range and plausibility tests, can be specifically created to meet the user's needs. Ultimately, verification of data accuracy is best accomplished by spot-checking records against the original documents. It is advisable to spot-check a higher percentage of records in the early stages; subsequently, verification can be reduced and focused toward the most critical data, assuming, of course, that the overall error rate is not excessive.

Once the data is stored to the disk it should be backed up immediately. Probably one master and two working copies of each program or data disk is the optimum level of protection. If a printer is available, then hard-copy

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documentation of raw and processed data files is highly recommended. This is especially true in multistage processing where the intermediate results will be modified by the final processing step.

It follows from this that some basic housekeeping rules are required if the data-processing operation is to run smoothly and efficiently. A transaction log containing a running narrative of the daily activities is vital. This log should record the names of newly created files, what files were used in processing, what processing steps were used, and what was the disposition of the results. Furthermore, all disks and printouts should be unambiguously labeled and stored in a safe and logical manner when not in use. Never assume you will remember a filename or the location of a printout; this is the fastest way to sink the entire operation into chaos. Disks should be kept in a dustproof file with the various generations of copies separated to minimize catastrophic loss. Likewise, printouts will be more useful if they are organized in labeled folders or binders, and they will last longer as well.

SYSTEM TESTING AND DEBUGGING

The entire system should be assembled at the earliest possible moment; this will allow you to become familiar with its operating characteristics prior to entering the field. Sufficient lead time is an extremely valuable asset. With it, you can develop applications programs, run test data, and uncover any bugs that may exist, all while you have technical support available. Without adequate lead time, there is a strong possibility that you will spend an inordinate amount of time on system basics, all to the detriment of the data-processing goals of the project.

Frequently, over-the-counter software is more than adequate for research programs and has the added advantage of being thoroughly tested. The specific procedures required can be tested with data similar to what you expect to collect. This can be accomplished either by creating artificial test data or, as we did, by extracting similar data from published reports within our discipline. In either event, tests should be made for any errors that appear to be likely or that would be disastrous. Tests using abundant normal data and some high and low values are recommended. Testing for a zero value in unexpected places may also uncover significant problems. Finally, checking for empty files or for errors in processing the first and last record should reveal any remaining difficulties.

MAINTENANCE IN THE FIELD

Maintenance requirements will vary with the kind of equipment selected, and the kind of environmental conditions that will be encountered is especially important. However, under every circumstance you will at least want to have dustcovers for all equipment, a head-cleaning kit (with refills) for the floppy-disk drives, and a very light (low-viscosity) oil for lubricating the printer. The only real variable is the maintenance scheduling for the floppy-disk drives. In our case, we have anticipated a severe and pervasive dust problem and so we have decided that the drive heads will be cleaned once each week. There is no hard and fast rule here; you must rely on your own judgment.

TRANSPORTATION

Despite their portability, microcomputers cannot withstand prolonged episodes of bumping and jostling about. Although more stable than minicomputers or mainframes, they are still relatively delicate. If they must be shipped, use sufficient packing to prevent damage. Probably the best assurance of your portable computer arriving safely is to hand-carry it onto jetliners. When traveling by air, have the computer hand-inspected at the airport rather than passed through electronic screening devices. The latter could potentially damage disks or, worse yet, the read-only memory (ROM) in the central processing unit. Also, while most portable computers are designed to fit
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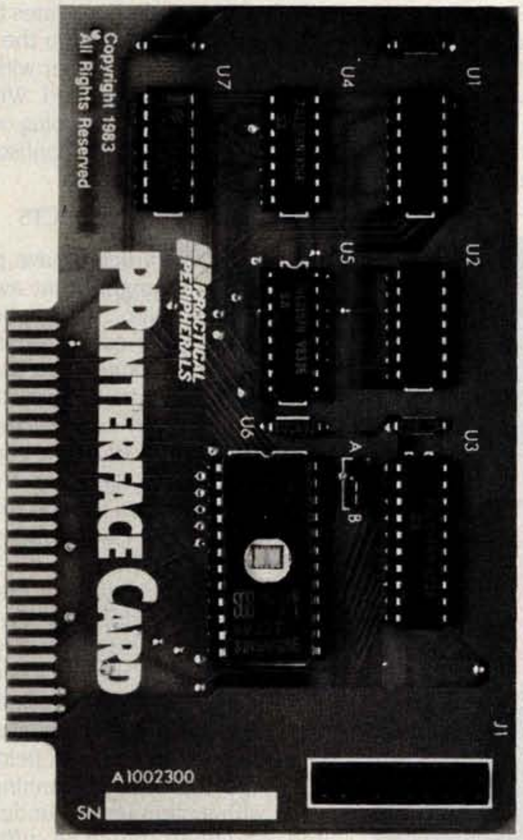

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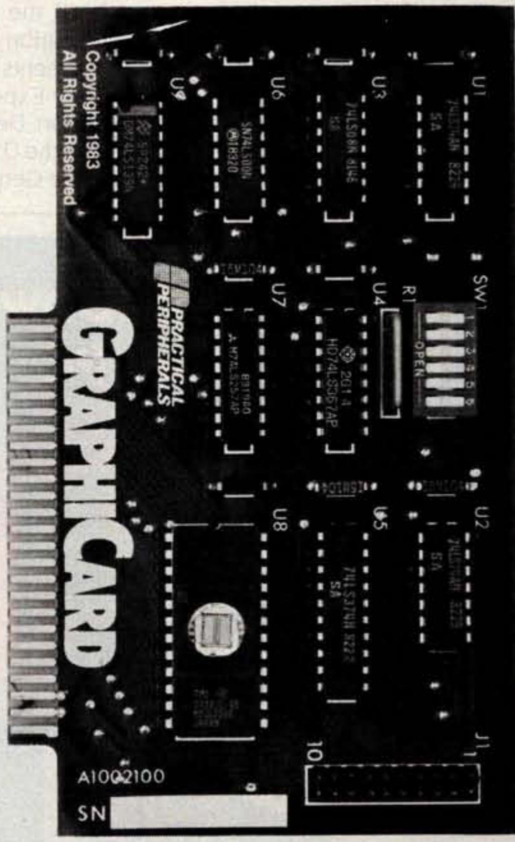

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under airline seats, some computers may be slightly oversize. To prevent unfortunate encounters, check with the airline you wil be traveling with before arriving at the airport. Even if your computer is slightly oversize, many airlines will allow it to be carried on and stored in one of the storage compartments in the passenger area.

Finally, if the project destination lies outside of the United States, special documentation is required. Two separate documents are needed: a General Temporary Export license and a Shipper's Export Declaration, both obtainable from the U.S. Department of Commerce. The General Temporary Export license (GTE) is necessary for exiting the United States, while the Shipper's Export Declaration demonstrates that the equipment was acquired in the United States and can thus re-enter without an import duty being imposed. Without a valid GTE in hand, a user going overseas may have his equipment confiscated at the point of embarkation.

Pitfalls and Prospects

Throughout this article I have pointed out numerous dangers that await the field scientist who would be bold enough to take a computer into the field. While the dangers are real, they are not insurmountable, and with sufficient planning they can be overcome. The importance of lead time cannot be stressed enough. Basically, the field scientist will be faced with two enemies. The first is system incompatibility, which can be either hardware that is incompatible with the software or the failure of the system to perform the user's tasks adequately. Careful system analysis and design will prevent this from occurring. The second enemy is a hostile environment; here the mitigating measures will depend on the anticipated field conditions. Again, thorough planning, combined with system testing under simulated conditions, should be sufficient to overcome this obstacle.

The benefits to be derived from a computer in the field are greater than the hazards faced. The turnaround time for data analysis is dramatically decreased. Multistaged research designs can be executed in a single season rather than over several seasons. As a planning tool, the computer permits the project staff and resources to be utilized to maximum potential. Preliminary reports can be started earlier, completed faster, and contain more substantive information than was possible ever before. We can hope that these prospects will encourage computer manufacturers to promote further development of fieldworthy portable microcomputers. ■

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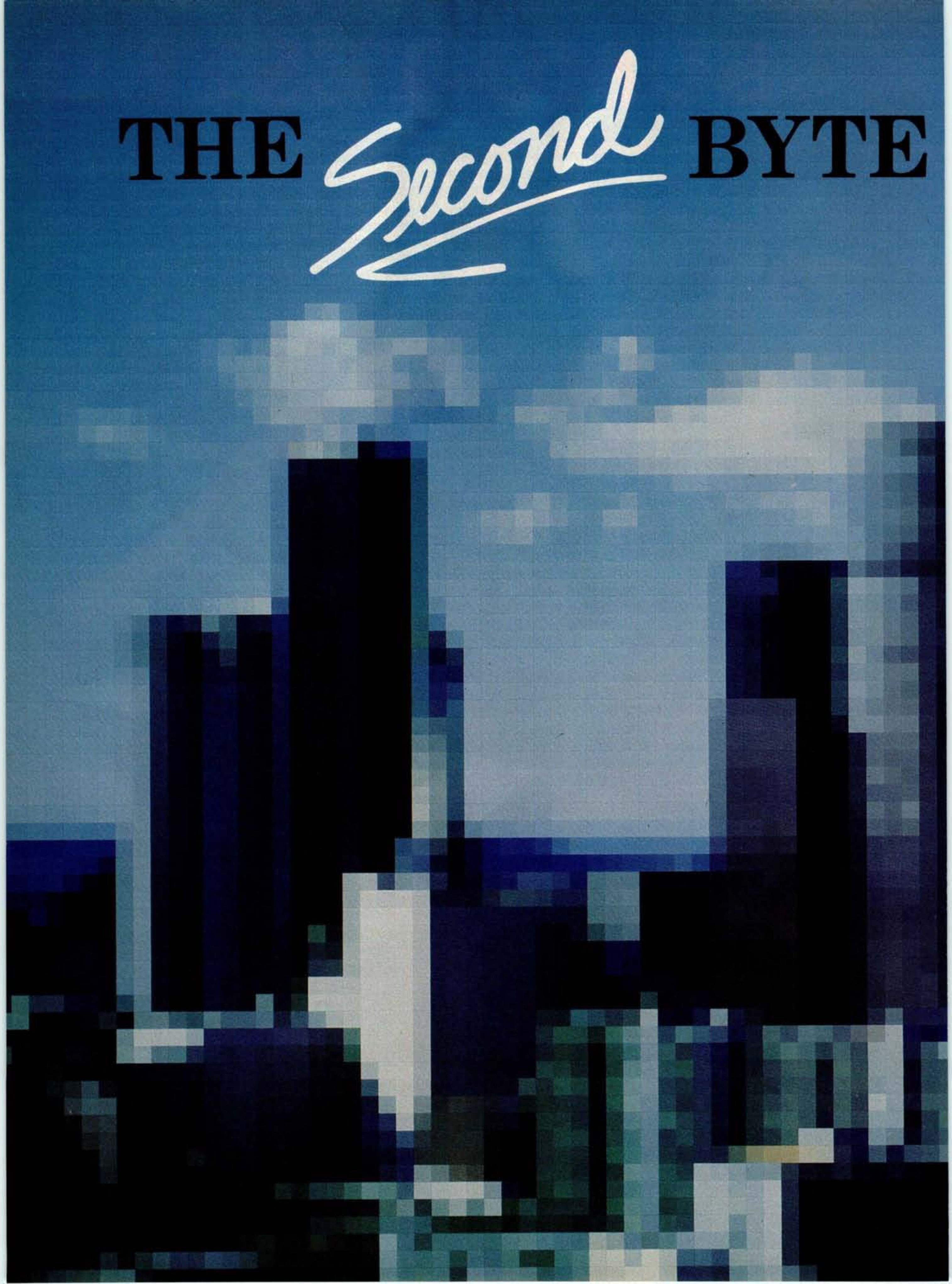
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PART 1: DESIGN CONSIDERATIONS AND SPECIFICATIONS

BY FRANK DA CRUZ AND BILL CATCHINGS

RECENTLY, A GREAT deal of attention has been focused on developments in computer networking—the IEEE 802 committee, IBM's System Network Architecture (SNA), the latest Ethernet interfaces, fiber optics, satellite communications, and broadband versus baseband transmissions. But little attention has been given to the single working mechanism that may be the most widely used in the real world for direct interprocessor communication: the so-called asynchronous protocol, which is found in some form at most institutions that have a need to transfer files between microcomputers and central computers.

Columbia University has large timesharing computers at a central site complemented by smaller systems scattered throughout laboratories, departments, homes, and dormitory rooms. As soon as these small machines began to appear, users asked for ways to exchange files with the central and departmental systems.

At the same time, student use of our central systems was growing at an astonishing rate. Because we could no longer afford to provide students with perpetual on-line disk storage, we began to issue identification codes valid only for a course and term. The decreased longevity of the IDs caused a need for students to economically archive their files. Given a reliable way to transfer files to microcomputers from the central mainframes and back, microcomputers with floppy disks could provide inexpensive removable media ideal for this purpose.

The situation called for a file-transfer mechanism that could work among all our computers, large and small. Some such mechanisms were intended for use between microcomputers, others between large computers, but none specifically addressed our need for communication between microcomputers and IBM and DEC mainframes.

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Most commercial packages served a limited set of systems, and their cost would have been prohibitive when multiplied by the large number of machines involved.

We thus embarked on our own project. Part 1 of this two-part article discusses some of the issues and tradeoffs that arose and illustrates them in terms of our result, the Kermit protocol for point-to-point file transfer over telecommunication lines. Because commercial local-area-networking products are expensive, not yet widely available, and unsuitable for one-shot or long-haul applications, humble asynchronous protocols such as Kermit are likely to be with us for a long time.

THE COMMUNICATION MEDIUM

The only communication medium common to all computers is the asynchronous serial telecommunication line, used for connecting terminals to computers. Standards for this medium are almost universally followed—connectors, voltages, and signals (EIA RS-232C); character encoding (ASCII, ANSI X3.4-1977); and bit-transmission

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A communication protocol is a set of rules for handling packets of information.

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sequence (ANSI X3.15-1976). Serial connections can be made in many ways: dedicated local cables ("null modem" cables), leased telephone circuits, and dial-up connections. Dial-up connections can be initiated manually from the home or office using an inexpensive acoustic coupler or automatically from one computer to another using a programmable dial-out mechanism. The asynchronous serial line offers the ordinary user a high degree of convenience and control in establishing intersystem connections—at relatively low cost.

Once two computers are connected with a serial line, information can be transferred from one machine to the other, provided one side can be instructed to send the information and the other to receive it. Right away, however, several important factors come into play:

1. *Noise*—It is rarely safe to assume that there will be no electrical interference on a line; any long or switched data-communication line will have occasional interference, or noise, that typically results in garbled or extra characters. Noise corrupts data, perhaps in subtle ways not noticed until it's too late.

2. *Synchronization*—Data must not come in faster than the receiving machine can handle it. Although line speeds at the two ends of the connection may match, the receiving machine might not be able to process a steady stream of input at that speed. Its central processor may be too slow or too heavily loaded or its buffers too full or too small. The typical symptom of a synchronization problem is lost data; most operating systems will simply discard incoming data they are not prepared to receive.

3. *Line Outages*—A line may stop working for short periods because of a faulty connector, loss of power, or similar reason. On dial-up or switched connections, such intermittent failures will cause the carrier signal to be dropped and the connection to be closed, but for any connection in which the carrier signal is not used, the symptom will be lost data.

Other communication media, such as the parallel data bus, have safeguards built in to prevent or minimize these effects. For instance, distances may be strictly limited, the environment controlled, special signals may be available for synchronization, and so forth. The serial telecommunication line provides no such safeguards, and we must therefore regard it as an intrinsically unreliable medium.

Reliable Communications

To determine whether data has been transmitted between two machines correctly and completely, the machines can compare the data before and after transmission. A scheme commonly used for file transfer employs cooperating programs running simultaneously on each machine, communicating in a well-defined, concise language. The sending program divides outbound data into discrete pieces, adding special information to each piece describing the data for the receiving program. The result is called a *packet*. The receiver separates the description from the data and determines whether they still match. If so, the packet is acknowledged and the transfer proceeds. If not, the packet is negatively acknowledged and the sender retransmits it; this procedure repeats for each packet until it is received correctly.

The process is called a communication *protocol*—a set of rules for forming and transmitting packets, carried out by programs that embody those rules. Protocols vary in complexity; our preference was for a simple approach that could be realized in almost any language on almost any computer by a programmer of moderate skill, allowing the protocol to be easily adapted to new systems.

Accommodating Diverse Systems

Most systems agree on how to communicate at the lowest levels—the EIA (Electronic Industries Association) RS-232C asynchronous communication line and the ASCII (American National Standard Code for Information Interchange) character set—but agreement rarely extends beyond that. To avoid a design that might lock out some kinds of systems, we must consider certain important ways in which systems can differ.

Mainframes versus Microcomputers—A distinction must first be made between microcomputers and mainframes. These terms are not used pejoratively: a microcomputer could be a powerful workstation, and a mainframe could be a small minicomputer. For our purposes, a microcomputer is any single-user system in which the serial-communication port is strictly an external device. A mainframe is any system that is host to multiple, simultaneous users at terminals, who log into jobs, and where a user's terminal is the job's controlling terminal. Some mainframe systems allow users to assign another terminal line on the same machine as an external I/O (input/output) device.

Mainframe operating-system terminal drivers usually treat a job's controlling terminal specially. Full-duplex systems echo incoming characters on the controlling terminal but not on an assigned line. System command interpreters or user processes might take special action on certain characters on the controlling line but not on an assigned line (for instance, Control-C under CP/M or most DEC operating systems). Messages sent to a job's controlling terminal from other jobs could interfere with transmission of data. The ability of a system to test for the availability of input on a serial line might depend on whether the line is the job's controlling terminal or an assigned device; CP/M and IBM VM/370 are examples of such systems. CP/M can test for data only at the console; VM can test anywhere but the console.

Output to a job's controlling terminal may be reformatted by the operating system: control characters may be translated to printable equivalents, lowercase letters specially flagged or translated to uppercase (or vice versa), or tabs expanded to spaces. In addition, based on the terminal's declared width and length, long lines might be wrapped around or truncated, formfeeds translated to a series of linefeeds, and

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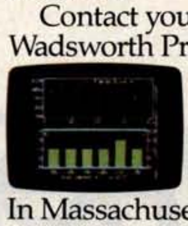

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the system may pause at the end of each screen full of output. Input from a job's controlling terminal may also be handled specially: lowercase letters may be converted to uppercase, a linefeed may be supplied when a carriage return is typed, or control characters may invoke special functions, such as line editing or program interruption. The DECSYSTEM-20 is an example of a computer where any of these might happen.

The moral here is that care must be taken to disable special handling of a mainframe job's controlling terminal when it is to be a vehicle for interprocessor communication. But some systems simply do not allow certain of these features to be disabled, so file-transfer protocols must be designed around them.

Line Access—Line access is either *full* or *half duplex*. If full duplex, transmission can occur in both directions at once. If half duplex, the two sides must take turns sending, each signaling the other when the line is free; data sent out of turn is discarded, or it can cause a break in synchronization. On mainframes, the host echoes characters typed at the terminal in full duplex but not in half duplex. Naturally, echoing is undesirable during file transfer. Full-duplex systems can usually accommodate half-duplex communication but not vice versa. IBM mainframes are the most prevalent half-duplex systems.

Buffering and Flow Control—Some systems cannot handle sustained bursts of input on a telecommunication line; the input buffer can fill up faster than it can be emptied, especially at high line speeds. Some systems attempt to buffer *typeahead* (unrequested input); others discard it. Those that buffer typeahead may or may not provide a mechanism to test or clear the buffer.

Systems may try to regulate how fast characters come in using a flow-control mechanism, either in the data stream (XON/XOFF) or parallel to it (modem control signals), but no two systems can be assumed to honor the same conventions for flow control—or to do it at all. Even when flow control is being done, the control signals themselves are subject to noise corruption.

Our experiments with several host
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computers revealed that a burst of more than a line's worth of characters (60 to 100) into a terminal port at moderate speed could result in loss of data—or worse—on some hosts. For instance, the communications front end of the DECsystem-2060 is designed on the statistical assumption that all terminal input comes from human fingers, and it cannot allocate buffers fast enough when this assumption is violated by sending continuous data simultaneously from several microcomputers attached to terminal ports.

Kermit is not written in any particular computer language as it is not a portable program but a portable protocol.

Character Interpretation—Systems differ in how they interpret characters that arrive at the terminal port. A host can accept some characters as sent, ignore others, translate others, and take special action on others. Communications front ends or multiplexers might swallow certain characters (typically, DC1, DC3) for flow control, padding (NUL or DEL), or transfer of control (escape). The characters that typically trigger special behavior are the ASCII control characters, including the delete character. For instance, of these 33 control characters, 17 invoke special functions of our DECSYSTEM-20 command processor. However, all hosts and communication processors we've encountered allow any printable character to reach an application program, even though the character may be translated to a different encoding, like EBCDIC (extended binary-coded-decimal interchange code), for internal use.

Some operating systems allow an application to input a character at a time; others delay passing the characters to the program until a logical record has been detected, usually a sequence of characters terminated by a carriage return or linefeed. Some record-oriented systems, like the IBM VM/370, discard the terminator; others keep it. And different ways of keeping it are used—UNIX translates a carriage return into a linefeed; most DEC operating systems keep the carriage return but also add a linefeed.

Timing Out—Hosts may or may not have the ability to time out. When exchanging messages with another computer, it is desirable to be able to issue an input request without waiting forever should the incoming data be lost. A lost message could result in a protocol deadlock in which one system is waiting forever for the message while the other waits for a response. Some systems can set timer interrupts to allow escape from potential blocking operations; others, including many microcomputers, cannot do so. When time-outs are not possible, they may be simulated by sleep-and-test or loop-and-test operations or deadlocked systems may be awakened by manual intervention.

File Organization—Some computers store all files in a uniform way, such as the linear stream of bytes that is a UNIX file. Other computers have more complicated or diverse file organizations and access methods—record-oriented storage with its many variations, exemplified in IBM OS/360 or DEC RMS. Even simple microcomputers can present complications when files are treated as uniform data to be transferred; for instance, under CP/M, the ends of binary and text files are determined differently. A major question in any operating system is whether a file is specified sufficiently by its contents and its name or if additional external information is required to make the file valid. A simple, generalized file-transfer facility can be expected to transmit a file's name and contents but not every conceivable attribute a file might possess.

Designers of expensive networks have gone to great lengths to pass file attributes along when transferring files between unlike systems. For instance, the DECnet Data Access Protocol supports 42 generic-system capabilities (such as whether files can be preallocated, appended to, accessed randomly, etc.), 8 data types (ASCII, EBCDIC, executable, etc.), 4 organizations (sequential, relative, indexed, hashed), 5 record for-

(text continued on page 262)

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mats (fixed, variable, etc.), 8 record attributes (for format control), 14 file-allocation attributes (byte size, record size, block size, etc.), 28 access options (supersede, update, append, rewind, etc.), 26 device characteristics (terminal, directory structured, shared, spooled, etc.), and various access options (new, old, rename, password, etc.), in addition to the better-known file attributes like name, creation date, protection code, and so on. All this was deemed necessary even when the designers had only a small number of machines from one vendor to worry about.

The ARPA (Advanced Research Projects Agency of the Department of Defense) network, which attempts to provide services for many more machines from many vendors, makes some simplifying assumptions and sets some restrictions in its File Transfer Protocol (FTP). All files are forced into certain categories with respect to encoding (ASCII, EBCDIC, image), record-format control, byte size, and file structure (record or stream), and it is generally left to the host FTP implementation to do the necessary transformations. No particular provision is made, or can be made, to ensure that such transformations are invertible. Invertibility involves sending a copy of a file to another system, receiving a copy of that file back from the other system, and having all the attributes of this second copy of the file match the original file's characteristics.

DECnet is able to provide invertibility for operating systems like VMS or RSX, which can store the necessary file attributes along with the file. But simpler file systems, like those of TOPS-10 or TOPS-20, can lose vital information about incoming files. For instance, if VMS requires some type of file to have a specific block size, while TOPS-20 has no concept of block size, the block size will be lost upon transfer from VMS to TOPS-20 and cannot be restored automatically when the file is sent back, leaving the result potentially unusable.

Invertibility is a major problem with no simple solution. Fortunately, file transfer between unlike systems usually involves only textual information—data, documents, program source—which is sequential in organization, and for which any required transformations (e.g., blocked to stream, EBCDIC to ASCII) are simple and not dependent on any special file attributes.

In fact, invertibility *can* be achieved if that is the primary goal of a file-transfer protocol. All the external attributes of a file can be encoded and included with the contents of the file to be stored on the remote system. For unlike systems, this can render the file less than useful on the target system but allows it to be restored correctly upon return. However, it is more commonly desired that textual files remain intelligible when transferred to a foreign system, even if transformations must be made. To allow the necessary transformations to take place on textual files between unlike systems, there must be a standard way of representing these files during transmission.

Binary Files versus Parity—Each ASCII character is represented by a string of 7 bits. Printable ASCII files can be transmitted in a straightforward fashion because ASCII transmission is designed for them: a serial stream of 8-bit characters, 7 bits for data and 1 bit for parity, framed by start and stop bits for the benefit of the hardware. The parity bit is added as a check on the integrity of a character. Some systems always transmit parity, some insist on parity for incoming characters, some ignore the parity bit for communication purposes and pass it along to the software, and some discard it altogether. In addition, communications front ends or common carriers might usurp the parity bit, regardless of what the system itself may do.

Computer file systems generally store an ASCII text file as a sequence of either 7-bit or 8-bit bytes. Eight-bit bytes are more common, in which the eighth bit of each byte is generally superfluous. Besides files composed of ASCII characters, however, computers also have binary files, in which every bit is meaningful; examples include executable core images of programs, numbers stored in internal format, and databases with embedded pointers. Such binary data must be mapped to ASCII characters for transmission over serial lines. When two systems allow the user-level software to control the parity bit, the ANSI (American National Standards Institute) standards may be stretched to

(text continued on page 264)

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permit the transmission of 8 data bits per character, which corresponds to the byte size of most machines. But since not all computers allow this flexibility, the ability to transfer binary data in this fashion cannot be assumed.

Software—Finally, systems differ in their application software. In particular, no system can be assumed to have a particular programming language. Even widespread languages such as FORTRAN and BASIC may be lacking from some computers, either because they have not been implemented or because they are proprietary and have not been purchased. Even when two different systems support the same language, it is unrealistic to expect the two implementations to be totally compatible. A general-purpose file-transfer protocol should not be written in or geared toward the features of any particular computer language.

THE KERMIT PROTOCOL

Kermit addresses the problems outlined above by setting certain minimal standards for transmission and providing a mapping among disk-storage organization, machine word and byte size, and the transmission medium. Kermit has the following characteristics:

- Communication takes place over ordinary terminal connections.
- Communication is half duplex. This allows both full- and half-duplex systems to participate, and it eliminates the echoing that would otherwise occur for characters arriving at a host job's controlling terminal.
- The packet length is variable, but the maximum is 96 characters so that most hosts can take packets in without buffering problems.
- Packets are sent in alternate directions; a reply is required for each packet. This allows half-duplex systems to participate and prevents buffer overruns that would occur on some systems if packets were sent back to back.
- A time-out facility, when available, allows transmission to resume after a packet is lost.
- All transmission is in ASCII. Any non-ASCII hosts are responsible for conversion. ASCII control characters are prefixed with a special character and then converted to printable characters during transmission to ensure that they arrive as sent. A single ASCII control character (normally SOH [start of header]) is used to mark the beginning of a packet.
- Binary files can be transmitted by a similar prefix scheme or by use of the parity bit when both sides have control of it.
- Logical records (lines) in textual files are terminated during transmission with prefixed carriage return/linefeed sequences, which are transparent to the protocol and may appear anywhere in a packet. Systems that delimit records in other ways are responsible for conversion, if they desire the distinction between records to be preserved across unlike systems.
- Only a file's name and contents are transmitted—no attributes. It is the user's responsibility to see that the file is stored correctly on the target system. Within this framework, invertible transfer of text files can be assured, but invertible transfer of nontext files depends on the capabilities of the particular implementations of Kermit and the host operating systems.
- Kermit has no special knowledge of the host on the other side. No attempt is made to integrate the two sides. Rather, Kermit is designed to work more or less uniformly on all systems.
- Kermit need not be written in any particular language. It is not a portable program but a portable protocol.

Thus, Kermit accommodates itself to many systems by conforming to a common subset of their features. But the resulting simplicity and generality allow Kermit on any machine to communicate with Kermit on any other machine: microcomputer-to-mainframe, microcomputer-to-microcomputer, mainframe-to-mainframe. The back-and-forth exchange of packets keeps the two sides synchronized; the protocol can be called asynchronous only because the communication hardware itself operates asynchronously.

As far as the user is concerned, Kermit is a do-it-yourself operation. For instance, to transfer files between your microcomputer and a mainframe, you would run Kermit on your microcomputer, put Kermit into the terminal-emulation mode to let you "connect" to the mainframe, log in and run Kermit on the mainframe, and then escape back to the microcomputer and issue commands to the microcomputer's Kermit to send or fetch the desired files. Any inconvenience implicit in this procedure is a consequence of the power it gives the ordinary user to establish reliable connections between computers that could not otherwise be connected.

PACKETS

Kermit packets need to contain the data that is being transferred, plus minimum information to ensure that the expected data arrives completely and correctly. Several issues arise when designing the packet layout: how to represent data, how to delimit fields within the packet, how to delimit the packet itself, and how to arrange the fields within the packet. Since the transmission medium itself is character oriented, it is not feasible to transmit bit strings of arbitrary length, as do the bit-oriented protocols like HDLC (high-level data-link control) and SDLC (synchronous data-link control). Therefore, the smallest unit of information in a packet must be the ASCII character. As we will see, this precludes some techniques used with other communication media.

Control Fields—Most popular protocol definitions view the packet as layers of information that pass through a hierarchy of protocol levels, each level adding its own information at the ends of an outbound packet or stripping its information from the ends of an incoming packet, and then passing the result along to the next level in the hierarchy. The fields for each layer must be arranged so that they can be found, identified, and interpreted correctly at the appropriate level.

Since Kermit packets are short, it is important to minimize the amount of control information per packet. It would be convenient to limit the control fields to one character each. Because we have 95 printable characters to work with (128 ASCII characters, less the delete character [DEL] and the 32 control characters), we can represent values from 0 to 94 with a single character:

- The *packet sequence number* is used to detect missing or duplicate packets. It is unlikely that a large number of

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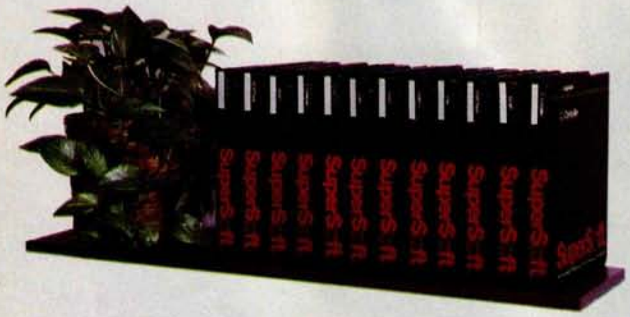

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Compatible with Microsoft BASIC

The SuperSoft BASIC compiler, available under CP/M-86 and MS DOS, is compatible with Microsoft* BASIC and follows the ANSI standard.

Greater accuracy with BCD math routines

If you have used other languages without BCD math, you know how disconcerting decimal round off errors can be. For example:

With IBM PC* BASIC	With SuperSoft BASIC with BCD math
10 A=.99	10 A=.99
20 PRINT A	20 PRINT A
30 END	30 END
Output: .9899999	Output: .99

As you can see, SuperSoft BASIC with BCD provides greater assurance in applications where accuracy is critical.

SuperSoft's BASIC is a true native code compiler, not an intermediate code interpreter. It is a superset of standard BASIC, supporting numerous extensions to the language. Important features include:

- Four variable types: Integer, String, and Single and Double Precision Floating Point (13 digit)
- Full PRINT USING for formatted output
- Long variable names
- Error trapping
- Matrices with up to 32 dimensions
- Boolean operators OR, AND, NOT, XOR, EQV, IMP
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Requires:	128K memory
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*SuperSoft BASIC is compatible with Microsoft BASIC interpreter and IBM PC BASIC. Due to version differences and inherent differences in compilers and interpreters some minor variations may be found. Machine dependent commands may not be supported. The vast majority of programs will run with no changes.

(*text continued from page* 264)

packets could be lost, especially since packet *n* is acknowledged before packet *n*+1 is sent. The sequence number can thus be a small quantity, which wraps around to its minimum value when it exceeds a specified maximum value.

- To prevent long packets, a small maximum length can be enforced by specifying the *packet length* with a single character; since 95 printable ASCII characters can be transmitted, this would be the maximum length, depending on how we count the control fields.
- The *checksum* can be of fixed length. The actual length depends on the desired balance between efficiency and error detection.

The packet length and checksum act together to detect corrupted, missing, or extra characters. These are the essential fields for promoting error-free transmission. So far, however, we've considered only packets that carry actual file data; we will also require special packets composed only of control information, for instance, to tell the remote host the name of the file that is about to come or to tell it that the transmission is complete. This can be accomplished with a *packet type* field. The number of functions we need to specify in this field is small, so a single character can also suffice here.

Packet Framing—We chose to mark the beginning of a package with a distinguishing start character, SOH (Control-A). This character cannot appear anywhere else within the packet. SOH was chosen because, unlike most other control characters, it is generally accepted upon input at a job's controlling terminal as a data character rather than as an interrupt or break character on most mainframes. This is probably no accident, since it was originally intended for this use by the designers of the ASCII alphabet. Should a system be incapable of sending or receiving SOH, it is possible to redefine the start-of-packet character to be any other control character; the two sides need not use the same one.

Three principal options for recognizing the end of a packet are available: fixed length, distinguishing packet-end

(*text continued on page* 270)

(text continued from page 268)

character, and length field. Arguments are made for and against each involving what happens when characters, particularly a length or terminator, are lost or garbled. These will be mentioned later. Kermit uses a length field.

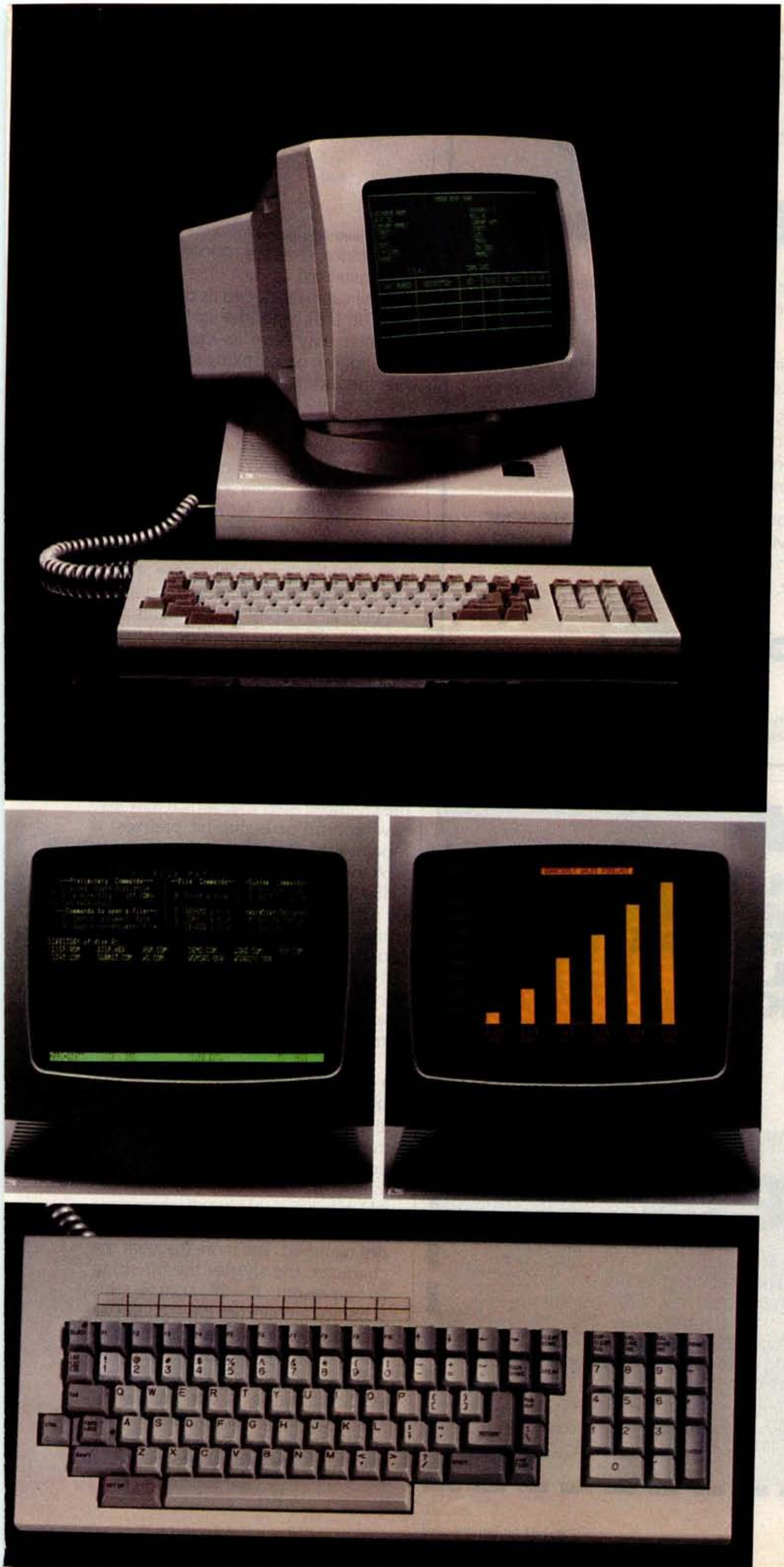
To take in a packet, Kermit gets characters from the line until it encounters the SOH. The next character is the length; Kermit reads and decodes the length and then reads that many subsequent characters to complete the packet. If another SOH is encountered before the count is exhausted, the current packet is forgotten and a new one started automatically. This strategy allows arbitrary amounts of noise to be generated spontaneously between packets without interfering with the protocol.

Encoding—When transmitting textual data, Kermit terminates logical records with carriage return/linefeed combinations (CR/LFs). On record-oriented systems, trailing blanks or length fields are removed and a CR/LF appended to outbound records, with the inverse operation performed on incoming records. On stream-oriented systems, incoming CR/LFs may be translated to some other terminator. Files, of course, need not have logical records, in which case record processing can be skipped altogether, and the file can be treated as a long string of bytes. This is known as image transfer, and it can also be used between like systems where no transformations are necessary.

In order to make each character in the packet printable, Kermit prefixes, or quotes, any unprintable character by transforming it to a printable one and precedes it with a special prefix character, normally #. The transformation is done by complementing the seventh bit (adding or subtracting 64 modulo 64). Thus, Control-A becomes #A and Control-Z becomes #Z. The prefix character is also used to prefix itself: ##. Upon input, the reverse transformation is performed. Printable characters are not transformed. The assumption is that most files to be transferred are printable, and printable text files contain relatively few control characters; when this is true, the character stream is not significantly lengthened by quoting. For binary files, the average quoting overhead will be 26.6 percent more characters if all bit patterns are equally likely, since the characters that must be prefixed (the control characters, plus DEL and # itself) comprise 26.6 percent of the ASCII alphabet.

Kermit also provides a scheme for indicating the status of the eighth bit when transferring binary files between systems that must use the eighth bit for parity. A byte whose eighth bit is set is preceded by another special prefix character, &. If the low-order 7 bits coincide with an ASCII control character, a control-character prefix is also added.

(text continued on page 272)



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LIBERTY

(text continued from page 270)

For instance, the byte 10000001_2 would be transmitted as &#A. The & character itself can be included as data by prefixing it (#&), and the control-prefix character may have its eighth bit set (&##). Eighth-bit prefixing is done only when necessary; if both sides can control the parity bit, its value is preserved during transmission. If the eighth bit is set randomly on binary files, eighth-bit prefixing will add 50 percent character overhead. For some kinds of binary data, it could be less; for instance, positive binary numbers in two's-complement notation do not have their high-order bits set, in which case at least one byte per word will not be prefixed.

A third kind of prefix implements rudimentary data compression. At low speeds, the bottleneck in file transmission is likely to be the line itself, so any measure that can cut down on use of the line would be welcome. The special prefix character ~ indicates that the next character is a repeat count (a single character, encoded printably) and that the character after that (which may also have control or eighth-bit prefixes) is repeated so many times. For instance, ~}A indicates a series of 93 letter As; ~H&#B indicates a series of 40 Control-Bs with the parity bit set. The repeat count prefix itself can be included as text by prefixing it with #.

To keep the protocol simple, no other transformations are done. At this point, however, it might be worth mentioning some things we did *not* do to the data:

- *Fancy data compression*. If the data is known to be (or resemble) English text, a Huffman encoding based on the frequency of characters in English text could be used. A Huffman code resembles Morse code, which has variable-length characters whose boundaries can always be distinguished. The more frequent the character, the shorter the bit string to represent it. Of course, this scheme can backfire if the character distribution of the data is very different from the one assumed. In any case, variable-length characters and ASCII transmission don't mix well.
- *Error-correcting codes*. Techniques such as Hamming codes exist for detecting and correcting errors on a

(text continued on page 274)

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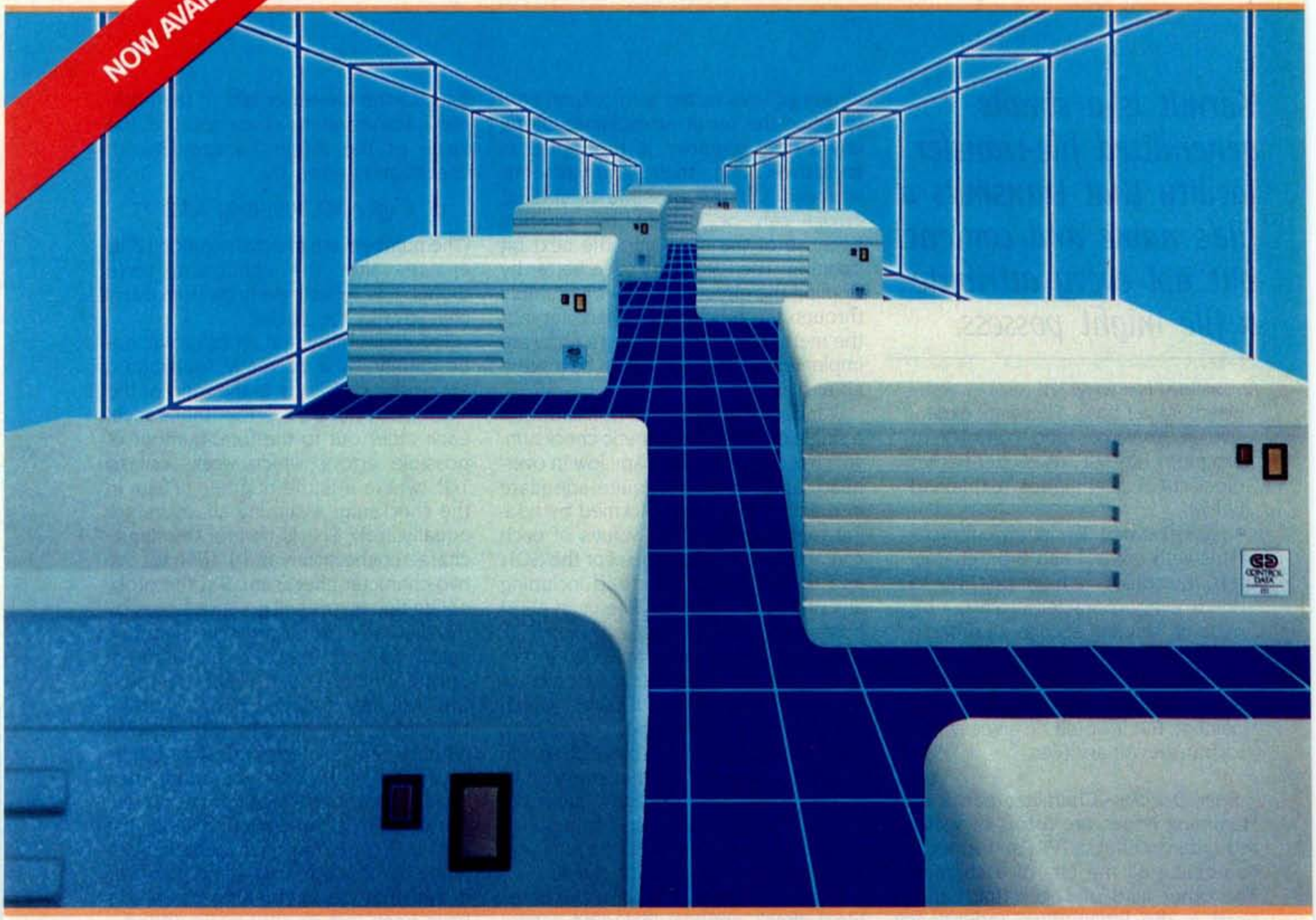

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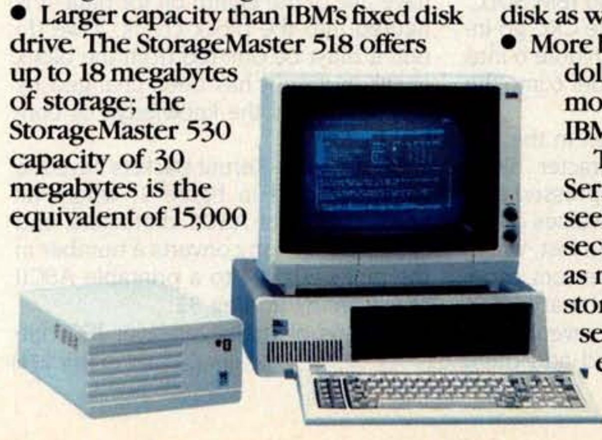

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*This capability requires the use of a StorageMaster 301 Controller.

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CONTROL DATA

Kermit is a simple, generalized file-transfer facility that transmits a file's name and contents but not every attribute a file might possess.

(*text continued from page* 272)

per-character basis. These are expensive in resources and complex to program. Kermit uses per-packet block-check techniques (explained below).

- *Nybble encoding*. To circumvent problems with control and 8-bit characters, it would have been possible to divide every character into two 4-bit nybbles, sending each as a printable character (e.g., a hexadecimal digit). The character overhead caused by this scheme would always be 100 percent. But it would be an easy way to transfer binary files.

Error Detection—Character parity and Hamming codes are forms of vertical redundancy checks (VRCs), formed by combining all the bits of a character. The other kind of check that can be used is the longitudinal redundancy check (LRC), which produces a block-check character formed by some combination of each character within a sequence. The sending side computes the LRC and sends it with the packet; the receiving side recomputes it for comparison. Various forms of LRCs exist. One form produces a column-parity character, or logical sum, whose bits are the exclusive-ORs of the corresponding bits of the data characters. Another is the checksum, which is the arithmetic sum of all the characters in the sequence, interpreted numerically. Another is the cyclic redundancy check (CRC), which passes the characters through what amounts to a shift register with embedded feedback loops, producing a block check in which each bit is affected in many ways by the preceding characters.

All these techniques will catch single-bit errors. They do vary in their ability to detect other kinds of errors. For instance, a double-bit column error will always go undetected with column parity, since the result of exclusive-ORing any 2 bits together is the same as exclusive-ORing their complements, whereas half the possible double-bit errors can be caught by addition because of the carry into the next bit position. The CRC does even better by rippling the effect of a data-bit multiply through the block-check character, but the method is complex, and a software implementation of a CRC can be inscrutable.

Standard, base-level Kermit employs a single-character arithmetic checksum, which is simple to program, low in overhead, and has proven quite adequate in practice. The sum is formed by adding together the ASCII values of each character in the packet except the SOH and the checksum itself and including any prefixing characters. Even non-ASCII hosts must do this calculation in ASCII. The result can approach 12,000 in the worst case. The binary representation of this number is 10111011100000_2, which is 14 bits long. This is much more than one character's worth of bits, but we can make the observation that every character included in the sum has contributed to the low-order 7 bits, so we can discard some high-order bits and still have a viable validity check.

The Kermit protocol also allows other block-check options, including a two-character checksum and a three-character 16-bit CRC. The two-character checksum is simply the low-order 12 bits of the arithmetic sum broken into two printable characters. The CRC sequence is formed from the 16-bit quantity generated by the CCITT-recommended polynomial $X^{16} + X^{12} + X^5 + 1$, which is also used in some form with other popular transmission techniques, such as International Organization for Standardization (ISO) HDLC and IBM SDLC. The high-order 4 bits of the CRC go into the first character, the middle 6 into the second, and the low-order 6 into the third.

Some care must be taken in the formation of the single-character block check. Since it must be expressed as a single printable character, values of the high-order data bits may be lost, which could result in undetected errors, especially when transferring binary files. Therefore, we extract the seventh and eighth bits of the sum and add them back to the low-order bits; if the arithmetic sum of all the characters is S, the value of the single-character Kermit checksum is given by

$$(S + ((S \text{ AND } 300)/100)) \text{ AND } 77$$

(The numbers are in octal notation.) This ensures that the checksum, terse though it is, reflects every bit from every character in the packet.

The probability that an error will not be caught by a correctly transmitted arithmetic checksum is the ratio of the number of possible errors that cancel each other out to the total number of possible errors, which works out to $1/2^n$, where n is the number of bits in the checksum, assuming all errors are equally likely. This is 1/64 for the single-character checksum and 1/4096 for the two-character checksum. But the probability that errors will go undetected by this method *under real conditions* cannot be easily derived, because all kinds of errors are not equally likely. A 16-bit CRC will detect all single- and double-bit errors, all messages with an odd number of bits in error, all error bursts shorter than 16 bits, and more than 99.99 percent of longer bursts. These probabilities all assume, of course, that the block check has been identified correctly, i.e., that the length field points to it and that no intervening characters have been lost or spuriously added.

A final note on parity—a parity bit on each character combined with a logical sum of all the characters (VRC and LRC) would allow detection and correction of single-bit errors without retransmission by pinpointing the row and column of the bad bit. But control of the parity bit cannot be achieved on every system, so we use the parity bit for binary data when we can or surrender it to the communication hardware if we must. If we have use of the eighth bit for data, it is figured into the block check; if we do not, it must be omitted from the block check in case it has been changed by agents beyond the knowledge or control of Kermit.

Packet Layout—Kermit packets have the format, shown in figure 1, where all fields consist of ASCII characters, and the char function converts a number in the range 0 to 94 to a printable ASCII character by adding 32.

In terms of the seven-layer ISO net-

(*text continued on page* 276)

(text continued from page 274)
work reference model, 8-bit bytes are presented to Kermit by the hardware and operating-system software comprising the physical-link layer. Correct transmission is ensured by the packet-level routines that implement the data-link layer using the outer "skin" of the packet—the MARK, LEN, and CHECK fields. The network and transport layers are moot, since Kermit is a point-to-point affair in which the user personally makes all the required connections. The session layer is responsible for requesting retransmission of missing packets or ignoring redundant ones, based on the SEQ field; the presentation layer is responsible for any data conversions (EBCDIC/ASCII, insertion or stripping of CR/LFs, etc.). Finally, the TYPE and DATA fields are the province of the application layer; our application, of course, is file transfer. In any particular implementation, however, the organization of the program may not strictly follow this model. For instance, since transmission is always in an ASCII stream, IBM mainframe implementations must convert from EBCDIC and insert CR/LFs *before* checksum computation.

The six fields of a Kermit information packet are listed in table 1. The packet may be followed by any line terminator required by the host, a carriage return by default. Line terminators are not part of the packet and are not included in the count or checksum. Terminators are not necessary to the protocol and are invisible to it, as are any characters that may appear between packets. If a host cannot do single-character input from a terminal, a terminator will be required for that host.

Some sample Kermit data packets are shown in listing 1. The ^A represents the unprintable SOH (or Control-A) character. In the last packet shown, E is the length. The ASCII value of the E character is 69, less 32 (the unchar transformation, which is the opposite of char) gives a length of 37. The next character, &, tells the packet sequence number, in this case 6. The next is the packet type D for Data. The next characters, "of#M#Jconstructing a theory conta", form the data; note the prefixed carriage return and linefeed. The final character, 5, is the checksum, which represents the number 21.

Effects of Packet Corruption—What are the consequences of transmission errors in the various fields? If the SOH is garbled, the packet will be treated as interpacket garbage and ignored. If any other character within the packet is garbled into SOH, the current packet will be discarded and a new (spurious) packet detected. If the length is garbled into a smaller number, a character from the data field will be misinterpreted as the checksum; if larger, the program will probably become stuck trying to input characters that will not be sent until one side or the other times out and retransmits. If the sequence number, type, any of the data characters, or the checksum itself is garbled, the checksum should be wrong. If characters are lost, there will most likely be a time-out. If noise characters are spontaneously generated, they will be ignored if they are between packets or will cause the wrong character to be interpreted as the checksum if they come during packet transmission.

Most kinds of errors are caught by the checksum comparison and are handled by immediate retransmission. Time-outs are more costly because the line sits idle for the time-out period. The packet design minimizes the necessity for time-outs due to packet corruption: the only fields that can be corrupted to cause a time-out are the SOH and the packet length, and the latter only half the time. Lost characters, however, can produce the same effect (as they would with a fixed-length block protocol). Had a distinguishing end-of-packet character been used rather than a length field, there would be a time-out every time it was corrupted. It is always better to retransmit immediately than to time out.

SUMMARY

We've covered the factors that should be considered in designing a simple, reliable, inexpensive, and yet comprehensive file-transfer protocol—Kermit. The asynchronous serial communications used by the Kermit protocol can accommodate a variety of diverse computer systems and their different ways of handling information and files. Kermit sets minimum transmission standards by providing a common subset of the machines' features. These features include transfer of the filename and contents for both textual and binary files, different error-detection methods, and time-out facilities if either end of the communication link experiences delays or difficulties. The encoding of the information in the packets, the error-detection checksums, and the layout of the fields in the packets were also presented.

(text continued on page 278)

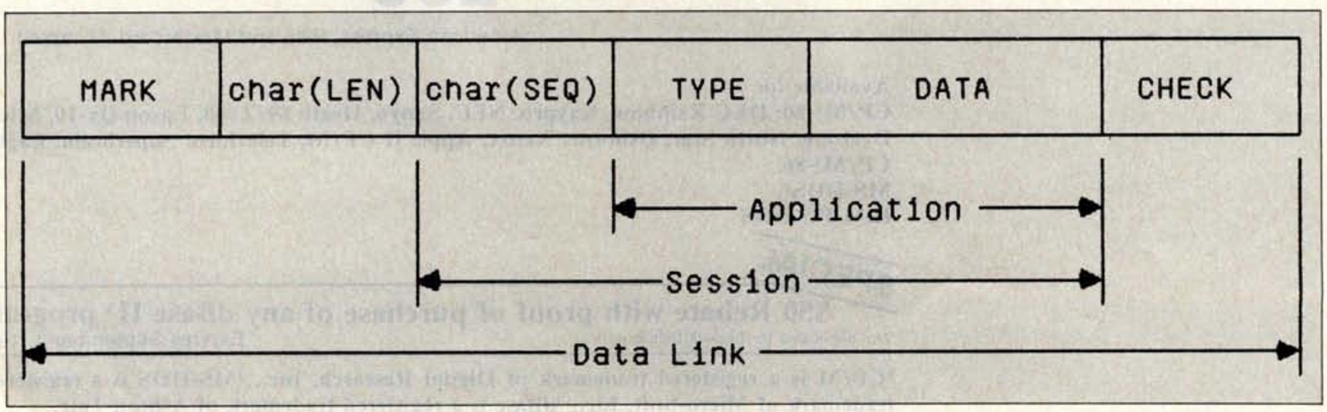

Figure 1: *The format for a packet of information according to the Kermit protocol.*

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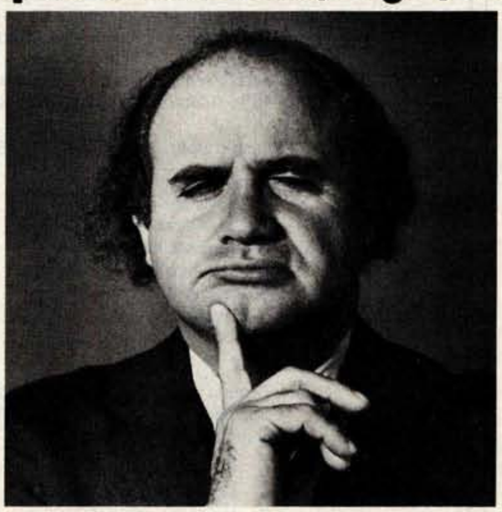

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(text continued from page 276)

In part 2, we'll look at how the Kermit protocol works and its uses: the different modes each side can be in when sending and receiving files, how initial connections take place and the exchange of initial packets of information that specify each side's setup requirements, the heuristics to improve efficiency and error recovery, examples of packets and a session using Kermit, performance figures, the user interface, and future directions for Kermit as a working network with file servers. ■

Listing 1: *Some sample packets of information in the Kermit protocol. The* ^A *represents the unprintable* ASCII *start-of-header character.*

```
^AE"D   No celestial body has required J
^AE#Das much labor for the study of its#
^AE$D#M#Jmotion as the moon. Since ClaA
^AE%Dirault (1747), who indicated a way7
^AE&D of#M#Jconstructing a theory conta5
```

(Kermit is not an acronym. It was named after Kermit the Frog, star of the television series, The Muppet Show. *Used by permission of Henson Associates Inc.)*

Table 1: *The six fields in a packet of information in the Kermit protocol.*

MARK	Start-of-packet character, normally SOH (Control-A).
LEN	The number of ASCII characters, including prefixing characters and the checksum, in the rest of the packet that follows this field; in other words, the packet length minus two. Since this number is expressed as a single character via the char function, packet character counts of 0 to 94 are permitted, and 96 is the maximum total packet length, including the MARK and LEN fields.
SEQ	The packet sequence number, between 0 and 63. The sequence number wraps around to 0 after each group of 64 packets.
TYPE	The packet type, a single printable ASCII character, is one of the following: D Data Y Acknowledge (ACK) N Negative Acknowledge (NAK) S Send Initiate (Send-Init) R Receive Initiate B Break Transmission (EOT) F File Header Z End of File (EOF) E Error G Generic command. A single character in the data field, possibly followed by operands, requests host-independent remote execution of the specified command: L Log out, bye F Finish, but don't log out D Directory query (followed by optional file specification) U Disk-usage query E Erase (followed by file specification) T Type (followed by file specification) Q Query server status and others. C Host command. The data field contains a string to be executed as a system-dependent (literal) command by the host. X Text display header. To indicate the arrival of text to be displayed on the screen, for instance, as the result of a generic or host command executed at the other end. Operation is exactly like a file transfer.
DATA	The contents of the packet, if any contents are required in the given type of packet, interpreted according to the packet type. Nonprintable ASCII characters are prefixed with special characters and then converted to printable characters by complementing the seventh bit. Characters with the eighth bit set may also be prefixed, and a repeated character can be prefixed by a count. A prefixed sequence of characters may not be broken across packets.
CHECK	The block-check sequence, based on all the characters in the packet between, but not including, the mark and the check itself, can be one, two, or three characters in length as described previously, each character transformed by the char function. Normally, the single-character checksum is used.

SAN FRANCISCO'S EXPLORATORIUM

BY JOHN MARKOFF

A *hands-on, interactive museum*

AS A VISITOR to San Francisco's Exploratorium, you will be struck by what seems at first to be utter chaos. Entering the dim, cavernous space the Exploratorium occupies, you will see children darting to and fro, hear random sounds from strange devices that echo into the distance, and observe spectral lights that seem to shine in every corner.

Soon the confusion clears and you realize that you haven't entered some high-tech asylum. You have found your way into a wonderfully diverse free-form science museum.

The Exploratorium represents science for the general public. There is no right or wrong way to conduct an experiment and the exhibits here are intended to be used in ways their designers never imagined.

Each year more than 450,000 visitors, almost as many adults as children, make the trek to this unique learning center. They play with—and learn from—more than 500 interactive scientific exhibits ranging from gravity wells to echo chambers to more esoteric computerized simulations.

The Exploratorium was founded in 1969 by physicist Frank Oppenheimer and has since gained an international reputation as a hands-on science museum. It has been called "the best science museum in the world" by the editor of *Scientific American*.

As might be expected, a museum that intentionally disregards many of the established conventions of scientific good manners uses personal computers in an unorthodox fashion as well. In exhibits scattered around the Exploratorium floor, it's possible to find microcomputers ranging from simple John Bell Engineering controllers to full-blown Intel 8086 development systems. The difference is that at the Exploratorium there are no personal computer exhibits per se. Computers are used to illustrate basic scientific concepts or to alter the perception of Exploratorium visitors about things around them that they haven't noticed before. Visitors may never realize that any particular exhibit is being guided by a personal computer.

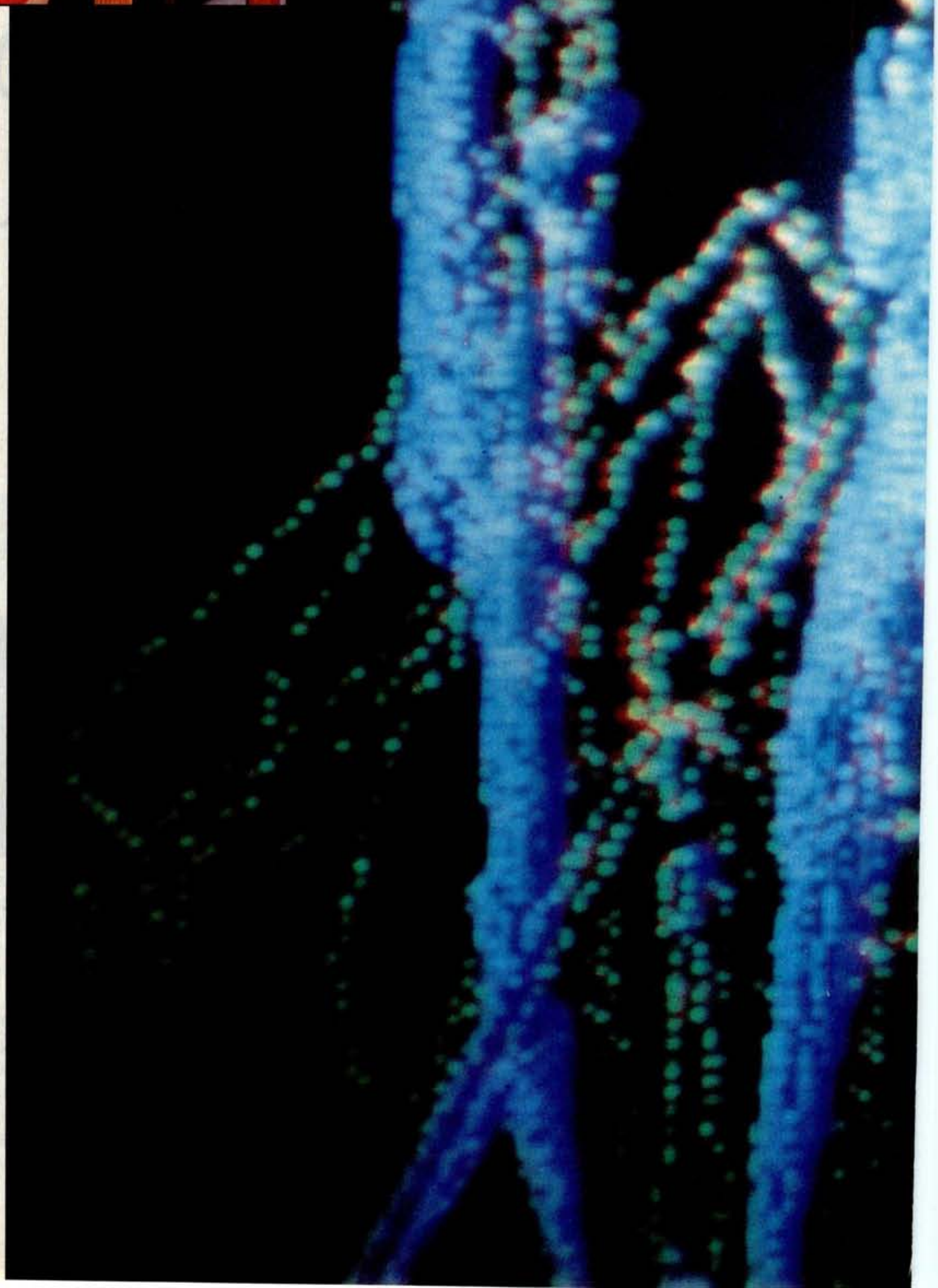
Unlike other computer-literacy projects, teaching programming is not a first priority at the Exploratorium. Instead, the goal is to convey the idea that computers are just tools and that they can

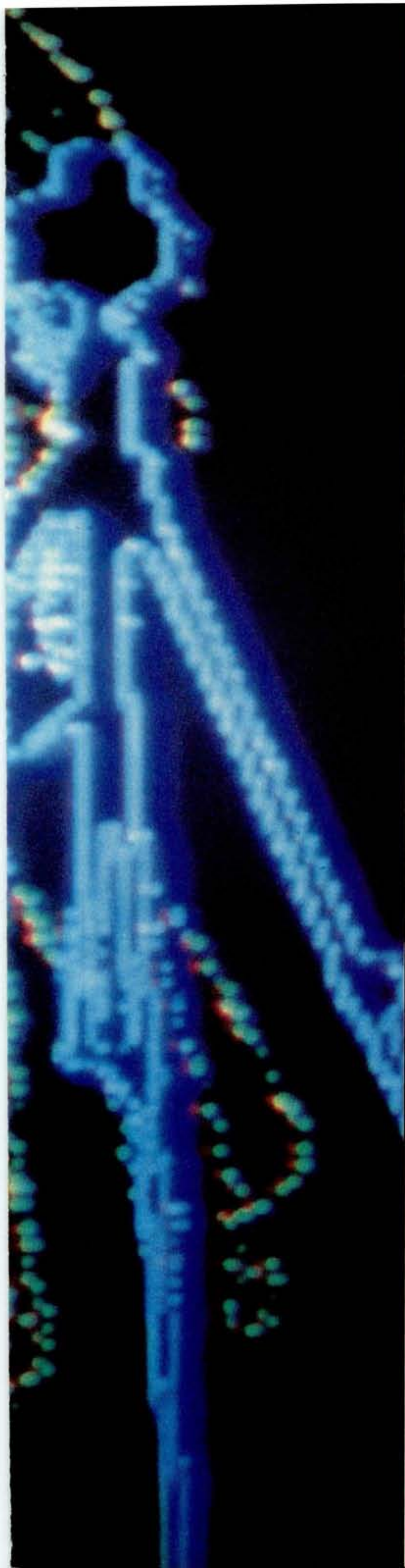
(text continued on page 281)

John Markoff is a BYTE *senior technical editor. He can be reached at* 1000 *Elwell Ct., Palo Alto,* CA 94303.

PHOTOS BY MARGARET MOULTON

The Exploratorium has received financial support and donations of equipment from a number of semiconductor and computer corporations. Intel Corporation has donated computer hardware and has permitted several of its engineers to spend three-month sabbaticals designing simulation exhibits based on Intel equipment. The children at this exhibit are controlling a simulated satellite in orbit around a planetary object. The simulation system is based on an Intel 8086 development computer with an 8087 math coprocessor.





(text continued from page 279)
be used like any other tool.

"We try to show people that you typically do not break computers by touching them. There's nothing you can do that is wrong," says Ron Hipschman, a San Francisco physicist who serves as the Exploratorium's resident computer wizard. "Our science museum is based on that concept, too. You can't do anything wrong with our exhibits. You may not do what we intended, but if you do something different, so what?"

Hipschman began teaching computer courses at the Exploratorium years ago with borrowed IMSAI and North Star computers. More recently, donations of computers from Texas Instruments and Atari have made it possible to hold regular introductory classes in both BASIC and Logo.

Logo fits in well with the philosophy of the Exploratorium, as it has always been perceived as an exploratory and experimental language.

"The Exploratorium is designed to give people the ability to explore and play," he says, "so our classes are much less structured than school. You can't force-feed the kids in school and you can't force-feed them on the computer either."

Several computer-based Exploratorium exhibits have been designed by artists. Recollections, by Ed Tannenbaum, employs an Apple II computer that controls a frame buffer hooked to a video camera. Like all Exploratorium exhibits, this one is participatory. Visitors walk into a three-sided room. On one side the video camera tracks their movements, which are then transformed by the Apple II and the frame buffer and projected on a screen in front of the observer.

Another thing that the children bring away from their introduction to computers at the Exploratorium is that if something goes wrong, it's usually their own fault, not the computer's. Hipschman strives to show the children that because the computer is a tool that doesn't often make mistakes, it's actually very reliable.

At the Exploratorium, the computer is viewed as a valuable instructional aid in demonstrating a system of scientific reasoning.

"It's a very logical process in finding your mistakes and it spills over into everyday life," remarks Hipschman. "You say, 'OK, something's not working here, what's going on?' You start at the beginning without any assumptions. It (the computer) has a logical sequence of events and it works everywhere."

In the future, the Exploratorium plans to use computers to simulate events that can't take place directly within the confines of the museum. Already the Intel 8086 development systems are being used to simulate simple orbital mechanics and the backscattering of light. Another simulation running on an Apple II computer illustrates how different growth rates of competing populations can interact.

What kinds of simulations are possible?

Recently Hipschman and Exploratorium co-worker Joe Ansel tried to envision a perfect computer simulation for
(text continued on page 282)

(text continued from page 281)

the Exploratorium. They began with a simple water fountain in which water shoots up into the air and makes a nice parabola, then comes back down.

In the physical world there are really only a few variables you can change easily; you might vary the velocity of the water or the height and angle of the nozzle. But in Hipschman's and Ansel's fantasies it would be nice if you could vary the viscosity of the air around the water to increase the friction. What would it look like if you varied the viscosity of the water or even changed the force of gravity?

Computer simulations will bring these physicists' fantasies to life in the Exploratorium. Perhaps Ansel says it best when he points out that "there is no pathway to walk through this museum." ■

Courses for Credit Through Electronic Mail

BY DONNA OSGOOD

As enrollments decline, colleges are looking for new ways to distribute their product—education. Personal computers with communications capabilities open new possibilities for away-from-campus learning.

A problem that's inherent in computer-based learning at home also plagues traditional correspondence courses: the student has no direct contact with the instructor. Without a human there to answer questions, direct discussion, and get the student "unstuck" when necessary, motivation can flag. If no one cares whether a student finishes the course, he may not.

One solution is offered by TeleLearning's Electronic University, which enrolled its first student in an accredited course last March. A student in the Electronic University studies course material and completes assignments using a personal computer, then transmits the work directly to the instructor's electronic mailbox. Within a day or two, the instructor sends a response to the student's mailbox. Instructors hold "office hours" when students can contact them directly.

TeleLearning provides a delivery system for courses developed and accredited by universities and community colleges. Instructors develop new courses using TeleLearning's authoring package. TeleLearning codes and digitizes lessons and graphics for each instructor. A student buys a software package and a simple modem from TeleLearning, and enrolls in the course on line. The software package includes an operating system and a front end for communications, to reduce the sign-on procedure and protocols to a keystroke.

Colleges can offer courses for credit to students who otherwise could not enroll because of time, work, distance, or financial constraints, or physical disability. Textbooks and course disks can be distributed through department stores and computer specialty centers, further extending the university's reach. The course costs are usually less than similar traditional courses.

Students and instructors introduce themselves to each other at the beginning of the course. An instructor typically spends twenty minutes per lesson with each student's work and can individualize questions and problems to fit the student's interests. Students and instructors find the system convenient and flexible—they can complete the work wherever and whenever convenient.

TeleLearning uses the Tymnet, Telenet, and Uninet public packet-switching networks, switching automatically from one to the other in case of network problems. A communications-analysis system monitors all functions and handles routing and error corrections. By compressing data and batching complete files, the system cuts communications costs to a minimum. The TeleLearning system runs on the IBM PC, Apple II series, and Commodore 64.

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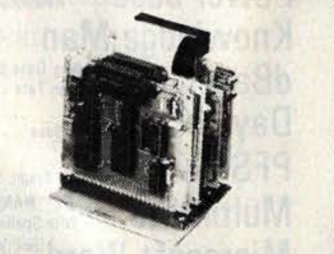

As featured in Ciarcia's Circuit Cellar. BYTE Magazine, July & August 1981

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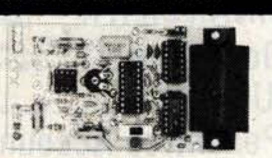

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MICRO MINT

DESIGNING A SIMULATED LABORATORY

BY NILS PETERSON

An example from cardiovascular physiology

THE DYNAMICS OF a medical laboratory spring to life with the aid of microcomputer simulation. Computer-simulated laboratories are increasingly valuable as teaching aids; without them, most medical students could only read about important discoveries. Laboratories are becoming too expensive and their maintenance too difficult to be practical. In today's fast-paced medical curriculum, it is hard for students to perform experiments that are a hundred years old but are still crucial to contemporary medical understanding. This creates a fundamental problem because the dynamics of a laboratory are an important supplement to the static explanations in textbooks. Simulated laboratories in the health sciences also serve to alleviate, in part, the need for experimental animals—an important ethical consideration. The laboratory must not be lost from medical training.

Photo 1 shows the simulation of an experiment first performed at the turn of the century. The experiment remains central to our understanding and treatment of heart disease. The computer provides an ideal environment for teaching the intellectual concepts of cardiac function while omitting those things that make a real laboratory prohibitive as a teaching environment (the long hours of open-heart surgery, the animal-care facilities, the expensive modern apparatus).

The lack of laboratory training is a problem not unique to medicine. It affects all disciplines in which theory and technology have advanced rapidly. A simulated laboratory can fill the gaps in a student's understanding by providing concrete demonstrations in the manner of a real laboratory, but without the expense and without making demands on the student's already precious time. Today, a 16-bit microcomputer with high-resolution graphics and a numeric coprocessor offers an enhancement that further increases the utility of laboratory simulation. This article is intended to show what we have done to take advantage of the microcomputer's growing prowess as a teaching aid.

Nils Peterson is a knowledge interface designer for Learning Tools (NE 1050 Alfred Lane, Pullman, WA 99163) *and a researcher in computer-based instruction at Washington State University.*

DESIGN CONSIDERATIONS

The design of an educational program requires some fundamental decisions long before any code is written. Our first choice was to use simulation programs as the instructional vehicle. These differ greatly from drill and practice programs. In drill and practice, the computer attempts to program the student with certain facts. The student is a passive learner. Simulations, however, are active learning environments. They provide a world for the learner to explore (see reference 1). In addition to facts, simulations teach the skills of the explorer: scientific method, debugging, and hierarchically organized thinking.

Simulations come in several forms, and our second design choice involved deciding what type of simulation to use. One type is based on empirical observations and rules. This is the approach of many artificial-intelligence simulations (for example, expert medical diagnosis). Adventure games are also simulations based on empirical rules, except that the rules reside solely in the imagination of the program author.

Simulations also may be based on ap-

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proximate equations. For example, an architect can design a small building that can withstand earthquakes by taking into account the maximum force that might push on each wall. Many earlier cardiovascular simulations used algebraic relationships to approximate the average behavior of the heart and arteries (see reference 2). These programs were forced to use approximate models because of the limited computational power of 8-bit microprocessors.

In the designing of a teaching simulation, the fundamental problem that constrains model complexity is the time required to update the system's outputs. To be lively and hold interest, the model must respond to parameter changes in 5 to 10 seconds. A 16-bit computer with a numeric coprocessor can do real-number arithmetic several hundred times faster than an 8-bit machine. This means that the model may be much more complex and still respond equally well.

The final type of simulation, and the one we chose, is based on dynamic causal principles. Large buildings and bridges must be designed using detailed descriptions of their oscillatory properties because their internal swaying motions are important to their structural integrity. For systems with a significant dynamic character, this type of model provides the most detailed description. The simulation in our Isolated Heart Laboratory program is based on equations that relate instantaneous pressure and volume events in both the heart and the arteries (see reference 3).

Selecting the Hardware

Several issues are important in selecting hardware for a simulated laboratory. Machine power, both graphic and numeric, is paramount. We felt we needed memory-mapped graphics to make our animation ideas work (see the text box on the next page). Experience with other cardiovascular models on research minicomputers showed us that we would need to perform 5000 to 50,000 floating-point operations per second. The Intel 8087 is sufficient. Finally, the computer has to be a model that's widely distributed; other medical schools already own, or would be willing to buy, a popular machine. Distribution is important, we felt, because our ideas are useful to many medical programs.

At the time of our hardware decision, the IBM Personal Computer (PC) was the only machine that satisfied all our demands. As with any choice, there were tradeoffs, but the IBM PC has proven quite adequate for the task. For example, many people might argue that the 8088's narrow bus and slow clock (5 MHz) are disadvantages, but no 68000-based machine was available that had both memory-mapped graphics and potential to be as popular as the IBM machine. In our numerically intensive application, we have found that the PC has a large numerical throughput and the capability to animate graphics quickly and smoothly without video-display flicker. In fact, its processor power enabled us to develop most of the code in UCSD Pascal. In the future, this will simplify transporting the program to a new architecture when one becomes available.

Designing the Software

In a simulated laboratory, the computer must be transparent. Our experience shows that medical students and operating systems don't mix. The solution is to make the program auto-booting and uncrashable, which frees the student to focus on the course material and not on the computer.

In terms of presentation, current interactive video games provide a visual standard against which students judge educational programs. Further, electronic spreadsheets and other highly refined interactive programs raise expectations about user interfaces. Animations in science-fiction movies depict elaborate computer simulations that create the impression that this technology can reproduce and display complex events in near-real time. Designers of instructional programs must learn from these examples to grab and hold the student's attention. These standards motivated us to improve instructional computing along two paths: user interface and graphics. We found that the most natural way to explain a model is with a drawing. Specifically, we drew pictures of the laboratory environment where the discoveries that led to the model were made. The most intuitive way to show and control the settings of the apparatus is by animating the drawing. The heart model illustrated on these pages uses as its interface an

(text continued on page 290)

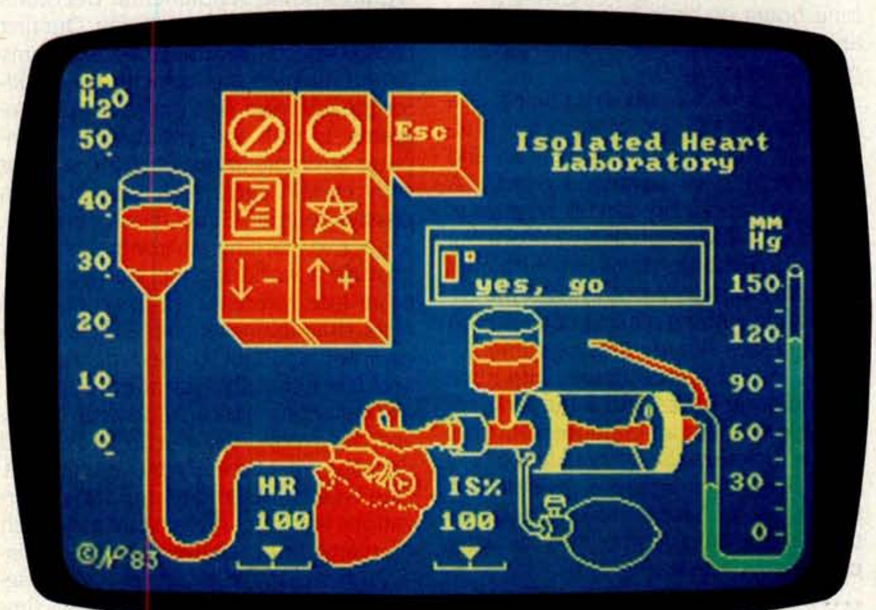

Photo 1: *A simulated early laboratory for studying cardiac mechanics. The student may control the animated apparatus to change the conditions and perform experiments on the heart. Only seven keys are required to control the program, including all numeric inputs.*

Graphics Displays and Animation

Graphics are commonly handled on microcomputers in one of two ways. An intelligent terminal may be used to receive high-level graphics commands, then plot and store the image in its private memory space. Alternatively, the main processor may have access to all the video memory and be responsible for drawing and modifying the figure. The penalty of this approach is the burden on the central processing unit. It must do all the low-level graphics operations. The advantage is greater flexibility in manipulating the graphics.

Some memory-mapped video displays use a small set of graphic shapes to build pictures. These shapes often are treated like characters and manipulated by PRINT statements. Usually they are assigned to the upper 128 values of the character set, above the standard ASCII (American National Standard Code for Information Interchange) sequence. The Pac-Man screen is an example of what is possible with this technique. The advantage is that it does not consume much memory, usually 2K bytes, and the graphic figure may be quickly manipulated in BASIC. The disadvantage is that the simple shapes are too limited to represent a laboratory well.

The IBM Personal Computer (PC) uses a bit-mapped display in which each pair of bits in one section of memory is translated into a single color dot. Each dot may be one of four colors. This technique consumes 16K bytes of memory in the PC but yields figures of higher resolution. Drawing on the display is done by altering the appropriate bits in the video memory. It may be done in BASIC with PEEK and POKE statements, but this process is slow. We code drawing primitives in assembly language for maximum speed.

Several different drawings are stored on disk and may be recalled by the program for different experiments. To move a full screen image, the disk reads 32 blocks of 512 bytes, and the program transfers them to the video-display memory (see figure 1 in this text box). An 8088 assembly-language instruction, the repeated string move, makes this very simple. The string move copies a byte in memory from the source index (SI) to the destination index (DI). If the instruction is prefixed with the REP instruction, the CX register is used as a counter. After each move, the source and destination are incremented and the CX is decremented. As a result, a string CX bytes long is moved from source to destination. To transfer a picture from disk to video, all you need to do is read blocks from the disk to a memory buffer and then use the string move to copy 512 bytes to the appropriate part of video memory.

The chart recorder in photo 2 is animated to move left as new data is written on its right-hand edge. To accomplish this, we have to move the "paper" to the left. The same string move is used, but this time both addresses are in video memory (see figure 2). We use shorter moves, one from the middle of each video line. It is critical to note that the designers of the video control chip organize the video data in memory differently than what is projected on the screen: all even screen rows (0 through 198) are placed together in memory, with the odd rows placed above them. This layout is slightly more awkward for programming, but conceptually it is no different.

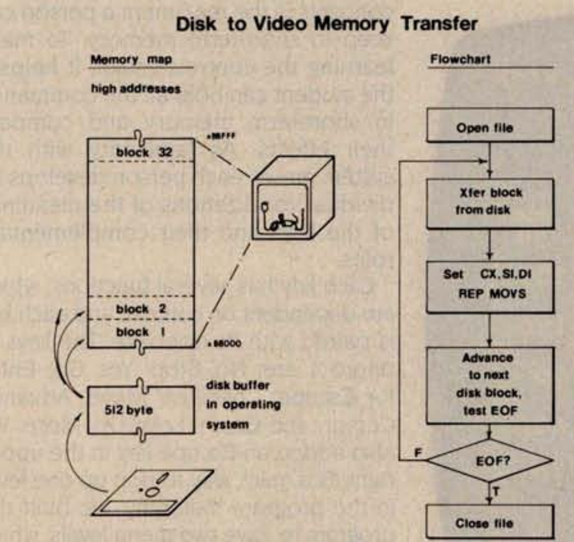

Figure 1: *String moves facilitate transferring images from a disk buffer to video memory. The 8088 registers CX (counter), SI(DS) (source), and DI(ES) (destination) are involved. Whole images move in a fraction of a second from RAM or hard disk; floppy-disk drives are slower.*

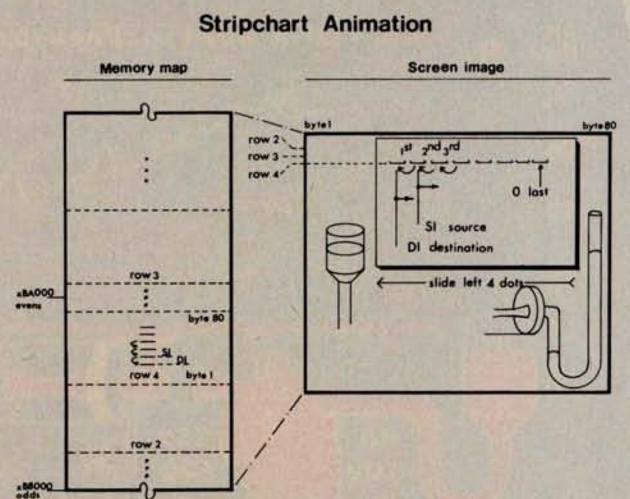

Figure 2: *The chart paper is animated by overlapping string moves within video memory. Each byte is moved one position to the left; its neighbor to the right then occupies the old position. The last byte must be zeroed separately to blank the old data at that position.*

(text continued from page 288)
animated drawing of an experiment patterned after the famous work of Patterson and Starling in 1914.

Cardiovascular simulations have been developed for teaching purposes before, but they have not included both the research laboratory and the heart in the simulation. This was our third major design decision.

The technological intensification of medicine has placed a strain on the usefulness of student laboratories. The concepts taught in the laboratory are increasingly more involved, requiring students to perform more elaborate laboratory exercises. The modern experimental laboratory is difficult to use in teaching because it requires that the student have high technical skills and because the apparatus is expensive.

Nevertheless, the laboratory approach to teaching has not been abandoned for several good reasons. It provides experiences that textbooks and lectures are incapable of capturing. Specifically, the laboratory learning environment provides a sense of realism and immediacy; shows dynamic events as they occur; includes scientific methodology as part of everyday problem solving; allows for errors, corrections, and rethinking; and, in contrast to lectures, is self-paced and flexible. We considered these features of the laboratory when we decided to design a new computer simulation.

Keyboard Inputs

Mice and touchscreens notwithstanding, the primary input device for some time to come will be the keyboard. This raises a problem: keyboards are devices with 96 wrong buttons for every correct one. Many students are not comfortable with computers, nor are they good typists. The combination can make the computer learning experience intimidating. To eliminate the intimidating factors, we decided to use as few keys as possible, put all the keys together to eliminate hunting around the keyboard, make the program monitor the keyboard continuously for keypresses, and provide an immediate visual response to each keystroke.

Photo 1 shows the keyboard we use in the Isolated Heart Laboratory. We developed seven generic functions to provide all possible program control. We assigned each key a core meaning that can be applied usefully in every setting. The meanings are thus general enough that we can also use them in future programs. This feature makes a student's knowledge of the interface transportable between different programmed laboratories.

We got the idea for the graphic symbols and core meanings from the Japanese *kanji*, or pictographic characters. The basic function of the *kanji* characters is to express meaning or concept, not sound or pronunciation. Arabic numerals also use this type of symbolic writing. The symbol 5 means the same quantity, no matter whether it is pronounced *five*, *cinco*, or *funf*. *Kanji* is slightly different in that each character may have a variety of meanings around a core concept. The exact meaning is inferred from context. The advantage of conceptual icons for our purpose is that the core concepts we need have many English words that, if spelled out, may seem contradictory or confusing. Graphic symbols are also more compact on the screen. Consider the circle-slash key. The symbol comes from international traffic signs, and its meaning on our keyboard is similar: no, stop (going), don't select that one, stop (pausing). At any point in the program, the key functions around its core meaning of "no."

We thought it important to restrict the keyboard to seven keys. Five to seven concepts is the maximum a person can keep in short-term memory. To make learning the controls easier, it helps if the student can hold all the commands in short-term memory and compare their effects. As familiarity with the system grows, each person develops individual vocalizations of the meanings of the keys and their complementary roles.

Each key has several functions, which are dependent on context, and each key is paired with its opposite. The keys in photo 1 are: No, Stop/ Yes, Go; Enter (or Escape) Checklist/ Move, Advance Cursor; and Down, Less/ Up, More. We also added an Escape key in the upper right as a quick way to pop up one level in the program hierarchy. We built the program to have two menu levels, which the students operate by pointing with the star and pressing the Yes, Go key. The outer level offers general types of displays and experiments; the inner level offers specific laboratory activities.

(text continued on page 292)

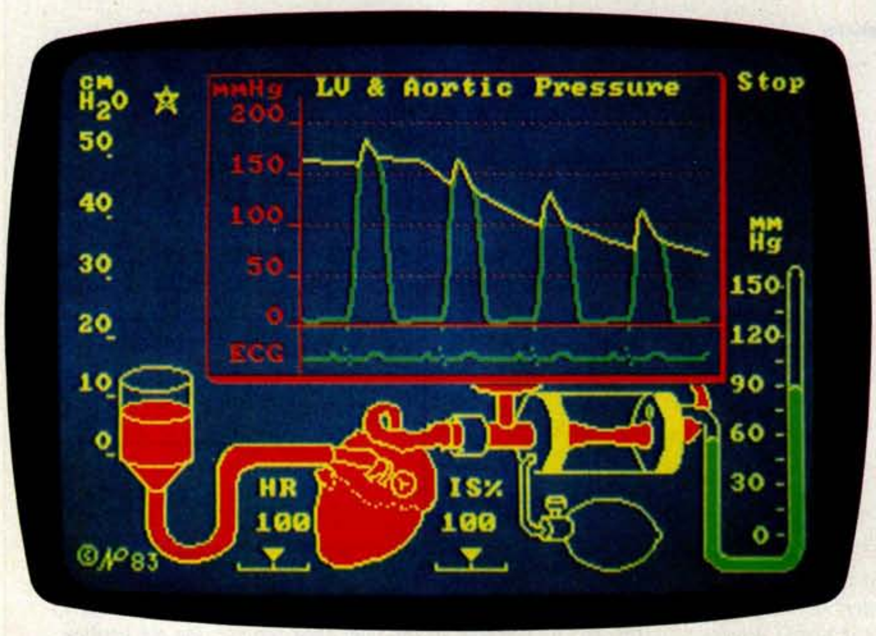

Photo 2: *An animated strip-chart display, showing pressures in the heart and arteries. The electronic "paper" slides left, and new data is displayed as fast as it is recorded from the experiment. The star cursor is set to control the reservoir.*

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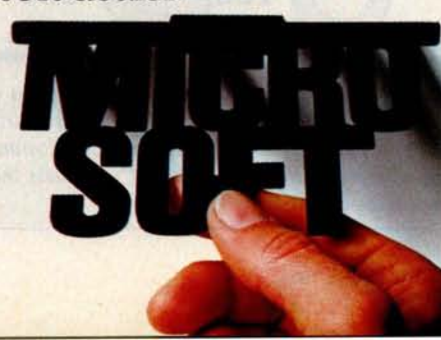

(text continued from page 290)

The Role of Graphics

The Isolated Heart Laboratory centers around a single graphic image. From left to right, in photos 1, 2, and 3, its components are: a filling reservoir, the heart, a surge capacitor, a variable hydraulic resistor, and a mercury manometer to measure the compression pressure around the resistor. We chose to measure pressure with a mercury manometer instead of a pressure gauge to emphasize the physical aspects of the laboratory apparatus. Two readings from the simulated meterstick must be subtracted to get the pressure reading. The heart rate (HR) and heart strength, or inotropic state (IS%), have no simple physical representation and are shown as scales with pointers. They, along with the manometer and the reservoir for filling, are animated and controlled by the student.

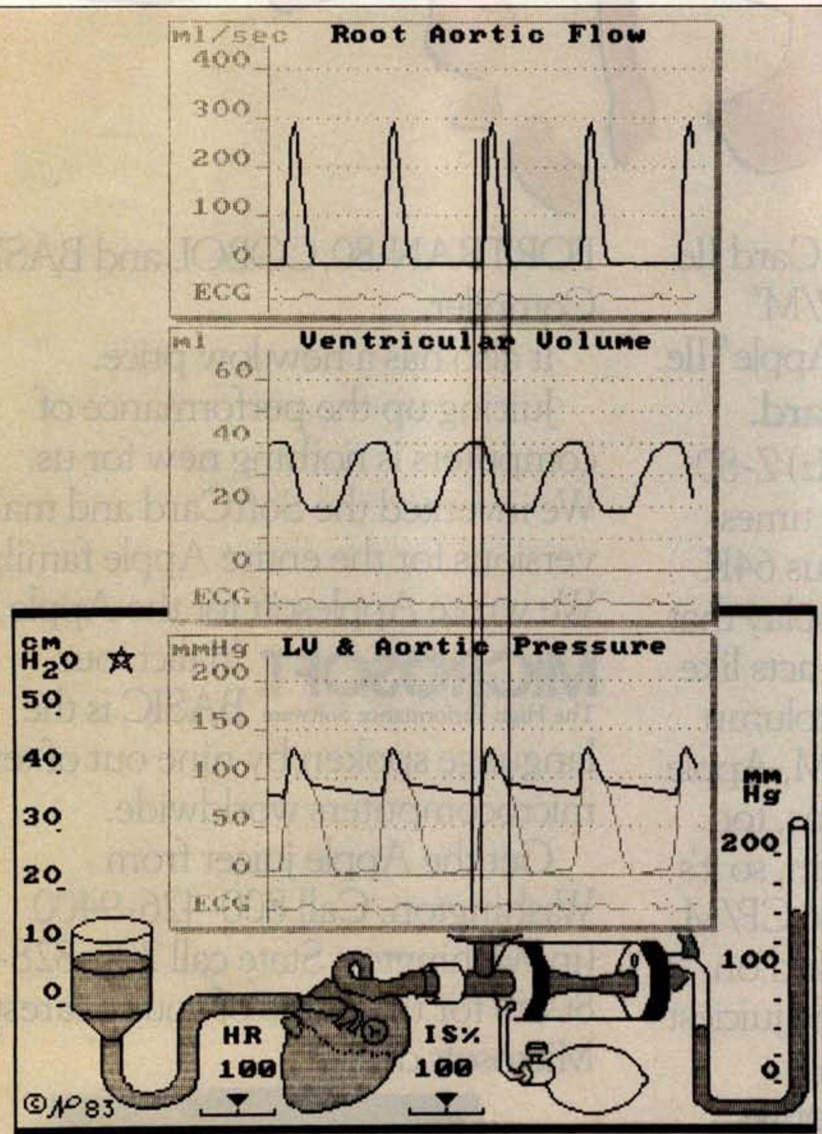

Figure 3: *A typical textbook illustration showing cardiac-cycle events for four types of data: volume in the heart, flow leaving the heart, pressure in the heart, and pressure in the arteries. The ECG (electrocardiogram) in each graph provides a common timing reference. The student can create this figure for many possible states of exercise or disease.*

To be faithful to the early cardiac laboratories, we used a canine heart for the picture and model parameters. The dog has historically been used because it is a good model of the human circulatory system. Blood pressures in dogs are the same as in humans. The flows and volumes are proportionally less because of the size differences between the species.

As an interface-design tool, the laboratory concept is crucial. A focus on animated physical objects in the laboratory makes numeric inputs both simple and natural. Rather than have the student type new numeric parameter settings, the program lets the student manipulate the laboratory apparatus to realize the desired input results (as can be seen by comparing the settings of the reservoir on the left in photos 2 and 3). There are several benefits to this approach:

- it eliminates typographical errors such as using a small *l* for the digit *1*
- the screen graphically and immediately conveys the range of possible inputs and the student's relative change
- moving the apparatus heightens the student's physical intuition about the laboratory experience

Photo 2 shows a strip-chart data display. This is the raw data format as it would appear during a real experiment. Simulated chart paper slides from right to left across the window, and new data is recorded on the fresh right edge. This display does not run in real physiologic time, but it is lively, requiring less than 10 seconds for a complete beat to appear. The 8087 coprocessor chip makes this feat possible. Also, note the star in the upper left of the display, above the filling reservoir. This is a graphic cursor. Its position indicates which variable is currently controlled by the Down and Up function keys.

Having the laboratory always visible, despite the complexity of fitting in the data displays, is an important design consideration. It provides a visual landmark and a constant reminder of each student-controlled parameter setting. When a printer is attached, the student can make hard-copy "snapshots" of the screen in order to have a complete record of all experimental conditions.

A laboratory's visual presence adds

(text continued on page 294)

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(text continued from page 292)

to the multidimensionality of this educational tool. Many people, from children to co-workers, have played with the program during its development. It is surprising and pleasing to see how often they point to an illustrative picture while explaining an idea or result. In a real laboratory, it would not be possible to examine closely the data and the laboratory at the same time, to say nothing of stopping an experiment in order to discuss events. This is yet another advantage of the simulated laboratory as a teaching device.

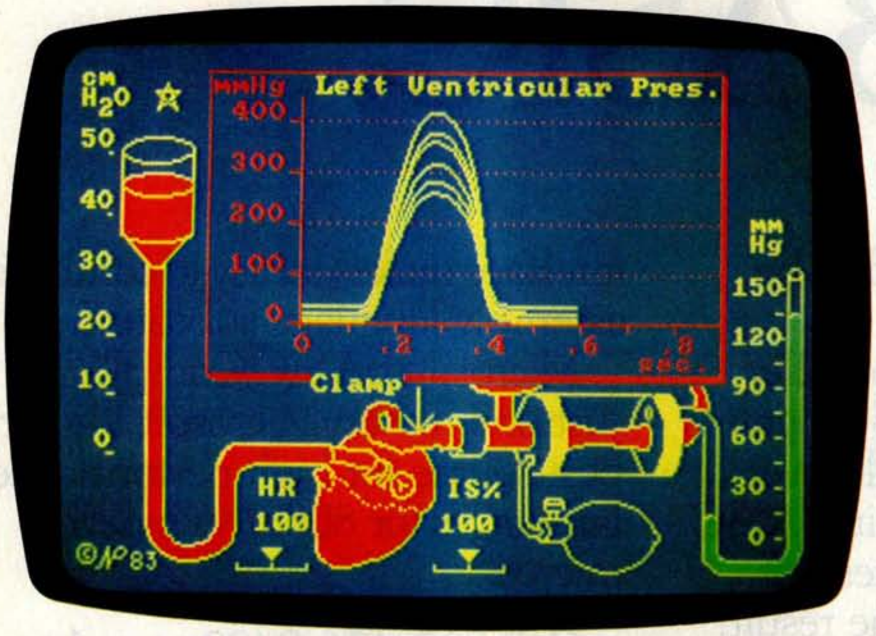

Photo 3: A *classic textbook figure showing the pressure response of the heart to changes in filling pressure. All beats are aligned to start at the same time. This experiment was first performed by* Otto Frank *in* 1896. *Note the clamp to prevent any flow from the heart.*

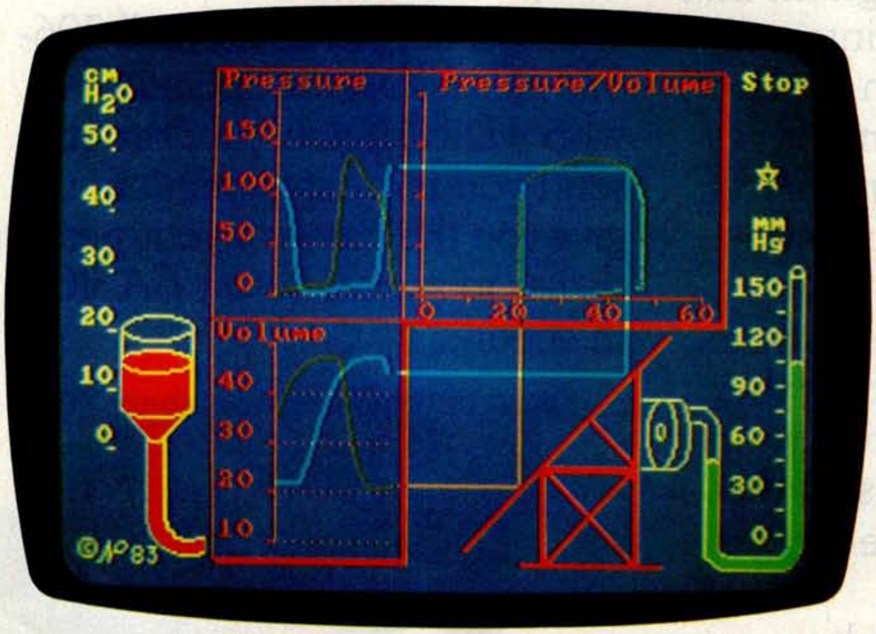

Photo 4: A *pressure-volume loop tutor. Instantaneous pressure and volume in the heart (graphs on left) are plotted together to make a standard diagnostic tool (loop figure on the right). Yellow lines transfer the information from the familiar graphs to the new one. A mirror is used in the volume transfer to "reflect" the data onto a horizontal axis.*

The student may observe flow and volume using the same format employed to study pressure. Figure 3 demonstrates a classic textbook illustration that shows all the events in the cardiac cycle. It is a collage of printer output from pressure, flow, and volume records. The student may experiment freely with the heart and strip-chart display, setting the four parameters to achieve over 6000 operating conditions. Some of these conditions would kill a real experimental animal, but they obviously don't hurt the computer, and they can be very instructive.

Dynamic and lively output graphics are a tool for holding interest and focusing attention on an important feature. Photo 3 illustrates another classic textbook figure that we recreated in the laboratory. In this example, we aligned all pressure beats to begin at the same time. All the displays of time-varying data are animated as smoothly continuous functions. This graphic technique visually conveys a real-life quality of measuring data, even though the display runs at less than the real speeds. Although the simulation program creates figures that closely resemble those in cardiology texts, watching the animation during transients as the figure develops adds an instructional dimension that a book cannot reproduce.

Beyond the Textbook

In addition to reproducing textbook displays and experiments, simulation has other uses. Specifically, it can be used to create graphic displays of textbook figures that students find hard to grasp. One such example is the pressure-volume display in photo 4.

The pressure-volume loop is a modern tool for assessing the health of the heart. Students are comfortable with the strip chart but often are confused by the loop display in which the trace is circular. Photo 4 shows the laboratory set up to explain the pres-

(text continued on page 296)

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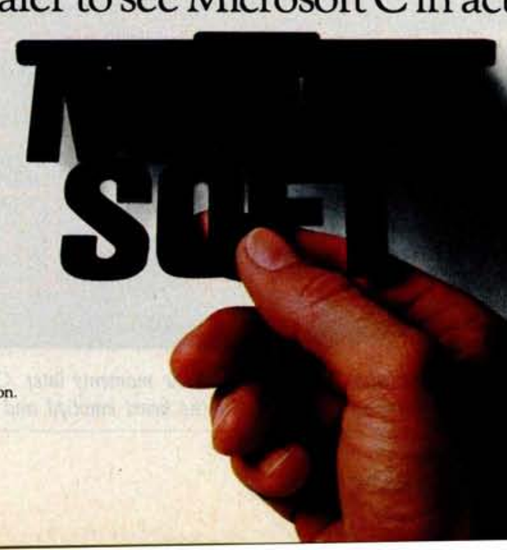

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(text continued from page 294)

sure-volume relationship. This display would never be available in a real laboratory because data processing is required concurrently with the experiment.

Three data windows appear in the display. In the upper left is the pressure strip chart from photo 2. It is sliding and showing instantaneous pressures in the heart. Below it is the volume strip chart, which shows the simultaneous volume data. To the right is a developing pressure-volume loop. In graphing the loop, pressure data is plotted on the vertical axis against volume data on the horizontal axis. The laboratory demonstrates this relationship by shooting a horizontal yellow line from the pressure strip chart rightward onto the loop graph. We call these data transfers "laser blasts." At the same time, volume is shot as a horizontal blast to the right. This bounces off a mirror in order to be correctly oriented for the horizontal volume axis. The two laser blasts intersect, and a new segment of the pressure-volume loop is drawn to the intersection.

We froze this figure at the point where the valve has just opened to let blood leave the heart. Note that volume in the heart has started to decrease. Photo 5 shows the situation a few moments later. At this point, the heart has quit ejecting blood and is relaxing to fill again. Volume is at its lowest point and pressure is falling rapidly.

The student may watch the display loop continuously or single-step the display with the Stop and Go keys. This freeze action would never be possible with a real animal in a real laboratory.

The student may watch this display loop continuously. It is also possible to single-step the display with the Stop and Go keys. This freeze action would, of course, never be possible with a real animal in a real laboratory. It represents the power of a simulated laboratory for medical education. The student can analyze each phase of the cardiac cycle. Two laboratory parameters may also be altered, enabling the student to examine the roles of filling pressure and hydraulic loading. Finally, when the student has mastered the pressure-volume concept, he may return to a smaller display window and the full set of variables.

We have found that problem-solving simulation can change some veterinary students' understanding of the cardiovascular system, from one narrowly based on anatomical relations to one that also includes a component of dynamic interaction (see reference 4). Students have reported that, in addition to the changes that were measured in their mental models, they have enjoyed the computer experience, felt that they have learned from it, and would like more computer materials in the curriculum.

CONCLUSION

We designed a simulated cardiovascular laboratory for medical education. Certainly other medical laboratories can be simulated with microcomputers, and students can move from one to another easily and efficiently. The general idea of laboratory simulation, moreover, can be applied to learning situations ranging from fluid pumping in an oil refinery to the complex relationships of predator and prey in an ecosystem. Simulated laboratories teach the facts of the subject area and also provide intellectual tools and insights for true professional growth. ■

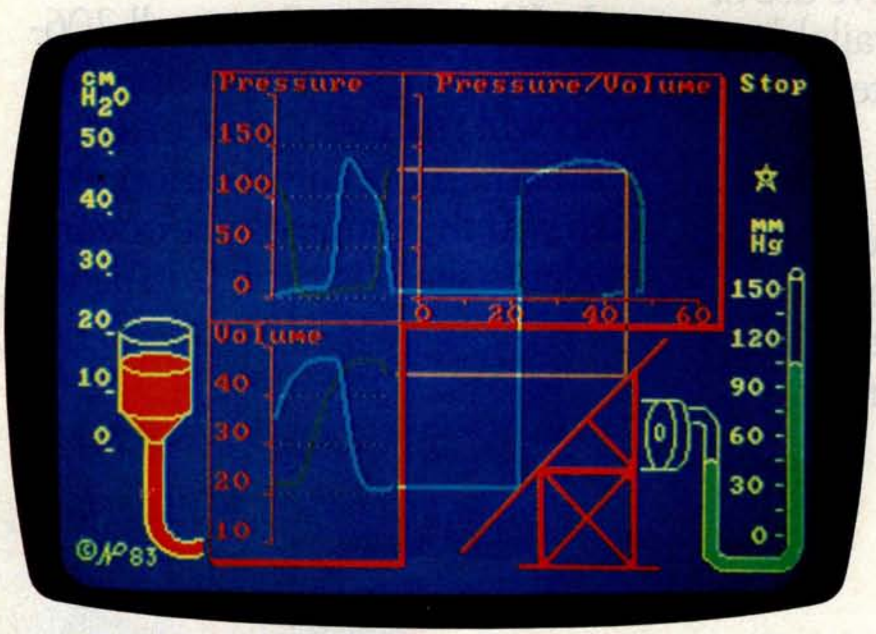

Photo 5: *The loop tutor from photo 4 a few moments later. Compare it with photo 4 to see the fall in pressure and volume after the heart emptied and relaxed.*

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ACKNOWLEDGMENT

I would like to thank Dr. Kenneth B. Campbell of the Department of Veterinary and Comparative Anatomy, Pharmacology, and Physiology, Washington State University. His cardiovascular expertise and criticism made the realism of this laboratory possible.

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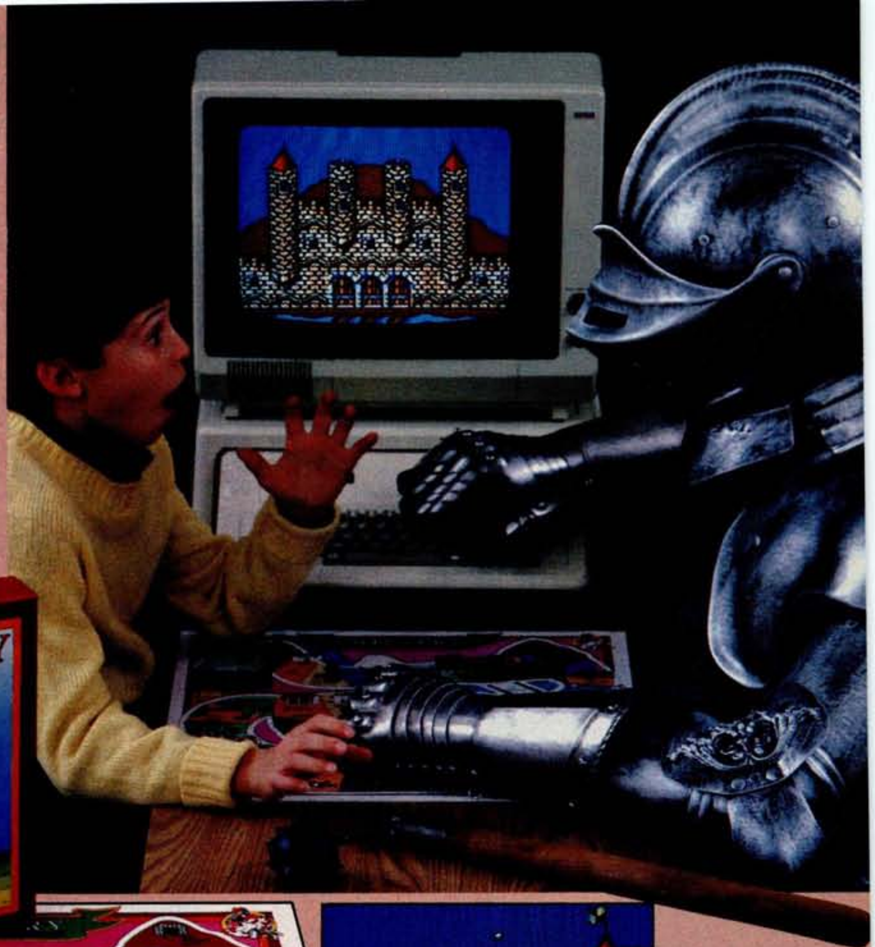

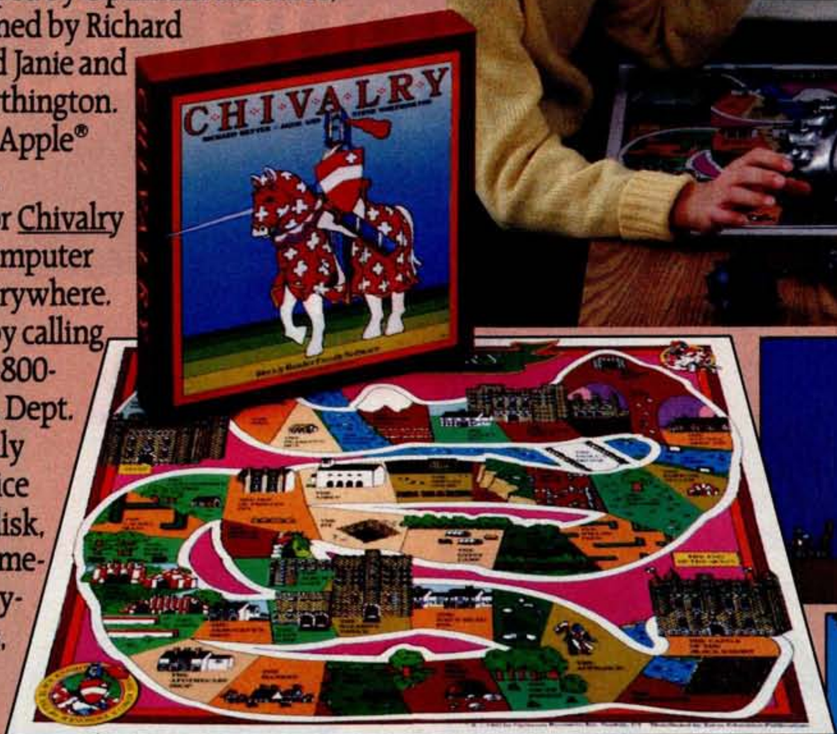

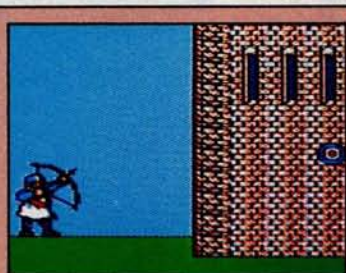

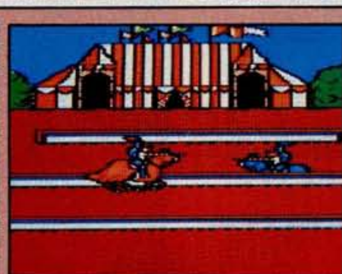

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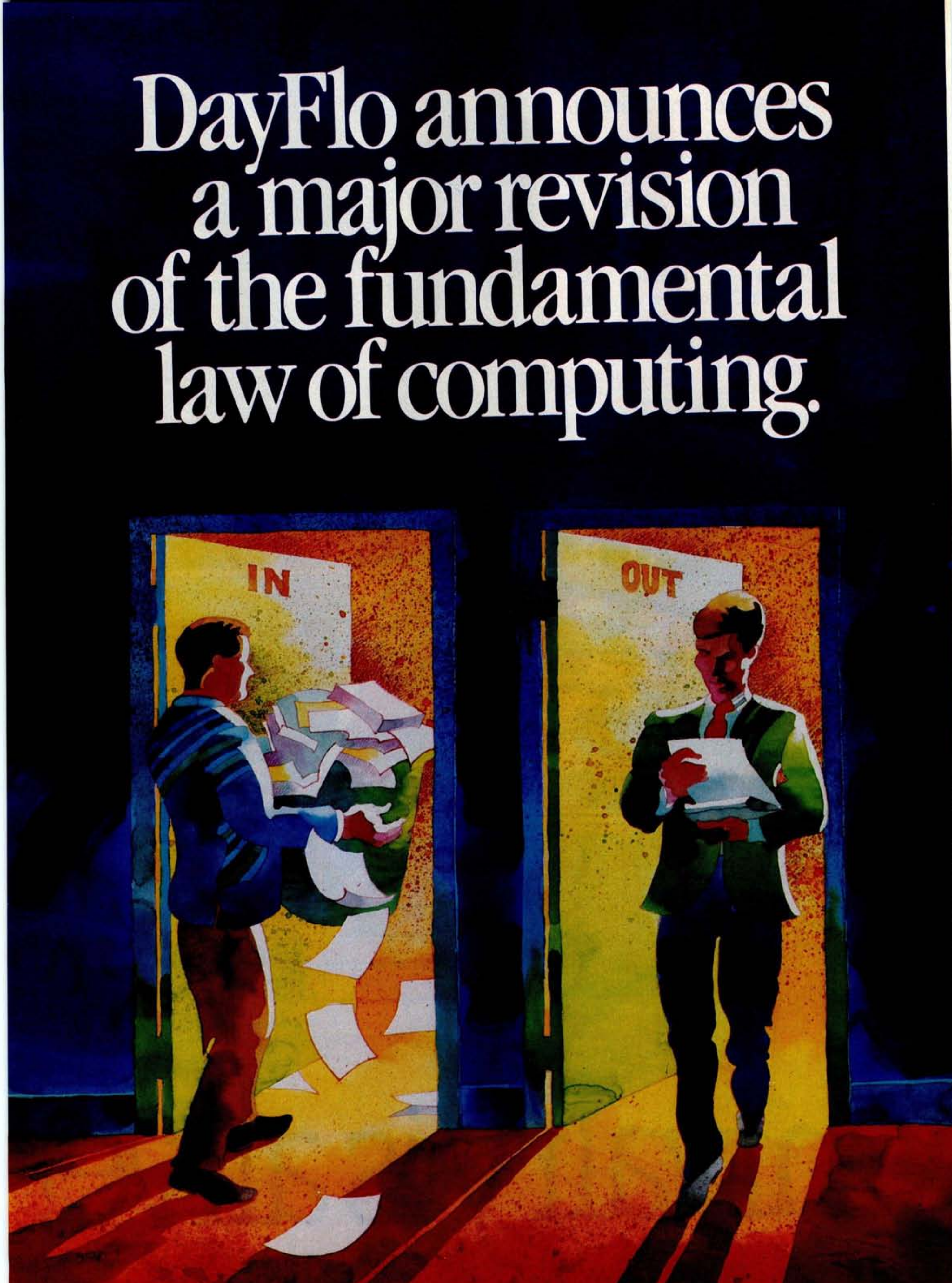
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Ivan Chermayeff

Reviews

REVIEWER'S NOTEBOOK

IF THE IBM PC WERE A MOVIE, the PCjr probably would be its spin-off TV situation comedy. And while some movie-based TV sitcoms (such as M*A*S*H) are very successful, others fall flat on their faces. The reason they fail is usually that too much of the original was lost.

As for the PCjr, we're not sure how it will fare. Almost all of the PC's features have been adulterated, but a few new ones have been thrown in to appeal to the home audience.

The chief deficiency of the PCjr is, of course, its keyboard. Worse than even the PC's keyboard, this should set a new standard for intentional product handicapping. The PCjr's second major deficiency is the way user memory has been usurped by video memory. Its 128K bytes of memory are not all available for user programs—32K bytes are used by the video display. The PCjr, thus, in IBM PC standards, is really a 96K-byte machine. And one more thing, whereas the Apple II is nice and quiet in your living room, the PCjr sounds like a small vacuum cleaner.

The PCjr does have some good features: its software is fairly good, broad ranging, and inexpensive. It has better graphics than the PC. The unit itself is also fairly inexpensive (by PC standards). And it has a fair degree of compatibility with its older sibling.

Need a good CP/M machine with a hard disk? You've probably already taken a brief look at the Morrow MD-11 with its 10-megabyte hard disk. Although they've raised the price to $2950, it still seems a bargain. The Morrow package includes New Word, supposedly comparable to WordStar. Look for a review of both the Morrow MD-11 and New Word in the next few months.

About every other day we get a request for a review of one of the Columbia PC-compatibles. Please note that we have been wanting to review the Columbia MPC portable for about nine months now—if only Columbia would loan us one for a short time. Fortunately, one of our reviewers bought an MPC and a review is finally in the works. From what I hear, the machine runs very well.

Apple Mouse II and Mouse Paint for the Apple II arrived recently and should give owners of that machine a chance to try some of the things they've seen on Macintosh. Mouse Paint appears to have about 75 percent of MacPaint's capabilities with no sacrifice in speed.

The reviews in this issue start with Christopher Kern's continuing examination of C compilers for CP/M. In this article, he looks at C compilers from SuperSoft, Q/C, and Whitesmiths and compares them with Cs previously reviewed.

After a few hours thrashing about with a compiler, you may welcome some diversion. Senior Technical Editor Gregg Williams tells you what to expect from Archon, a game that combines the strategic elements of chess with the demands on dexterity made by arcade games.

For many of us, nothing is quite so diverting as a new personal computer. Technical Editor Rich Krajewski spent three months playing with the Chameleon Plus and gives his considered opinions of this IBM PC-compatible. Note BYTE's new benchmarks and format for system reviews.

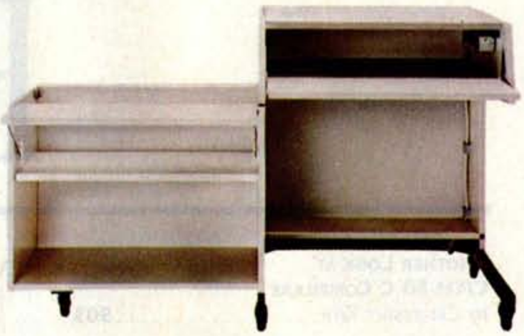
We all have moments when we feel like telling a computer off. The TI Speech Command System for the TI Professional Computer may be able to listen. Mark Haas spoke to the TI Professional and reports on the results.

Eric Eldred compares Volition's Modula-2 for the Apple II to Pascal for the same machine. If you want to try Niklaus Wirth's latest language before reading our coming August Modula-2 issue, Volition's version could be for you.

George Bond, BYTE's Managing Editor for User News, used Microstuf's new data-management program for the IBM PC, Infoscope, and gives it high marks for many applications. The RAM-based system runs fast and exploits color well.

—Rich Malloy, Product-Review Editor

One good idea 



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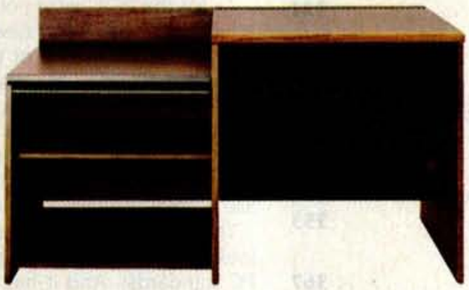

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Another Look at CP/M-80 C Compilers

A proliferation of products makes a choice more and more difficult

CHRISTOPHER KERN

This article uses various benchmark programs, Sieve, Fibonacci, Copy, and Sort, to compare three new CP/M-80 C compilers—Q/C version 3.0, SuperSoft version 1.2.3., and Whitesmiths version 2.2—with three C compilers evaluated previously—Aztec version 1.05G, BDS version 1.5a, and C/80 version 2.0 (see "Five C Compilers for CP/M-80," by Christopher Kern, August 1983 BYTE, page 110). All are designed for 8080, 8085, and Z80 computers running under the CP/M-80 operating system.

When I first compared CP/M-80 C compilers last year, I did not find one that was clearly superior in both compilation speed and object-code quality. Since then, three new products—a significant update to Whitesmiths and two compilers that I did not cover, SuperSoft and Q/C—have made it even more difficult to choose the "best" 8080-family C compiler.

What's New

At the time of my original tests, the Whitesmiths compiler came with an idiosyncratic "standard" function library; now it has a library that really is standard. This update makes a crucial difference because C uses standard library functions to perform all input and output. It means that the Whitesmiths compiler is now compatible with the one available on Bell Laboratories' UNIX operating system—C's native habitat—and with the language definition published in the standard reference on C, *The C Programming Language*, by Brian W. Kernighan and Dennis M. Ritchie.

My latest tests also include SuperSoft C, distributed by SuperSoft Inc. of Champaign, Illinois, and Q/C C, distributed by The Code Works of Santa Barbara, California. The SuperSoft product is a fairly complete implementation of the language and performs well on the benchmark programs. The Q/C compiler was recently reviewed in BYTE ("Two More Versions of C for CP/M," by David D. Clark, May, page 246). I am including it here to provide a more comprehensive comparison.

The Benchmark Programs

I base my evaluation on four benchmark programs that are short enough to type in manually and simple enough to use with all the compilers (with minor modifications in a few instances).

Execution times for the Sieve, Fibonacci, and Copy programs are presented graphically on the "At a Glance" page for easy comparison among the various C compilers.

The prototype programs conform to the language definition in the Kernighan and Ritchie book—essentially the same syntax accepted by the current UNIX C compilers. The programs test a number of factors affecting the overall performance of a compiler on an 8-bit system with floppy-disk mass storage.

Sieve.C is the now familiar prime-number generator based on the Sieve of Eratosthenes algorithm. Generating prime numbers sounds like an exercise in number crunching; actually, it's not. As the source code in listing 1 shows, the Sieve program does not perform much difficult arithmetic. However, it does involve juggling a number of variables. The program is essentially a test of variable access.

You can place external variables, such as the **flags** array in listing 1, in absolute locations in memory and access them fairly easily. This is not true with automatic variables, which the program creates dynamically as it executes.

The program creates automatic variables when it enters a function and discards them when it exits that function. They are known only to the function in which they are declared. Automatic variables challenge the 8080-family compilers because these 8-bit central processors have only a few internal registers and limited addressing modes.

The benchmark programs also test the overhead associated with a function call. C programs typically contain a large number of functions. (Other programming languages refer to some of these as procedures; C doesn't distinguish between those subroutines that return a value and those that do not.)

It is important to determine how efficiently each compiler generates the code necessary

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to enter and leave a function because any given program is likely to contain many functions and use some of them over and over again. The benchmark Fib.C (see listing 2) is designed to test each compiler's efficiency by computing a Fibonacci number recursively—an exercise involving only one local variable and little processing other than the function call. The Fibonacci function, F(x), is defined as:

$$F(x) = 1 \quad \text{for } x <= 2$$

$$F(x) = F(x - 1) + F(x - 2) \quad \text{for } x > 2$$

The next benchmark program, Copy.C (see listing 3), tests file access. File input and output in C normally is performed by "buffered" I/O (input/output) functions from the standard library. These functions permit you to read or write a disk file one byte at a time. The Copy program simply copies its input directly to output with no intermediate processing.

Sort.C tests the string-handling ability of each compiler. It sorts a list of words alphabetically using a quicksort algorithm. Sort is a bit longer than the other benchmarks, as listing 4 illustrates, but is still a reasonable length to copy manually if you want to try these programs yourself.

String handling is a potential problem because C deals with strings somewhat differently than most programming languages. Strings in C are not distinct data types; they are just character arrays delimited by a *null*, or zero, byte. You access them through pointers—variables containing memory addresses. The standard library includes a number of primitive string functions that permit efficient string copying, string comparison, and length determination.

METHODOLOGY

I compared the compilers under conditions that were as similar as possible. First, I made a batch of identical disks containing the benchmark programs and some test data. Then, to test each product, I copied the programs and files necessary to perform the compilations onto one of the disks.

The test data for the Copy program was a text file of 1000 lines, 80 columns each. The Sort program alphabetized a file composed of the first 1000 words of one of my previous BYTE articles, listed one word to a line in sequential order. I used Microshell, a UNIX-like command interpreter that permits input redirection to read the file prior to sorting (see "Microshell and Unica: Unix-Style Enhancements for CP/M" by Christopher Kern, December 1982 BYTE, page 206). This equalized the time required to get the file into memory with the different products.

In an attempt to minimize observational error, both the test compilations and the execution of the compiled benchmark programs were automated. A D.C. Hayes Chronograph (a clock that you can read as a serial device) measured the intervals. The benchmark programs were timed under Microshell so the commands to read the clock and execute the program could be put on the same line. I used CP/M's standard batch utility, SUBMIT, to perform the compilations because not all the compilers would operate under Microshell.

While these procedures guaranteed consistency, they also introduced some additional errors. Both Microshell and SUBMIT exact some overhead, and it takes some time to read the serial clock at 1200 bps (bits per second). The total error for the execution measurements was less than 1 second under Microshell. The overhead was greater for the compilation measurements—which involved more individual programs and were performed with the considerably slower SUBMIT utility—about 1 second for each program executed in a given command stream. There was no instance where the timing errors significantly altered the comparative ratings. The only practical effect of the timing procedure was to understate the BDS compiler's speed. The BDS product compiled the benchmark programs so much faster than its competitors that an error of a second or two was significant.

All the tests were performed on a CompuPro computer system with a Z80 microprocessor running at 6 MHz and one memory-request wait state. The

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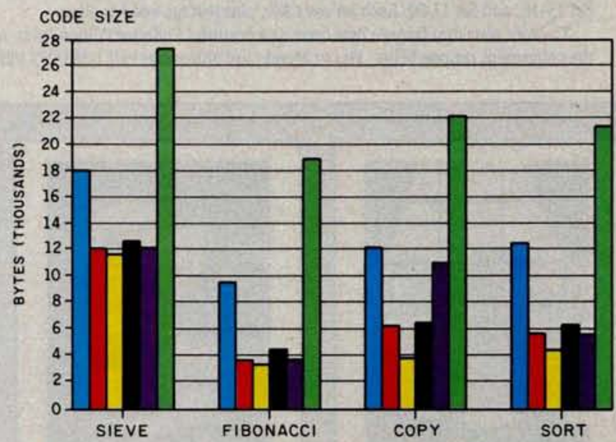
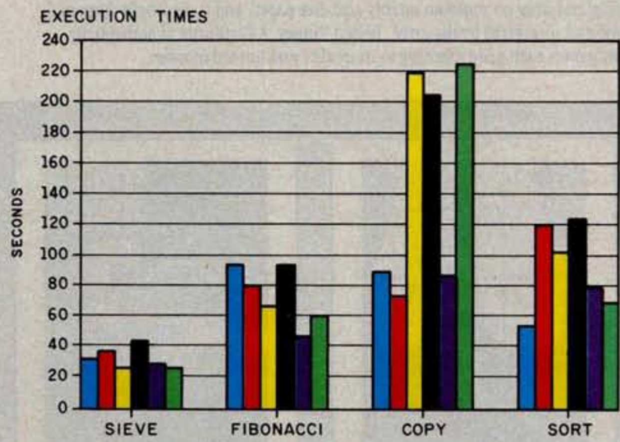
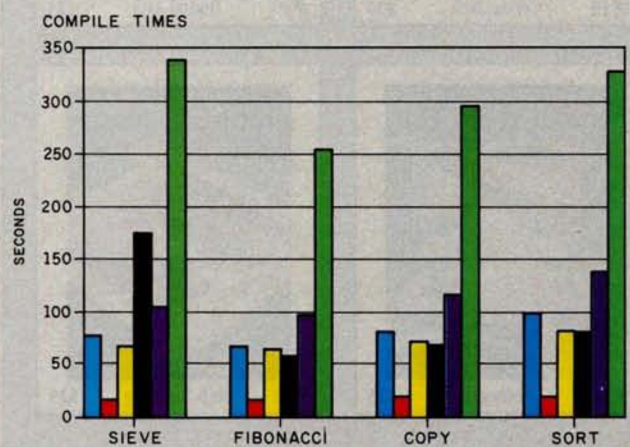
Listing 1: *The prototype Sieve program.*

```
#include <stdio.h>

#define NTIMES     10      /* number of times to run sieve */
#define SIZE       8190    /* size of number array */

#define FALSE      0
#define TRUE       1

char    flag[SIZE + 1];

main()      /* compute primes using Sieve of Eratosthenes */
{
        int     i, j, k, count, prime;

        printf("%d iterations: ", NTIMES);

        for (i = 1; i <= NTIMES; i++) {
                count = 0;
                for (j = 0; j <= SIZE; j++)
                        flag[j] = TRUE;
                for (j = 0; j <= SIZE; j++) {
                        if (flag[j] == TRUE) {
                                prime = j + j + 3;
                                for (k = j + prime; k <= SIZE; k += prime)
                                        flag[k] = FALSE; /* discard multiples */
                                count++;
                        }
                }
        }

        printf("%d primes.\n", count);
        exit(0);
}
```

AT A GLANCE







A comparison of Q/C C, SuperSoft C, and Whitesmiths C compilers for CP/M systems with the Aztec, BDS, and C/80 compilers. Four benchmark programs were used: the Sieve of Eratosthenes prime-number program, a Fibonacci Series program, a Copy program, and a simple Sort program. All tests were run on the same CompuPro S-100 system. More details on the benchmarks are given in the text.

AZTEC BDS C/80 Q/C SUPERSOFT WHITESMITHS

Name	Q/C C	SuperSoft C	Whitesmiths C
Type	Compiler for the C programming language	Compiler for the C programming language	Compiler for the C programming language
Version	3.0	1.2.3.	2.2
Manufacturer	The Code Works 5266 Hollister, Suite 224 Santa Barbara, CA 93111	SuperSoft Inc. POB 1628 Champaign, IL 61820	Whitesmiths Ltd. 97 Lowell Rd. Concord, MA 01742
Price	$95	$275	$550
Computer Needed	8080, 8085, and Z80 microcomputers running under CP/M-80 with floppy- or hard-disk mass storage and at least 56K bytes of main memory	8080, 8085, and Z80 microcomputers running under CP/M-80 with floppy- or hard-disk mass storage and at least 48K bytes of main memory	8080, 8085, and Z80 microcomputers running under CP/M-80 with floppy- and hard-disk mass storage and at least 60K bytes of main memory
Documentation	136-page manual	174-page manual	Manual of more than 300 pages
Audience	Systems and application software developers, hobbyists	Systems and application software developers, hobbyists	Systems and application software developers, hobbyists

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mass storage used was an 8-inch disk formatted into 1024-byte sectors (extended double-density). The summaries of the test results give the absolute measurements in "units" that correspond to seconds on the test computer system.

THE COMPILERS AND THE STANDARD

I had to customize the benchmark programs somewhat to compile them with each product. Only the Aztec and Whitesmiths compilers accepted the prototype source code essentially without change. Actually, the Whitesmiths compiler requires all external variables to be initialized; therefore, I had to explicitly set the first element in the Sort flags array to zero. However, I consider that change minor. It's fair to say that both Aztec C and Whitesmiths C are compatible with the UNIX compilers and the language defined in the Kernighan and Ritchie book.

All the other compilers are incomplete implementations of C, although SuperSoft C is relatively complete (see table 1 on page 312). BDS C makes up for some of its omissions by providing special library functions. You use these to simulate the initialization of variables, simulate the initialization of variables, for example, and for floating-point and long-integer arithmetic.

Most changes to the prototype benchmark programs were minor. The Q/C compiler won't accept a function that returns anything other than an integer value, so I altered the Fib.C code slightly to compile the program.

The SuperSoft compiler comes with nonstandard buffered I/O library functions. When you open a file for buffered input or output in SuperSoft C, you must specify the buffer size you want to use (see listing 5a). In the Copy program I chose a buffer size of 1024 bytes, a reasonable memory expenditure for this type of program.

The Copy program required more significant changes to compile under BDS C because the BDS buffered I/O functions are different from the standard ones (see listing 5b).

The C/80 package does not provide the standard string comparison and string copy functions, so I had to add them to the source code of Copy and Sort.

None of the compilers that I tested

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Listing 2: *The prototype Fibonacci program.*

```
#include stdio.h>

#define  NTIMES     10     /* number of times to compute Fibonacci value */
#define  NUMBER     24     /* biggest one we can compute within 16 bits */

main()                     /* compute Fibonacci value */
{
        int     i;
        unsigned value, fib();

        printf("%d iterations: ", NTIMES);

        for (i = 1; i <= NTIMES; i++)
                value = fib(NUMBER);

        printf("fibonacci(%d) = %u.\n", NUMBER, value);
        exit(0);
}

unsigned fib(x)            /* compute Fibonacci number recursively */
int x;
{
        if (x > 2)
                return (fib(x - 1) + fib(x - 2));
        else
                return (1);
}
```

continued from page 307

Listing 3: *The prototype Copy program.*

```
#include <stdio.h>

main(argc, argv)                    /* copy file a byte at a time */
int argc;
char *argv[];
{
        int     c;
        FILE    *infile, *outfile;

        if (argc < 3)
                errexit("Usage: copy oldfile newfile", NULL);
        if (strcmp(argv[1], argv[2]) == 0)
                errexit("File names must be different", NULL);
        if ((infile = fopen(argv[1], "r")) == NULL)
                errexit("Can't open", argv[1]);
        if ((outfile = fopen(argv[2], "w")) == NULL)
                errexit("Can't create", argv[2]);

        printf("File %s ", argv[1]);

        while ((c = getc(infile)) != EOF)
                putc(c, outfile);

        fclose(infile);
        fclose(outfile);

        printf("copied to %s.\n", argv[2]);
        exit(0);
}

errexit(s1, s2)                     /* print error message and die */
char *s1, *s2;
{
        printf(s2 == NULL ? "%s\n" : "%s %s\n", s1, s2);
        exit(-1);
}
```

Listing 4: *The prototype Sort program.*

```
#include <stdio.h>

#define  MAX        1001   /* maximum number of entries */
#define  MAXLINE    135    /* longest line expected */
#define  NTIMES     10     /* number of times to sort entries */

main()                             /* sort lines in memory */
{
        int     i, j, n, length;
        char    buf[MAXLINE], *sort[MAX], *unsorted[MAX], *alloc();

        for (n = 0; n < MAX; n++)
                if ((length = getln(buf, MAXLINE)) == 0) {
                        n--;
                        break;
                }
                else if ((unsorted[n] = alloc(length + 1)) == NULL)  {
                        printf("Sort: not enough room\n");
                        exit(-1);
                }
                else
                        strcpy(unsorted[n], buf);
```

listing 4 continued on page 311

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listing 4 continued from page 309

```
		printf("%d iterations: ", NTIMES);

		for (i = 1; i <= NTIMES; i++) {
			for (j = 0; j <= n; j++)
				sort[j] = unsorted[j];
			quick(0, n, sort);
		}

		printf("%d entries.\n", n + 1);
		exit(0);
}

getln(s, n)				/* get a line of up to n characters into s */
char s[];
int n;
{
		int	c, i;

		for (i = 0; n > 0; n--, i++)
			if ((c = getchar()) == EOF || c == '\n')
				break;
			else
				s[i] = c;
		s[i] = '\0';
		return (i);
}

quick(lo, hi, base)			/* quicksort */
int lo, hi;
char *base[];
{
		int	i, j;
		char	*pivot, *temp;

		if (lo < hi) {
			for (i = lo, j = hi, pivot = base[hi]; i < j; ) {
				while (i < j  strcmp(base[i], pivot) <= 0)
					i++;
				while (j > i  strcmp(base[j], pivot) >= 0)
					j--;
				if (i < j) {
					temp = base[i];
					base[i] = base[j];
					base[j] = temp;
				}
			}
			temp = base[i];
			base[i] = base[hi];
			base[hi] = temp;
			quick(lo, i - 1, base);
			quick(i + 1, hi, base);
		}
}
```

support two recent changes to the UNIX C language. One of these changes enlarges the number of legal operations on composite data types, known as "structures." Current UNIX C compilers allow structures to be assigned, passed as parameters to functions, and returned as function values. The other change is the creation of the "enumeration" data type, which takes on values enumerated by the programmer. For example, you might create a data type called color with legal values of red, white, and blue. I didn't expect to find either of these features implemented under CP/M-80, but I was surprised that the BDS and SuperSoft compilers failed to generate an error when compiling a program where structures were passed to a function as parameters. Both compilers accepted the program without protest, even though neither one could compile it correctly.

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Table 1: *Features of* 8080 C *Compilers.*

	Q/C	SuperSoft	Whitesmiths
Kernighan and Ritchie complete			x
Kernighan and Ritchie standard library			x
library source	x	x	
run-time package source	x	x	
link compiled modules	[2]	[1]	x
preprocessor arguments			x
generates assembly code	x	x	x
in-line assembly code	x	x	
I/O redirection	x		x
library manager			x
debugging aids			
floating-point math		x	x
M80-compatible code	[2]	[3]	
requires CP/M 2.0			
minimum system size (kilobytes)	56	48	60
size of manual (pages	136	174	>300 [4]
list price	95	275	550

[1] With relocating macro assembly language/linking loader (not supplied)
[2] User must supply relocating assembly language/linking loader
[3] Optional
[4] Includes manual pages for several operating systems

Listing 5a: *The SuperSoft Copy program.*

```
#include <stdio.h>

#define BUFSIZ        1024
#define EOF           -1

main(argc, argv)                /* copy file a byte at a time, SuperSoft version */
int argc;
char *argv[];
{
        int     c;
        FILE    *infile, *outfile;

        if (argc < 3)
                errexit("Usage: copy oldfile newfile", NULL);
        if (strcmp(argv[1], argv[2]) == 0)
                errexit("File names must be different", NULL);
        if ((infile = fopen(argv[1], "r", BUFSIZ)) == NULL)
                errexit("Can't open", argv[1]);
        if ((outfile = fopen(argv[2], "w", BUFSIZ)) == NULL)
                errexit("Can't create", argv[2]);

        printf("File %s ", argv[1]);

        while ((c = getc(infile)) != EOF)
                putc(c, outfile);

        fclose(infile);
        fclose(outfile);

        printf("copied to %s.\n", argv[2]);
        exit(0);
}

errexit(s1, s2)                 /* print error message and die */
char *s1, *s2;
{
        printf(s2 == NULL ? "%s\n" : "%s %s\n", s1, s2);
        exit(-1);
}
```

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Listing 5b: *The* BDS *Copy program.*

```
#include <bdscio.h>

main(argc, argv)                /* copy file a byte at a time, BDS version */
int argc;
char *argv[];
{
        char    c;
        FILE    infile, outfile;

        if (argc < 3)
                errexit("Usage: copy oldfile newfile", NULL);
        if (strcmp(argv[1], argv[2]) == 0)
                errexit("File names must be different", NULL);
        if (fopen(argv[1], infile) == ERROR)
                errexit("Can't open", argv[1]);
        if (fcreat(argv[2], outfile) == ERROR)
                errexit("Can't create", argv[2]);

        printf("File %s ", argv[1]);

        do {
                putc(c = getc(infile), outfile);
        } while (c != CPMEOF);

        fclose(infile);
        fclose(outfile);

        printf("copied to %.\n", argv[2]);
        exit(0);
}

errexit(s1, s2)                 /* print error message and die */
char *s1, *s2;
{
        printf(s2 == NULL ? "%s\n" : "%s %s\n", s1, s2);
        exit(-1);
}
```

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Assembly Options

During the tests, there were two procedural decisions I had to make concerning the use of optional relocating assembler. Both C/80 and SuperSoft C permit you to compile a program without a relocating assembler, which means that the compiler must read all your program's source code during a single compiler run. With an optional relocating assembler and linking loader, such as Microsoft's M80 and L80, you can compile different modules independently and link them together later.

A relocating assembler is a practical necessity with the SuperSoft compiler. While the SuperSoft manuals describe ways to compile programs for an absolute assembler, the results are disappointing. You either must endure a cumbersome editing procedure to get the library routines you need, or accept a mammoth amount of object code. Therefore, all the SuperSoft C tests were performed with M80 and L80.

C/80 programs, on the other hand, are not impractically large when assembled without a relocating assembler—primarily because the C/80 function library is small. It also seems inappropriate to use a $150 relocating assembly-language package for a $50 compiler.

The Q/C compiler *requires* that you supply a relocating assembler, and the remaining compilers all come with one.

The Timing Tests

BDS C is much faster than any of the other products in compiling and linking

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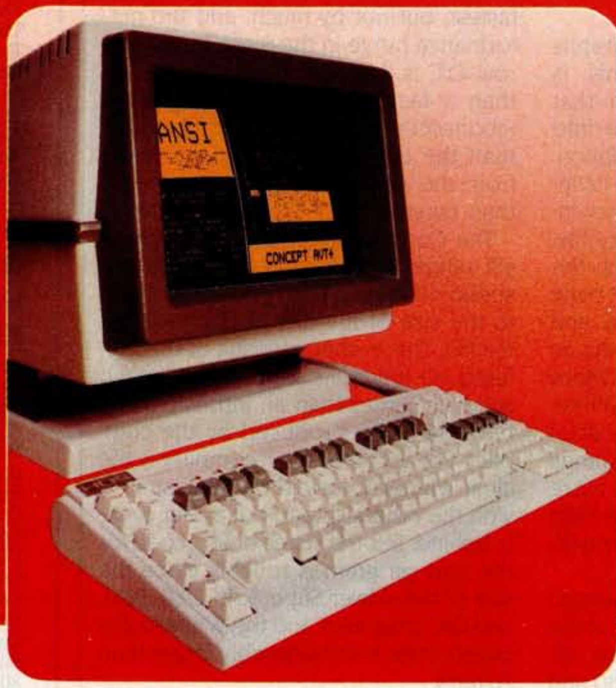

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a program (see table 2 and the graphs on the At-a-Glance page). This is because it is the only compiler that reads the entire source module into memory before beginning compilation, and it is the only one that keeps its intermediate output in main memory instead of placing it in a temporary file. As you can see in table 2 and on the At-a-Glance page, the C/80 object code is the most compact, but BDS, Q/C, and SuperSoft are not far behind. The Aztec programs require noticeably more memory than the others, and Whitesmiths requires the most memory of all the compilers tested. The Whitesmiths Sieve program, for example, took more than 27,000 bytes—almost half the main memory available on the average 64K-byte CP/M-80 system.

The results of the most important speed test—the execution speed of the compiled programs—are the most difficult to generalize about. The C/80 and Whitesmiths Sieve programs are the fastest, but not by much, and the performance range in the Sieve test is narrow. Q/C is the slowest, though by less than a factor of two. The SuperSoft Fibonacci program is noticeably faster than the others, but again, the range from the slowest to the fastest is less than two-to-one.

The Copy program shows the greatest range of execution times, but the speed difference is largely attributable to the size of the disk buffer used for file I/O. This is characteristic of the buffered I/O functions supplied with each product, rather than an intrinsic quality of the code produced by the compiler. For Sort the Aztec compiler is the clear winner, followed by Whitesmiths, with the others spread out about evenly behind. But the Aztec object code for the Sort program is roughly twice the size of the slower SuperSoft, C/80, BDS, and Q/C programs, and the Whitesmiths object code is considerably larger than Aztec's.

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Table 2: *Test results for six C compilers for CP/M systems using four benchmark programs. All tests were run under the Microshell operating environment program and* CP/M's SUBMIT *batch-processing utility program running on a CompuPro* S-100-*bus system with a* 6-MHz Z80 *processor. The Sieve program is the Sieve of Eratosthenes prime-number program (see "Eratosthenes Revisited: Once More through the Sieve," by Jim Gilbreath and Gary Gilbreath, January* 1983 BYTE, *page* 283). *The Fibonacci program determines a series of Fibonacci numbers (i.e., each number in the series is the sum of the two preceding numbers). The Copy program measures how long it takes to input and output an 80,000-character text file. The Sort program measures how long it takes to alphabetically sort the first* 1,000 *words in a* BYTE *article. A graphic comparison of these results is given on the "At a Glance" page.*

Execution Time (seconds):

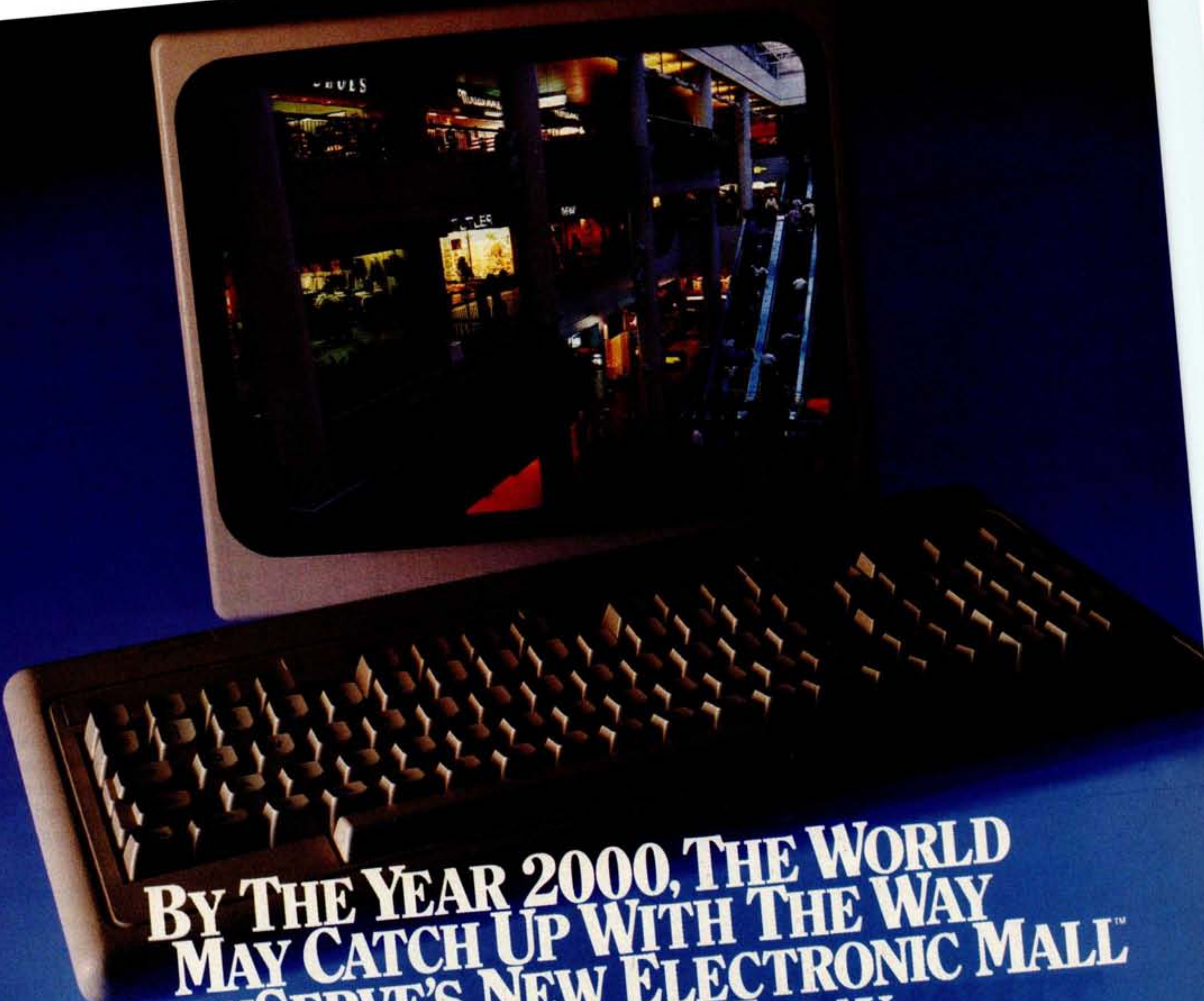
	Aztec	BDS	C/80	Q/C	SuperSoft	Whitesmiths
Sieve	32	37	26	45	29	26
Fibonacci	95	81	69	95	49	60
Copy	91	75	218	205	88	224
Sort	54	119	102	123	79	71

Compile Times (seconds):

	Aztec	BDS	C/80	Q/C	SuperSoft	Whitesmiths
Sieve	76	18	65	173	105	339
Fibonacci	65	18	62	57	97	253
Copy	80	20	70	67	116	296
Sort	99	20	81	80	139	327

Amount of Code Generated (K bytes):

	Aztec	BDS	C/80	Q/C	SuperSoft	Whitesmiths
Sieve	18	12	12	13	12	27
Fibonacci	10	4	3	4	3	19
Copy	12	6	4	6	11	22
Sort	12	6	4	6	6	21



continued from page 316

Listing 6a: *The string-length program.*

```
#include <stdio.h>

#define NTIMES  25000

#define S "Now is the time for all good men to come to the aid of the parity."

main()                          /* string: get length of string */
{
        int i;

        for (i = 1; i <= NTIMES; i++)
                string(S);

        exit(0);
}

string(s)
char *s;
{
        char *p;

        for (p = s; *s != '\0'; s++)
                ;
        return (s - p);
}
```

Register Variables

There are tricks you can use with the various compilers to optimize the object code they produce both temporally and spatially, but I wanted to keep the benchmark tests as similar as possible, rather than adapt each program to make it most efficient for a particular compiler.

However, I did perform a separate test of each compiler's ability to use register variables. This standard C feature allows you to specify that a particular variable be kept in a machine register whenever possible. Because data kept in the registers is more accessible than data stored in ordinary read-write memory, the intelligent use of register variables can substantially speed a program up.

To measure the effect of using register variables with each compiler, I wrote a short program to repeatedly count the number of characters in a string. Listings 6a and 6b show this program's regular and register versions.

While the SuperSoft manual claims that the compiler generates true register variables, both SuperSoft test programs executed at the same speed. BDS C does not support register variables, but all the other compilers did generate faster object code for the register version of the program.

A Tough Choice

Some people may find these results disappointing because they don't clearly determine which compiler is "best." I think they are encouraging. They show that competition is indeed alive and well in program-development tools, a relatively small part of today's CP/M-80 software market.

A few years ago it was impossible to find a C compiler suitable for serious software development on an 8-bit microcomputer. I, for one, am not going to complain that the proliferation of these products now makes the choice among them increasingly difficult. ■

Listing 6b: *The string-length program using register variables.*

```
#include <stdio.h>

#define NTIMES  25000

#define S "Now is the time for all good men to come to the aid of the parity."

main()                          /* string: register version */
{
        int i;

        for (i = 1; i <= NTIMES; i++)
                string(S);

        exit(0);
}

string(s)
register char *s;
{
        char *p;

        for (p = s; *s != '\0'; s++)
                ;
        return (s - p);
}
```

DON'T COMPROMISE:
compare COMPARE
compare COMPARE
compare COMPARE
compare COMPARE
OURS:
compare COMPARE
compare COMPARE
compare COMPARE
compare COMPARE
THEIRS:
THE PRINCETON HX-12
HIGH RESOLUTION RGB COLOR MONITOR
for the image
your eyes deserve
PRESS ANY KEY TO RETURN TO MENU
IBM

S·O·F·T·W·A·R·E R·E·V·I·E·W

Archon

In this innovative game, animated pieces vie for control of a disputed square

BY GREGG WILLIAMS

I like games—board games, video games, word games, any kind. I browse in game and video stores the way most people browse in bookstores. I play and analyze the games I see (a lot of which come in to BYTE) and buy the few that are worth the money. I've even tried designing different kinds of games. I mention all this only to lend weight to what I'm about to say: that Archon (pronounced "ARK-on"), from Electronic Arts (see photo 1), is one of the best computer games I've ever played.

What makes a computer game good? For me, an original game concept, a strong design, and high repeat playability are all important, but I also value something many computer games don't address: appropriateness to the computer format. In other words, whether the game uses the computer to create something that couldn't be done without a computer. Sophisticated interactive adventures put the computer to good use; computer cribbage games do not.

Archon is special because it weds the strategy- and the arcade-style video game genres, and that makes for a very powerful synergistic combination. The playing pieces are mythological figures with different characteristics (photo 1). When one piece moves onto a square occupied by an enemy piece, the playing board becomes a battlefield, where the pieces battle to the death in best arcade fashion (photo 2). The object of the game is to capture five "power points" on the board or to eliminate all enemy pieces. Whether you play against another person or against the computer, you must use both strategy and arcade skills to win.

(My praise is for the Atari version of Archon. Electronic Arts is adapting the game to other machines, but I am not sure the game will play as well on other machines.)

THE BOARD

The pieces appear on a 9 by 9 playing board. Some squares are permanently dark, others are permanently light, and 33 of them (called *luminance squares*) continuously change from light to dark (through four shades of gray) and back again, one change per turn. There are five power points, one in the exact center and one in the middle of each edge of the square board. The power points are also luminance squares; the other luminance squares trace a path from any power point to any other power point (making for a plus-sign-inside-a-diamond shape). When the game begins, the light pieces occupy the first two columns of squares and the dark occupy the last two.

THE PIECES

Each player has 18 pieces, two columns of nine each. The initial layout resembles a chess board; the innermost column consists mostly of pawn-like pieces (knights for the light side, golems for the dark), leaving the more powerful pieces behind them.

Each player has eight kinds of pieces, each with its own movement (walking, flying, or teleporting) and method of attack (throwing an object, thrusting with a short sword, or emitting a destructive circular aura). Players control piece selection, movement, and combat with joysticks. Each piece also has a fixed attack force (how damaging the attack is), attack speed (how fast the attack "moves"), attack interval (how long until the piece can attack again), and lifespan (how resistant the piece is to an attack). For example, the phoenix can fly up to five squares per turn, attacks by radiating a fireball, and has a long lifespan; its fireball is very powerful but radiates outward slowly and takes a long time to build up.

One piece on each side (the wizard on the dark side, the sorceress on the light) can cast a spell instead of moving. There are seven spells, and each can be used only once. Each spell is potent (for example, one revives a selected piece that has been killed), but you shouldn't necessarily hoard them for later use—you lose all remaining spells if your spell-casting piece gets killed.

The rule book offers a lot of information about the pieces, but be sure to read the Archon Command Summary Card packaged with the program disk. It contains information that doesn't appear elsewhere in the package.

(text continued on page 322)

Gregg Williams is a senior technical editor at BYTE. *He can be reached at* POB 372, *Hancock,* NH 03449.

AT A GLANCE

Name
Archon (Atari version)

Type
Arcade/strategy game

Manufacturer
Electronic Arts
2755 Campus Dr.
San Mateo, CA 94403
(415) 571-7171

Price
$40

Authors
Anne Westfall, Jon Freeman, Paul Reiche III

Format
One 5¼-inch floppy disk

Number of Players
One or two

Language
Assembly language

Computers
Atari home computers with 32K bytes of memory (expanded Atari 400 and 600XL, standard Atari 800, 800XL, and 1200XL) (Also available for Apple and Commodore computers and the IBM PC.)

Documentation
A 14-page rule book, reference and command summary cards

Audience
People who want action, thinking, and human interaction in a video game

(text continued from page 321)

COMBAT

You are advised to choose the time and place of your combat well, because it is influenced by your opponent's piece, the combat history of both pieces, and the color of the square. You have an edge if your piece is "fresh" (i.e., unwounded), inherently powerful, or if it is fighting on a square of its own color. During combat, vertical bars called *lifelines* appear on both sides of the combat screen. These decrease in size every time a piece is hit (see photo 2) and tell you how close your piece is to being destroyed. The wounds from a previous battle leave a piece weakened until sufficient time passes or a "heal" spell is cast; pieces resting on power points heal faster than those on ordinary squares. Because pieces can be weakened by combat, several weak pieces, with some skill on the part of the player, can successively weaken and destroy a strong piece.

Combat is also affected by irregular barriers that appear, fade, and disappear cyclically. Depending on its solidity, a barrier can allow, retard, or prevent piece or projectile movement. To survive in the battlefield, you must make the best use of these barriers.

A final factor, square color, heavily influences combat. The lifeline of a piece is considerably lengthened if it faces combat on a square close to (or the same as) its own color—the closer the match, the greater the advantage. Regardless of your piece's strength, you'll usually want to do battle on your own color.

Archon, from Electronic Arts.

Balance and Diversity

Another feature that distinguishes Archon from other games is its attention to balance and diversity. Examples of its diversity are that there are two ways to win and that seven spells are available to the sorceress and wizard pieces. An example of balance is that, although opposing pieces are different from each other in shape and capabilities, neither player has an advantage.

Archon gains vitality from its diversity and playability from its balance. Without diversity, a game becomes repetitive and boring. Without balance, one player has an unfair advantage, and the game suffers.

Unfortunately, Archon suffers from an imperfect balance between arcade and strategy skills. Although the game calls on both strategy and arcade skills, it seems to favor the player with more of the latter. I know—I seem to constantly lose to the same people who beat me in arcade games.

Evaluation

Archon can be played against either the computer or a human opponent. (In this respect, it reminds me of two of my favorite multiplayer games, M.U.L.E. from Electronic Arts and Cytron Masters from Strategic Simulations.) The version reviewed here runs on any Atari home computer with 32K bytes of memory (an expanded Atari 400 or 600XL or a standard Atari 800, 800XL, or 1200XL). I wish the authors had made it a 48K-byte game and used the extra 16K to provide some variant games, differently skilled computer opponents, or some kind of handicapping. The computer opponent is unmercifully skillful, making the single-player game an exercise in good sportsmanship (how can you be a good sport when you lose to a computer?). Some Archon players claim they can consistently beat the computer—I'd be interested in knowing how.

Archon's authors, Anne Westfall, Jon Freeman (cofounder of Automated Simulations and author of the award-winning game Temple of Apshai), and Paul Reiche III, all of Freefall Associates, are to be thanked for their contribution to the gaming community. (They're said to be working on a sequel, Archon II.) Electronic Arts deserves praise as well for its superior game packaging and rule book, which make a good game even more enjoyable, and for the exceptionally high standards that mark this and other Electronic Arts products.

Although Archon would be better if it had some game options and if it placed less of an emphasis on arcade skill, it is still a great game: fun, yet not mindless; involved, yet not hard to learn; and rewarding and varied enough to be played again and again. ■

Photo 1: *The chess-like strategy board of Archon. When two pieces meet on the same square, the action transfers to a combat battlefield (see photo 2).*

Photo 2: *The Archon battlefield. Here, a dark goblin prepares to strike a light knight.*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Alvalyn

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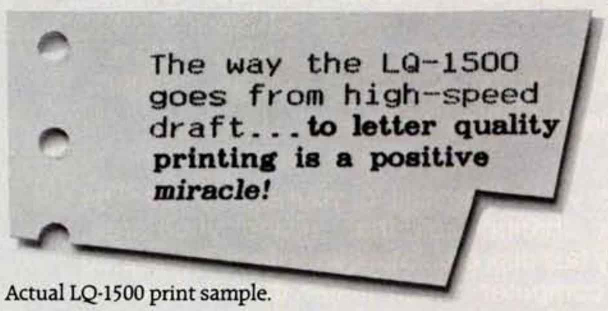

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The Chameleon Plus

It's a good mimic of the IBM Personal Computer, but its packaging needs revision

BY RICH KRAJEWSKI

The Chameleon Plus is an enhanced version of the Chameleon, an IBM PC-compatible that was announced in 1982. Like the $1995 Chameleon, the $2895 Chameleon Plus is a portable computer that can run three different operating systems: MS-DOS, CP/M-86, and CP/M-80. Seequa Computer Corporation, based in Odenton, Maryland, designed the Chameleon Plus to be compatible with MS-DOS and IBM Personal Computer software in particular.

After using the Chameleon Plus for three months, I've come to believe that Seequa has almost succeeded. I loaded a wide variety of software—all marked "for the IBM PC"—into the Chameleon Plus, and it ran most of it without complaint or mistake.

The Chameleon Plus is intended for business people who want a computer and enough software to get running, and who want IBM compatibility, but who don't necessarily want an IBM. These people are willing to trade the security of the IBM name for a lower price. Hobbyists will reject the Chameleon Plus because it has no built-in expansion capability. Home computerists will be turned off by the price, which is lower than that of an IBM PC but is still too high for the home market.

The original Chameleon had only single-sided floppy-disk drives and 128K bytes of memory. The price of the Chameleon Plus includes 256K bytes of memory; a 9-inch green monitor; two 5¼-inch, double-sided floppy-disk drives; an IBM-style keyboard; a serial port; a parallel printer port; a 5-MHz 8088 microprocessor; and a 2.5-MHz Z80A microprocessor. In the software department you get MS-DOS version 1.25, Perfect Writer, Perfect Calc, Perfect Speller, and Microsoft's BASIC-86.

The Condor I database program and the GW BASIC interpreter are supposed to come with the machine, too, but so far Seequa has been substituting IOUs for these programs. Can you imagine buying a computer system that's supposedly bundled with software and getting an IOU instead of the software? Strangely enough, that's happening.

THE CASE OF THE CHAMELEON PLUS

Before I opened the Chameleon Plus, I had to carry it home. Let me tell you, that machine is heavy—28 pounds heavy. I could probably have endured the weight if it weren't for the handle, which is cold, poorly shaped, and no friend to hands. If you grab the handle just a little off center, the machine tries to wrench itself out of your hands. The solution, if you do buy one of these things, or if your uncle gives you one for your birthday, is to purchase a Kaypro carrying bag. I've heard from reliable sources that the Chameleon Plus fits just dandy into it, and it makes toting the machine a bearable task.

The Chameleon Plus opens as shown in photo 1: place your finger between the latch and the knob, then pull the latch out and up. Notice in the photo how the finger strains. This latch was definitely not designed for arthritic hands, nor was it designed for frequent openings and closings. I would pass up the Chameleon Plus (as well as its fewer-featured relative, the Chameleon) because of that latch. There are plenty of inexpensive, easy-to-open latches available for a manufacturer to choose from. Why did Seequa purposely choose such a rotten one? I hope that someday the product designers at Seequa will replace this painful latch with a small, easy-to-open, metal latch.

And while they're doing that, they ought to redesign the case of the machine. It's a metal case, which has the virtue of durability, but unfortunately it mars the furniture. The unit does have some tiny rubber pads on its bottom, but they help only when the machine is lying flat. When you prop it up on its carrying handle, the case's unprotected rear edge engraves designs on your desk.

The display screen is like any other good monochrome display: it has fine contrast, a sharp 80-character by 25-line image, and comfortable brightness. It can also show high-resolution graphics with its 640- by 200-pixel matrix. Unlike good displays, though, this one tends to waver: the characters start undulating every so often, which is not on my list of desirable display characteristics. I suspect the

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Rich Krajewski is a technical editor at BYTE. *He can be reached at* POB 372, *Hancock*, NH 03449.

(text continued from page 327)
problem is an inadequate or poorly regulated power supply, but the system is no less guilty for that.

The Chameleon Plus has an outlet for connection to a composite color monitor. As with the IBM PC, the Chameleon Plus can display 16 different colors in the text, with up to 4 on the screen at one time in medium-resolution graphics mode. According to the *Chameleon Plus User's Manual*, the Chameleon Plus has 16K bytes set aside for display memory, which is enough to handle one screen of graphics.

The keyboard (made by Key Tronic) is much like the IBM PC's, except that the Chameleon Plus's keys are springier. It took me a while to get used to the different feel. Two improvements it has over IBM's keyboard are the Caps Lock key and Num Lock key indicator lights, which tell you when these keys are active.

The Chameleon Plus has an 8088 microprocessor (which has a 16-bit internal and an 8-bit external data path) and a Z80A microprocessor (which has 8-bit internal and external data paths). This lets the Chameleon Plus tap two major sources of business programs—the IBM PC world and the CP/M-80 world. At least it does *theoretically*. In real life, though, it is more an IBM work-alike than an 8-bit CP/M machine, as I'll explain later in this article.

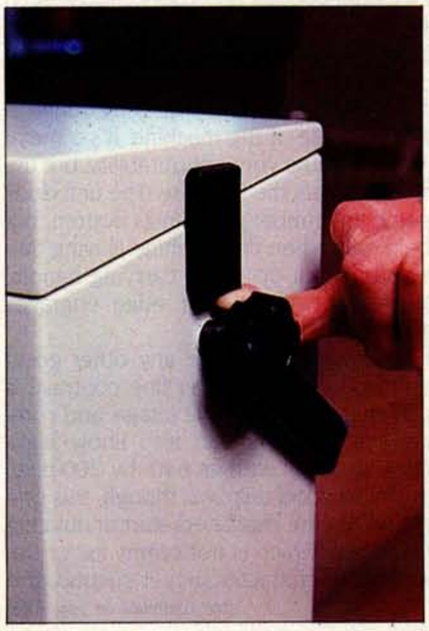


Photo 1: *Opening the Chameleon Plus can result in digital pain.*

The Chameleon Plus comes with 256K bytes of RAM (random-access read/write memory) and 16K bytes of ROM (read-only memory). The ROM contains initialization, booting, and some diagnostic routines. (It does not contain a BASIC interpreter as the ROM in the IBM Personal Computer does, but the intended market for the Chameleon Plus—business people—will probably not care.) According to Seequa, technically knowledgeable users can add 80K bytes of extra ROM to the Chameleon Plus for special applications. Seequa claims that extra RAM can be added, too, with an external expansion box. I have not seen the expansion box (and, it appears, neither has anyone else), so I don't know how it affects the operation or portability of the computer. It can't make carrying the Chameleon Plus any easier. Without the expansion box, you won't be able to expand memory, but 256K bytes of RAM is enough for most of today's personal computer applications.

The two double-sided, double-density disk drives that come with the machine, the same kind used in many IBM PCs, hold 320K bytes each with the version of MS-DOS that is provided. If you buy MS-DOS version 2.0 (which you'll probably have to buy from IBM because Seequa doesn't yet offer it), you'll be able to store 360K bytes on each drive.

Every computer should have one parallel port for connection to a printer and one RS-232C serial port for connection to a modem. The Chameleon Plus comes with these two ports standard. The utility program called Option lets you configure the ports, direct data from one port to another, set the speed of data transmission, and change the protocol of the data. For example, you can tell the computer to send printer output to the serial port at 1200 bits per second, with even parity, 7 data bits, and 1 parity bit.

A drawback of the ports is their lack of labeling. Once again, Seequa has made a packaging error. To be sure, this is a drawback that is easy to overcome, but only with the help of a dealer or the user's manual. It is a nuisance that Seequa could have easily avoided.

The power supply is designed to operate with either 110- or 220-volt power, but your dealer must make the switch for you. Seequa advertises an optional battery pack for the computer, but a spokesman for the company told me that it's not yet available. I have no idea how long the battery pack will take to recharge or how long it will provide power, but guess what? Seequa doesn't know either.

The Mystery of the Missing Options

Seequa advertises several options for the Chameleon Plus: the expansion chassis, extra RAM, the battery pack that I've already mentioned, a hard disk, a second asynchronous-synchronous serial port, an IEEE-488 bus port, an analog-to-digital converter, an RGB (red-green-blue) color-monitor interface, and an 8087 math coprocessor. On the software side you can purchase two additional operating systems, CP/M-86 and CP/M-80.

This is an admirable selection of options that, surprisingly, seems geared to the scientist. For instance, the analog-to-digital converter is certainly not for business applications. The converter, the IEEE-488 bus port (which controls scientific instruments), and the 8087 math coprocessor are for the laboratory.

Though this is an admirable selection, it is also a misleading one; two dealers I spoke with said that they did not have in stock the expansion box nor about half of the other options. One said that the expansion box was not available, while the other said that he could order one for me. Whom to believe? I called Seequa, and a spokesman confirmed that the options in question were not available (see the "At a Glance" box on page 329), but he promised that eventually they would be. This leaves the last chapter in this mystery unwritten, for we do not know if Seequa's promise will be fulfilled. We shall have to wait and see.

You could, of course, tell yourself that you don't need options; the Chameleon Plus can handle the usual applications programs—word processors, spreadsheets, databases—without accessories.

Software

MS-DOS version 1.25, standard on the Chameleon Plus, works exactly like PC-DOS version 1.1 as far as the business user is concerned. You can also buy CP/M-80 and CP/M-86. If you want, you can buy PC-DOS version 2.0 from an

(text continued on page 332)

AT A GLANCE

Name
Chameleon Plus

Manufacturer
Seequa Computer Corp.
8305 Telegraph Rd.
Odenton, MD 21113
(301) 672-3600 or
(800) 638-6066

Components
Size: 8 by 18 by 15½ inches
Weight: 28 pounds
Processor: 5-MHz 16-/8-bit 8088 and 2.5-MHz 8-/8-bit Z80A
Memory: 256K bytes
Display: 9-inch diagonal, green phosphor, built-in monitor; 80 characters by 25 lines; nonadjustable; composite color video jack
Keyboard: IBM PC-style
Mass storage: Two 5¼-inch floppy-disk drives, 320K bytes each
Expansion capability: None
I/O interfaces: One RS-232C serial port and one parallel printer port

Software
MS-DOS 1.25, BASIC-86, GW BASIC, Perfect Writer, Perfect Calc, Perfect Speller, Condor I, C-Term communications program

Optional Hardware

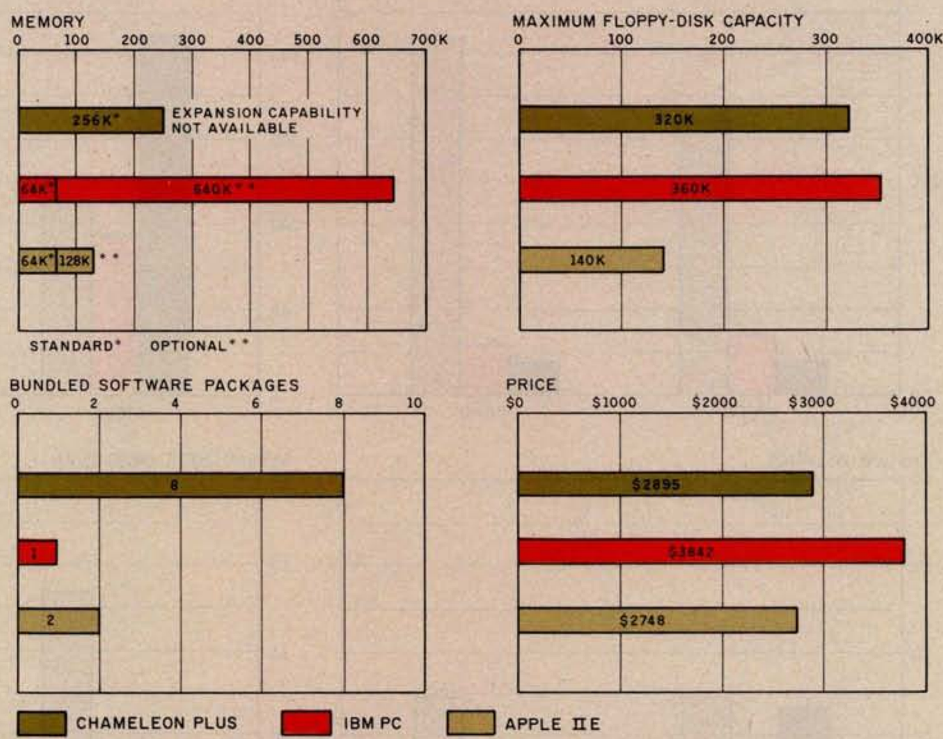
Second RS-232C port	$49
4-channel, 8-bit analog-to-digital converter	$49
RGB monitor interface	$49
8087 coprocessor	$320

Optional Software

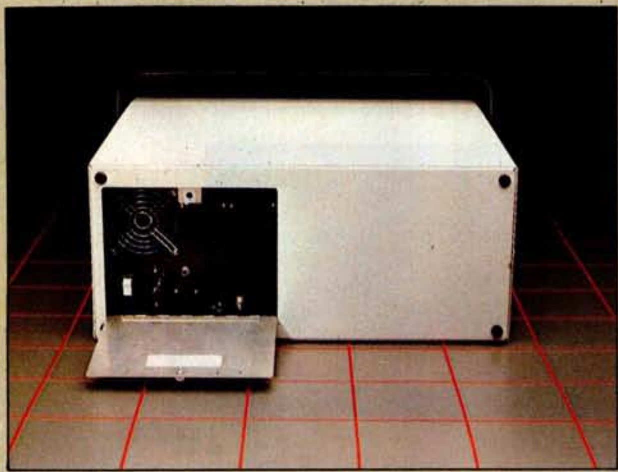
CP/M-80 version 2.2	$150
CP/M-86	$60
Perfect Filer (runs under MS-DOS)	$495

Documentation
User's manual, 147 pages; MS-DOS, 154 pages; Microsoft BASIC, 69 pages; BASIC reference guide, 149 pages; Perfect Writer/Speller, 377 pages; Perfect Calc, 346 pages

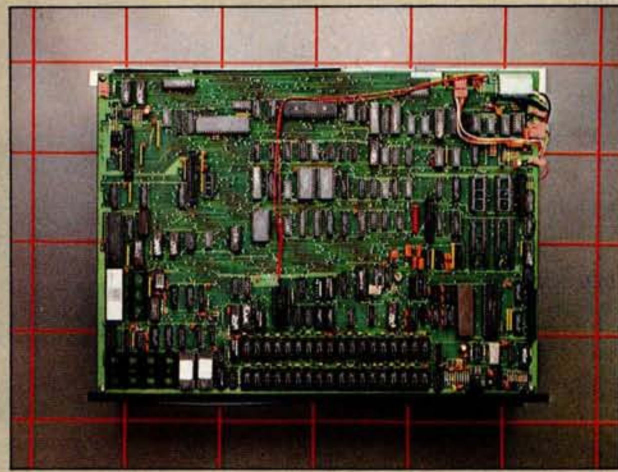
Price
$2895



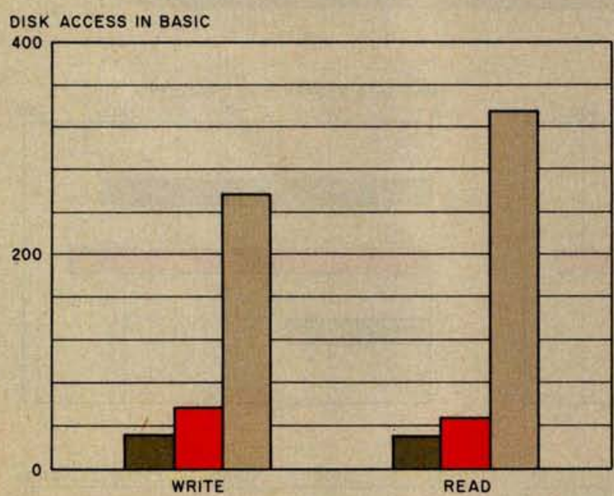
The memory graph shows the standard and optional memory available for the computers under comparison. The graph of disk storage capacity shows the highest capacity of a floppy-disk drive on each of the computers. The bundled software graph shows the number of software packages that are included with the system. The price graph shows the costs of the Chameleon and the IBM PC with two 5¼-inch, double-sided, double-density, floppy-disk drives; a monochrome monitor with connection apparatus; color-display capability; a printer port and a serial port; 256K bytes of memory; the standard operating systems for the computers being compared; and their standard BASIC interpreters. The Apple IIe includes a monochrome monitor, two disk drives, 64K bytes of memory, and a printer port and a serial port.

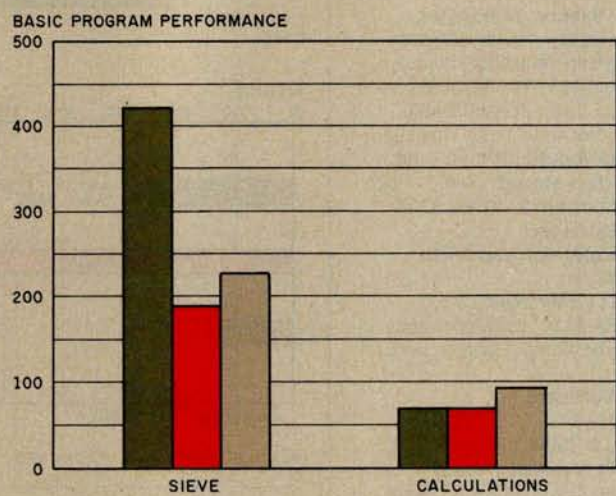


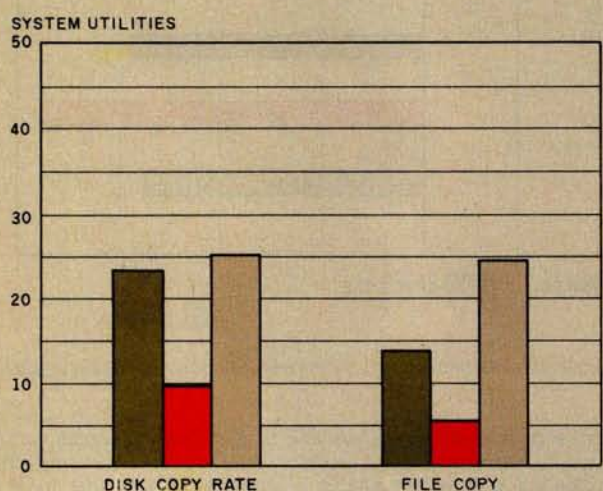
The rear of the Chameleon Plus, pictured on a 4-inch grid. Notice the lack of labels and the trap door.

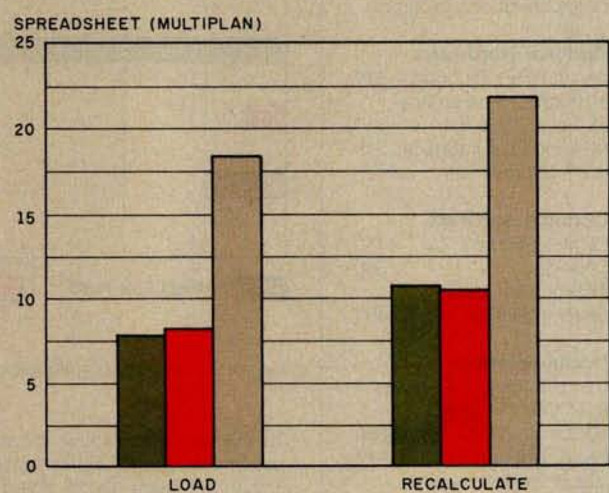


The top of the Chameleon Plus with the cover removed. Servicing the unit should be easy because of the accessibility of the components. Unfortunately, there is no room for expansion.



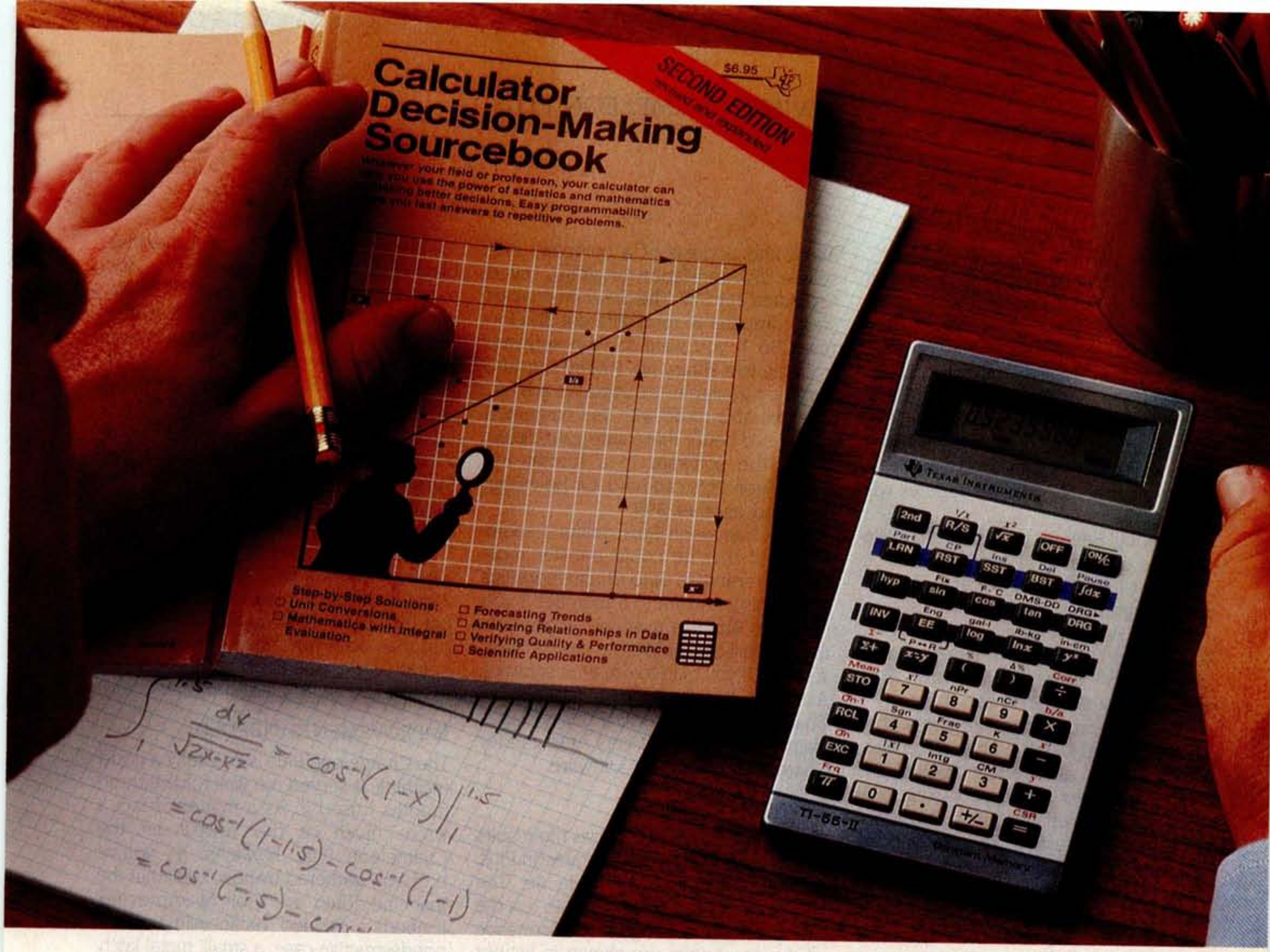






CHAMELEON IBM APPLE

The graphs of BASIC program performance and disk access in BASIC show the times for running the benchmarks in listings 1 and 2. The system utilities graphs show how long it took to format and copy a disk (adjusted for 40K bytes of disk data) and to transfer a 40K-byte file using the system utility programs. The spreadsheet graph shows how long the computers took to load and recalculate a 25- by 25-cell spreadsheet using Microsoft's Multiplan.



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TEXAS INSTRUMENTS

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(text continued from page 328)
IBM PC dealer. PC-DOS 2.0 gives you the advantage of additional disk space and slightly faster disk access time. It runs with no glitches on the Chameleon Plus, as far as I can tell. The only problem in the MS-DOS department is the TIME command. In either version of MS-DOS, TIME keeps terrible time; it loses about 2 seconds every minute. This means that programs that rely on time updates will run poorly.

Currently, Seequa provides BASIC-86 with the Chameleon Plus. This lets you run most IBM BASIC programs that do not use graphics. Seequa promises to send GW BASIC to its customers one of these days. GW BASIC, I understand, is completely compatible with IBM BASICA, but I haven't seen it yet.

The word-processing programs that come standard with the Chameleon Plus, Perfect Writer and Perfect Speller, are similar to other word-processing programs and are perhaps better. These two programs have a number of advanced features that you would expect to find on a dedicated word processor. For instance, Perfect Writer has commands that let you transpose words or letters. Most other word-processing programs require that you either type the items over again or use the command for moving blocks. However, these simpler programs are also simpler to learn than Perfect Writer and Perfect Speller.

Perfect Calc is a spreadsheet program that's also standard with the Chameleon Plus. I would rate it as average because there are several more sophisticated spreadsheets on the market (for example, Lotus 1-2-3).

As for the optional CP/M-80 operating system, a surprise awaits you: Seequa's version of CP/M-80 does not open the world of CP/M-80 software to you. At best, it lets you get your toe in the door. But in no way could anyone say it leaps ahead of you, opens the door wide, and bows low when you pass through; Seequa's version of CP/M can read only disks that are in the IBM PC CP/M-86 format. And good luck finding CP/M-80 software in CP/M-86 format. Even Seequa doesn't sell any. I understand Zenith Data Systems may carry some 8-bit software in this format, but what a patch quilt. I'd rather have a guaranteed source of software.

In its helpfulness, Seequa gives you the name and address of a company that sells a disk-translation program, called Crossdata, for $99. The program enables your computer to read different disk formats. So, if you want to "run software from the vast library of CP/M-80 software currently available," as Seequa's ads say you'll be able to do with its Chameleon Plus, you'd better make sure your dealer stocks the software in a format the Chameleon Plus can read. Or be willing to spend another $99.

One Chameleon Plus dealer I spoke with said that he could transfer most CP/M-80 software onto Chameleon Plus disks. This is a point to remember if you intend to buy this machine—make sure the dealer can help you get CP/M-80 software if you plan to use 8-bit software. Actually, I talked to a couple of Chameleon dealers about this and they claimed that there is very little call for Chameleon Plus 8-bit software.

Performance

The "At a Glance" box shows the results of a comparison of the Chameleon Plus, the IBM PC, and the Apple IIe. The BASIC benchmarks that I used to test the disk access and program performance of the computers are shown in listings 1 and 2. The benchmarks for system utilities and standard spreadsheets are quite different from our previous benchmarks and require some explanation.

Since much computer time is spent transferring files from disk to disk, I measured how quickly the system utilities (DISKCOPY, COPY, etc.) of the three computers were able to perform this function. The results are presented in the system utilities graphs. I also tested how quickly the machines ran a popular applications program, Multiplan.

Before you start writing letters to me, let me say I know that the times I measured are functions of the computer, the applications program, the operating system, and the test files. I know that if I had used different programs or files, the times might have been faster or slower. Don't get upset because you feel that your favorite applications program would have done the job better. This is not a comparison of applications programs; this is a comparison of computer systems. The numbers are for comparison only—to demonstrate whether one computer saves more time than another in typical applications.

I placed the test files on otherwise blank disks to avoid unknown delays due to random disk file arrangement. The applications program was in drive A, the test file in drive B. I always began timing from the last keystroke needed to begin the action under test; I stopped timing when the cursor reappeared.

I did the spreadsheet tests on a 25- by 25-cell spreadsheet. I didn't use the spreadsheet provided with the Chameleon because I wasn't as familiar with it as I am with Multiplan.

The IBM PC I used had 256K bytes of RAM on its motherboard and another 256K bytes on a QuadRAM board. I did not use any of the QuadRAM software, but that does not mean the board did not affect the operation of the IBM. The PC also had an IBM monochrome board.

Improvements Needed

The Chameleon Plus is basically a good machine. It served me well for the three months I used it. As a matter of fact, I wrote much of this review on the Chameleon Plus. However, as you've probably gathered by now, I feel that the machine could use a bit of improving. It needs a padded, balanced handle; a nondestructive case; a small, metal latch; a copy of Crossdata or a similar program thrown in when you buy CP/M-80; labeled I/O ports; and no IOUs. And Seequa ought to stop advertising accessories that aren't available and, indeed, may never be.

If Seequa doesn't or can't include Crossdata, then I think it ought to offer 8-bit applications software with the proper disk format for the Chameleon Plus. With the recent introduction of the IBM Portable Computer, Seequa will have to work extra hard to stay competitive; providing a convenient source of 8-bit software is one way to do it.

Documentation

I received my first version of the Chameleon Plus several months ago. With that first machine came a typographically hard-to-read and incomplete manual that was utterly useless. Nevertheless, I thought that the machine itself was very useful. Before the latest version of the Chameleon Plus arrived, I was going to recommend to you cognoscenti who read BYTE that you shouldn't let the bad documentation steer you away from

(text continued on page 334)

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The best price/performance ratio of any 212A modem on the market today for under $500! That puts ProModem 1200 on top of the stack. Compare the 26 features. You'll see why. Only ProModem offers all 26. 15 are exclusive.

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212A Modem Comparison Chart*

STANDARD FEATURES	PRO	HAYES STACK	NOVATION SMARTCAT	ANCHOR 1200	US ROBOTICS PASSWORD
300/1200 Baud (212A)	✓	✓	✓	✓	✓
Intelligent Microprocessor	✓	✓	✓	✓	✓
Tone and Pulse Dialing	✓	✓	✓	✓	✓
Hayes Command Compatible (Works with Smartcom™)	✓	✓		✓	
Additional telephone jack with exclusion switching	✓				
Analog loop back self test	✓	✓	✓		
Self Test at Power Up	✓		✓		
Call Progress Detection (Busy, Dial Tones, Trunk Busy, etc.)	✓		✓		
Speaker and External Volume Control	✓	✓			
Full Complement of Status Lights	✓	✓			
8 Switch Selectable power-up defaults	✓	✓			
Adaptive Dialing	✓				
Auto Redial on Busy	✓				
Ergonomically designed easy to read front display panel	✓				
Internal Stand-Alone Power Supply	✓				
Built in Real Time Clock/Calendar	✓				
Help Command	✓				
300 baud connect while maintaining 1200 baud RS-232 link	✓				

EXPANDABLE OPTIONS	PRO
Automatic Receiver Buffer	✓
Automatic Transmit Buffer	✓
On-board Personal/Business Directory	✓
Buffer, Expandable to 64K	✓
Auto Logon Macros	✓
Auto message transmission to groups of numbers	✓
Records call duration	✓
12-character Alphanumeric Display	✓

*Comparison made by Prometheus on the basis of the best information available to Prometheus at time of printing.

(text continued from page 332)

this computer because, for most purposes, all you have to do is buy a book about how to use the IBM PC and you'll learn how to use the Chameleon Plus. The difference in price between the IBM and the Seequa more than makes up for the additional cost of the books.

Fortunately, all that rigmarole is no longer necessary because the Chameleon documentation has been improved tremendously. The manual now includes unpacking and setup instructions, as well as enough information to get you started on the applications software.

The documentation for the optional CP/M-80 operating system is another story. The CP/M-80 user's manual supplied with the Chameleon Plus version of CP/M-80 is just a reprint of Digital Research's *CP/M Operating System Manual*. It is far from being a "user's guide"; it is, instead, a programmer's guide. The average purchaser of the Chameleon Plus with the CP/M-80 option will be on his own when it comes to using CP/M-80. Fortunately, several good CP/M-80 guides are available, but it's disappointing to be left in the lurch by Seequa.

THE MANUFACTURER

Seequa Computer Corporation has been in existence since 1979. It is a privately owned corporation. The firm seems to be growing, but that may change with the introduction of the IBM Portable Computer. If the company were to fold, the dealers that sold the Chameleon Plus will not, so you will probably still be able to obtain service for the machine. The Chameleon Plus uses no unique components as far as I can tell, so replacing parts should not be a problem. Of course, even if the IBM Portable becomes a big success, Seequa may still survive.

SERVICE

According to the warranty, service for the Chameleon Plus is available from authorized Seequa dealers. The machine has a warranty for 90 days. Since you know that all computers break eventually, you ought to check with your local dealer to find out what the repair costs might be. It may help swing your purchase decision either toward or away from the Chameleon Plus.

(text continued on page 336)

Listing 1: *The* IBM PC *and Chameleon Plus benchmark programs.*

```
LISTING 1

5 REM: THE DISK WRITE BENCHMARK FOR THE IBM PC
40 A$="12345678123456781234567812345678"
60 B$=A$+A$+A$+A$
80 NR=512
100 OPEN "b:test" FOR OUTPUT AS #1
140 FOR I=1 TO NR
180 PRINT #1, B$;
200 NEXT I
220 CLOSE
240 PRINT "DONE"


5 REM: THE DISK READ BENCHMARK FOR THE IBM PC
10 NR=512
20 OPEN "b:test" FOR INPUT AS #1
30 FOR I=1 TO NR
40 B$=INPUT$(128, 1)
50 NEXT I
60 CLOSE
70 PRINT "done"

5 REM: THE SIEVE BENCHMARK
10 SIZE = 7000
20 DIM FLAGS(7001)
30 PRINT "start one iteration"
40 COUNT=0
50 FOR I=0 TO SIZE
60 FLAGS(I)=1
70 NEXT I
80 FOR I=0 THEN 170
90 IF FLAGS(I)=0 THEN 170
100 PRIME =I+I+3
110 K=I+PRIME
120 IF KSIZE THEN 160
130 FLAGS(K)=0
140 K=K+PRIME
150 GOTO 120
160 COUNT=COUNT+1
170 NEXT I
180 PRINT "done: ";COUNT;" primes found"


5 REM: THE CALCULATION BENCHMARK
10 NR=5000
20 DEFSNG A-Z
30 A= 2.71828
40 B=3.14159
50 C= 1
60 FOR I=1 TO NR
70 C=C*A
80 C=C*B
90 C=C/A
100 C=C/B
110 NEXT I
120 PRINT "done"
130 PRINT "error = ";C-1
```

(*text continued from page* 334)

The two dealers I talked to offer repair service. Dealer A offered a service contract for $245 per year; dealer B said he did not offer such a contract, but said he would replace inoperative parts at price plus a "small markup." He couldn't tell me what the small markup would be. I am not a suspicious man, but I tend to shy away when facts cannot be given. You would be wise to do the same.

AVAILABILITY

Certainly availability is a factor in deciding which computer to buy. At press time, the two dealers I spoke with said that Chameleon Plus computers were available. Seequa recently moved into larger quarters and expanded its work force to keep up with demand.

I also asked the dealers if they like the machine, its manufacturer, and if the machine is selling well. One said he sells 10 Chameleons for every 1 Columbia portable microcomputer. According to him, "Columbia doesn't care about its dealers or customers. Seequa has been more responsive. Seequa has had problems, but everybody is going to have startup problems." He said that the Chameleon also sells better than the Eagle, the Morrow, and the NEC APC, all of which he offers.

Here, I thought, is a testimony for Seequa. But further questioning cast doubt on its validity. "Do you," I asked, "make more money when you sell a Chameleon than when you sell one of the other brands?" I had him there. "Yes," he conceded, "but not always, and even when I do make more, it is only a small amount more."

SUMMARY

On its plus side, the Chameleon Plus is a reliable machine that offers more features and a lower price than the IBM Personal Computer. On the minus side, it is hampered by several errors in ergonomics and support—the case, the latch, and the unavailable options come to mind. If I could get quick delivery, if I didn't need to carry the computer, if there were a service facility nearby, and if I had a Formica desktop, I would consider buying the Chameleon Plus. But I wouldn't make up my mind until I had seen some of the other portables, such as the Panasonic Sr. Partner and the IBM Portable Computer. ■

Listing 2: *The Apple IIe benchmark programs.*

```
LISTING 2

5 REM:  THE DISK WRITE BENCHMARK FOR THE APPLE II E
40 A$="12345678123456781234567812345678"
60 B$=A$+A$+A$+A$
80 NR=512
100 PRINT CHR$(4);"OPEN TEST"
120 PRINT CHR$(4);"WRITE TEST"
140 FOR I=1 TO NR
180 PRINT B$;
200 NEXT I
220 PRINT CHR$(4);"CLOSE TEST"
240 PRINT "DONE"
```

```
5 REM:  THE DISK READ BENCHMARK FOR THE APPLE II E
10 NR=512
20 PRINT CHR$(4);"OPEN TEST"
25 PRINT CHR$(4);"READ TEST"
30 FOR I=1 TO NR
40 INPUT B$
50 NEXT I
60 PRINT CHR$(4);"CLOSE TEST"
70 PRINT "done"
```

```
5 REM:  THE SIEVE BENCHMARK
10 SIZE = 7000
20 DIM FLAGS(7001)
30 PRINT "start one iteration"
40 COUNT=0
50 FOR I=0 TO SIZE
60 FLAGS(I)=1
70 NEXT I
80 FOR I=0 TO SIZE
90 IF FLAGS(I)=0 THEN 170
100 PRIME =I+I+3
110 K=I+PRIME
120 IF KSIZE THEN 160
130 FLAGS(K)=0
140 K=K+PRIME
150 GOTO 120
160 COUNT=COUNT+1
170 NEXT I
180 PRINT "done: ";COUNT;" primes found"
```

```
5 REM:  THE CALCULATION BENCHMARK
10 NR=5000
30 A=2.71828
40 B=3.14159
50 C= 1
60 FOR I=1 TO NR
70 C=C*A
80 C=C*B
90 C=C/A
100 C=C/B
110 NEXT I
120 PRINT "done"
130 PRINT "error = ";C-1
```

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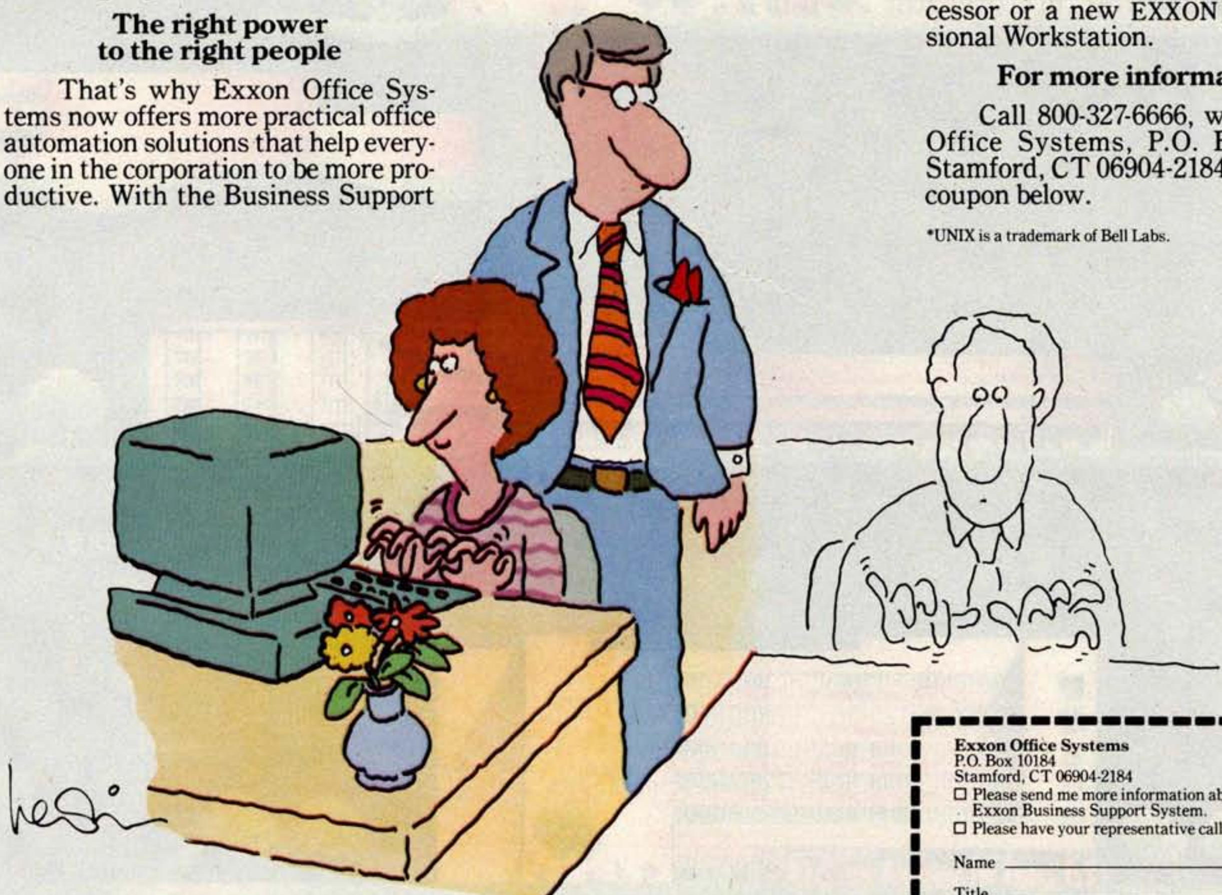

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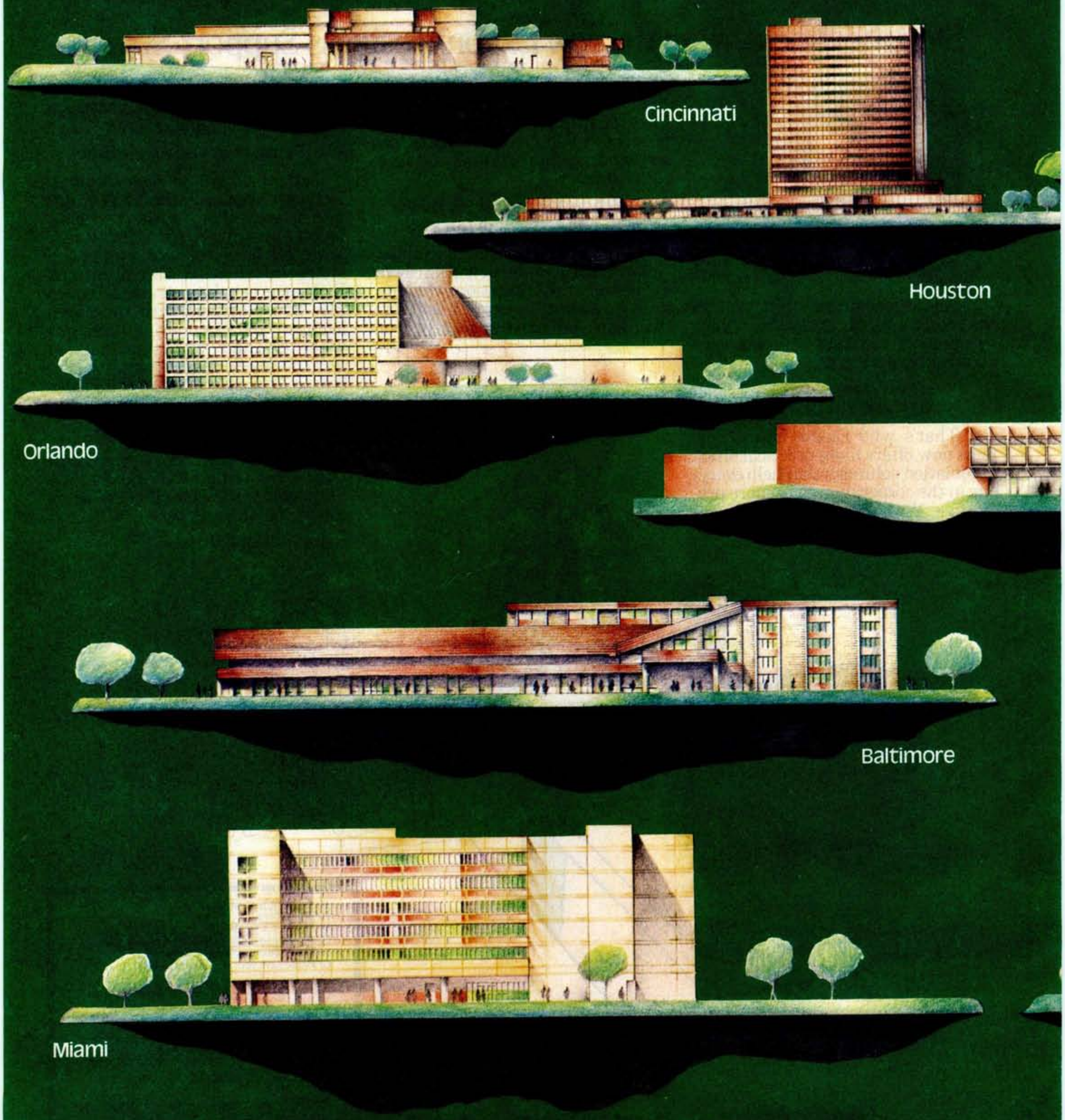

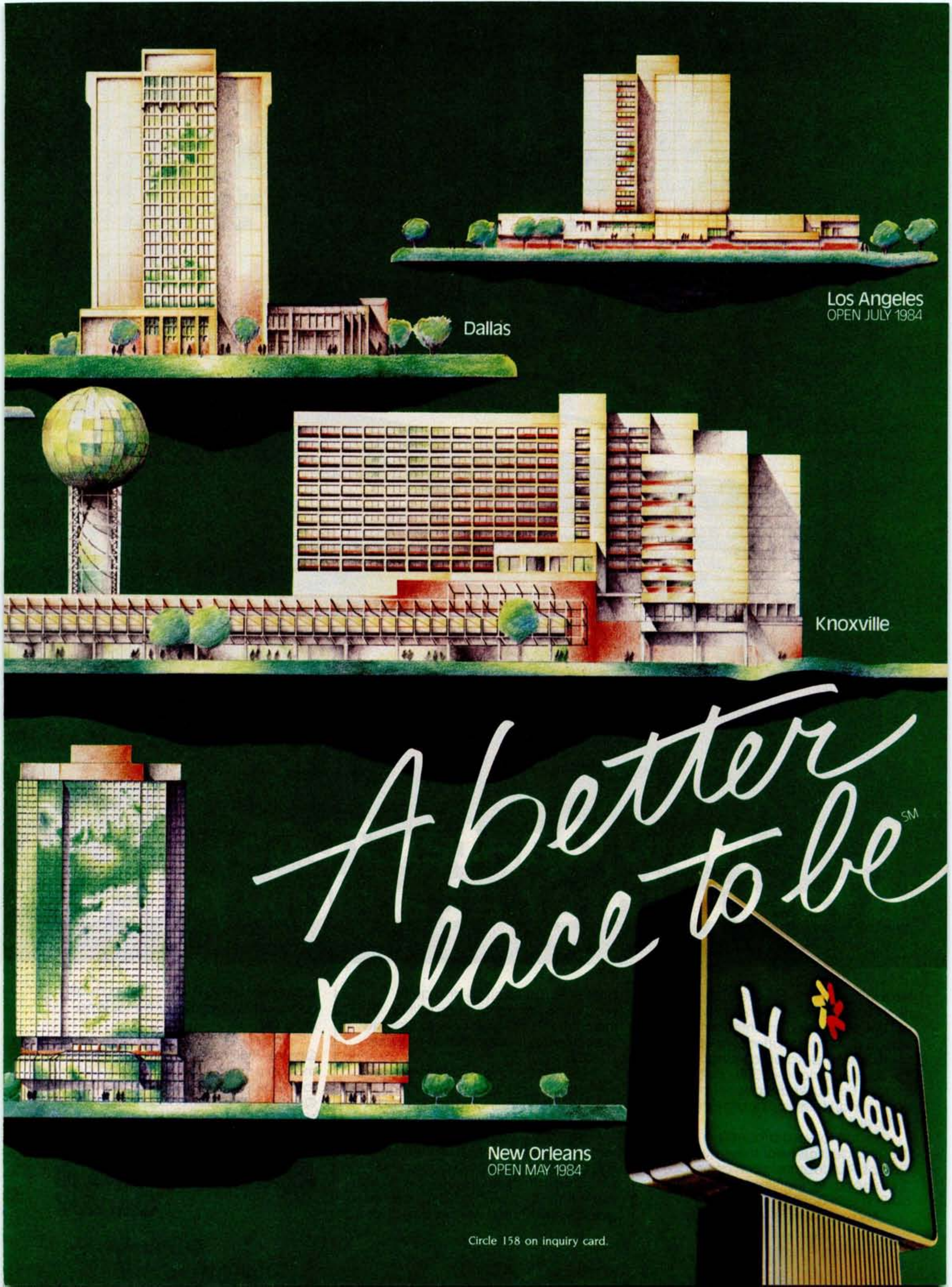
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Switch to word processing and the 7065 delivers near letter quality at 125 cps. Plus features such as proportional spacing, justification, auto-underline and bold.

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The 7065 is also a dot addressable graphics printer with resolution to 144 x 144 dots per inch and a full complement of line drawing graphics.

Besides being very fast, the 7065 is very compatible — with IBM, Apple, Lotus 1-2-3 and just about any other personal computer or software on the market. It offers built-in bar code capability. And its 500-million-plus character print head and industrial quality construction are designed for long, hard use.

To find out how quickly the Qantex 7065 could bring your information processing up to speed, contact Qantex for details or a demo. Qantex, 60 Plant Avenue, Hauppauge, NY 11788. Call toll-free 800-645-5292; in New York State 516-582-6060.

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The Texas Instruments Speech Command System

You can now give voice commands to the TI Professional Computer or use it as an answering machine and a smart telephone

BY MARK HAAS

The TI Professional Computer can now listen to its master's voice and carry out the commands. The Texas Instruments Speech Command System is an advanced voice interface and communications package that provides a base for sophisticated voice and data integration. The piggybacked, two-board speech-processing system is built around proprietary components, occupies one of the TI Professional Computer's expansion slots, and provides a combination of communication functions never before offered to the personal computer user. These functions include:

- voice recognition
- voice storage
- voice playback
- integrated telephone functions
- pulse or tone dialing
- dual-tone multifrequency decoding
- selection of communications channel

By combining these functions with the proper software, it is possible to give voice commands to any application and have an intelligent telephone or a sophisticated telephone-answering machine, and more.

Setting Up the Speech Command System

The TI Speech Command System has three major components: the Speech Command System hardware, the Speech Command System software, and the Transparent Keyboard software. These components work together to combine the functions described above into useful tools. In addition, Texas Instruments is offering a Speech Design Kit to software developers to allow them to design additional applications around the hardware component.

The average user does not need to know what the various components of the Speech Command hardware do. It is really a special-purpose computer system with its own proprietary coprocessor, designed to perform a limited number of tasks. Texas Instruments provides the software necessary to program this computer to perform its special tasks. You only need to install this piggybacked board into a slot on the TI Professional Computer system board and run a series of diagnostic tests.

Installation is fairly straightforward. I found it necessary to move some of the boards already installed in the system to accommodate this new thicker board. (I have already installed an internal modem, a Winchester hard-disk controller, and an asynchronous communications board.) The speech board cannot fit in either the first or last slots, leaving only three possibilities. Because it is a piggybacked system, it takes a bit of care fitting the board into the narrow space (see photo 1). A wire connecting this board to the speaker on the main system board must also be installed if you intend to use the internal speaker. It takes a steady hand and perhaps a pair of needle-nose pliers to do the job.

After the board is installed, the headset (or an external microphone and speaker) is connected and the diagnostics are run. Every function of this complex system is tested, even the voice quality. It was a bit of a shock when the computer first started talking to me. This is *not* synthesized speech but rather the reproduction of someone's voice that had been stored as data on the diagnostics disk. When the tests are successfully completed, the system is ready to be used.

The software for the Speech Command System is contained on two disks that in my case had to be copied first onto the hard disk. Before the system can actually be used, a number of commands must be issued from the operating-system level, and they must be used in the proper order. Some of these commands also have one or more arguments associated with them that may or may not be included, depending on how you will be using the system. It took me awhile to sort out the numerous software components.

First, a command file called CALIBRAT is used to determine the gain setting necessary for your particular voice and microphone. It can also be used to actually set the gain, too. Then, if your computer uses a Winchester

(text continued on page 342)

Mark Haas is the technical director at Osborne/McGraw-Hill (2600 Tenth St., Berkeley, CA 94710).

AT A GLANCE

Name
Speech Command System

Manufacturer
Texas Instruments
Data Systems Group
Austin, TX 78769

Price
$2600

Hardware Required
Texas Intruments Professional Computer with 192K bytes of RAM; hard disk recommended

Documentation
Hardware installation and test manual; Speech Command software users manual

Audience
Serious computer users or users with special needs

(text continued from page 341)
hard disk, you invoke WINPATCH to modify the speech system for use on a hard disk. Next, you enter PCSPEECH to install interrupt vectors in the operating system and load the control software into the Speech Command hardware. PCSPEECH can also contain arguments for setting the gain (previously determined by using CALIBRAT), the output volume, and a switch to turn the Smartphone (described below) on or off. The manual accompanying this system presents several examples of batch files that can be used instead of invoking each of these commands individually. At this point you are finally ready to do something.

THE TRANSPARENT KEYBOARD

The Transparent Keyboard software provided by Texas Instruments allows the user to enter data into the computer by voice. What this data is and how it is used is left up to the individual, although a number of predefined vocabularies are provided for applications such as Lotus 1-2-3 and EasyWriter. I used the Transparent Keyboard and a vocabulary I designed to verbally enter commands into my word-processing software, PeachText, to write this article. I can insert and delete, scroll forward and back by line or page, perform block moves and cursor movements, and even save my file and return to the operating system without touching the keyboard. But not having to touch the keyboard is not the point here. What is important is that I can concentrate on writing this article without having to remember which function key is the one that will insert a line, which one will delete a line (they are next to each other), and then have to move my hand from the keyboard to enter it. All I have to do now is say "split" to insert a line and "line delete" to delete a line. All this does not come easily, however.

In order to use the Transparent Keyboard, you must first define a vocabulary (or use one of the prepared ones) and then teach the computer to recognize your voice. The Speech Command (SC) software allows you to accomplish this. After initializing the system with all the preliminary commands described above, entering "SC" will activate the Speech Command software.

The Speech Command software, by the way, can do a number of things besides defining the vocabulary for the Transparent Keyboard. These include:

- activating a sophisticated telephone management system
- setting up a calendar/tickler manager
- setting up a dictation system

Defining a vocabulary comprises several steps. First, the words you want the system to recognize must be determined and typed into the system. The system uses these only as a prompt later when you are teaching it to recognize your voice. If, for instance, you type COPY but say "directory," it will recognize the word "directory." Of course, any language can be used, too.

Next, the equivalent keystrokes these words will activate must be defined. Alphanumeric keys, control codes, function keys (alone or in conjunction with Control, Shift, and Alternate), and even phone pad keys can be used. In fact, any key or legitimate combination of keys can be used because you can enter this data either literally (COPY for the word "copy"), as a hexadecimal code (using a caret | ^ | as a prefix), as a key code (using a tilde | ~ | as a prefix), or as a phone pad command (using two tildes | ~~ | as a prefix). All the codes are contained in an appendix to the users manual. A definition can contain up to 254 characters. Thus, it is possible for one voice command to activate a whole series of commands that would normally be entered manually.

Up to 50 words may be defined in any one vocabulary, but if more words are necessary, there is a mechanism that allows you to switch among several vocabularies. For example, during my test of this system I defined one vocabulary for the operating system and another for PeachText. The two vocabularies totaled more than 50 words. In my operating system vocabulary I included a command called EDIT. The equivalent keystrokes defined for EDIT look like this:

```
PT^0DED^0D~~2
```

PT is the name of the PeachText command file. The ^0D defines the hexadecimal code for a carriage return. This combination causes the PeachText program to start. ED and the second carriage return then tell PeachText that I want to edit a file. Finally, the ~~2 tells the Speech Command System to swap

vocabularies, turning off the operating-system vocabulary and turning on the PeachText vocabulary. Whenever I say "edit" at the operating-system level, these characters are presented to the system as if I had entered them manually.

Once the second vocabulary is activated, only the words contained therein will be recognized. It is possible, therefore, for the same word contained in two vocabularies to have different keystrokes specified for it, and thus obtain different results. For instance, the word "delete" in my operating-system vocabulary produces the string DEL, while the same word in my PeachText vocabulary produces the equivalent of the Delete key.

There must be another switch in the second vocabulary to get back to the first one (or to a third one that, in turn, will lead back to the first). In my case I have defined the command DOS to get me back. This keystroke definition ends with ~^1 to switch back to the first vocabulary.

The vocabulary words and their equivalent keystrokes are entered in two columns on a series of screens in the SC software: words on the left, keystrokes on the right. After all definitions are entered, they are saved onto disk by pressing function key F8.

It is then necessary to teach the computer to recognize your voice. The SC software makes this an easy two-step process. First, words are entered by saying each one once as it is pointed to by the SC software. Since it is nearly impossible to say any word exactly the same way twice, the words are then updated by repeating each word a number of times to average the variations in the way a word is pronounced.

The degree to which the system is recognizing your voice can be tested using a built-in test function. All the words of a vocabulary are displayed on the screen and as you say each one, in any order, the system tries to recognize and point to it. The screen also displays a number from 0 to 9 as an indication of the degree of fit as each word is recognized. In addition, the highlighting used to point to a recognized word will be either green (high degree of fit), yellow (moderate degree of fit), or red (marginal recognition). This information can then be used to update those words with marginal or moderate recognition until all words test green.

After all the vocabularies are determined, the equivalent keystrokes defined, and the system taught to recognize your voice, you still need to install these vocabularies into the system and turn on the Transparent Keyboard feature. Assuming you've already performed the steps outlined above (CALIBRAT, WINPATCH, and PCSPEECH), the next step involves a bit more user interaction.

From the operating system the command TPKSETUP is entered. TPKSETUP changes the keyboard interrupt vector. If you intend to use more than one vocabulary, it will be necessary to also add a numerical argument to the command, based on the size of the vocabulary files you want to include, plus some overhead figure to tell TPKSETUP how much memory to reserve. If you don't reserve enough memory, not all the vocabularies will be able to be installed at the next step in the process. It then will be necessary to start again from scratch by rebooting. I found this a rather roundabout way of dealing with this problem, but it seems that once TPKSETUP is run, you can't run it again without rebooting.

Next, the command TPK is entered. Here you are asked for the number and names of the vocabularies you wish to use, whether you are using a headset or microphone, and which vocabulary you want to activate first. If you didn't reserve enough memory when using TPKSETUP, then TPK will not load all the vocabularies. But at least it will tell you how much memory you should have reserved. Assuming you did reserve enough memory, you can now begin using voice input.

Using Voice Input

The first command I gave the computer was "directory return," which caused the directory of the entire hard disk to scroll by, all 317 files (actually, it was two commands). I noticed that it seemed to be scrolling a bit more slowly than usual. Then I noticed that if I issued another command, even just a "return," while the directory scrolled by, it started scrolling faster. This would appear to indicate that the Speech Command System, operating in the background, could degrade performance to some degree.

To test the degree to which performance was affected, I ran three of the standard BYTE benchmarks while the Transparent Keyboard was enabled. The first test I ran was the Sieve of

(text continued on page 344)

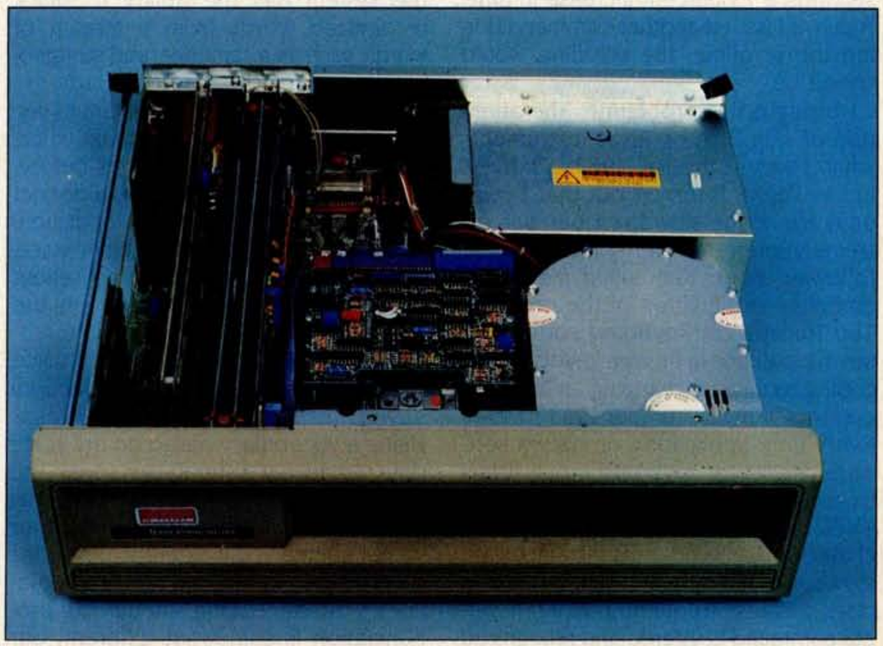

Photo 1: *The TI Speech Command hardware consists of the plug-in circuit card, a headset and extension cord, and a modular phone cord to connect the circuit card to a telephone wall jack.*

The system can pluck recognized words from a stream of words, and string together multiple recognized words.

(*text continued from page* 343)
Eratosthenes (see January 1983 BYTE, page 283). Surprisingly, it ran in 2 minutes 38.2 seconds, exactly the same time it ran in before the speech hardware was installed. Next, I ran the disk write and read benchmarks, using the hard disk for convenience. This time, however, the times were slower, running 7.8 and 5.5 seconds respectively, instead of the 7.1- and 5.1-second times recorded previously. These times represent 10 percent and 8 percent degradations. (See "The Texas Instruments Professional Computer" in the December 1983 BYTE, page 286, for a table listing all the benchmark times.)

Since I originally noticed the slowdown during display scrolling, I next issued a TYPE command from the operating system to display the contents of a 53K-byte file. Without the Transparent Keyboard enabled, the file scrolled by in 59.8 seconds. With the Transparent Keyboard enabled it took 1 minute 43.6 seconds, a 73 percent increase in time. Again, if I issued another command during the scrolling, the scrolling would speed up.

I brought this problem to the attention of Ken Bice of Texas Instruments while I was at the Fall 1983 COMDEX in Las Vegas. It turned out that TI was unaware of the slowdown but was extremely interested in my findings. The following week, Ken called me with a complete explanation of the problem. The Transparent Keyboard software, it seems, patches in its own keyboard decoding routine by changing an interrupt vector (see my December 1983 review). Every time application or system software checks for keyboard input, it has to pass through this extra code. The TYPE command does this after every character displayed, thus the significant slowdown. Reading and writing to disk does this less frequently. When a verbal command is uttered and recognized by the speech system, the keyboard checks pass through less code since there is data in the keyboard buffer, and the processes then speed up. Apparently it would take a major revision of the Transparent Keyboard software to fix this.

Distinguishing Voices

An important factor to consider when evaluating a speech system is how well it recognizes your voice. I defined a simple vocabulary consisting of words beginning or ending in plosives, such as "type" and "edit," as well as words beginning or ending in sibilant esses such as "search" and "thesaurus." I also included combinations of similar words such as "delete," "line delete," and "word delete," and "scroll forward" and "scroll back." The results were interesting.

The system had no trouble distinguishing the similar word combinations. The words "delete," "line delete," and "word delete," as well as the two scroll commands were never confused. The sibilant esses proved to be no problem either. But I did have trouble with the plosives. I attribute this more to my diction, however, than to some shortcoming in the system, since further testing by another individual showed no problem, and a serious effort on my part to more clearly pronounce the words resulted in improved performance. Also the system has the ability to pluck recognized words from a stream of words, such as a sentence, and string together multiple recognized words.

I also wanted to test the system to see how well it recognized a female voice. Using the same vocabulary as before, I had my sister-in-law (who has a distinct midwestern accent but excellent diction) teach the system to recognize her voice. In most cases the recognition (closeness of fit) was greater, especially on the words that had given me trouble.

Next, I wanted to test how well voice recognition could be used as a security device, responding only to my voice. Using a vocabulary based on my voice data, I had my sister-in-law speak the contents of the vocabulary. There was no recognition whatsoever. Since our voices are markedly different, this didn't surprise me. I then had my brother-in-law try the same thing. Though our pronunciation is somewhat different, our voice qualities are very similar. This time the system recognized every word. Using the built-in test facility of the SC software, I looked for closeness of fit. In most cases the closeness of fit was moderate to marginal, although one word did score a nine. I would not recommend using this system as a security device.

Ambient sounds are present in any office environment. Although I didn't test this system in an office, I did try to simulate it by having others talk in the background and make other loud noises while I used the system. I could detect no adverse effects on system performance.

Finally, I tried changing my voice, speaking in a moderately higher pitch as might be the case when one has a cold. This time the system did have trouble recognizing my voice and missed most words.

The only other problem I encountered concerned false triggers, the issuance of a command when none was spoken. Whether this was due to ambient sounds (the fan on the computer is quite noisy) or a bug in the software, it can become not only quite annoying but dangerous. There were enough of these false triggers that I would hesitate to recommend using the Transparent Keyboard feature for important work. I made sure there were no words defined in my vocabulary that could cause irreparable damage should they be invoked accidentally. For example, I did not include the QUIT command in my PeachText vocabularies because invoking it would cause the entire file to be lost. On several occasions during the writing of this article I found PeachText suddenly stopping when no command had been spoken. Fortunately, it was executing a normal END and saving the file on disk. It was annoying, but not disastrous. These false triggers occurred only when the microphone on the headset was on. I called TI to ask about this problem. According to TI, it seems to be a matter of a buffer overflowing, and they are working on it.

It should also be noted that the Transparent Keyboard feature will not work with TI's communications software unless a patch is installed. TI informs me that this is a temporary solution and that with the release of MS-DOS 2.0

(*text continued on page* 346)

The Speech Command software lets your TI PC send telephone messages and serve as an answering machine.

(text continued from page 344)

(due out by the time you read this) the problem will solve itself.

Other Features of the Speech Command System

Besides allowing you to define vocabularies to be used with the Transparent Keyboard, the SC software can turn your TI Professional Computer into a sophisticated telephone messaging system.

In its most traditional role, SC software allows the TI PC to act like an answering machine. You can "record" up to five greeting messages of any length, provided you have enough disk space. You can then direct the system to play one of these messages whenever it answers the phone. You can program how many rings to wait before answering, too. When the computer picks up the line it immediately plays the chosen greeting message and then goes into record mode and awaits the caller's response. In most cases, the caller will simply leave a message of some arbitrary length. The message is saved after the caller hangs up, and the file is time and date stamped. Remember, the voice information is being digitized and stored as digital data on a disk as any other type of file would be, not recorded in analog form as with a tape recorder. Consequently, the file can be time and date stamped, copied, and combined with other information such as a text description of the contents of the message. TI's software allows you to do all these things and more.

The answering machine functions allow you to review the messages in two ways, either from the keyboard or remotely using a Touch-Tone keypad. Messages are stored in two groups: new messages that have been added since the last review, and older messages that have been previously stored. When performing this function from a remote location over the telephone, a four-digit password must be entered first, and voice prompting then guides you through the rest of the process. You can even request the time and date of a message and the system will respond by voice. Again, this is not synthesized voice, but rather a real voice that has been processed and stored in a file and provided with the software.

The SC software also allows your TI PC to become a message-sending system. It will automatically deliver a message you have recorded to every phone number listed in a directory you create and then optionally record any reply the called party may have. You program the system to begin calling at a certain time, to allow each phone called to ring a certain maximum number of times before going on to the next number, and to keep trying unreached numbers until a certain cutoff time. The system will then start calling at the predetermined time, beginning with the first number in the directory, proceeding down the list. If a phone is not answered before the maximum number of rings programmed, the system will go on to the next number until the end of the directory is reached. At this point the computer attempts to call numbers not reached the first time, and so on until the cutoff time is reached.

One of the more mundane functions the SC software performs, but one that is fun to play with, is that of a dictation machine. You talk and it records. You can then play your words back. But you can also control the speed of playback without changing the pitch of the voice. Push a few buttons and you, too, can sound like the fast-talking man on the Federal Express commercials. As with any dictation machine, you can also move forward and back within the "recording" and pause at any point.

Lastly, the SC software provides a calendar/tickler system. You can enter appointments, birthdays, and such, along with an associated date and time. You can choose to have a reminder placed on the screen when you first use the SC software on any given day. But this functionality is low, in my opinion, since you could be wrapped up for hours designing, say, a Lotus 1-2-3 model and you won't be reminded of anything until you run the SC software again. This function could be quite useful if the tickler system were running in the background with the ability to play back a verbal message or pop a message onto the screen at any time no matter what other program you were running.

Quality versus Quantity

The quality of voice reproduction in a system such as this is closely associated with the rate at which the recorded voice is sampled. The higher the sampling rate, the more bits per second, the greater the fidelity on playback. The price paid for this fidelity is the amount of storage needed to hold all this data. The new compact disk stereo players use a laser to record music at a sampling rate of 55,000 samples per second, and each sample is a 16-bit word. When recording is limited to voice only, several "tricks" can be performed to greatly reduce the volume of data necessary to produce intelligible speech on playback.

When you consider that the recording rate of the Speech Command System is only 2400 bits per second, it's astounding that you can understand the playback at all. TI has done a remarkable job of providing adequate voice quality and high storage density. At this rate, a single 320K-byte disk is capable of holding up to 16 minutes of digitized speech, and a 5-megabyte hard disk can accommodate over eight hours of voice data. TI accomplishes this minor miracle with a technique called linear predictive coding, or LPC. Basically, LPC converts the incoming voice signal into a series of numbers representing the coefficients of an equation. This equation models the human vocal tract. Upon playback, these coefficients are then used to drive this artificial vocal tract, and speech is produced. One side benefit of this system is that long pauses between words or sentences are eliminated, and precious disk space is not used for "dead air." Also, this system is designed for voice recording only, and it does that very well. An attempt to record music resulted in a series of blips and squeaks, though they did have a definite rhythm.

The Smartphone

Another component of the Speech Command System is the Smartphone. The Smartphone provides a truly inte-

(text continued on page 348)

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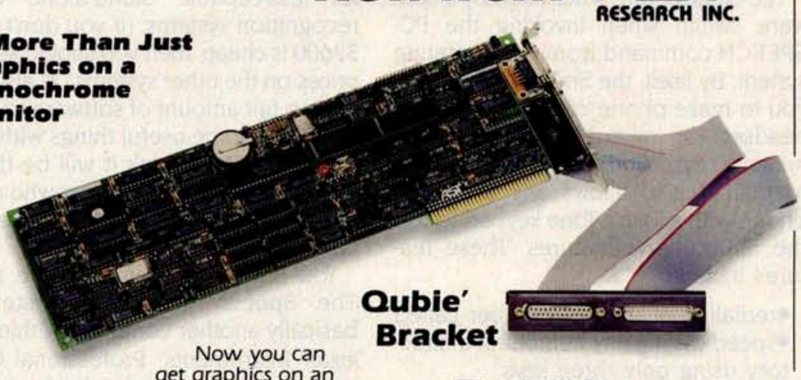

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(text continued from page 346)
grated phone system for your TI PC that is capable of completely "hands-off" phone operation.

The Smartphone is activated by a software switch when invoking the PC-SPEECH command from the operating system. By itself, the Smartphone allows you to make phone calls through your headset (or microphone) using the numeric keypad on the TI PC's keyboard to dial. It also allows any extension phone with a Touch-Tone keypad to use the Smartphone features. These features include:

- redialing of the last number called
- speed dialing any number in a directory using only three keys
- eliminating incoming calls (callers hear the phone ring, not a busy signal)
- switching between tone and pulse dialing
- dial tone detection

The Smartphone becomes even more impressive when used with the Transparent Keyboard.

Imagine yourself deeply immersed in an application, such as writing a review of a Texas Instruments product, when you suddenly realize you need to call someone at TI for information. While you're still using your trusty word processor you utter "Call TI" and a few moments later you hear the phone ringing in your headset. You get the information you need, jotting it down with your word processor as you talk, press a key to hang up, and complete your article. This is not a fantasy. What I just described is possible using the Smartphone in conjunction with the Transparent Keyboard.

DOCUMENTATION

Texas Instruments provides a comprehensive manual detailing every function of the Speech Command System. It does a decent job of familiarizing you with the use of a fairly complex system. It provides several examples to aid in understanding and even suggests methods for streamlining system operation, such as creating batch files for system initialization. A smaller, separate guide is provided for the physical installation of the processor card, and it, too, clearly describes the process, pointing out trouble spots and supplying illustrations for clarity.

CONCLUSIONS

Texas Instruments has provided a truly unique package of functions at a price that is only a fraction of that charged for less-capable, stand-alone voice-recognition systems. (If you don't think $2600 is cheap, then you should see the prices on the other systems.) TI also provides a fair amount of software to allow you to do some useful things with your computer. But I think it will be the independent software vendors who determine whether this product succeeds or fails.

You have to understand one thing. The Speech Command System is basically another computer within your Texas Instruments Professional Computer. TI provides two levels of software. There is the systems software that gives this computer its basic smarts—digitize a voice, reproduce a voice, detect Touch Tones or produce them, and so on. The second level of software is the application that runs on the TI PC and accesses the functions of this second computer, in this case the SC software and the Transparent Keyboard software, and combines them with its own logic to produce a useful product. Without the proper software the hardware is useless. At the same time, however, the user has absolutely no access to this computer-within-a-computer and cannot develop any other applications for it. Instead, a software developer needs to invest about $8000 to license the run-time software for integration into an application, and then needs to purchase a development kit to be used in conjunction with a high-level language to develop the application. Thus, any purchaser of this system will have to rely on (as yet nonexistent) third-party software developers to provide new ways in which to use it. (Software developers interested in designing applications for this system should contact Bill Smiers at Texas Instruments in Austin, Texas.)

The potential of voice input is exciting and could solve many of the problems now encountered with mice and touchscreens. There are perhaps dozens of specialized applications for this system (e.g., an aid to the disabled). All in all, I found the Speech Command System quite impressive. With the exception of the false triggering, which is a problem I suspect TI will solve, the system performed as advertised. ■

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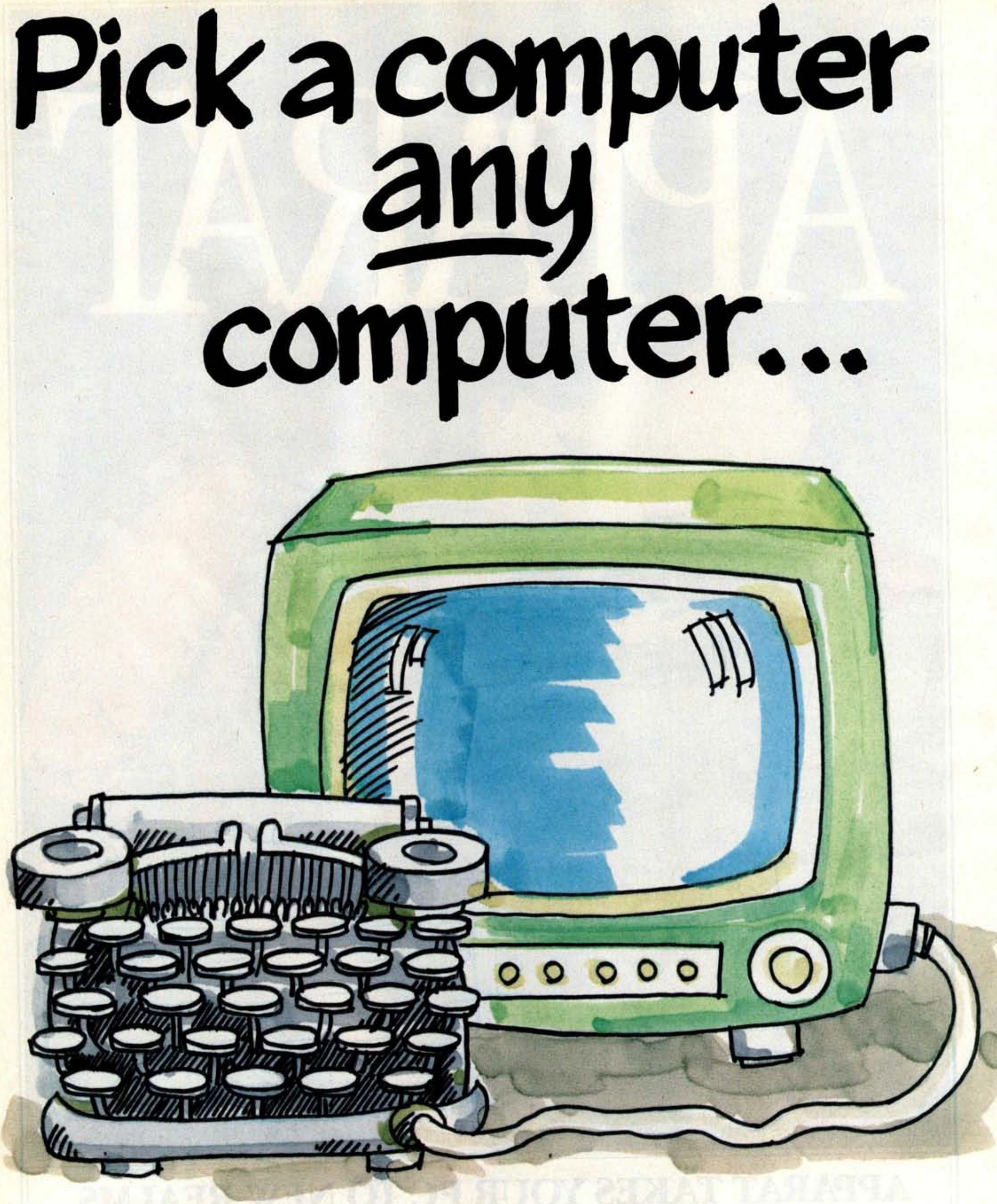
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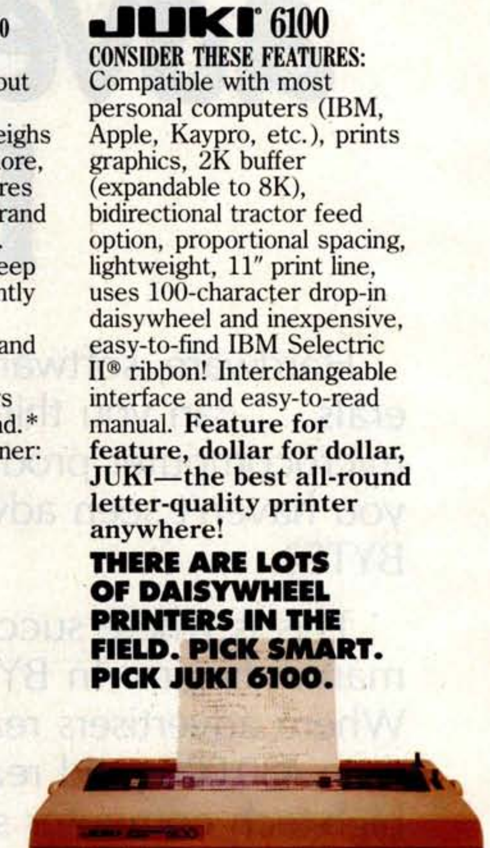

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Volition Systems' Modula-2

A version of Modula-2 for the Apple II

BY ERIC ELDRED

How does Volition Systems' implementation of Modula-2 stack up in the hands of a nonprofessional Apple Pascal programmer? This review should answer that question.

WHY MODULA-2?

Modula-2 was designed for systems programming, so it has speedy low-level facilities built into a readable high-level language. You don't have to restrict yourself to one microprocessor's assembly language. Modula-2 has interrupts and coroutines and can perform multitasking on the Apple II.

The language embodies the ideals of structured programming. Its module concept is superior to Apple Pascal's intrinsic units both in ease of use and efficiency. The definition module, which replaces the interface section of a unit, can be compiled separately and can make teams work well together. Only the data that must be shared need be exported; everything else will be inaccessible and, therefore, protected against accidental or malicious tampering. Modules maintain type checking, and version checking protects against changing the definition module without recompiling the programs that depend on it. It is possible to do some of this in Apple Pascal but it is never easy (see Michael Feldman's "Information Hiding in Pascal," November 1981 BYTE, page 493).

Modula-2 remedies some of the problems of Apple Pascal (few units, no open arrays, limited I/O (input/output), etc.) but it doesn't force you to abandon Pascal entirely. Pascal's block structure is still there because variables exist inside the same procedures. Yet there are some arbitrary differences as well as improvements in syntax, so it will take a Pascal programmer a few weeks to become comfortable thinking in Modula-2. For example, see the connected example of source code in listing 1. When you run this program, it will ask you to enter a real number, which must have a decimal point. If the number converts to integer 1, then the module Scheduler creates a status window and you can type anything into the top window while the trivia test is going on below. If what you type contains either of the two uppercase characters not on the standard phone dial, you will create another silly process. Statements in the form (*$..*) are directives to Volition's compiler. If you set (*$UPCASE:=TRUE;*), enter "|" (which divides CASE statements) as "!".

THE PRODUCT

Let's take a closer look at the Volition Systems package. Three disks come with it: M2SYS:, M2LIB:, and M2PROGS:. Volition's Advanced System Editor (ASE, pronounced "ace") and p-Shell (formerly "p-Nix") are available as options on separate disks.

On M2SYS:, there is a file called SYSTEM.MODULA that replaces Apple's SYSTEM.PASCAL. This is the standard Apple 6502 operating system, based on UCSD Pascal II.1, but the file is 40, rather than 41, blocks long (a block is two sectors, or 512 bytes). Your command prompt line will work exactly the same as in Apple Pascal.

M2SYS: also contains a p-code ("pseudocode," or the instruction set of an imaginary, portable p-machine) interpreter, called SYSTEM.APPLE, written in 6502 assembly code. It is 32 blocks long and is not much different from the Apple Pascal file it replaces, except that it has extensions for Modula-2. Because it does not have the two UCSD support routines IDSEARCH and TREESEARCH, it cannot run the Apple Pascal compiler or any user-written Pascal programs containing TREESEARCH.

Volition does not supply a Pascal compiler with the Apple system; therefore, you must boot Apple Computer's SYSTEM.APPLE and SYSTEM.COMPILER on a separate disk if you wish to program in Pascal. Also, the system will crash if Pascal programs using long integers are run under the Volition interpreter; this problem may be resolved in a later release of Modula-2. Incidentally, many people who have made patches to the Pascal SYS-

(text continued on page 354)

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AT A GLANCE

Name
Modula-2

Type
Modula-2 one-pass p-code compiler, p-code interpreter, library modules, and utilities.

Version
0.3k

Manufacturer
Volition Systems
POB 1236
Del Mar, CA 92014
(619) 481-2286

Format
5¼-inch disks, Apple Pascal 1.1 format, unprotected

Computer Needed
Requires 64K-byte Apple II+ or IIe and two disk drives; 80-columns and lowercase input and display helpful but not essential; versions available for the Apple III, 64K-byte IBM PC (not XT or PCjr), Z80/8080, and Sage II and IV

Software Required
Apple Pascal 1.1 or 1.2 (not 1.0); Apple III version needs Pascal and SOS

Documentation
241-page user's manual, 8½- by 11-inch 3-ring binder; Niklaus Wirth, *Programming in Modula-2*, 2nd edition (NY: Springer-Verlag), 1983, 176 pages, hardcover

Price
$295
with ASE, $395;
Modula-2 User's Manual, $35;
ASE User's Manual, $25;
Wirth's book, $16; p-Shell available through UCSD p-System Users' Society (USUS) and the International Apple Core

Audience
Systems and application software developers, individuals advanced in Pascal

(text continued from page 353)
TEM.APPLE for various reasons will find most will not work with the new interpreter unless done with SYSTEM.ATTACH.

The more recent Volition releases include a file called SMALL.APPLE, which uses significantly less memory than SYSTEM.APPLE, and SMALL.COMPILER, with which you can compile larger Modula-2 programs—as long as you do not employ real numbers.

P-CODE COMPILER

The centerpiece Modula-2 compiler was written in Pascal and is one block shorter than Apple Pascal's 75. It is a fast, one-pass compiler that compiles to p-code.

Using a p-code compiler is significant because such programs can execute on other machines for which there is a suitable p-code interpreter. (Even Apple II Pascal code files can't run under the Apple III Pascal interpreter.) The Volition compiler has an option to flip the "byte-sex" of the code, so you can compile a program on a 6502-based system and then on a computer that has the high byte in opposite order, such as the 68000. I think the Volition Modula-2 system will be attractive to programmers who want to reach a majority of the business market (Apple, IBM, CP/M, 68000) with a single tested program.

The compiler has some other advanced features, including conditional compilation. I found it convenient to use with Volition's optional ASE edition. When the compiler caught a syntax error, it first reported an English phrase, not an error number. I then got a chance to enter the editor at the place the error was found, hit the space bar, and correct it. After finding and correcting the error, I still had to start the compilation all over again. If you set the (*$DEBUG:=TRUE;*) compiler option, a run-time error will report the procedure name, rather than some cryptic number. But there is still no true debugger with breakpoints or single stepping.

The major difference between Volition's implementation and Wirth's Modula-2 standard is Volition's inclusion of PACKED variables, FORWARD declarations, and CODE procedures. PACKED variables and FORWARD declarations were included to save memory and disk space. (The FORWARD declaration could have been dispensed with because it is logically possible to write mutually recursive procedures in a roundabout fashion, but its inclusion does simplify work for a one-pass compiler.) The CODE procedures, which allow you to perform low-level operations with p-code instructions, are not needed in standard Modula-2. Programs that use any of these extensions will not be directly compilable with a standard Modula-2 compiler. Other differences occur between Volition's and Wirth's Modula-2. Volition uses INTEGER, rather than the standard CARDINAL, values for FLOAT and TRUNC and integer size limits for the maximum CASE label, DIV, and MOD, but these are more limits than violations of the Modula-2 standard.

USING MODULA-2

Volition has added most of the I/O and string-handling features that have made UCSD Pascal so popular, but they are located in the utility library on the M2LIB: disk. Thus the standard language is sparse, pure, and elegant, and the user has access to as much power as desired. There are minor syntax differences from the Pascal versions of some procedures.

The utility library includes the module Decimals, which gives COBOL-like formatting "pictures" for business or scientific purposes.

You will need to put the library (97 blocks) and user files on the second drive because of the Apple's limited disk capacity. Much of the time it takes you to get used to Modula-2 will be spent in determining which module to import and which module is dependent on which. Because whenever you import a module you put it and its dependent modules in memory, you will quickly use up your workspace unless you are careful. The manual gives helpful hints on how to maximize either compilation or run-time space. I had to make up a map of module dependencies.

LIB.CODE, the library manager on M2LIB:, is an improvement over the similar Apple Pascal LIBRARY.CODE because

- You can hide and unhide modules in the library to speed up the compilation process.
- You can remove definition

modules after all the implementation modules and programs have been compiled and they are no longer needed.

- You can concatenate user modules into a program library that you can then compact by doing an update.
- You can go into compiled program code, extract a module, and reuse it in another program. You don't have to disassemble it to get the source text, you can make full use of it without its being a separate code fragment.
- You have 64 slots in the standard library versus 16 in Apple Pascal, and module overlays are much superior to Pascal's segments.

Software Benchmarks

Is Volition Systems' Modula-2 any faster than Apple Pascal? To find out, I ran BYTE's Sieve of Eratosthenes prime-number generator program (see "Eratosthenes Revisited: Once More through the Sieve," by Jim Gilbreath and Gary Gilbreath, January 1983, page 283).

The Modula-2 program in listing 2 ran in 322 seconds (or about 11 percent faster) on the Volition system versus 363 seconds for the Apple Pascal version in listing 3. I couldn't resist tinkering with the declaration order of the original benchmark. I declared the integer or cardinal variables before the array, reversing the customary sequence of lines 9 and 10. Though it's not widely known, the UCSD p-machine was designed with more efficient storage instructions for the first 16 words of data in a procedure, so you should always declare the most-used scalar variables first and arrays (which take more space) last. Other Pascal compilers' times may not improve using the modified Sieve shown in listing 3.

The Modula-2 compiler also does not allocate storage in backward order as the Apple Pascal compiler does when you assign several variables the same type within the same statement. Thus, to be absolutely fair, I reversed the order inside the Pascal integer variable declaration (see line 9), but because those variables are still within the first 16 words of data, it made no difference in running time.

BYTE's original Modula-2 benchmark

(*text continued on page 356*)

(text continued from page 354)

was not written in standard Modula-2 syntax, so it would not compile. (The Apple Pascal benchmark wouldn't compile either until I changed the name of the program from "Prime," which aliased one of the identifiers, to "prime.") When I tuned up the text, turned off range checking, and optimized both with addition instead of multiplication on line 18 (leaving the declaration order as in the originals), the benchmarks ran in 375 seconds for Volition's Modula-2 and 451 for regular Apple Pascal 1.1. Both might run faster if the arrays were initialized with FillChar, but that was specifically disallowed because of portability concerns. The Volition system has FillChar, but it should be used cautiously because it avoids some of the usual tight type checking. The Sieve article explained how to turn off range checking if that were available, and so I did.

The fourth column of the listings, which gives the offsets, or bytes, generated, shows that the way these compilers work is different from what you would expect from the text files. The Modula-2 compiler left the message shown below the listing; the program is compact, occupying 176 bytes. This doesn't count the module InOut, which will also be loaded into memory at run time, before the timing starts. Note that procedures such as WriteString don't generate more code than Pascal's WriteLn, they simply make the programmer do more of the work.

In particular, observe that the Volition Modula-2 compiler uses comparatively few bytes for a FOR loop. I understand that Volition's president, Joel McCormack, invented a new method of coding the FOR. . .TO. . .BY. . .DO. . .END loops that saves the p-machine much space and time. Because benchmarks such as BYTE's mainly use this control structure, Volition's programs test faster. Other constructs might not be as efficient, but Wirth claims that Modula-2's CARDINAL type and the built-in INC procedure, to name a few, are superior to Pascal's.

Please note that for some reason my benchmarks were slower than others BYTE gave for Apple Pascal, but some of my timings have been confirmed by Alan Anderson in an article submitted to *Apple Orchard* magazine.

In my experience, Volition's Modula-2

Listing 1: *This program creates four windows on the screen to demonstrate some features of Modula-2. Each coroutine has memory space and processor time allocated by the modules* Window *and* Scheduler. *Note the similarities to Pascal (e.g., calling procedures by name or by value) as well as the differences (e.g., expressions and an* ELSE *within* CASE *labels,* ELSIF, *and two methods of module unqualifying:* FROM . . . IMPORT *or the alternative used in* RealInOut.ReadReal). *See text for more information.*

```
MODULE WindyDay;
(* multitask Modula-2 program "improved" from Joel McCormack's WindowDemo *)
(*$NOT "original, copyright 1982 by Volition Systems, all rights reserved" *)
(*$SET "Old stock Apple II keyboard?" FatherWoz *)(*$IF NOT FatherWoz THEN *)
FROM Windows IMPORT WINDOW, Open, Write, WriteString, Borders;
(*$TYPE "Remember, first compile definition and implementation modules" *)
(*$TYPE "you edit from Scheduler, and assign (*$SEG:=8;*) to definition." *)
FROM Scheduler (* in M2-LIB:WindDemo.text *) IMPORT CreateTask, Sleep, Start;
FROM Terminal IMPORT BusyRead; (* FROM Mouse IMPORT Swiss;*) IMPORT RealInOut;
FROM ASCII IMPORT esc; (* all these must be in library modules, prefix #5: *)

  PROCEDURE MaBell;
    VAR wind : WINDOW;
  BEGIN
    Open (wind, 11, 18, 5, 22);                    (* appears in center of screen *)
    LOOP
                      WriteString(wind, "You can't dial these 2"); Sleep
    END
  END MaBell;

  PROCEDURE IsaacWatts;
    VAR wind: WINDOW;
  BEGIN
    Open (wind, 12, 1, 10, 16);                              (* toward left side *)
    LOOP
                           WriteString(wind, "little busy bee "); Sleep
    END
  END IsaacWatts;

  PROCEDURE WriteItOnTheWind;
    VAR   ch : CHAR;   wind : WINDOW;
  BEGIN
    Open (wind, 2, 24, 6, 15);                         (* type anything in top window *)
    Borders (wind, '+', '|', '-');                      (* nice border around wind *)
    LOOP
      BusyRead(ch);                                   (* checks for character typed *)
      IF ch = 0C THEN Sleep                                   (* if not, continues *)
      ELSIF (ch = 'Q') OR (ch = 132C)                       (* 'Z' : nC is octal *)
                          THEN CreateTask (IsaacWatts, 'What?')
      ELSIF ch = esc THEN HALT
      ELSE Write(wind, ch) END                              (* types buffer in wind *)
    END                                       (* if you have an Apple IIe 80-column card, *)
  END WriteItOnTheWind;                      (* you get inverse wind when you hit CTRL-0*)

  PROCEDURE OpenWindow;
    VAR number: REAL; choice: INTEGER; wind: WINDOW; CONST two = 1 + 1;
  BEGIN
    Open (wind, 0, 1, 39);
    WriteString(wind, "Won't you really type one number? ");
    RealInOut.ReadReal(number); choice := TRUNC(number);
    CASE choice OF
      two - 1 : CreateTask (MaBell, 'Phony');
                CreateTask (WriteItOnTheWind, 'Typer'); Start
      | 2..9 :  HALT
      ELSE      OpenWindow
    END (* CASE Swiss *)                              (* Scheduler creates status box. *)
    END OpenWindow;                       (* 'Phony', etc., appear in box when created *)

  BEGIN
    OpenWindow
  END WindyDay
(*$END*)(*If stock Apple II keyboard, set (*$UPCASE:=TRUE;*) at top first*).
```

runs about 10 to 20 percent faster than Pascal on the p-System, if you do not include disk-access time. More informative comparisons could be obtained with other high-level languages. I believe that Modula-2 will run many times faster than BASIC or COBOL, but somewhat slower than most C or FORTH implementations, everything else being equal. But I think Modula-2 is the most readable.

It would be wise to heed the warning in the benchmark article, "Execution time of the Sieve program, of course, should be regarded as only one of several considerations in choosing a particular language, system, or processor." For example, it took about 40 seconds to compile (without listing to the printer) and then load the Modula-2 Sieve program, versus 22 seconds for Apple Pascal. The Modula-2 compiler accesses the disk more, to find modules to import from the standard library. But you can edit the standard library or even package necessary library modules directly into the program and so reduce the disk access. You might also place your files on a RAM (random-access read/write memory) disk.

HASSLES

I had only a few minor problems with the Volition Systems' Modula-2 package. One was the documentation. Though complete, the manual is segmented into six parts, each with its own index, but there is no overall index and no common reference chart or summary. You have to read through the whole manual before it makes sense.

The last part of the manual is what you will need first—it is the implementation guide for your system. This guide has important differences from earlier sections of the manual. For example, section one of the user's manual says FLOAT and TRUNC work with CARDINAL numbers and even gives an example of how they work. That example will not compile as listed because, as we discover later, the Apple implementation uses the type INTEGER instead of the standard CARDINAL for those functions. Also, some examples in the first part of the text do not assign segment numbers to definition modules; therefore, if you try to compile them as is, the compiler just breaks off. Later, the manual tells you what numbers to assign and how, but I wish I had been advised earlier not to try to type in the manual's examples. The ones that do work are on disk and can be compiled.

The sample programs on the PROG2: disk and on M2LIB: disk are an excellent tutorial to the Volition system. You should first print out the text files of these programs so you can follow along as you try to compile them.

The manual advises that you are limited to 10 significant characters for module names (the Modula-2 standard does not mention a limit). But two sample programs on PROG2:, namely LIBMODB.TEXT and OBJECTMODB.TEXT, have the same first 10 characters in their identifiers (NumberGenerator and NumberGenerators). When I compiled the second program it overwrote the file of the first one without any warning. I learned that it doesn't matter if you tell the compiler to give the code file a different filename because the compiler uses the identifier in the text file and then adds a suffix .SYM (or .MOD in the case of implementation modules). This procedure is different from the UCSD Pascal compiler's and deserves to be treated cautiously.

I also had one problem with the conditional compilation feature, using the (*$IF...THEN...$ELSIF...$ELSE...$END*) directives. At first, I could not compile more than one module at a time, as was suggested by David Carlisle in the *Journal of Pascal and Ada* (May/June 1983). The compiler stops when it sees a period in the text. The compiler directive (*$END*) to end the choice must come once, before the last period. Each separately compiled module or program usually ends with a period, and if there is more than one the compiler can't find either a (*$END*) or a (*$IF*), depending on which module I chose at compile time. When I inquired about this, Volition Systems told me the compiler had been changed somewhat from the 0.3a version Carlisle used, and that when using version 0.3k I should end each module prior to the last module with a semicolon instead of a period.

Listing 2: *The Sieve of Eratosthenes prime-number program written in Modula-2. This program was compared to its Pascal equivalent, seen in listing 3.*

```
7  1:D    0  (* $TO "PRINTER:" *)
7  1:D    1  (* $RANGE:=FALSE; *) (* Note range checking off for speed *)
7  1:D    1  (* Eratosthenes Sieve prime-number program in Modula-2 *)
7  1:D    1  (* Original by Gunter Dotzel, ETH-Zurich, BYTE, January 1983, p. 290 *)
7  1:D    1  (* Modified by Eric Eldred *)
7  1:D    1  MODULE Prime;
7  1:D    1  FROM     InOut IMPORT WriteLn, WriteCard, WriteString;
7  1:D    1  CONST    Size = 8190;
7  1:D    1  VAR      i, prime, k, count, iter : CARDINAL;
7  1:D    6           Flags : ARRAY[0..Size] OF BOOLEAN;
7  1:C    0  BEGIN
7  2:C    0           WriteLn; WriteString("10 iterations");
7  2:C   24           FOR iter := 1 TO 10 DO
7  2:C   27             count := 0;
7  2:C   30             FOR i := 0 TO Size DO Flags[i] := TRUE END;
7  2:C   49             FOR i := 0 TO Size DO
7  2:C   52               IF Flags[i] THEN
7  2:C   60                 prime := i + i + 3;
7  2:C   67                 k := i + prime;
7  2:C   72                 WHILE k <= Size DO
7  2:C   80                   Flags[k] := FALSE;
7  2:C   87                   INC(k, prime)
7  2:C   92                 END;
7  2:C   94                 (* WriteCard(prime,6); WriteLn; *)
7  2:C   94                 INC(count)
7  2:C   98               END;
7  2:C   98             END;
7  2:C  107           END;
7  2:C  114           WriteLn; WriteCard(count, 6); WriteString(' primes')
7  1:C  133  END Prime.

30 lines, 1750 words left
176 bytes generated
```

(text continued on page 358)

(text continued from page 357)
That worked fine. The documentation should be updated.

In addition to the user's manual and the tutorial disk, Volition includes Wirth's book, *Programming in Modula-2*, which is hardly mentioned in the user's manual. Some of the modules in the manual are explained, with full source code, in the book. It's hard to know which to read first, but if you are just beginning programming you might study the first few chapters of the Wirth book before anything else. It is hard to find some things in the book because of its woeful index. Wirth not only wrote Modula-2, but also set the standard, helped develop hardware on which to run the new system, used the hardware to write the book about the language, then wrote a program to format the book's text, and finally typeset it with the computer and a Canon laser printer.

Wirth's book gives the definition module LineDrawing and states that it should be included in each implementation's standard library. It is not included in Volition Systems' library. Apple's Turtlegraphics unit (with minor syntax changes) is used instead, and it is somewhat different. It is not clear how Apple's high-resolution screen memory pages can be protected from user programs overwriting them. Some programs in Wirth's book can't run directly on an Apple because they were designed for the LineDrawing module or the Lilith's graphics screen. There is the module Windows on Volition's library disk, but it is not exactly the same as the WindowHandler in Wirth's book.

I must admit that I ran into these problems only because of my eagerness to get going with Modula-2. If I had approached it in a more organized fashion, I would have learned Modula-2 from the documentation rather than my own mistakes. If you have used Apple Pascal, it should not take more than a few weeks to feel comfortable with Volition's Modula-2.

I did experience some hardware problems.

When I attempted to install Modula-2 on my Corvus Winchester disk, the hard disk would no longer boot. Eventually, I had to completely reformat the disk and wipe out all its data in the process. Corvus customer support did not know about Modula-2 but I later learned that they were working on getting it up on the Corvus drive. Similar problems probably will occur if any hardware depends on patching Apple's SYSTEM.APPLE in a nonstandard way. The

(text continued on page 360)

Listing 3: *The prime-number program in Apple Pascal. Both prime-number programs were modified from the originals found in* "Eratosthenes Revisited: Once More through the Sieve," *by Jim Gilbreath and Gary Gilbreath, January* 1983 BYTE, *page* 283.

```
1  1:D    1  (*$L PRINTER:*)
1  1:D    1  (*$R-*) (* Note range checking turned off for speed *)
1  1:D    1  (* Eratosthenes Sieve prime-number program in Pascal *)
1  1:D    1  (* Original in BYTE, January 1983, p. 284 *)
1  1:D    1  (* Modified by Eric Eldred 25 Dec 83 to compare to Modula-2 *)
1  1:D    1  PROGRAM PrimePascal;
1  1:D    3
1  1:D    3  CONST   Size = 8190;
1  1:D    3  VAR     iter, count, k, prime, i : INTEGER
1  1:D    8          Flags : ARRAY[0..Size] OF BOOLEAN;
1  1:0    0  BEGIN
1  1:1    0          WriteLn; WriteLn('10 iterations');
1  1:1   43          FOR iter := 1 TO 10 DO BEGIN
1  1:3   57            count := 0;
1  1:3   60            FOR i := 0 TO Size DO Flags[i] := TRUE;
1  1:3   90            FOR i := 0 TO Size DO
1  1:4  106              IF Flags[i] THEN BEGIN
1  1:6  114                prime := i + i + 3;
1  1:6  121                k := i + prime;
1  1:6  126                WHILE k <= Size DO BEGIN
1  1:8  133                  Flags[k] := FALSE;
1  1:8  140                  k := k + prime
1  1:7  141                END;
1  1:7  147                (* WriteLn(prime); *)
1  1:6  147                count := count + 1
1  1:5  148              END;
1  1:5  159
1  1:2  159          END;
1  1:1  166          WriteLn; WriteLn(count,' primes')
1  1:0  211  END (* PrimePascal *).

30 lines
Smallest available space = 2349 words
```

Table 1: *These p-Shell utility programs add* UNIX*-like capabilities to the p-System. All of these shell utilities are written in Modula-2 and their source code is available.*

cat	concatenates/copies input to output
cl	clears screen and home cursor
cp	copies any kind of file to another file
date	writes current date to standard output
echo	writes command arguments to output
ed	invokes editor, and edits file if listed (ASE is too large to fit in memory along with Modula-2 on the Apple II, but the original SYSTEM.EDITOR works fine here.)
f	invokes SYSTEM.FILER.
grep	searches input for string and writes lines to standard output; can search files listed
ls	catalogs files on disk
mc	invokes compiler (this won't work on Apple II)
mem	writes words of memory available
more	echoes input to terminal and writes "More?" when output reaches bottom of screen. If you then type "y", the screen will clear and the next 24 lines appear
mv	changes name of file
rm	removes file
sh	invokes shell (recursively)
sort	sorts lines of text file by ASCII (American National Standard Code for Information Interchange) order and writes to standard output; uses recursive quicksort in memory
wc	counts words, lines, and characters and writes totals to standard output

(text continued from page 358)
standard way is to use the SYSTEM.ATTACH utility, as described on a disk from the International Apple Core. For example, I was able to install my Saturn 128K-byte card as a RAM disk with no trouble.

To be fair, Volition Systems did not suggest that I could perform any such surgery on my Corvus. If I had checked with the company first, it would have warned me of the consequences. Modula-2 can be used with the Corona Starfire (with minor patches) and Xebec hard disks, but some early Videx Videoterm 80-column card ROM (read-only memory) chips may need to be updated before Modula-2 will work with them, according to a manual addendum.

Other difficulties I experienced using Modula-2 on the Apple are not Volition's fault. The Apple II has limited memory, speed, and disk space and Modula-2 pushes the machine to its limits. Apple has promised that Apple Pascal version 1.2, when released, will allow you to use Volition's Modula-2 more conveniently, at least on a 128K-byte Apple IIe.

The version of Modula-2 I tested (0.3k) did not support long integers. Volition Systems has been working on implementing them in two directions. First, Richard Gleaves revealed to me that he had worked out a zero-page change to allow Pascal long integers to run under Volition's Apple p-code interpreter, and this should be available in the next Modula-2 release. Second, Volition, together with the Modula Research Institute, is developing a standard long-integer approach, a natural tool on 16-bit machines, and hopes to persuade Wirth to include it in the standard language. Although Volition does include the Decimals module to do scientific and commercial mathematics, so many programs have been written using long integers in Pascal that it would be senseless to disregard them and start over.

There are several ways to use Pascal with this Modula-2 system. One is to run Pascal straight, as a completely separate program under the Modula-2 interpreter. ASE, a large Pascal program, does this. If the program works, there will be no need to waste time converting it. But if you wish to convert a Pascal
(text continued on page 362)

Table 2: *A feature-by-feature comparison of Volition Systems' Modula-2 (version 0.3k) with Apple Pascal (version 1.1).*

Language Comparison Chart

Feature	Apple Pascal (version 1.1)	Volition Modula-2 (version 0.3k)
Separate compilation, information hiding	units, constricted; no true packages with local variables, user-defined opaque types	modules, flexible; definition modules give version control; locals, opaques
Large programs	26 segments, chaining	64 modules, overlays
Input/output	awkward, not standard	standard library
Machines access	machine language or variant records	type transfer, SYSTEM, fixed address variable
Concurrency, interrupts	not standard	standard, coroutines
Procedure variables	none	standard type
Functions	return only scalars	return any type
Arrays	fixed size, typed	open array parameters
Expression evaluation	not always clear order	AND, OR short-circuits
Constants	no expressions, fixed order of declaration	expressions too (also allowed in CASE labels); declare in any order
Declaration order	fixed, at beginning; all CONST, etc., together	any place before use; ok to group in any order
Identifiers	case-insensitive; no standard style among programmers	CaseSensitive (standard—unless $UPCASE directive)
Character significance	first__eig(ht	AsManyAsItTakes
Underscore character	ignored, more__readable	NotAllowedAtAll
Predefined	GET, PUT, INTERACTIVE	not needed
ATAN	same as standard ARCTAN	arctan only
CAP	none; use nonstandard capitalization procedure	standard identifier, converts to uppercase
CONCAT	joins two or more strings	only two arguments
Log (base 10)	in TRANSCEND unit	not provided
NEW, DISPOSE	use MARK, RELEASE	standard identifiers
NIL	reserved word	standard identifier
ORD	returns INTEGER, value of CHAR is decimal	returns CARDINAL, but CHAR value is octal
PAGE	no UCSD ClearScreen	use ClearScreen
Power of ten	PWROFTEN	PowerOfTen
PRED, SUCC	standard	none, use INC, DEC
PROC	none; no procedure variables allowed	standard type, denotes parameterless procedure
ROUND	standard UCSD identifier (integer)	none, use FLOAT(integer) (standard is CARDINAL)

(table 2 continued on page 362)

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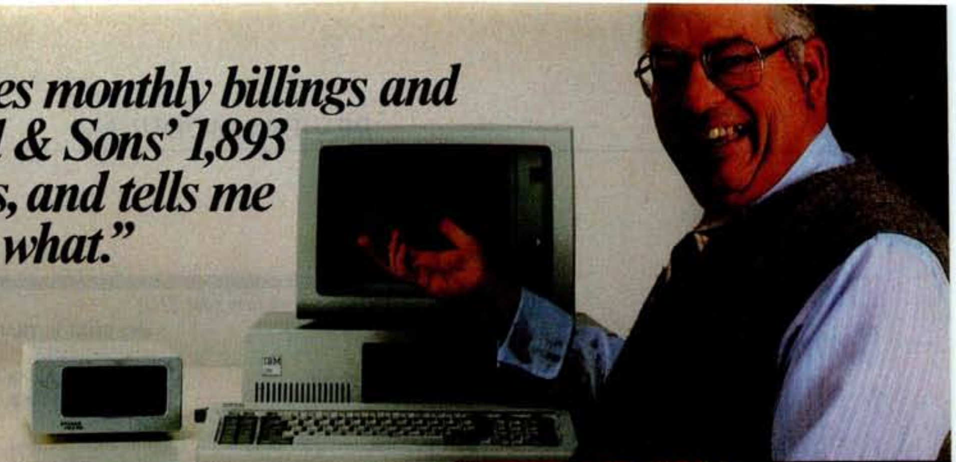

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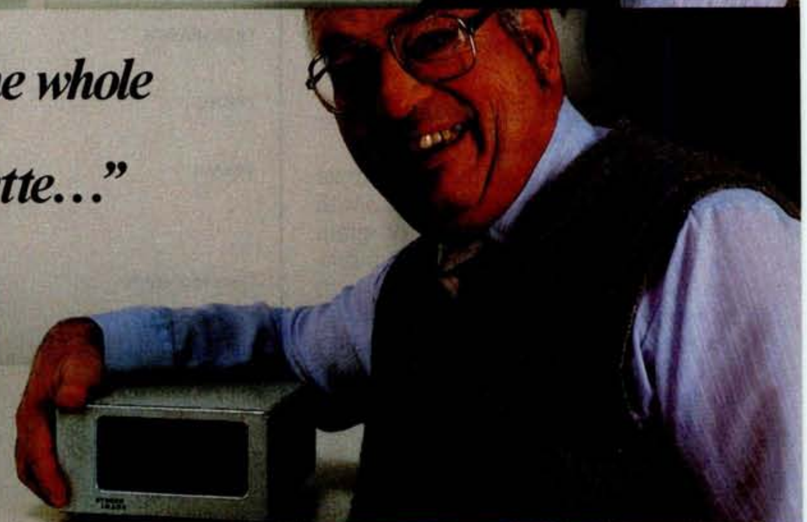

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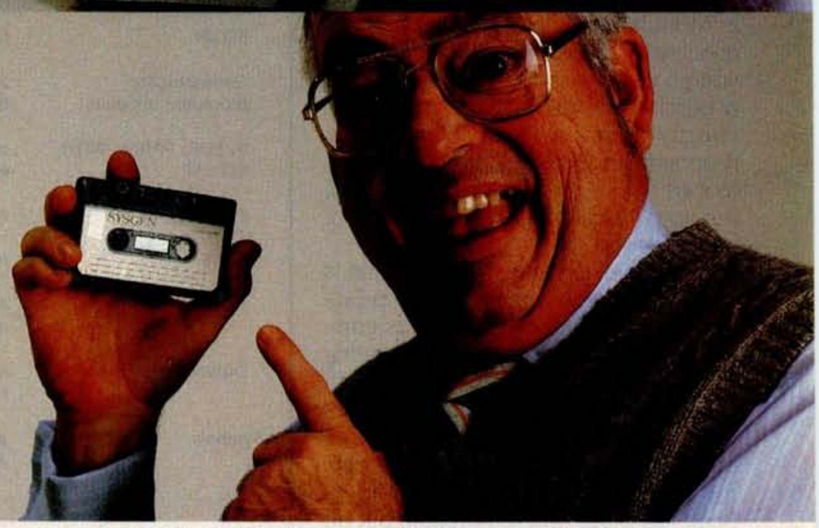

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The p-Shell (formerly called p-Nix) is an optional replacement for the p-System command envelope.

(*text continued from page* 360)

procedure to Modula-2, as for example a software tool, then you can do so with the aid of CONVERT.CODE, a program on M2LIB:. This will not convert a program automatically. First you have to compile the program (or assemble an external procedure) and make it a Pascal intrinsic unit. Then you have to change the interface syntax by hand so it agrees with Modula-2's and make that part into a definition module. You do not even need the text of the unit. Finally, you can convert the unit code into a Modula-2 implementation module and use it in MODULA.LIBRARY. Unless you go through these steps, all carefully described in the manual, you cannot directly access a Pascal or assembly routine from Modula-2. It makes sense to start thinking in Modula-2 right away, but your Pascal programming need not all be wasted.

The p-Shell (formerly called p-Nix) is an optional replacement for the p-System command envelope. It adds commands like those in the UNIX operating system to the p-system. (See "The Software Tools: Unix Capabilities on Non-Unix Systems," by Deborah K. Scherrer, et al, November 1983 BYTE, page 430, for another implementation.) The p-Shell has pipes and redirection, but no hierarchical files and no control structures such as IF. . .THEN. Also, it creates a temporary file on the root volume when needed, so it is rather slow and disk-intensive.

Volition has generously donated the full Modula-2 text files of many shell utilities (see table 1).

You may add commands of your own to the shell. Facing the disk and memory limits of Apple II version 1.1, you will need to use all the tricks suggested in the disk documentation when recompiling the shell programs. I'd like to see some utilities such as a style checker

(*text continued on page* 364)

(*table 2 continued from page* 360)

SQR	also SQRT in TRANSCEND	sqrt only
STR	may convert long integers or integers to string	none; use Decimals, Conversions
TIME	not implemented	not implemented on Apple
TREESEARCH	fast binary tree search function	absent; thus can't run Pascal compiler
TRUNC	accepts long integer, but error if >32767	returns INTEGER, no long; (standard is CARDINAL)
WriteLn	if followed by string, number, or character, then writes it and return, else return alone	carriage return and line feed only; import WriteString, WriteCard, etc. for other functions
Reserved words	case-INsensitive (more legible if in CAPS)	MUST BE ALL CAPS (but see $UPCASE directive)
Include	PROGRAM, FUNCTION, EXTERNAL, UNIT, USES, INTERFACE, SEGMENT	use modules isntead; convert intrinsic units (assembly language too)
Also	PACKED, FORWARD	nonstandard but present
CODE procedure	none; use assembly language	p-code instructions
BEGIN	one for every END	most not needed
Terminator for procedure (module)	END; (END. for program) ok: END (* Big_Program *).	add identifier after END as END Stuff; END Foon
IF, FOR, WHILE, WITH, REPEAT	use compound statements each with BEGIN. . .END	require only closing END; (UNTIL if REPEAT)
ELSE	none allowed in CASE	ok in CASE for otherwise
ELSIF	none; use maze of IF. . .THENs	use for cascaded IF. . .THEN
GOTO, LABEL	programming's Piltdown man; useful for multiple exits	streng verboten; use LOOP/EXIT, RETURN, HALT
DOWNTO	negative steps in FOR. . .TO. . .DO	none; step can be BY −1 or almost any value
Symbols	generate all needed from old Apple II keyboard	use nonstandard $SPECIAL to transliterate some
";"	";" expected to delimit all statements	also, "|" delimits CASE statements and record variants
Extra delimiter	not before ELSE	no "|" before ELSE
Pointer	"^"	declare POINTER TO
Set constant delimiter	[square, brackets]	{curly, braces}
Subranges, array Declarations	"(", ")" around subranges	"[", "]", also arrays if explicitly declared
AND	AND	"&" also used
Not equal	"< >"	"#" also used
Comment delimiters	either "(*" or "{"; if use both, then one-level nesting, not standard	only "(*" multiple nesting is standard

(*table 2 continued on page* 364)

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Volition Systems' Modula-2 for the Apple II has useful features to correct most of Pascal's problems.

(*text continued from page 362*)

and dictionary, and others have suggested that *lint*, a program syntax checker, would be welcomed.

Volition Systems is composed of a small group of programmers, many of whom worked on the original UCSD Pascal project. Their support ranks among the highest I have encountered. I found them approachable, patient, and anxious to fix all bugs. They are active in helping users groups, and they make you feel we are all in this together.

CONCLUSIONS

Volition Systems' Modula-2 for the Apple II is much more than enhancement to the Apple Pascal operating system and language. The system has useful features to correct most of Pascal's problems; the modules are a big improvement over units, especially for teams of programmers. It has advanced features such as multitasking and low-level access. See table 2 for a feature-by-feature comparison with Pascal.

The system is not intended for beginners, but it would be suitable for any advanced user who is reaching the limits of Apple or UCSD Pascal. Most students start with BASIC, go on to Pascal, and then on to Modula-2, C, etc.

This version of Modula-2 is designed to be portable. Not only will most existing Apple Pascal programs run unchanged under its interpreter, but you can easily convert most Pascal units to Modula-2 as well. You should be able to compile Modula-2 programs on the Apple II that will run directly on an Apple III, an IBM PC, a Sage, or a Z80 computer.

The Advanced System Editor and p-Shell are inexpensive and effective tools for software development. You may find you spend a lot of time using them for everyday purposes, even if you don't program in Modula-2. ■

(*table 2 continued from page 362*)

String delimiters	single quotes; contained single quotes can be expressed by doubling them	either single or double quotes; use other mark to express contained one
"()"	not allowed	empty parameter list
INTEGERs	decimal only; ok to mix with reals	also hex and octal; convert before mixing
MOD	unreliable with negatives; works with any INTEGERs	undefined for negative; no CARDINALs >32767
CARDINALs	none, use (long) integers	unsigned units 0 to 65535
Long integers	up to 36 BCD digits for business, scientific use	use Decimals (19 digits) no long integers yet
Reals	no decimal point is required, "e" ok; ok to mix with integers	requires decimal point, "E" only, not "e"; don't mix with integers
Reading a real	mistaken string input will crash system; read string instead and then convert	ReadReal uses ReadString, so no crash, but you must check if it's real
Characters	standard Pascal maybe not standard ASCII sequence	in ISO, US ASCII order; ordinal value octal
Strings	UCSD: first byte is length of string	ARRAY, not predeclared, can convert to UCSD
One-character string	ok	allowed in versions after .3k
Constant, variable length	must match	constant can be shorter than ARRAY length
Sets	elements 0-511, integer, maximum	same, up to 32 words on Apple, 255 on others
Type	determined by elements	can be explicitly typed
BITSET	lacking; (NB: PACKED ARRAY [0..7] OF BOOLEAN is 16 bits)	standard default type to fit in one machine word
Set operations	within same type	can also use INCL, EXCL; "/" for bitwise XOR
Record variants	very important, but only one variant part available	can contain several variant parts, each terminates with END;
	"trick" variants for PEEK, POKE	use SYSTEM for machine-independent access
Compiler	supplies dots for each line	no dots
Swapping	compiler option	nonswapping
Even more swapping	S++ gives more memory	$RECYCLE option
Conditionally compiles	no	yes
Byte-flip option	no	yes
Debugger	not implemented	minimal $DEBUG
Version control	none or minimal	both at run and compile
Input-output check	(*$I-*) disables	not compiler option

Photo: Peter B. Kaplan

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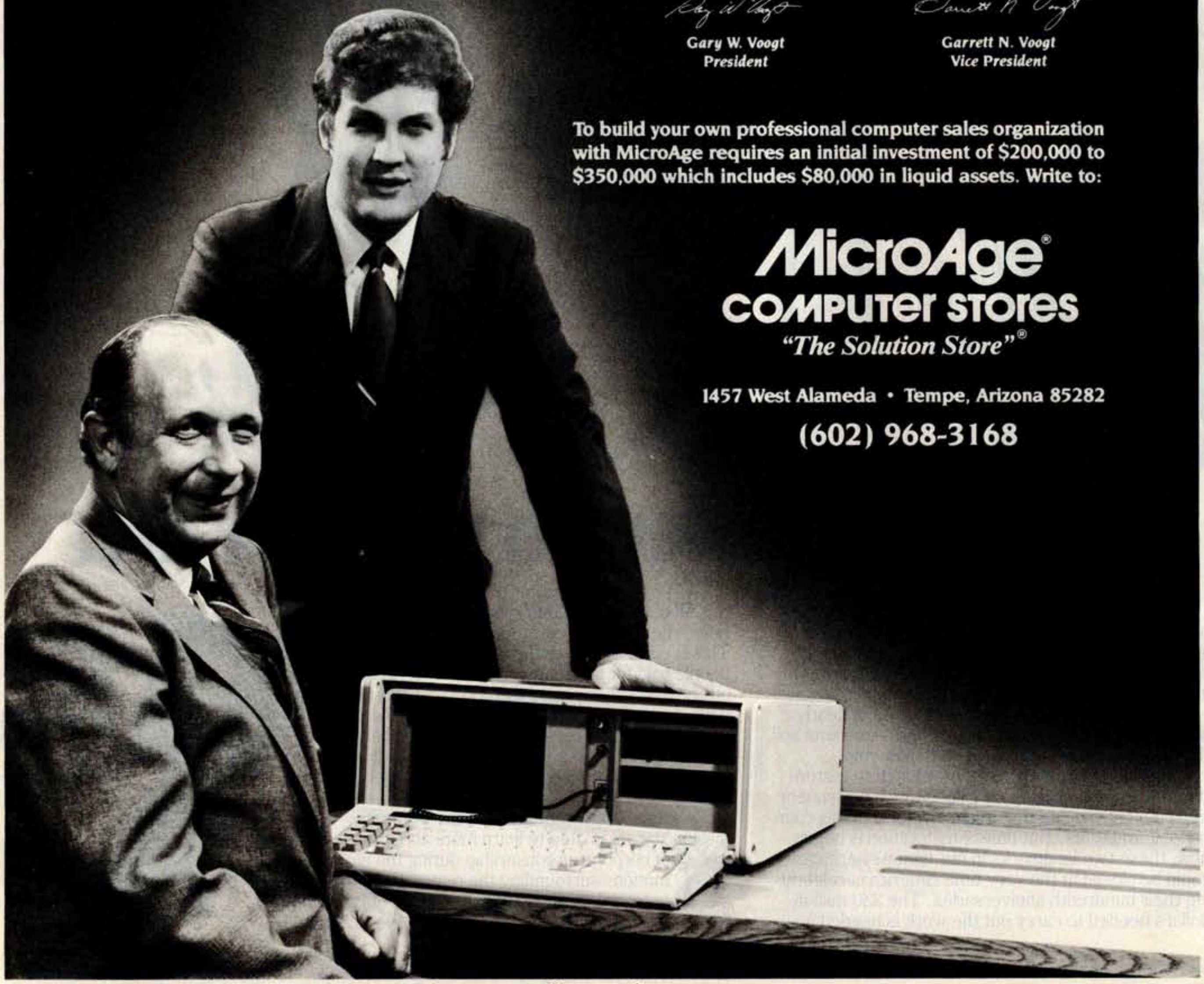

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Infoscope

A RAM-based database-management system

BY GEORGE BOND

Infoscope is a database-management system for the IBM PC that is significantly different from other similar products. Unlike many other programs in the new generation of database-management systems (DBMSs), Infoscope is not relational. It does not handle huge data files. It does not do fancy formatting of reports. And, more than just incidentally, it does not cost over $400.

What Infoscope does do is run extremely fast. The program is RAM (random-access read/write memory) based rather than disk based, giving it a faster operating speed without the usual wait for disk accesses for data retrieval. You can have as many as 12 "scopes" (the program's term for windows) on the screen and 8 files open at once. However, only one scope may be used at a time—the program does not offer multiple active windows in the sense that Concurrent CP/M-86 does. Infoscope does sophisticated, complex sorts and searches. It is as close to being truly "user friendly" as anything on the market today. Its use of color adds genuine utility to the program. It has an excellent on-line, interactive spelling checker and it can use files generated by other popular programs, such as dBASE II and Lotus 1-2-3. And Infoscope carries a retail price of $225.

BASIC FUNCTIONS

The main program, written in assembly language, occupies almost 85K bytes of disk space. Help and other subsidiary files add about 150K bytes to the disk load. Infoscope allows a maximum of about 8000 records per file, 254 fields per record, and 254 characters per field. It can use straight ASCII (American National Standard Code for Information Interchange) text command and vocabulary files; these files can be created with MS-DOS's EDLIN editor or a compatible word processor.

The basic trade-off made in writing the Infoscope program seems to have been speed versus file size. The program runs entirely in RAM, which makes it exceptionally fast, but it requires a lot of memory, which limits the amount of data that can be used at one time. The specified minimum system requirement for RAM is 192K bytes. With the memory-address space available to 16-bit microprocessors, such as the 8088 in the IBM PC, the large memory requirement for Infoscope is not a serious problem. For example, when the program is loaded into an IBM PC having 512K bytes of RAM, 392K bytes will be left for data-file manipulation. When a file of 1418 records, each containing 173 characters, is loaded on top of the Infoscope program, 153K bytes of RAM remain free. This means that Infoscope is not limited to files of trivial size, although it will never become the program of choice for running a population analysis of the People's Republic of China or an econometric model of the United States.

RAM limits also cause problems when using Infoscope's DOS command (under DOS 2.0 or higher, only). This command allows you to temporarily leave Infoscope, drop into MS-DOS, run another program, and return to Infoscope exactly where you left it. This is very handy but, unfortunately, if you leave Infoscope with, say, 240K bytes of RAM free and run a BASIC program from DOS, you may find only 100K bytes or so of RAM free when you get back to Infoscope. Infoscope generates a warning message if it is in danger of overwriting itself in memory.

THE QUICK SORT

If you are used to working with dBASE II or another DBMS that is I/O (input/output) intensive, sorting on Infoscope will be a pleasant surprise. The 1418-record file described previously can be sorted on one field, 40 characters long, in about 6 seconds. Sorting on two fields takes about 8 seconds, and on three fields takes about 10 seconds. Sorting the same file on the same single field using dBASE II (the file was originally created in dBASE II and converted by an Infoscope utility program) on a computer with an Intel 80186 microprocessor running at 8 MHz (instead of the 4.7 MHz of the IBM PC's 8088) took about an hour and five minutes. Multi-

(text continued on page 368)

George Bond is managing editor of User News *for* BYTE. *He can be contacted at* POB 372, Hancock, NH 03449.

(text continued from page 367)

field sorts are not possible using the dBASE II sort program.

Sorting the BYTE standard benchmark file for DBMSs (see table 1) took about 3.2 seconds using Infoscope. In contrast, dBASE II took 6 minutes and 33 seconds on the same IBM PC using a 10-megabyte hard disk. On a DOS 2.1 formatted 5¼-inch floppy disk, the dBASE II sort took 12 minutes and 45 seconds. Lotus 1-2-3 required 12.8 seconds for the sort. (Both 1-2-3 and Infoscope work entirely in memory, so the type of disk you use has no effect except when loading and saving files.) Finding specific records within the file is equally fast. In Infoscope, it again takes about 0.5 second to find and display the 1000th record in the benchmark file as opposed to 0.3 second on the hard disk using the "locate" function in dBASE II (however, if the dBASE file is indexed, its "find" function slightly outperforms Infoscope, taking about 0.3 second to find the 1000th record, but not display it). On the floppy disk, the dBASE II "locate" took 43 seconds.

COLOR

Infoscope uses color to make the program more effective. The program displays information inside a scope. The scope is outlined by a white line when first displayed. Up to 12 scopes, containing information from different files, can be displayed on the same virtual screen. When multiple scopes are open, moving among them can be a problem. Infoscope helps you cope with this through its COLOR command. You can outline a scope in yellow, red, blue, cyan, magenta, or green (see photo 1). Once a scope is colored, you can refer to it in commands by its color instead of its filename. (For example, you can command the program to "move red here" rather than type "move payrol63.dat here.") The same method can be used on a monochrome screen, but instead of actually changing color the scopes are merely labeled with the color name.

The colors of all parts of the screen can be easily changed, albeit only for cosmetic reasons outside of naming scopes. Having black characters on a white background inside the scopes, however, does seem to make them easier to read and less visually fatiguing than the normal VDT (video-display terminal) light-on-dark screen. Black, incidentally, is an undocumented color; press K to get it from the PAINT menu.

WORKING ENVIRONMENT

When Infoscope is booted, it displays a "command box" on the bottom left of the screen and a "scanner" on the right (see photo 2a). The command box, which occupies about 80 percent of the horizontal space at the bottom of the screen, is where commands are entered and some basic system information is displayed. The scanner is a simulation of the program's workspace and is intended to show you where the cursor is located in that workspace. The workspace is 62 lines deep by 253 characters wide; the physical screen, which is a window into the workspace, is 22 lines deep by 78 characters wide.

Cursor movement in the workspace is slow compared to other Infoscope functions. It takes about 7 seconds to move from the left edge of the screen to the right edge using the right cursor key. The cursor movement can take even longer if a scope is wider than 80 characters (see photo 2b). Fortunately, there are alternatives. You can use the MAP command for an overall view of the workspace, showing the relative location of scopes from above the screen (see photo 2c) or from the left side or bottom of the screen. MAP also allows you to jump the cursor directly to a new

Photo 1: *Scopes, Infoscope's name for windows, can be colored and then referenced by the color name rather than by the filename. On this screen, for example, the scope at top left could be moved to the cursor position with the command "move red here."*

Table 1: *These benchmarks were compiled using a standard* BYTE *benchmark file composed of 1000 records, each 100 characters long. The first field of the record is 4 characters long and contains a unique number from 1001 to 2000. The remaining three fields are also numeric, each containing four continuous strings of the characters "1" through "8" ("12345678123456781234567812345678").*

The sort was done on the first field. It was sorted into normal order from reverse order. "Locate" is a dBASE II function that locates records in nonindexed files. The time shown is the time needed to find the last record in the file, using the four-numeral field as the search field. "Find" is the dBASE II procedure for finding a record in an indexed file; again, the four-numeral field was the search field. Neither Infoscope nor Lotus 1-2-3 require indexing, although Lotus 1-2-3 does require a look-up table for its "find" function. The dBASE II times for both "locate" and "find" are compared to nonindexed, nontabled procedures in Infoscope and to look-up table procedures in Lotus 1-2-3. All times are the average of four trials.

Note that three of the times are ½ second or less, and normal margins of error could make relatively large differences. However, these should be useful measures relative to each other.

	Infoscope	dBASE II (floppy disk)	dBASE II (hard disk)	Lotus 1-2-3
Sort	3.2	765	393	12.8
Locate	.5	43	13	1.8
Find	.5	.3	.3	1.8

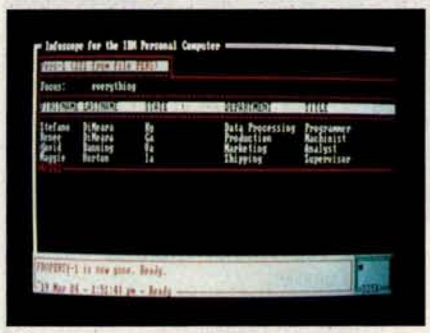
(All times in seconds)

scope. The POINTER command lets you enter vectors to jump the cursor to a new location. For example, you can enter the command "pointer R 59 D 22" to move 59 columns to the right and 22 down. Finally, you can set up to 10 markers—"landmarks" in Infoscope jargon—anywhere in the workspace and jump directly to any one with a Control-Alt-*number* command. Using the numeric keypad's plus and minus keys in conjunction with the arrow keys also helps by causing the cursor to do a long tab, 10 characters at a time horizontally or vertically.

Infoscope's spelling checker should make entering long commands, such as the pointer strings and other data, less frazzling for the fumble-fingered. Type "poniter" in a command line and Infoscope politely asks if you really mean "pointer." Respond with a Y and the command is entered. In fact, the spelling checker is so effective and makes the program so much faster and easier to use, it's a wonder more programs don't have such an amenity.

Overall operation of Infoscope is straightforward. Most procedures can be run either by pointing to choices in a series of menus and submenus or by typed-in commands. Help screens are available for many functions (see photo 2d). New scope files can be made through a CREATE command. Data is entered into a scope from the keyboard by using the ADD RECORD command, and edited or deleted with the CHANGE and DELETE commands. Changes are permanently saved with a SAVE command and printed with a PRINT command. On-screen forms may be designed using a FORMS command and saved for later use. In all, there are 67 Infoscope commands; they can be displayed by typing "list commands" (see photo 3). If you don't like some of the command words, you can change them within the program. If you prefer the concept of rearranging data rather than sorting it, you can add the REARRANGE command to the system vocabulary as a synonym for SORT.

(2a)



(2b)

(2c)

(2d)

Photo 2: *Infoscope provides operating information in several ways. "Tiers" of commands can be displayed at the bottom of the screen (2a) by pressing the Tab or Slash key and individual commands can be selected by stepping to them with the space bar or by typing their first character. The blue square at the right is the "scanner" showing the cursor's relative position on the virtual screen. The colors of any screen section may be changed with a short series of commands. The scopes themselves may extend beyond the real screen boundaries (2b), requiring scrolling to be displayed fully. The program can provide a map of the virtual screen (2c), showing the position of multiple scopes on the virtual screen. You can jump directly to any screen by locating the cursor over it on the map. Help screens (2d) are available for many functions. An unusual feature of Infoscope's help screens is that they may be kept on the screen while the instructions are executed, eliminating the need for the user to remember a complex series of steps to do a task.*

FEATURES

Infoscope can deal with several foreign file formats. It can read and write files for dBASE II and Lotus 1-2-3 by simply "loading" them before "looking" at them (LOAD converts the file format and LOOK puts an Infoscope file into memory). DataStar files can be read after having their extensions changed to conform to Infoscope requirements. After data is manipulated by Infoscope, it is semi-automatically converted back for use by one of these programs (you must "write" the file instead of "saving" it). Infoscope also can write but not read Multiplan SYLK files.

Two kinds of sorts are available. One is the ordinary sort-on-last-name variety to reorder an entire file. It works in the same manner as many other DBMS sorts, although much faster. The second sort is called Focus, and it creates temporary new files that contain only specific records within a file. The range of words you can use in focusing is much wider than the usual collection of Boolean terms (see table 2). These words include several that use an algorithm to locate similar-sounding words—freed and Fried, for example. In a personnel file, all June hires could be found and placed in a special, temporary file (that can be saved if a permanent file is needed) by using the command "focus hired in june." The FOCUS command does not reorder the contents of the temporary file; it is a selection and creation command. But a Focus file can be reordered with the SORT command.

Infoscope procedures can be automated through the use of command files either from DOS or in the program. Also, function keys may be reprogrammed easily from the keyboard. Infoscope was written by Jeff Garbers, who wrote the Crosstalk telecommunications program, and its parentage

(*text continued on page* 370)

One of the nice features of Infoscope is that most of its data is stored in ASCII files. No fancy control codes are used, so you can write simple BASIC programs that process Infoscope data.

(text continued from page 369)

shows in the command-file procedures. Anyone familiar with writing Crosstalk's command files will be at home with Infoscope's. Reprogramming function keys is accomplished by the KEY command. "Key 1 sort date |" would program key F1 to sort the active scope by date. Combinations of Alt, Shift, and Control keys plus a function key can be programmed also, allowing 40 macros to be stored at once.

As mentioned before, one of the nice features of Infoscope is that most of its data is stored in ASCII files. No fancy control codes are used. This means that you can write simple BASIC programs that can process Infoscope data. It also means that you have an "escape valve." If you can't figure out how to change a certain parameter in your data, you can use an editor program or word processor to change it directly. For example, a BYTE editor using the program couldn't figure out how to change the name of a data field from "Received?" to "Date-Rec'd." But he quickly found the file that contained the field names and changed them using the PeachText word-processing program.

PROBLEMS

Not all program bugs have been fixed yet. Directions for using two of the data types, "date" and "time," are incorrect in the manual. (The types must be entered as "date-type" and "time-type" when creating a scope.) A tutor program is misnamed on the disk, which could cause problems for an inexperienced user. Formatting for printing is poor; the program simply breaks lines at the eightieth character, no matter if it's in the middle of a word. And the screen formatting can be difficult to read (see photo 4). A "maximum-field-width" command is promised for later versions, which should help correct the latter two problems.

The user manual could be improved. Its biggest problem is that it was designed to be read with a powerful magnifying glass and not the unaided human eye. Physically, it looks like the IBM PC user-manual format—a 7- by 9-inch three-ring binder with slipcase. Unlike IBM, which sets type specially to fit this format, Infoscope information was set on 8½- by 11-inch sheets and apparently simply shrunk to fit in the binder (I know because I had a preproduction version of the manual still in its 8½- by 11-inch format). The illustrations are useless. All of this is a shame because the content is not only readable, but also bright and interesting—

(text continued on page 372)

Photo 3: *There are 67 Infoscope commands; the full command set can be displayed on the screen by typing "list commands."*

Photo 4: *Infoscope's screens can sometimes be difficult to read, especially when long lines are broken to fit into an 80-column display.*

AT A GLANCE

Name
Infoscope

Type
In-memory database manager

Manufacturer
Microstuf Inc.
1845 The Exchange
Suite 140
Atlanta, GA 30339
(404) 952-0267

Price
$225

Author
Jeff Garbers

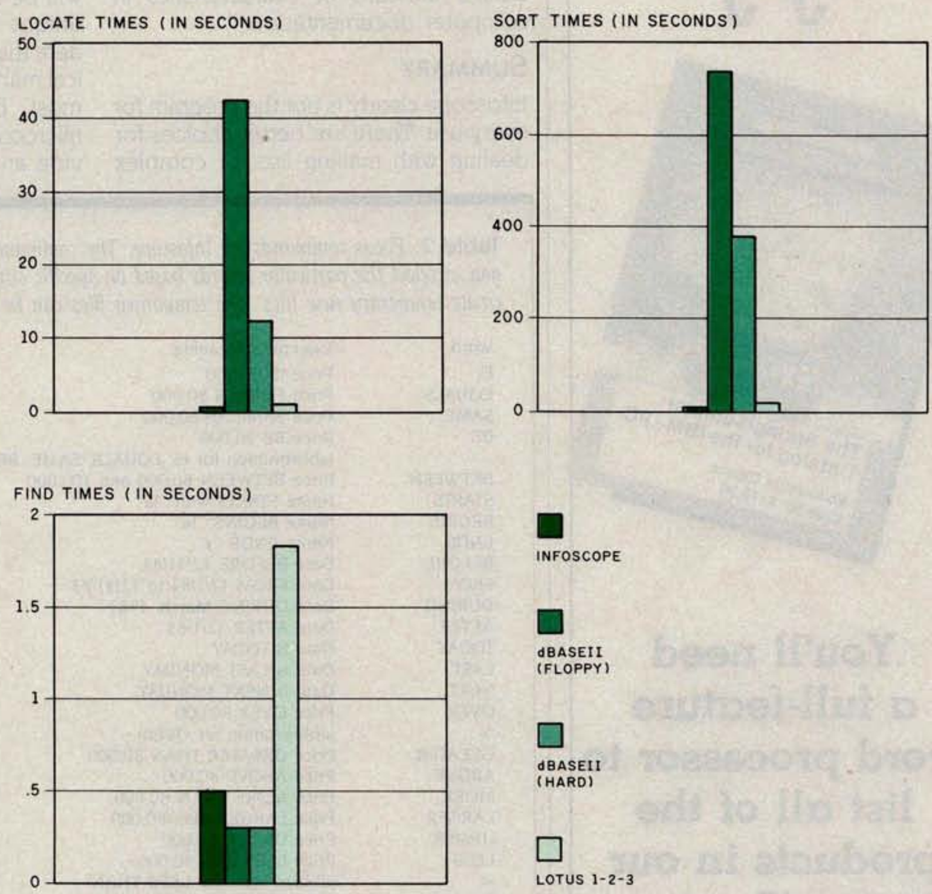
Format
One 5¼-inch floppy disk

Language
Assembly language

Computers
IBM PC and PC XT

Documentation
IBM PC-style 162-page, indexed manual

Audience
Anyone needing to organize and analyze moderate amounts of data



These are the results of three sets of benchmark tests comparing Infoscope, dBASE II, and Lotus 1-2-3. All were run on an IBM PC with 512K bytes of RAM (256K on the motherboard and 256K on a Quadboard I) and an external 10-megabyte hard-disk drive manufactured by Great Lakes Computer Peripherals. The operating system was PC-DOS 2.1.

The first test was to determine how long it takes to sort a file containing 1000 records, each 100 characters long, on a field containing four numeric characters. The second test was to determine how long it takes to access and display the last record in the file without using an index; the third test was for the same thing, but using an index. Creating the dBASE II index on the four-numeral field took about 96 seconds. Neither Infoscope nor Lotus 1-2-3 require indexing, but Lotus 1-2-3 requires a look-up table for its Find function. Also, when dBASE II executes a "locate" or "find" command, it does not automatically display the record found; that requires a second command.

All times listed were clocked by hand using a stopwatch, so they are not absolute. However, they should be accurate in relation to each other.

(text continued from page 370)

almost unheard of characteristics in computer documentation.

Summary

Infoscope clearly is not the program for every use. There are better choices for dealing with mailing lists or complex sets of related but separate data that will be combined into a multiplicity of unique databases or for dealing with data that requires sophisticated numerical manipulation. But for many, perhaps most, DBMS applications suited for microcomputers, Infoscope should provide an attractive solution. ■

Table 2: *Focus commands for Infoscope. The commands, using "plain English," enable you to select the particular records based on specific criteria in any of a record's fields to create temporary new files. The temporary files can be saved if needed.*

Word:	Example / Meaning:	
IS	Price IS 80,000	
EQUALS	Price EQUALS 80,000	(same as IS)
SAME	Price SAME AS 80,000	(same as IS)
BE	Price BE 80,000	(same as IS)
=	(abbreviation for IS, EQUALS, SAME, BE)	
BETWEEN	Price BETWEEN 80,000 and 100,000	
STARTS	Name STARTS with "fa"	
BEGINS	Name BEGINS "fa"	(same as STARTS)
ENDS	Name ENDS "y"	(similar to BEGINS)
BEFORE	Date BEFORE 12/31/83	
FROM	Date FROM 12/1/83 to 12/31/83	(similar to BETWEEN)
DURING	Date DURING March, 1983	
AFTER	Date AFTER 12/1/83	
TODAY	Date is TODAY	
LAST	Date is LAST MONDAY	
NEXT	Date is NEXT MONDAY	
OVER	Price OVER 80,000	
>	(abbreviation for OVER)	
GREATER	Price GREATER THAN 80,000	(same as OVER)
ABOVE	Price ABOVE 80,000	(same as OVER)
MORE	Price MORE THAN 80,000	(same as OVER)
LARGER	Price LARGER than 80,000	(same as OVER)
UNDER	Price UNDER 80,000	
LESS	Price LESS than 80,000	(same as UNDER)
<	(abbreviation for LESS THAN)	
BELOW	Price BELOW 80,000	(same as UNDER)
SMALLER	Price SMALLER than 80,000	(same as UNDER)
OR	(conjunction — used to express multiple conditions, i.e.: City is "moria" OR "Riveria")	
AND	(conjunction — used to express more than one focus condition at a time, i.e.: Price over 80,000 AND city is "Moria")	
&	(abbreviation for AND)	
INCLUDES	Features INCLUDES "school"	
$	(abbreviation for INCLUDES)	
CONTAINS	Name CONTAINS "BERT"	(same as INCLUDES)
HAS	Name HAS "BERT"	(same as INCLUDES)
SOUNDS	Name SOUNDS "Freed"	(finds records which sound like "Freed"; "Freid", "Fried", etc. First letter MUST match)
LIKE	(alternate form of SOUNDS)	
NEAR	(alternate form of SOUNDS)	
NOT	City NOT "Moria"	
~	(abbreviation for NOT)	
REJECT	(alternative form of NOT; i.e. Focus reject city "moria" is the same as Focus city not "moria")	
BUT	(alternative form of NOT; i.e. Focus All BUT city "moria")	
EXCEPT	(same as BUT)	
AMONG	(Include only items which are contained in a certain set; i.e. Focus company AMONG automakers will locate only those companies in the file that are also contained in the AUTOMAKERS set. The set must have been previously defined with the DEFINE command.)	
IN	(same as AMONG)	
CHANGED	(finds records that have been changed since last Infoscope session)	
MARKED	(focus on specially marked records)	
DELETED	(finds records that have been deleted during this Infoscope session)	
NEW	(finds records that have been added during this Infoscope session)	

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Basis 108

I read with interest Seth Bates's informative review of the Basis 108 (January, page 354). I bought a Basis in August 1983 and agree with Bates's positive comments about its advantages. However, he failed to note some of the limitations of which your readers should be aware. Here are those we have discovered:

- The Basis 108 is *not* fully compatible with Apple II+ CP/M software, in much the same way that the Apple IIe is not.
- Technical support from the current Basis distributor (and Basis itself) has been very poor.
- Documentation is poorly organized and uneven in depth. Those professionals planning to add peripherals or do anything out of the ordinary should be aware that no assembly code of the CP/M BIOS is available. Since this is essential also for debugging and using advertised options, it is a distinct disadvantage that it has not been included in the documentation.

M. J. Mayer
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Your review of the Basis 108 computer in the January issue missed some features of this computer that I have found very helpful. It also overlooked some deficiencies and contained some errors.

On the positive side, the Basis does not normally require a fan for cooling purposes (because of the large metal housing and sufficient power supply). This means it is without the nerve-wracking hum that many computers have. Other writers who work in a quiet environment, as I do, would appreciate this feature. The power supply also comes with surge protection built in.

One of the utility programs included is a "pseudo disk" that transforms the extra 64K bytes of RAM into a "RAM disk," a most useful feature that can speed up processing immensely and can automatically be booted upon power-up.

While the Basis has many improvements over its Apple counterparts, this also means some programs written for the Apple need to be specially configured ("optimized" in the words of the reviewer) for the Basis. This means you may be forced to buy the software from a Basis dealer. Some dealers will not provide computer help unless you are using their software.

Seth Bates is obviously a computer technician, since he didn't comment on the documentation of the Basis. The documentation that to date has come with the Basis is very technical. For a technician the manual is probably useful, but for a layperson it is confusing and not helpful. Computer Systems Designs informs us that a new, more friendly manual is in process but not yet available.

We purchased our machines in 1982 and no documentation is available for the CP/M utilities (CP/M 2.2): this means you borrow an Apple/CP/M Softcard Manual from an Apple owner, or spend hours on the phone handholding a dealer, who you hope is patient and intelligible. Even then, some of these utility programs include the configuration program for the Basis, GBASIC, and MBASIC, which require documentation to use.

This makes it imperative to have Basis users groups. However, your review erred in listing a California Basis users group in Salinas, California. The gentleman listed is a former Basis dealer, period. The only Basis users group is the one listed in New Jersey, under Bill Cook.

The Basis is a well-built, powerful computer (like a well-designed German car), but the average driver needs a good drivers manual, not an electrical specs pamphlet. The average layperson will find it difficult to use the full powers of the Basis without more clear and simple documentation.

Martin Thommes
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Bugs in the Pinball Construction Set

I was surprised to read Elaine Holden's review, "Pinball Construction Set" (January, page 282) and see that she could not find anything wrong with it. I have had the Commodore 64 version for two months now and find it extremely bug infested. Some of the problems, which were apparent the first day I had the product, are:

- The drop targets can "catch" a ball and jam. Also, hitting a drop target near the side can drop the target on the opposite side.
- The "multiball unit," the most advanced feature of the playfield, hardly works at all. With the default "world" settings, the balls tend to sit at the top of the unit but never enter it. Increasing the gravity (not always desirable) seems to reduce this, but the problem may still occur. However, after multiball play, if a ball reenters the unit, the game may never detect that that player's turn is over.
- The construction mechanism itself is prone to hang or crash without apparent cause. I have talked with other users and found that this is a common problem. Anyone who works with the set for a few hours can expect to see such a crash. There's no restart mechanism, so you are back to zero when this happens. When playing the game and bugs like those mentioned hang a player, there's no recourse but to cycle power and reload to continue to play.

There are also a number of limitations and design flaws I hoped the review would mention, but these are not truly bugs. Many show limitations of the Apple origin of the software, however, and could have been cleaned up quickly.

I have not seen the Apple or Atari versions of the Pinball Construction Set, but I expect they do not suffer the same problems. Apparently Electronic Arts rushed this product out for the Commodore 64. The package reads "Designed and programmed by Bill Budge," but when the disk is booted, we find a message that the 64 version has been programmed by someone else. (I doubt if Bill Budge, having spent the time he obviously did, would have let the bugs slip out.) Electronic Arts' "warranty" is a disclaimer: it claims the company will not be responsible for the bugs.

Pinball Construction Set is certainly a spectacular piece of software, and it is sure to be a big seller. It's unconscionable that Electronic Arts would push the Commodore version to market in the state that it's in.

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Raleigh, NC 27609

The IBM CS-9000

After reading Thomas R. Clune's review of the CS-9000 from IBM Instruments (February, page 278), I felt that he had left some things unsaid. We have had a CS-9000 in our laboratory since January 1983, and we have experienced every difficulty mentioned in the review and then some. The amount of time I have spent with that machine is just appalling.

We purchased the CS-9000 for two major reasons. First, because its multitasking operating system (OS) would let us acquire data from our two liquid scintillation counters and two gamma counters concurrently. These devices output digital data on multiple samples at sample intervals of several minutes over periods of several hours. Our plan was that after one counter had finished its samples we could massage the data via BASIC or Pascal programs while the other counters were still active. The second reason for purchasing the CS-9000 was to add the four RS-232C ports on the optional analog-sensor board to the three RS-232C ports on the motherboard, ending up with seven ports: four for the counters, one for a digital plotter, and two for future expansions.

When our CS-9000 arrived, we went through every problem that Clune noted (including

(text continued on page 376)

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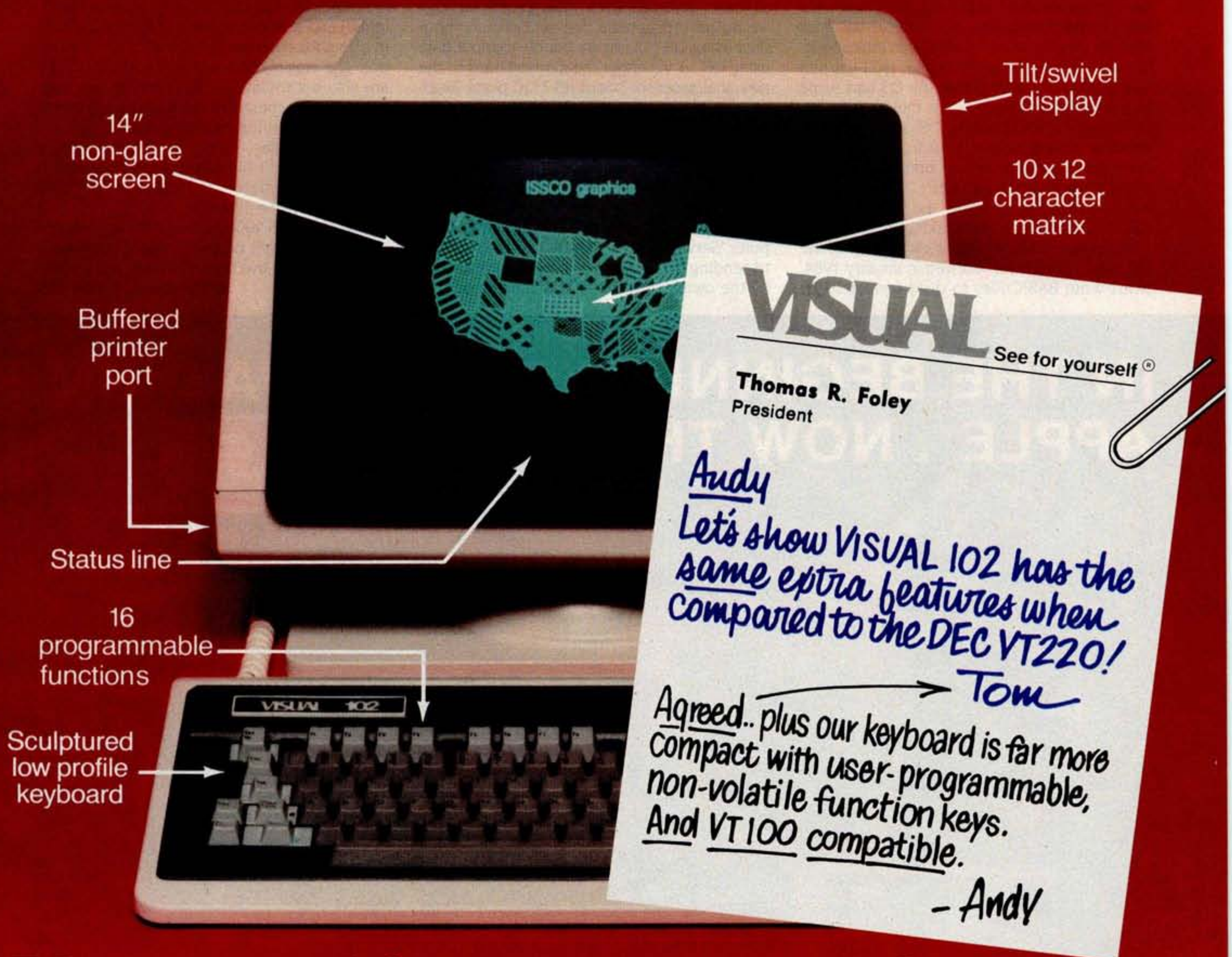

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(*text continued from page* 374)
breaking the plastic nut on the CRT ball joint). We discovered that the CS-9000 multitasks only with compiled programs. No compiler was available for months and the BASIC was interpreted. Then we got the Pascal compiler (so I learned Pascal) and discovered that the OS had some bug that effectively prevented multitasking. We finally got a multitasking OS and the long-awaited analog-sensor board. The RS-232C ports on the analog-sensor board never have been made to work with OS 1.0. However, we were successful in using the motherboard RS-232C ports in a multitasking mode.

Where are we now? The latest version of the OS, OS 1.1, which we received in January 1984, won't write BASIC files to disks formatted by OS 1.0. The programs we wrote to input data via the motherboard RS-232C ports using OS 1.0 don't work with OS 1.1. Despite the fact that we do have programs that successfully input data using OS 1.0., we are unable to input data using OS 1.1 via either the motherboard or the new analog-sensor board RS-232C ports. Readers should also know that the XENIX operating system mentioned by Clune is only in the "intended" stage—it is *not* available now. Additionally, I know of no commercially available software for the CS-9000 other than the languages available from IBM Instruments. The OS for the CS-9000 is not compatible with *any* other computer. Service on the CS-9000 consists mostly of sending the owner new parts for installation by the owner. The CS-9000 is built to occupy as little space as possible, and doing anything other than plugging in a new options board is not trivial. We have had several hardware problems. I can now gut, scale, and fillet a CS-9000 in about 10 minutes, but it took a lot of practice. The ergonomic problems noted by Clune are also not trivial. Our lab benches are standard for a biochemistry lab, but too narrow for the CS-9000—siting has been a problem.

But the cruelest blow was when a visiting scientist brought his Apple II+ to our lab. A few lines of Applesoft and it took in data from a counter on the first run.

To give the CS-9000 its due, it is very capable hardware. It might be the choice if you have a few highly repetitive tasks for which you are will-
(*text continued on page* 378)

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(text continued from page 376)
ing to write the software, and you have another computer for spreadsheets, general graphics, and the like. At present, the CS-9000 is definitely not a general-purpose laboratory computer. And it never will be one until it becomes dependable, easy to use, and begins to get a software base.

And, to give IBM Instruments its due, it has agreed to take back its computer and give us a refund.

PETER S. TOBIAS, PH.D.
Department of Immunology
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After reading the article by Thomas R. Clune, I was amazed. Not as amazed as I have been by the lousy service we have received from IBM, however. It's terrible! Our research group ordered a CS-9000 in the fall of 1982, and the string of promises, inaction, and bugs that followed (and are continuing) has forever tarnished the IBM name for me.

First there were the delays in shipping, then the lack of documentation or a high-level language. When we finally did receive versions of Pascal and BASIC, they weren't compatible with the current (original) version of the operating system (OS). Similar problems plagued us for at least another year. Finally, after seven months of promises from our former marketing representative, the company replaced our unit. The new processing unit didn't work with the old disk drives or old software, so more waiting followed.

You call this customer service? There have been several updates of both the high-level languages and the OS since our new machine arrived last fall. We were not informed of them nor did we receive any of them. Most of our information about software updates and new offerings comes from the rumor mill, not from our current marketing representative.

Most recently we discovered yet another bug in the system. The editor has the habit of inadvertently overwriting parts of other files on the same track of the disk, leaving all of the affected files unusable and unretrievable. When I described this problem to Dr. John Tesch of IBM, he agreed that it does do that sometimes. Even though IBM is aware of this bug, it is still shipping an OS containing it, without warning customers.

I agree with Clune's description of the potential that this system possesses. That's what compelled us to purchase one when it was first introduced. Unfortunately, unlike Clune, we were not the beneficiaries of any significant attention from the customer service department at IBM Instruments. Without that support, and with this trouble-laden product, none of us are very fond of our CS-9000 system.

MICHAEL RIEBE
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I enjoyed your article on the IBM CS-9000 laboratory computer, but I feel the article grossly understates the computing power of the CS-9000 system. The performance example cited in the article involved polling a device once per second, receiving, and averaging 2K bytes of data. In our application (high-performance NMR spectroscopy and medical imaging), a CS-9000-based system is used for polling several devices every 200 milliseconds, receiving, scaling, and graphically displaying 6K-byte data packets. In addition, the system is able to simultaneously transform the data to floating-point format and perform complex manipulations on it rapidly (for example, 1024-point complex floating-point Fourier transforms in 145 milliseconds). By way of comparison, a VAX 11/780 with DEC's floating-point accelerator requires 228 milliseconds of processing-unit time and an indeterminate amount of real time to perform the same 1024-point complex floating-point Fourier transform (IMSL scientific subroutine library "FFTCC").

To be fair, I must point out that my CS-9000s have been configured with extra hardware including 1 megabyte of RAM, a 10-megabyte Winchester disk, and a SKY Computers SKYMNK-V floating-point processor. Even with all these goodies, the CS-9000 system can be purchased for $20,000, an order of magnitude less than the cost of the VAX. The implications of this are quite remarkable, and they suggest that a new generation of supermicrocomputers is now available. These machines are desktop computers that offer real computing power, affordable by small laboratory or business groups. Only 5 or 10 years ago comparable performance figures would have been regarded as competitive for a low-end mainframe.

The ENIAC, a room-size behemoth that revolutionized the world of computing, required 200 milliseconds to perform one multiplication. The CS-9000 sitting on my desk does one multiplication in less than 2 microseconds. In other words, my little computer is 100,000 times faster than the ENIAC. I think it is impressive.

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Staff Scientist
MIT
Building NW14-5122
Cambridge, MA 02139

THE WANG PROFESSIONAL COMPUTER

I was pleased to see the review, "The Wang Professional Computer," by Elaine Long in the December 1983 issue, page 360. This is the first article I have seen about the machine.

There are three Wang PCs at my place of employment. I have been using one almost daily since July for spreadsheet and word-processing applications (using Multiplan and Wang Word Processing). And I introduce new users to the computer and software. I like the hardware very much. The keyboard in particular is excellent. The arrangement of the keys favors the person with some typing experience, but the shape and response of the keys suit almost everyone except those with unusually large fingers. On the other hand, the lack of an Escape key is irritating.

The menus make it easy for our users to spend time using the computer rather than learning how to command the operating system. If the menus are time-consuming to a regular user, they can be circumvented quickly.

Wang Labs' sales and support has been rather poor in my area; I feel it is not ready to sell the equipment. There is a toll-free PC hotline in Lowell, Massachusetts, for customers. Answers to questions are being delayed one to two days at this time. The people on the hotline are very diligent in their efforts to solve problems; however, they are still learning about the equipment.

Regarding quality, on the first two machines a memory-expansion board and a Winchester controller card failed to function on delivery. A floppy-disk drive failed in three days after delivery. Both of these machines were delivered to us before September of last year. We received an extensively configured machine in December; everything still functions. A board inside one of the older monochrome monitors was replaced recently. Service (on maintenance contract) has been painless, of the replace and test variety.

For us, delivery of hardware takes about eight weeks. We have waited for several months for delivery of our 2.0 version of Wang Word Processing and the *Program Development Manual*. The local sales office will not show us the Wang Data Base, explaining that it is too bug-ridden to be demonstrated.

When we purchase a system, the second drive and expansion boards arrive in separate packages. The customer is expected to install them or engage Wang (the fee is extra). There are instructions included, and the current set is correct. There are no caveats regarding static charge and the like, however. Installation is simple for the type of person who would fearlessly attack a broken toaster—and be able to avoid creating further damage.

I like the computer, and I will like Wang better in a few more months when, I hope, the newness of the product has been overcome.

By the way, the printer in photo 1 of the article is not a daisy-wheel model. It is the Wang Dot Matrix printer, correctly listed as model PC-PM010. The printer looks and acts remarkably like an Epson MX-80 F/T. The daisy-wheel printer available is model PC-PM012; it looks like a Diablo (640, I think). I recommend that any prospective Wang Word Processing user either purchase one of Wang's printers, an Epson or similar printer, or do some very thorough investigation. Wang's generic parallel-printer driver supports few of the word-processing package's features, not even the double line spacing. I have not worked with the generic serial printer driver.

KANDACE L. MYERS
17 East Factory St.
Mechanicsburg, PA 17055

VIDEX ULTRATERM

I would like to extend Videx's thanks for the recent review of the UltraTerm in the February BYTE (p. 310). There has been a change, however, in the VisiCalc preboot for the UltraTerm that occurred after the review was written. The 160-column mode of the preboot was replaced with another display mode that uses 80 columns and 32 lines. We feel that this display will better complement the UltraTerm with VisiCalc.

Videx is now sending a list of available software that utilizes the expanded features of the UltraTerm upon request.

WILLIAM LEINEWEBER
Customer Service
Videx Company
897 NW Grant Ave.
Corvallis, OR 97330

Z-100 DOCUMENTATION AND OTHER VIEWS

I have just read "The Zenith Z-100" (January, page 268) written by Ken Skier. I am a sophomore computer-science major at Clarkson University and have had a Z-100 for about six months. Mr. Skier's review was excellent in all aspects but one: the documentation. In my opinion, the documentation as a whole is lousy. It is often incomplete, difficult to use, and very confusing. The BASIC, FORTRAN, Pascal, Multiplan, CP/M, and Z-DOS manuals consist of one or two ring-bound binders. Almost all are lacking a detailed index consolidating both binders in a clear and concise fashion. Although, as Mr. Skier mentioned, the documentation is quantitative (in terms of pages), it certainly is not qualitative.

Other than this section, I think the review was very accurate and did justice to the underpublicized Z-100.

BRENT N. HUNTER
Clarkson University
Potsdam, NY 13676

I enjoyed reading Ken Skier's Z-100 review. (I've had my H-120 since last May.) I'm writing because of one small inaccuracy regarding the dual-processor configuration.

Any time you are running CP/M-85, you are using the 16-bit 8088 almost constantly. Briefly, all I/O (input/output)—disk, screen, keyboard, serial, and parallel ports—is being done in the bottom page of memory under the control of the 8088. Anytime there is I/O activity, the 8085 swaps out to the 16-bit side.

There are a couple of significant advantages to this, besides the fact that the 8088 is running more efficient code routines:

• The BIOS in the 8-bit memory page is considerably smaller; CP/M-85 therefore gives the user around 3K bytes more program and data workspace.

• Warm boots are extremely fast, as copies of the BDOS and CCP are kept in the bottom page of RAM and therefore do not have to be reread from a bootable disk. A warm boot merely logs in the new disk, as the 8088 very quickly copies the BDOS and CCP from low RAM to the CP/M page of memory.

A couple of minor points—the separate video RAM banks are not parity-checked, and the

(text continued on page 380)

(text continued from page 379)
11-megabyte Winchester upgrade has been announced at $1799.

I thought the article was very good—comprehensive and well written. I have three Heath/Zenith micros; the H-120 is rapidly becoming my favorite because of its exceptional capabilities.

AL HEIGL
Mill City Records
POB 3759
Minneapolis, MN 55403

I would like to take this opportunity to comment on the Zenith Z-100 review. I own a Heath H-100, which is the kit version of the Zenith Z-100, and I am extremely pleased with this machine.

Ken Skier states that "8-bit CP/M software is hard to come by in the Z-100 5¼-inch format." I have found that almost all software that I am interested in comes in the Heath/Zenith format. Perhaps your author was not aware that the Zenith format is the same as the common Heath format. In particular, the complete CP/M User's Group and SIG/M public-domain CP/M libraries are available on Heath soft-sectored disks (two sources of these public-domain disks are: Robert Todd Jr., 1121 Briarwood, Bensalem, PA 19020, and Headware, 2865 Akron St., Atlanta, GA 30344).

Skier states that the Z-100 cannot transfer files between disks of different formats. Computer Consultants to Business (1033 Bishop Walsh Rd., Cumberland, MD 21502) sells several Z-100 programs that allow file transfers between the Heath/Zenith CP/M format, the Heath/Zenith Z-DOS (IBM PC-DOS) format, the Osborne CP/M format, and the Kaypro CP/M format. This company is also considering other formats, such as DEC Rainbow and North Star.

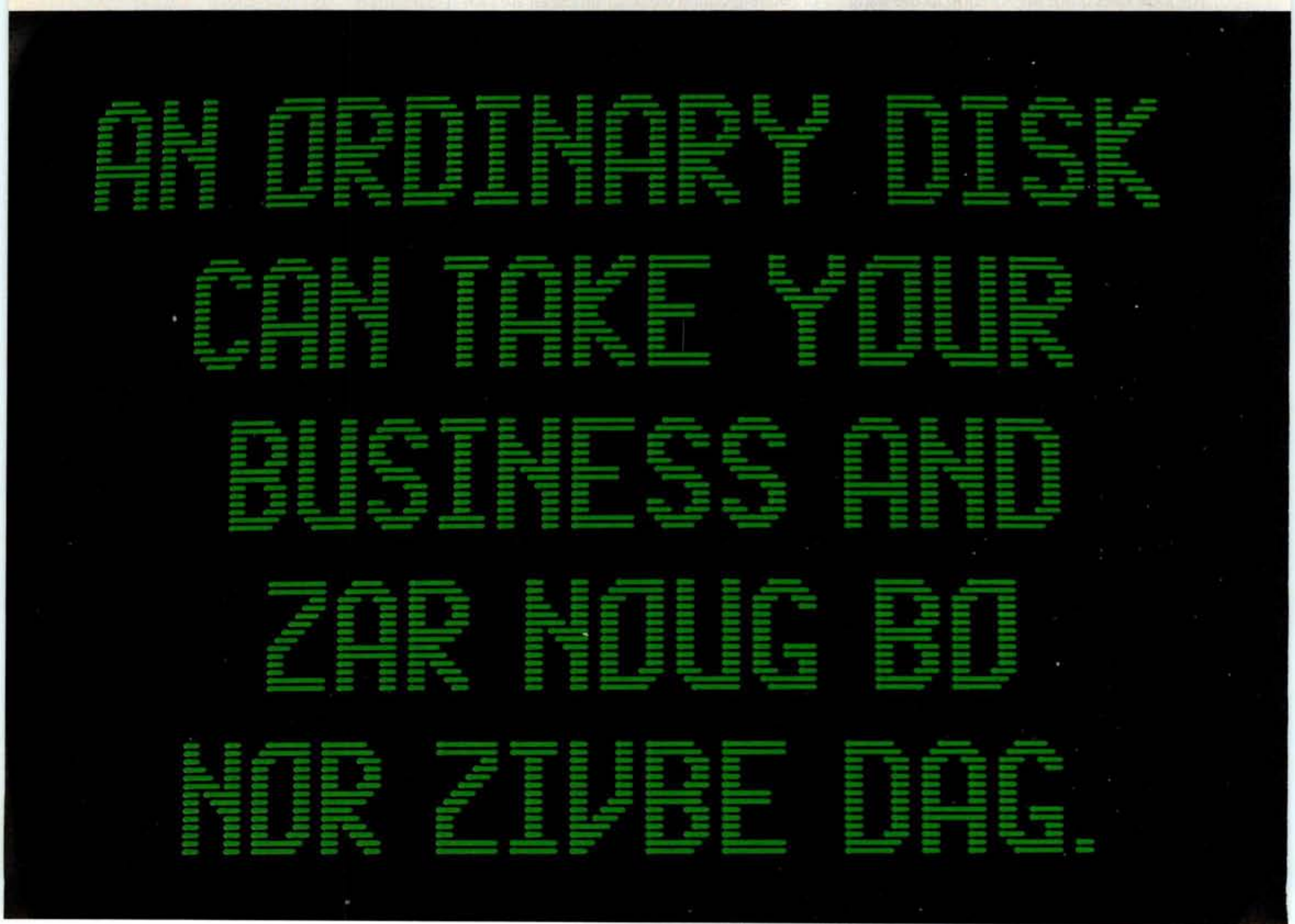
The author also stated that "although both processors [8088 and 8085] are present . . . I am not aware of any applications that transfer control from one processor to another." One such application, called "CP/EMulator," is available from the Heath User's Group, which produces hundreds of programs for the Heath/Zenith computers (and sells them, with source code, for about $20 each). This program runs on the 8088 (Z-DOS) and allows the user to temporarily switch control to the 8085 (CP/M) to run CP/M programs. These CP/M programs may use Z-DOS files for I/O (input/output).

Skier states that "a light-pen port is available, but Zenith does not yet provide a light pen to go with it." While it is true that Zenith does not yet fully support this option, at least one third-party vendor does. Software Wizardry (122 Yankee Drive, St. Charles, MO 63301), a long-time supporter of the Heath/Zenith computer line, sells a light pen that is compatible with the Z-100. This firm also sells a graphics software package for the Z-100 that optionally accepts input from this light pen.

The author mentioned that the Z-100 is not IBM PC compatible. While it is true that many programs written for the IBM PC will not run on the Z-100, almost all of the most popular applications programs are available in versions for the Z-100 or in MS-DOS versions (the Z-100 can run all MS-DOS programs). Many of the Z-100 applications are even superior to the IBM PC versions; for example, the Z-100 version of Lotus 1-2-3 supports more colors and higher-resolution graphics than the IBM PC version. Also, there are two programs available for the Z-100 that allow some incompatible IBM PC software to run on the Z-100. These programs are "IB-Em" from Wideman Computer Consulting (1320 Pepper Villa Dr., El Cajon, CA 92021) and "RUNPC" from Lindley Systems (21 Hancock St., Bedford, MA 01730).

I agree with Skier's conclusion that the Z-100 is an excellent machine. This is probably one of the best 8088-based microcomputers on the market today, and although third-party software support is not as large as for the IBM PC, the Z-100 hardware is far superior to the IBM PC (and its clones) in terms of hardware.

Also, please note that I am not affiliated with



any of the companies mentioned in this letter. I am a computer user and have used some of the products that I have described. Those I have used all operate as advertised.

KENTON LEE
2138 Aldrin Rd.
Apt. 5A
Ocean, NJ 07712

I appreciated Ken Skier's hardware review on the Zenith Z-100. While suitably glowing in its assessment of the machine, the review understandably omits mention of an immense resource that is readily available to users of Zenith computers—namely, users of Heath computers.

The omission is understandable because Zenith never mentions it either. From the company's advertising and its dealers one might think that a Z-100 has nothing in common with an H-100 (the kit version of the same machine). In fact, however, the only thing they *don't* have in common is 4 square inches of plastic on the front panel: the product logo.

The H-100 is one of the newest toys to capture the imagination of the rather large community of Heath computer builders and users and—equally important—to capture the attention of the rather large number of independent hardware and software vendors who provide support for Heath machines. The users themselves, to judge from the publications that cater to them, are hardware and software hackers in the fine old sense of the word: people who stay up until morning breathing solder fumes and banging on keyboards for the fun of it. The vendors provide what these people need: hardware and software that exploit the machine's capabilities and don't cost a mint. The journals provide information of use to everyone from beginners to professionals.

What H-100 users need is also what Z-100 users, including Mr. Skier, need. Almost everything his review says a Z-100 won't do, it *will* do—with the help of cheap or free things from the Heath users and their commercial allies.

Eight-bit CP/M software is *not* hard to come by in the Z-100 5¼-inch disk format. Several vendors, such as the Software Toolworks, sell very economical software—compilers, utilities, editors, games—in that format. Users groups and other sources provide a great deal more at lower prices.

For example, Z-DOS indeed can't write CP/M files—however, CP/M *can* be tricked into reading Z-DOS files, with identical results. RDZDOS, a $20 program from an independent vendor, makes that possible. If you don't have $20 left, you can trick the machine into doing the same thing using just the utilities that come with the operating systems; the trick is explained in a letter to *REMark* magazine, issue 45 (October, 1983). *REMark* is the journal of the Heath Users' Group, which is actually a part of the Heath company.

That should be enough to make the point. Anybody considering a Z-100 should take into account its underground support system. You don't have to be a genius to use it. You just have to be inquisitive.

ARNOLD SEIBEL
621 Parcel St.
Monterey, CA 93940

FLIGHT SIMULATOR

In regard to Stan Miastkowski's review "Microsoft Flight Simulator" (March, page 224), I realize that the programmers can, and did, take literary privilege in writing this software. But the comments of Miastkowski, who purports to be a pilot, are simply astounding.

On page 228, Miastkowski says that Meigs Field, in Chicago, is an uncontrolled airport. If he had checked with his "Jepp" manuals, he would have assuredly known that Meigs is indeed a controlled airport, to the extent that student pilots are forbidden to take off or land there.

(text continued on page 383)

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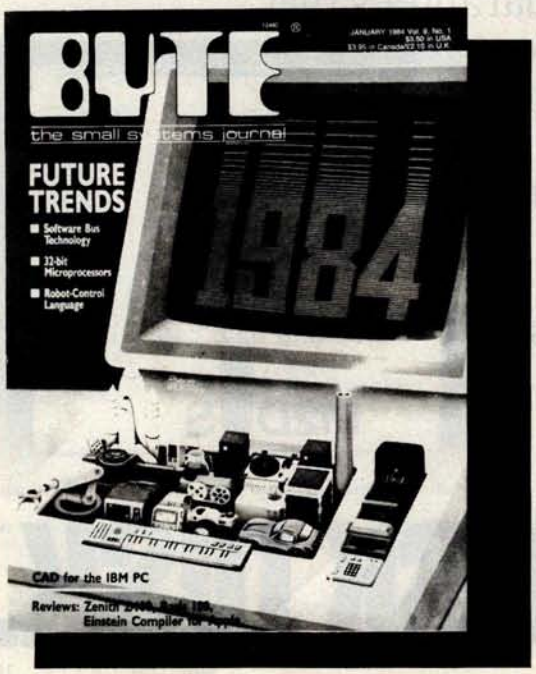

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(*text continued from page* 381)

Since its construction, Meigs Field has been plagued by crosswinds and burbles (disturbed winds coming from buildings and structures), as well as convection currents (from flying over water and then flying over heated concrete or other hard terrain). This is the result of the fact that Meigs has only two runways.

I find that the Flight Simulator software should not be used without a joystick control, which the IBM PC does not make allowances for.

LOVELL E. SWANIGAN JR.
2801 South King Dr. #517
Chicago, IL 60616

INTERRUPTING HERCULES

With reference to the review, "The Hercules Graphics Card" by Tom Wadlow (December 1983, page 343), I would like to point out a problem with the examples presented.

The assembler language interrupts will not work on an IBM XT running DOS 2.0 due to the fact that INT 40-4F are used by the system.

A close look at the technical reference manual will show that these interrupts are, indeed, reserved.

Hercules, it seems, has fallen into the same trap as so many others (including ourselves).

The only interrupts that are reserved for the user are 60-6F.

CHARLES ALLEN
Managing Director
Gulf Computing Systems
POB 25125
Safat, Kuwait

Hercules responds:

Since Mr. Allen took the trouble to send us a copy of the letter that he wrote to you, I will take the trouble to correct him. The Hercules Graphics Card uses interrupt 10, not any interrupts in the range 40-4F, as is his understanding. The fact that I am composing this letter on an XT running DOS 2.0 with a Hercules card in the system convinces me that there is no problem with this arrangement.

ANDREW FISCHER
Technical Support
Hercules Computer Technology
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Berkeley, CA 94710

APPLAUSE FOR APL

Thank you very much for the excellent article "STSC APL*PLUS and IBM PC APL: Two APLs for the IBM PC" by Jacques Bensimon (March, page 246).

The author established immediate empathy, I am sure, with every APL "true believer" when he recounted his disappointment that APL was not chosen over BASIC as IBM's premier language for the PC. Having established his credentials as an APLer, though, he did not go on to abandon those unfamiliar with the language, as I have seen many authors do. The section "A Brief Look at APL," with numerous clear examples, was worthy of publication all by itself.

The entire article was very well written, technically accurate, to the best of my knowledge (I have had professional exposure to both systems), and a fair and equitable comparison between the two implementations.

A heartfelt "keep up the good work" is in order for both you and Jacques Bensimon.

JIM FIEGENSCHUE
1805 High Meadow Cove
Carrollton, TX 75006

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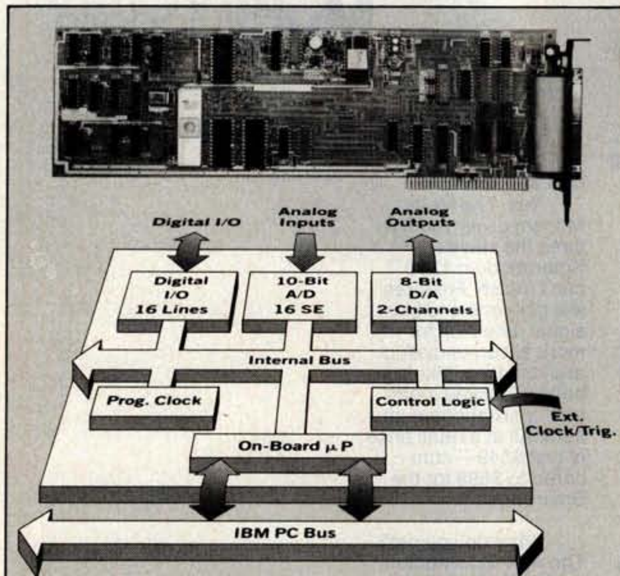

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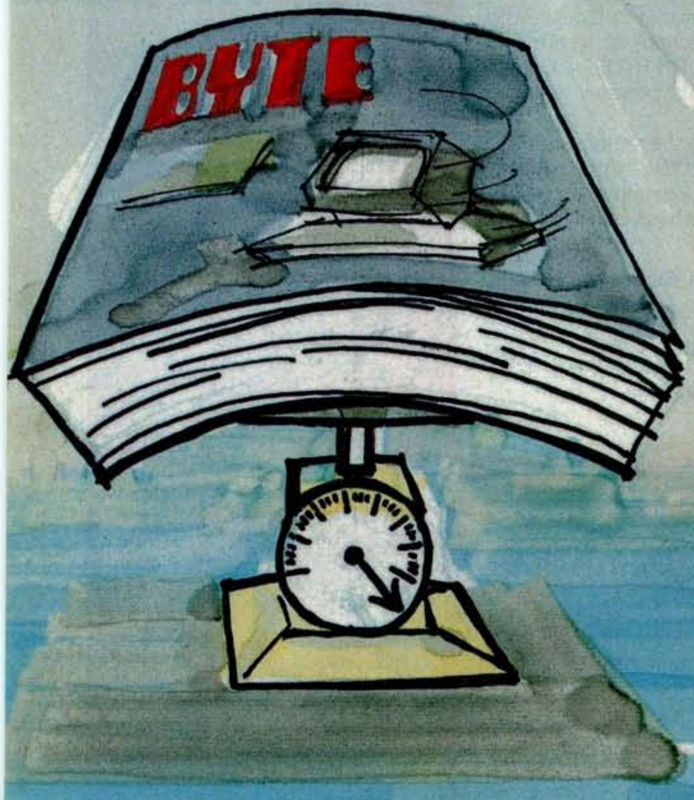

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BY JERRY POURNELLE

"How do you manage to find so much to write about?" my sane friend asked.

I just looked at her. When your subject is small computers, the problem isn't finding enough to write about, it's knowing when to stop.

I thought I knew where to start. We've been expecting two new machines, the Sage IV and the CompuPro 10. Alas, both arrived today. The flu has blasted through Chaos Manor, and we're not likely to uncrate either machine until well after the deadline for this column, so this month maybe I can catch up on the backlog. Maybe.

THANKS

First, a pair of thank-yous. As some of you know, I've been heavily involved in the L-5 Society Promoting Space Development, which is an outfit that takes seriously Robert Heinlein's dictum that the earth is just too small and fragile a basket for the human race to keep all its eggs in. (You can join the L-5 Society by sending $25 to L-5, 1060 East Elm St., Tucson, AZ 85719.)

The L-5 Society isn't broke, but I don't suppose it's much of a surprise that there's no surplus money, so when we found ourselves in need of some new computer equipment we had a problem.

Indeed, it was more of a problem than you might think. I'm fully aware that I could get any number of companies to donate equipment to L-5; but might someone see my request as attempted extortion?

Fortunately, there was a simple solution to the problem.

Some years ago the L-5 Society bought a CompuPro computer to keep the books and membership list on. CompuPro's Bill Godbout arranged to have that system completely updated, donating a new set of hardware with all the bells and whistles, including a new CompuPro hard disk.

Meanwhile, the Bay Area L-5 people were putting on the annual meeting, and their computer died; whereupon David Kay's company donated a Kaypro IV, which, I am pleased to report, arrived in time to bail our people out of a mountain of paperwork.

Since what I think of those machines was in print long before I brought up the subject of L-5, I've no fear anyone will get the wrong idea. My thanks to both companies and their presidents.

THE COPYRIGHT DECISION

The papers announce that Apple and Franklin have settled out of court.

That's fine, but it means that for the moment we'll have no final and binding decision on the questions the suit posed. We do have a decision by the U.S. Court of Appeals for the Third Circuit. That's binding only in that area; judges in other circuits could rule otherwise, although in practice the Third Circuit decision is likely to be persuasive wherever the issue comes up.

What's at stake is the whole question of copyright protection for software.

The facts of the case were pretty simple. Franklin (of Philadelphia) wanted to market a computer that would run Apple software. It studied the situation and concluded that it wasn't feasible to rewrite the Apple operating system including the code in the boot ROM (read-only memory) because, in the words of Franklin's vice-president for engineering, "there were just too many entry points in relationship to the instructions in the program."

Franklin therefore copied Apple's ROM. According to the Circuit Court decision, "Apple produced evidence at the hearing . . . that programs sold by Franklin in conjunction with its ACE 100 computer were virtually identical with those covered by the fourteen Apple copyrights. The variations that did exist were minor, consisting merely of such things as deletion of reference to Apple or its copyright notice."

In fact, James Huston, an Apple programmer, found his name embedded in one of the programs sold by Franklin and the word "Applesoft" in another. Franklin didn't dispute that

(text continued on page 388)

Jerry Pournelle holds a doctorate in psychology and is a science-fiction writer who also earns a comfortable living writing about computers present and future.

(text continued from page 387)
it copied the Apple programs. "Its factual defense was directed to its contention that it was not feasible for Franklin to write its own operating system programs."

In short, Franklin's defense was (1) it had to copy the Apple programs or it couldn't produce a machine that would run Apple software, and (2) operating systems and machine codes aren't subject to copyright because they're not literary works.

This isn't a totally unreasonable position. My late mad friend thought copyright law was sufficiently complicated already, and he was adamantly opposed to adding computer-program object code to the works protected by copyright. MacLean thought there ought to be special legislation based on patent law. I didn't agree with him, but he could be pretty persuasive.

Moreover, there are only so many ways to make computers do things. You can't copyright an idea; only its expression. Thus, it can certainly be argued that had Franklin been able to rewrite the Apple operating system in such a way as to keep all the same entry points but not have made an exact copy of the copyrighted Apple programs, it would have been home free.

This would be akin to taking a book of nonfiction and rewriting it so that the table of contents for the original and the rewrite were identical: on each page of both the same ideas would be expressed, but the actual words and sentences would be different. That would be a lot of work but certainly not impossible.

Franklin didn't do that. My reading of the Court's decision leads me to think that it would have won if it had, but in fact the Court specifically didn't address that issue in the decision. What it did do was rule that "a computer program in object code embedded in a ROM chip is an appropriate subject of copyright," and that "a computer program, whether in object code or source code, is a 'literary work' and is protected from unauthorized copying, whether from its object- or source-code version."

This can have some pretty far-reaching effects. For one thing, software publishers can't have it both ways: if they want to rely on *copyright* protection, they're going to have to give up those ridiculous licensing agreements their lawyers are so fond of. That's probably just as well, because I suspect those agreements are worthless.

The idea of licensing software is a legacy of the mainframe and minicomputer days, when software could and did cost hundreds of thousands of dollars and was installed and maintained by experts. There was a time, after all, when you couldn't buy an IBM computer; they could only be leased, and severe restrictions on what peripheral equipment you could connect to the IBM were built right into the lease contract.

In those days, software licensing agreements were actual contracts, negotiated between independent entities that, if not in an equal bargaining position, were at least not as unequal as a consumer and a major software company.

That's no longer true. Now you go to a store and plunk down money for software exactly as you might buy a cable or an all-day sucker or a Jerry Pournelle science-fiction novel. The difference is that when you get your software home, there's this imbecilic licensing agreement under which the publisher warrants nothing at all and guarantees that his product isn't worth anything, and you "agree" not to copy the program, show it to others, or run it on more than one machine or during the dark of the moon. You also agree that this unwarranted and unmerchantable program is enormously valuable, and if you do violate the terms of the agreement you have done the publisher irreparable harm, and you'll sell your spouse and children into slavery in partial recompense to the poor damaged publisher.

I've never heard of a court trial based on one of those goofy licenses, and I find it hard to believe that any judge would take one seriously. Of course, one is never safe in relying on lawyers to exhibit common sense. Even so, I really doubt the enforceability of those agreements, and I suspect that software publishers would do much better to rely on copyright.

There are, however, some limits to copyright protection. For one thing, educational and nonprofit groups have some privileges under the Copyright Act. So do those outfits that translate and adapt works for use by the blind. Educators, reviewers, and scholars have the right of "fair use." Finally, there's the question of backup copies. Under copyright law, you are prohibited from selling or distributing copies of a protected work without the owner's permission; but making a copy for your own use is a different story. You can't make a copy and sell the original, but I see nothing to stop you from making and keeping copies for your own use.

You can also lend books to friends, so long as they don't make copies. Indeed, as I've said before, the law requires me to pay taxes in support of institutions whose business is to lend people copies of my books.

Thus, one result of the Franklin-Apple case may be the demise of software licensing agreements in favor of something more sensible. I hope so. It's too bad, though: I can sympathize with both companies' desire to stay out of court and get this thing settled, but I wish it had gotten to the U.S. Supreme Court so we'd have some of the issues settled once and for all.

CP/M-8/16 Revisited

It's hard to believe that I've had my CompuPro 40-megabyte hard disk and CP/M-8/16 for only a month now. In fact, it's hard to see how I ever lived without them. Not that it has all been smooth sailing. As I mentioned last month, it's just as well that Chaos Manor was a test site for the new BIOS (basic input/output system): we were still flushing bugs out of the system as late as last week.

None of them was fatal, but some were annoying. Diagnosing one of the errors was instructive. The directory of the E: segment of my hard disk kept going haywire. That is: the hard disk is divided by software into five logical disk drives. The A:, B:, C:, and D: drives have 10 megabytes each. The E: drive has 1.1 megabytes and is set up to look exactly like an 8-inch double-sided double-density floppy, making it possible to copy to and from it. However, whenever I'd put any great amount of data onto the E: drive, the directory would get trashed, and I couldn't even erase it. When I tried, it would tell me there were Read/Only files on it, but then STAT couldn't find them. It made the E: drive useless.

Then we had another glitch, some-

(text continued on page 390)

Circle 104 on inquiry card.

(text continued from page 388)

thing like keyboard bounce, that would go away once the system had been running for a few minutes. Hardly fatal, but annoying, and as Bill Godbout is fond of saying, if the error rate is high enough to measure, it's too high. Little glitches can be symptoms of coming big trouble.

Tony Pietsch, the guru who maintains my systems, couldn't figure out what was happening and kept coming up with new hypotheses, most of which involved removing features from The Golem (our CompuPro Dual Processor). That's no bad way to proceed, of course. Get the system down to basics you understand. The relentless application of logic will generally solve the most puzzling problems.

Finally, he removed Jim Hudson's 8087 add-on board. That did clear up the cold-start glitch, and the E: drive seemed to be behaving itself.

However, it left me without an 8087 math-chip system, and that's not acceptable. Logitech's Modula-2, the language I've fallen in love with, doesn't do floating point unless you have an 8087. Thus, I found myself on the phone to tell Jim Hudson we'd yanked his board.

He wasn't happy and decided to come down with a new math board and his own Dual Processor's processor board, which was known to work in a system nearly identical to mine. Just to be sure he hadn't left anything out, he brought Bob Greene, a troubleshooter from Intel, who carried a couple of new 8-MHz 8087 chips.

After a few tests it transpired that I had a very early 8088 chip, which doesn't surprise me since The Golem was one of the first Dual Processor systems to leave the CompuPro factory; it too began life as a test box, but we'd never had any trouble before. We replaced the 8088, at which point all seemed to work fine. Then, when we had everything swapped out, I needed a copy of Jim's Modula-2 disk. He'd brought down a lot of small program modules he'd got from Willy Steiger at Logitech: more than 200, in fact.

Fine, thought I. We'll use the newly working E: disk to copy onto. I started PIP going. Things went well for a while. Then, suddenly, error messages. Worse, when I checked the E: disk to see what had managed to get copied, there was that same old trash in the directory again!

I still didn't have a copy of Jim's disk. Alas, no one has yet written a copy program that understands that my 8-inch disks are I: and J:, respectively. (That's coming Real Soon Now.) It was lunchtime, and we were in a hurry, so I tried to use PIP to move Jim's disk off to the M: memory drive, which is certainly the fastest way. That didn't work either. Now what?

In fact, try as I liked, I couldn't use PIP to move that disk to *any* part of my hard disk. It would go a long way, then come up with a BDOS (basic disk operating system) error, even on the D: segment, which had never given me any trouble. There was nothing for it but to fire up Zeke II, my superreliable Z80, and copy that disk.

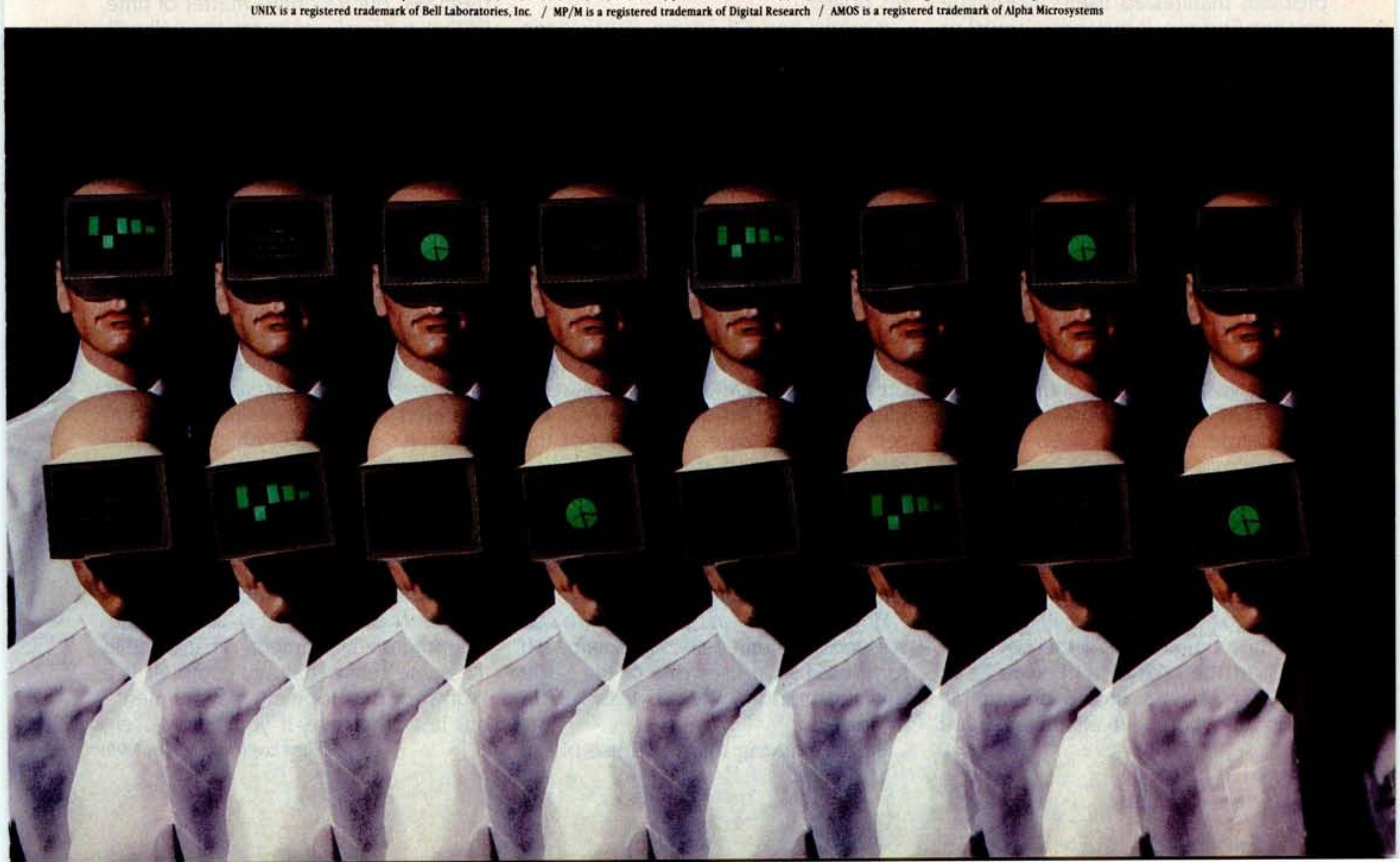
Jim went home feeling much better: it wasn't his board causing the problem. Now it was Tony's turn to sweat.

We also knew it wasn't the processor board. Nothing for it, then: Tony brought over his own CompuPro hard disk and controller. We installed them. Everything worked fine. I breathed a sigh of relief. "Not yet," said Tony. "Where's that disk that kept crashing the system?"

We put that into the floppy-disk drive and started PIP going. File after file came across. Then—blooey. Same error messages. Tony sat down with a St. Pauli Girl to think. For some reason, I started to use PIP to move the disk to the M: memory drive while he was puzzling it out.

That provided the clue. After 128 files had been sent over, we got an error message. Tony thought for a second. "Oh, sure," he said. "There's no more directory space. There's not room for more than 128 files in the M: drive/H: RAM [random-access read/write memory] disk."

(text continued on page 392)



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I hadn't known that, and I guess Tony had forgotten it. "Hardly a serious limitation," I said. "Strange, though, the file just after that one is where we get the other problem . . ."

I stopped talking because Tony was scribbling madly.

It didn't take long to fix things after that. When Tony and the CompuPro people ginned up the new superfast BIOS, they'd managed to put in a wrong number in the part that allocates directory space. Five minutes with DDT fixed things. We phoned the fix up to CompuPro just in time: it was due to begin shipping the next day. No one had tested the new software's ability to use PIP on more than 129 files.

As I said, an instructive lesson: if I hadn't happened to notice precisely *where* things went wrong, we might still be wondering why this particular disk full of software would crash the system. The moral of the story is, if you have a problem, keep a log. Write down every bit of information you can get. What did you do, what error message did you get, what are the symptoms of the problem, what was happening just before the problem manifested itself; everything you can find out. It may seem trivial or irrelevant, but write it down anyway, before you forget. More often than not there's a powerful clue buried in among the details, and if you don't record the details, you may not spot the clue.

It Can Change Your Life

That may have been the last bug in CompuPro-8/16. It does have some annoying "features," nearly all associated with user numbers, but they're endurable; and now I don't understand how I ever got along without 8/16 and a hard disk. I have a larger temporary program area (TPA), floppies work faster than ever before, and I can keep an enormous pile of stuff on the hard disk.

It has made some surprising changes in the way we do things here. When I find a minor problem in a program I've written, instead of logging it, often I fix it on the spot. It's easy, now that I don't have to go find the source, find the disk with the compiler, load the compiler, and load the source, all before I can start. Now I have source, programming editor, and compiler all on the hard disk.

Bookkeeping is easier, too. I keep the journal on the hard disk, and it's very easy to call up the Journal program and enter checks and cash as it happens, rather than save it all up for frantic entry just before April 15.

Hard disks are wonderful.

Hudson's Z-100 Board

One major application for microcomputers is spreadsheets, and the complaint I most often hear about them is that they're too slow. Since spreadsheets are often associated with financial calculations, which demand high accuracy combined with large numbers, it's understandable: floating-point calculations are inherently slow. Fortunately, though, there's a hardware remedy: the 8087 math chip, which does floating-point calculations at about 500 times the speed that the 8088 chip can do them.

I've already mentioned Jim Hudson's 8087 board for the CompuPro Dual Processor. It's a small board that rides piggyback on the processor board; to install, remove the 8088 chip, insert Hudson's board where the 8088 was, and insert the 8088 into the socket on his board.

It works fine. Of course, if you don't have an 8-MHz 8087 chip—they're still fairly rare and expensive—you have to slow your Dual Processor down. Hudson's board does that automatically, and it has provisions for letting you speed things back up when you get a faster 8087 chip.

The results of using an 8087 are impressive: some 120,000 floating-point math operations take less than 10 seconds. If you're doing much number crunching with an 8086 or 8088, you *must* get an 8087. The IBM PC has a slot on board for the 8087; just get one and plug it in. Ditto for the Eagle 1600, except that the Eagle needs one of the 8-MHz parts, and that will cost you some change. There's no way—at least none known to me—to slow the Eagle down, and an 8087 won't work in a system in which the microprocessor is running faster than the 8087.

Hudson's 8087 for the CompuPro was so successful that he designed a board for the Z-100. It uses one of the S-100 bus slots and has 256K bytes of RAM in addition.

Before you can make real use of the memory on Hudson's board, you'll need to fill those empty memory sockets on the Z-100 motherboard with nine 4164 64K-bit dynamic-memory chips. You ought to do that anyway; it's easy enough. You can get the chips from Hudson when you buy his board; he isn't in the chip business, though, so to order separately, go to an outfit like California Digital. (You can also get a "kit" from Zenith, but there's nothing in it but nine chips and some instructions, and Zenith charges a *lot*.)

Hudson's board comes with programs to test both the memory and the 8087, and Hudson supplies source code to the tests. Installing the Hudson 8087 board in the Z-100 is simple, and it has given us no problems. I'd have been shocked if it had; I've known Jim for a couple of years now. He's one of the good guys, a perfectionist who would take it personally if something he supplied didn't work properly.

There's already a lot of support software for the 8087, and more is coming all the time. Borland's Turbo Pascal, for instance, has a Turbo87 version. If there are any spreadsheets that make use of the 8087's great speed, I haven't seen them yet, but it's only a matter of time. Within a couple of years they *all* will. Anyone developing new software for the IBM PC or Z-100 really ought to get in on the 8087 revolution.

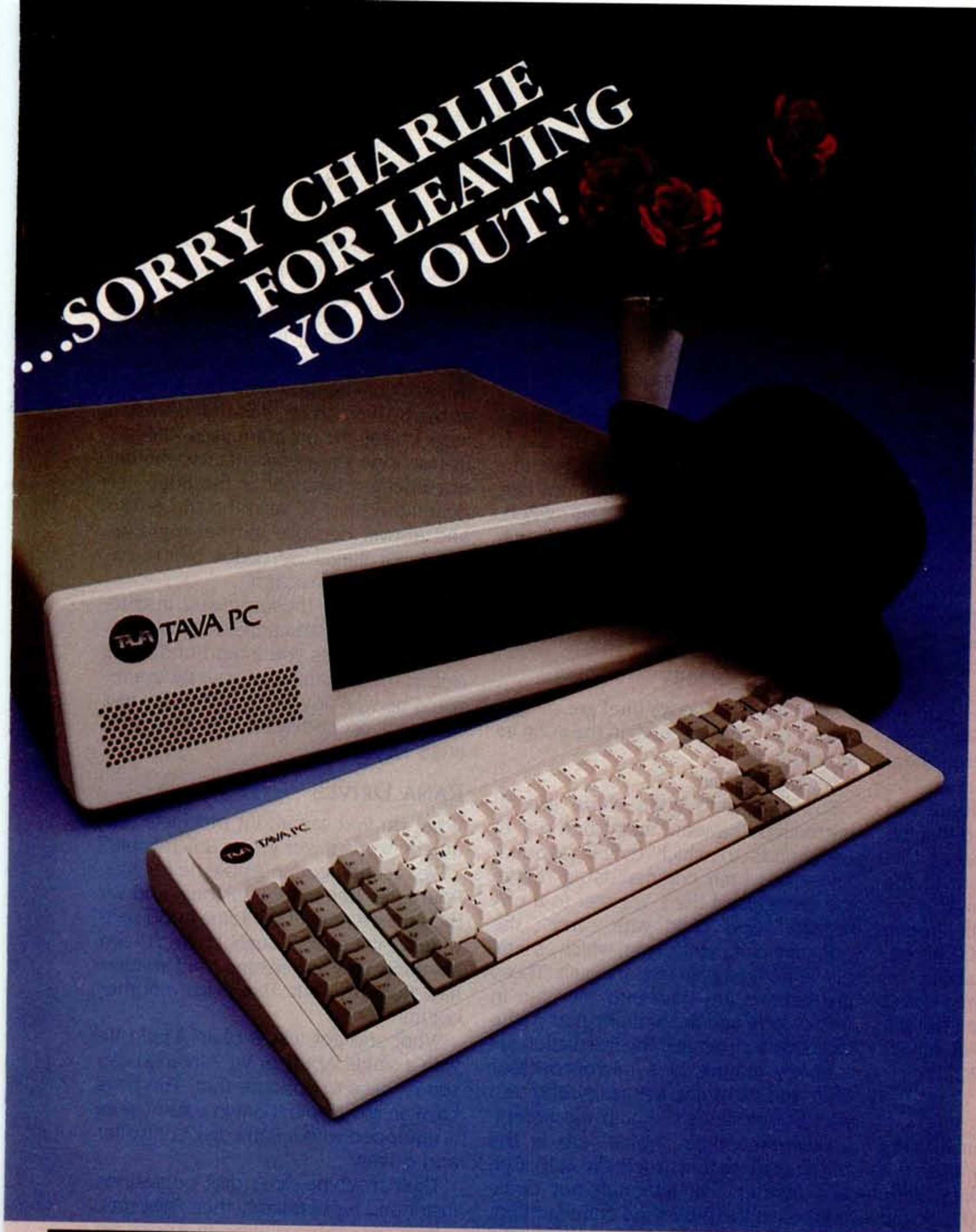
Turbo!

I'm not fond of the name "Turbo," but that's about the only thing in Borland International's Turbo Pascal that I'm not mad about. So are my readers. I have tons of mail praising Turbo—and I have yet to get one complaint.

Borland's coming out with a new version, 2.0, that's a significant improvement over the old. Meanwhile, it has canceled that silly licensing-agreement policy. It's doing everything right and deserves the full support of the micro community.

Meanwhile, Microsoft is selling Potent Pascal. I hate that name. I don't care much for the product, either; it's IBM Pascal, essentially unchanged. The Microsoft ad speaks of a "software development environment." That's true in the same sense that any compiler is a "software development environment," but not otherwise. If you believe "en-

(text continued on page 394)



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vironment" implies a compiler integrated with an editor, as with the MT+86 Speed Programming Package or Turbo Pascal's integrated editor, Potent Pascal isn't one. Kaypro's Tyler Sperry, who's here to deliver the 1984 model of the Kaypro IV (faster, new video, built-in modem; it's a real improvement), wonders if the company couldn't call Kaypro's S-BASIC an "environment." It compiles, doesn't it?

I remain impressed with Borland.

Hot Tips

As I've said before, I'm in the middle of a storm: Rod Coleman of Sage Computer is certain that the Motorola 68000 chip and its successors are the real future for microcomputers. So, of course, does Apple. My son Alex tends to agree with Rod, and between them they make an awfully good case.

On the other hand, Bill Godbout and his people are just as convinced that the future lies with the Intel 8086 and its successors, and they can point to the success of the IBM PC for confirmation. When Jim Hudson and Bob Greene came down with the new Z-100 board, we spent some time talking about the future of the micro revolution. I didn't come to any conclusions, but I did get some hot tips on using 8088 equipment, particularly the IBM PC.

Oops!

If you have a hard disk in your IBM PC, you can have a real problem when the time comes to format a new floppy disk. If you're logged onto the hard disk and invoke the format program without modifications, you get the message "Ready to format hard disk. Strike any key when ready."

Generally, you didn't want to format the hard disk. Formatting erases *everything*, permanently and irrevocably. If you don't do just the right thing, though, that's what will happen. Alas, many PC users see that message, panic, and hit either the Escape key or Control-C, both of which usually rescue them—but neither will rescue them this time. Nor will the ersatz "reset" of Ctrl-Alt-Del; that "Strike *any* key when ready" message really means it.

The only escape is to turn the machine off.

This is obviously an undesirable situation. Bob Greene suggests a permanent solution: on the hard disk, rename "FORMAT" to "DOFORMAT." Now create a batch file named FORMAT.BAT that has one, and only one, line in it:

```
DOFORMAT A:
```

The A: disk will be a floppy-disk drive.

Incidentally, when making up batch (.BAT) files for the PC, the proper termination for the last entry is not carriage return but Control-Z (Control-Zed, as Greene puts it; he spends too much time in England). If you don't use Control-Z, you get an extraneous carriage return in the command string, which produces an annoying extra prompt.

You'll Be Sorry

One thing that annoys Intel are people who do original research in the 8086 instruction set.

Let me explain.

The 8088 and 8086 chips, like all micro chips, have an "instruction set" of commands to which they'll respond. These are such commands as "Move the contents of the C register to the A register" and "Add with carry": the primitive commands from which assembly-language programs are built. These instructions are built into the chip in micro code and are actually part of the chip's very structure. The instruction set is a key feature of a microprocessor chip, and the manufacturer publishes a list of commands the chip will accept.

However, some "holes" are in the micro code that instructs the chip. Certain instructions, although not documented in the published command list, will in fact work, often to produce useful results, such as to clear a certain register without resetting the carry flag. Some programmers have zealously experimented with the 8086 and 8088 chips, finding a number of these "undocumented features," which they have made use of in programs.

This looks at first like a good idea. Why shouldn't you make use of all the chip features, whether documented or not?

Bob Greene says it's not a good idea at all. Since these features are not supported by Intel, there's no obligation on Intel's part to keep them: subsequent "editions" of the 8086 and 8088 chips may not have those features at all, and there's a good chance that another manufacturer making the chips under license from Intel won't include them either.

Moreover, one of the strongest features of the 8086 family is that programs written for the 8086 and 8088 will work unchanged on upgrades such as the 80186 and 80286—that is, they'll work unless the program uses "illegal" instructions. Programs that use the undocumented features of the 8086 are guaranteed not to work on the 80186 and above, because all the upgrades check for illegal op codes before executing any instruction.

Intel reserves those unused instructions for new instructions of its own devising; so unless you intend unduly to restrict the portability of your programs, you'd be well advised not to make use of illegal op codes for the 8086 and 8088 chips.

Rana Drives

What do you say about products that quietly work, never giving any trouble?

We recently got an Apple IIe for Mrs. Pournelle; her school has one, and we thought we might find some good software for it. So far, though, I haven't seen anything very interesting, and neither has Roberta, but that's for another column.

What she got was a plain Apple IIe with a single Apple drive. Already I can see I'll have to upgrade that. The boys have an old Apple II out in back. Theirs is equipped with a Rana disk controller and drives.

Their machine does disk operations faster and more reliably than Roberta's.

If you're contemplating an Apple, get Rana disk drives. You won't regret it.

Dilog's RAM Disk

Longtime readers of this column know I'm a fan of RAM disks, which fool the computer into thinking that a big chunk of memory is a disk drive. True, once you have a hard disk you may not use the RAM disk so much, but if you're confined to floppy disks, you'd do well to look into getting a RAM disk.

RAM disks make WordStar and other programs that routinely do disk accesses not only endurable, but very nearly a pleasure. They also take a lot of the delay out of games like Star Fleet that have overlays.

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They have one major drawback, of course: since they're only a kind of memory, whatever you put onto a RAM disk goes away when you turn off the computer. There are some remedies to that, the most obvious being a battery backup; but it takes considerable power to keep memory intact, and most batteries can't do it for long. (There are low-power memory chips on the market but they tend to be pretty expensive.)

An alternative is to give the RAM-disk board its own power supply. That won't do you any good in the event of a power failure, but it will save you if you've accidentally turned off the machine before copying your work to permanent storage. It also saves you the trouble of using PIP to move your editor and files each time you want to use the RAM disk.

The Dilog Model DP-100 Electronic Disk comes with its own power supply but no battery backup. There's also an RS-232C port, called an "Asynchronous Communications Adapter"; it's said to be functionally identical to the IBM Communications Adapter, and I'm willing to believe it, although I've not tested it.

The Dilog DP-100 comes with idiot-proof instructions, complete with pictures and diagrams; I can't imagine anyone being unable to install the board properly. The manual shows what a jumper plug looks like and tells precisely how to install them, as well as how to set the internal switches on the IBM PC. Dilog has covered every combination of floppy and hard disk, and tells precisely how to address its electronic-disk board for each.

We've had the DP-100 running for a couple of weeks now, and it goes fine. Indeed, it came in while I was out of town, and Peter Flynn installed it; I didn't even know it was aboard for the first week, and it was only by accident that I found out that when you turn off the IBM, the DP-100 RAM disk doesn't lose anything. It's well made, installs in a few minutes, and does everything Dilog says it will.

You still have to worry about power failures, playful kittens, and small children; writers should save early and often.

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(text continued from page 396)

DAY OF THE JACKPOT

Four long-awaited systems came in today. All come highly recommended. One, the Disk Maker I by New Generation Systems, is supposed to solve all my disk-format problems forever: it has one 5¼-inch drive that will do both 48 and 96 tpi (tracks per inch; IBM uses 48, while Eagle does 96) and an S-100 card. I'm to plug the card into Ezekial II, my CompuPro Z80, after which I can read all known 5¼-inch disk formats on the Disk Maker's 5¼-inch drive and transfer the files to my 8-inch disks. Disk Maker knows both CP/M and PC-DOS, and it will move files back and forth between them. Leor Zolman, the author of BDS C and an always reliable source, swears by it.

Meanwhile, Security Microsystems Consultants has sent a little gizmo, Quickon, that you install in an IBM PC, after which you can disable the mandatory memory test or let it run, as you prefer. I haven't installed mine yet, but Jim Baen swears by his. It ought to save considerable time.

I also have a printer buffer at long last. Applied Creative Technology's Printer Optimizer not only contains a box full of memory, but both serial and parallel input and output ports: you can cross-connect as you like. The Printer Optimizer is a handsome little box, and I'm looking forward to using it between The Golem and the NEC 7710; more next month.

As soon as I wrote all that, Daniel Benton brought over the new Helix Laboratories bubble-memory board for the IBM PC. I was really impressed with it at COMDEX; it's in production now.

If that weren't enough, Shirley has yet to be uncrated; the Sage IV, complete with EMACS text editor, LISP, and a bunch of other new software, came in two hours ago; and Tyler Sperry came up from Kaypro with the 1984 model Kaypro 4.

All in all, it looks to be a superbusy month at Chaos Manor. ■

Jerry Pournelle welcomes readers' comments and opinions. Send a self-addressed, stamped envelope to Jerry Pournelle, c/o BYTE Publications, POB 372, Hancock, NH 03449. Please put your address on the letter as well as on the envelope. Due to the high volume of letters, Jerry cannot guarantee a personal reply.

Items Reviewed

CompuPro Hard Disk.........$5495
CP/M-8/16 and BIOS...........$250
CompuPro
3506 Breakwater Court
Hayward, CA 94545
(415) 786-0909

Disk Maker I.................$1500
96 tpi option..................$385
New Generation Systems Inc.
2153 Golf Course Dr.
Reston, VA 22091
(800) 368-3359

DP-100 Electronic Disk........$1295
Dilog PC Products
12800 Garden Grove Blvd.
Garden Grove, CA 92643
(714) 534-8950

Helix PC Bubble Disk..........$1495
Helix Systems
11601 Wilshire Blvd., Suite 720
Los Angeles, CA 90025
(818) 710-0300

Printer Optimizer.............$499
Applied Creative Technology Inc.
2156 West Northwest Hwy., Suite 303
Dallas, TX 77520
(214) 556-2916

Quickon...................$69.95
Security Microsystems Consultants
16 Flagg Place
Staten Island, NY 10304
(212) 667-1019

Rana Disk Drives Elite I (Apple)..$379
Rana Systems
21300 Superior St.
Chatsworth, CA 91311
(213) 709-5484

Sage IV.....................$7300
Sage Computer
4905 Energy Way
Reno, NV 89502
(702) 322-6868

Turbo Pascal...............$49.95
Borland International
4807 Scotts Valley Dr.
Scotts Valley, CA 95066
(408) 438-8400

8087 Math Board for Dual Processor.....$495
8087 Math and Memory Board for Z-100........$595
memory only.................$595
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Mac and (Sigh) Valdocs

Dear Jerry,

I've seen the Apple Macintosh, and it is exactly what I hoped it would be: a little 68000 monster that takes up as much room as a stack of paper. Mac shows off its speed in MacPaint with good cut, paste, and copy performance. Take a look!

Why do you hate the Epson QX-10 so much? I think it's the best 8-bit computer for the money. If you want more speed, go into Help and turn on Quirks (this works only in the expert or advanced mode). Then turn on the Quick display and turn off the center line. You'll find your screen now looks like a "regular" terminal. All Valdocs attributes are still there when you turn Quick off. Valdocs II exists, but it won't be released till late spring. CP/M 3 or CCP/M could be configured for this computer. TP/M runs CP/M programs right out of Valdocs and will return with your document preserved (assuming you had one). Try it; select Menu; go for applications on the right drive. When Valdocs asks for an application, insert any CP/M disk with a program on it. Press Return twice, then you can use the cursor controls to select a program. When you're done, perform a Control-C and put the data disk back in. This also works with two-drive CP/M stuff. Just put the Valdocs disk back in before you drop out of your program.

As soon as someone optimizes the QX-10's 16-bit screen processor and gets those 8-bit subprocessors marching in step, we will get substantial performance in Valdocs. That may become less important with Epson's little sister Comrex offering an MS-DOS card and a 512K-byte semidisk. By the way, a Control-Print does a screen dump any time. Now quit being such a brat and get some good laser-cut fanfold paper for that FX-80. Then hook it up to something that will use it (like your Eagle or Sage) in the manner it would grow accustomed to.

Frank McConnell
Greendale, WI

You're not the only one who wants me to look at the Mac. As it happens, Dr. Michael Hyson and I have Macintoshes on order, and we're assured by Volition Systems that it will have a Modula-2 for the Mac (Mac Modula?) before the end of summer. We may write a book about the Macintosh.

We've had many letters about the Epson QX-10. A lot of readers feel I've been too hard on the machine. Others hate it.

For the record: I don't hate the QX-10. It has some of the best hardware I know of, especially the capability for really good graphics. Alas, it seems that Epson just didn't have its act together when it released the machine.

If a company sends me a test model, hardware or software, I feel no compulsion to publish my opinions; but when the company is selling the product, I think I have more obligation to my readers than to any manufacturer or publisher. I do not believe customers should unwittingly be made into either venture capitalists or a quality-assurance department.

The first Epsons were shipped with totally unsatisfactory software. As time went by, successive improvements were made to Valdocs, and what Epson is shipping now is enormously better than what I originally reviewed. However, Epson America officials tell me there will be an even bigger improvement (version 2.0) Very Soon Now, and other improvements, including 16-bit capabilities, Real Soon Now. I'm waiting for those before I do another evaluation.

Those in the market for a new machine in the Epson price range would be well advised to look at the QX-10. It has a lot of neat features. Valdocs 1.18 is usable. However, it's slower than I care for, especially if you want to use it as a substitute for a typewriter. It still hasn't a convenient way of dealing with business letters on letterhead. I advise people to see a demonstration before they buy.—Jerry

50-Hz Help

Dear Jerry,

Howdy. I've been reading your columns for about three years, and your December 1983 column really hit home. I'm a noncommissioned officer in the Air Force and don't have a lot of money to spend on my computer: a Ferguson Big Board and a pair of Siemens 8-inch drives. I am stationed in Great Britain and am looking for motor-shaft pulleys to convert to 50-Hz operation. The drives are advertised to operate at 50/60 Hz, so the pulleys must be available somewhere. Could you please tell me where? I am thinking of purchasing the following low-cost software: Borland Pascal and Ellis Computing BASIC. I would appreciate any reviews of these products. Do they handle strings and overlays (chaining in BASIC)? I would appreciate any help. Please send addresses and not telephone numbers. Overseas calls cost quite a bit. Thanks.

SSgt Chris Beachy
POB 4645
APO NY 09755

Alas, I haven't any clues about the pulleys; but I expect one or another reader can help you. We don't ordinarily print addresses, but I'll have yours listed.

Borland's Turbo Pascal may be the best software deal going; while Ellis's Nevada products are certainly good value for the money.

The current version of Turbo Pascal doesn't allow overlays, but I'm told Borland will have a version that will by the time this is in print.—Jerry

Disk Doubler

Dear Jerry,

In the February "User's Column," you address the use of the Disk Doubler to enable the use of the back side of disks on single-sided drives. I was happy to see that you recommended against using this tactic, but I feel that you left out the most important reason for not using it.

What was not addressed is that the inside of the disk jacket is lined with a porous material that is designed to both lubricate and clean the disk as it rotates in the jacket. Many small particles are trapped by this material and held out of danger's way so that the disk will not be harmed. However, when the Disk Doubler is used and the disk is inserted in the drive upside down to use the back side, the disk rotates in the reverse direction. Thus, any and all particles that were trapped during the original rotation direction can now be released back onto the disk. Premature failure of the disk, or at least loss of data on the disk, is virtually guaranteed.

I have long recommended to my clients that this is not a worthwhile savings tactic, and the potential of lost data far outweighs the small dollar savings in disks.

Larry C. Hansford
New Carlisle, OH

It's not a "guaranteed" way to lunch the disk, but spinning them in the wrong direction is a risk I'm not ready to take. The savings just can't be worth it.—Jerry

An Understandable Disclaimer

Dear Jerry,

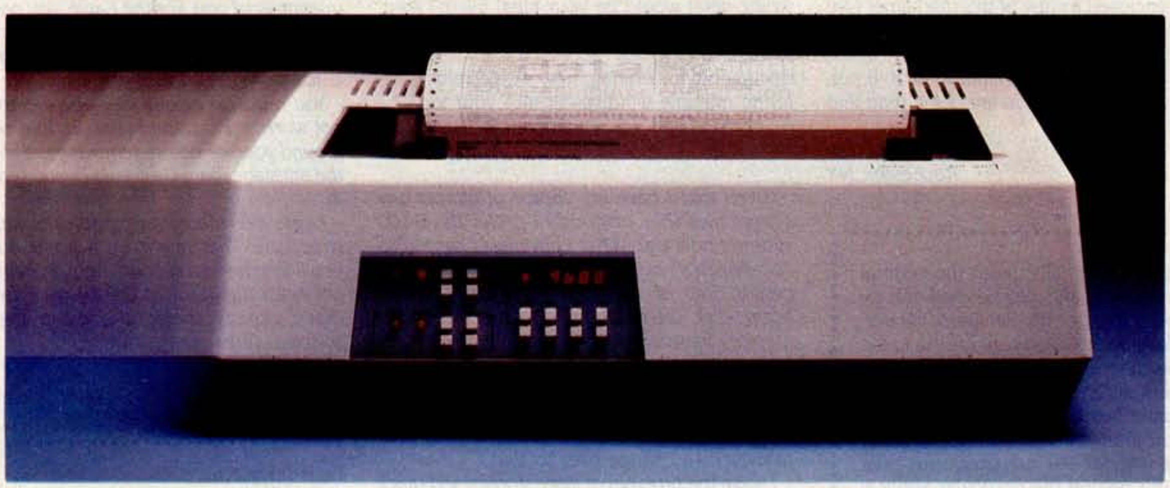
My friend Bill Voglesong has begun to write computer programs and has asked me to edit them. I know nothing about computers, but as an unemployed English teacher, I do know something about grammar and punctuation.

After reading your thoughts in the "User's Column" in the June 1983 BYTE, specifically, "Again, the Piracy Problem," my friend consulted me again. He did not want his disclaimer to read as poorly as did those noted in your article. He wanted a disclaimer written in plain English, not in legalese. I tried. His attorney said

(text continued on page 402)

HIGH PERFORMANCE

LONG DISTANCE RACER



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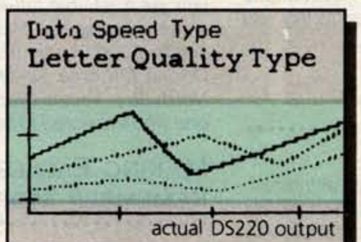

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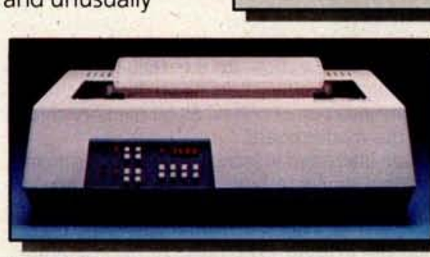

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Circle 366 on inquiry card.

(text continued from page 400)
what I wrote would even protect him legally (and commented that it must have been written by someone not of the legal profession).

I have enclosed a copy of this disclaimer (see table 1) for your consideration. If you could find the time to read it, Mr. Voglesong and I would be very interested in your opinion of it. If not, at least you know that you are being read and studied!

PENNY HETZER
Rochester, NY

This program falls under the Federal Copyright Law and may be used only by the purchaser for his own personal use. PSI designed this software for use in the Apple II and the Epson MX series printers using the Graftrax or Graftrax+ character set. With proper application, this program will perform as promised in the manual; PSI, however, is responsible for neither the particular application nor any problems resulting from that input.

Updates and corrections will automatically be received by filling out the registration card packed in the manual. We at PSI invite you to contact us with any questions, problems, or suggestions you might have so that later versions may be even more useful in printing with your system.

Table 1: *The* PSI *software disclaimer.*

I think your disclaimer is great. I wish all the software outfits would pay attention to this sort of detail.—Jerry

MEDICAL DIAGNOSIS

Dear Jerry,

I find your monthly columns of great interest. Unfortunately, I don't file them, and therefore I am writing to request information on how to obtain the software Dr. Lawrence Weed has been developing.

As you probably know, his book on the medical record was a seminal contribution to the organization of medical information. Fifteen years ago he set the stage for the possibilities that microcomputer technology now makes available to us.

Thanks for any help you can give me.

ROBERT L. COHEN, M.D.
East Elmhurst, NY

Dr. Lawrence Weed's address is Problem-Knowledge Coupler, PKC Corporation, RR 1, Box 630, Cambridge, VT 05444.

We got more than a hundred letters asking about Dr. Weed's diagnostics programs; the address was listed under Problem-Knowledge Coupler, but I guess I wasn't clear enough in the article that that's what Dr. Weed calls it.—Jerry

TYPEWRITER REPLACEMENTS

Dear Jerry,

If you were starting out today as a fiction writer, what would be your ideal micro? And, considering a writer's need for large memory storage and quick access to a variety of documents for editing, how would micros offering multiple windows fit into your ideal?

STEVEN A. HARDESTY
Arlington, VA

Given that I have my choice of almost any system available, obviously I prefer the S-100 system I now use. What I have is a CompuPro "boat-anchor" box that houses a Z80 microprocessor, lots of memory drives, and 8-inch floppy-disk drives. It talks to me through a memory-mapped video board that drives a 15-inch monitor; I talk to it on an Archive keyboard. As soon as CompuPro releases its upcoming S-100 video board that emulates the IBM PC display (but will put it up on my 15-inch monitor), I'll change over to that.

I solve the problem of large storage and quick access to a variety of documents by having a separate S-100 8085/8088 System 8/16 with a 40-megabyte hard disk. That system also drives the printer.

You did say "ideal."

You also could build a "dream system" for writers around the Sage IV; we're even looking into the possibility of using a Macintosh as the terminal for the Sage!

Obviously, not everyone has access to so much equipment.

Writing with computers is so much faster, better, and easier than working with typewriters that it hardly matters what you get, so long as you get a reliable full-service computer, not a games-playing toy. I know writers who love: Zenith Z-100; Apple IIe; Sage; IBM PC; Eagle; Otrona; Osborne; Kaypro; Corvus; Wang; Altos; North Star; Vector Graphic; Epson QX-10; and one who's devoted to his Exidy Sorcerer.—Jerry

MAKING EAGLES REMEMBER MORE

Dear Jerry,

As an Eagle 1600 user, I read with great interest your section in the January "User's Column" concerning beefing up the Eagle 1600 by the insertion of several 8K-bit memory chips on the motherboard.

I am interested in increasing my 1600's memory in a similar fashion and would be grateful if you could advise me of the chip's specifications and the cost of acquiring such chips. I note that the existing 128K bytes of my computer are made up of Mitsubishi 8K-bit chips, serial no. FMB 8264-20.

Second, should any special handling precautions be taken while inserting the chip, aside from careful use of an IC tool and correct orientation of the chip? Also, are they simply inserted in the IC sockets immediately adjacent to the existing chips? I note that there are 48 sockets.

DAVID W. FULLERTON
St. Catharines, Ontario, Canada

My apologies: I should have given those details then.

You want 8K-bit dynamic-memory chips (4164 types); California Digital lists them at $5.95 in quantities of one. For the Eagle, you need them in sets of eight; for the Zenith Z-100 or IBM PC, you'll want them in sets of nine (the extra chip is for storage of the parity bits).

You must be careful of static electricity: do not work in a carpeted area, and be certain to ground yourself before removing the chips from the antistatic foam California Digital sends them in.

Eagle sells memory-upgrade kits with full instructions. That might be a good buy, since you'll also need a second memory-refresh chip (an exact duplicate of the 48-pin refresh chip that's already there; it goes in the empty socket.)—Jerry

ADA SUBSETS

Dear Jerry,

I think it was a great mistake when it was decided not to "permit" Ada subsets. The decision did not prevent subsetting; it just ensured there would be no control over subsets. No one has been able to do any Ada programming without spending a lot of time picking out the nonstandard features of one's particular implementation and finding out which parts of the standard were left out.

The proper approach would have been a phased development using compiler subsets, somewhat as the Stoneman document defined subsets for the Ada programming support environment. Phase 1 would be the kernel "Pascal subset," with strong typing the most important feature. It would include all data types except private and task types. The kernel would also include subprograms and high-level I/O.

Phase 2 would introduce packages—the minimal requirement for a language to call itself Ada—and the other aspects of separate compilation, such as private types and the separation of specifications and bodies. The minimum would also need type-checking across module boundaries—otherwise, the purpose of type-checking is subverted. The final element of the minimum would be representation specifications and low-level I/O to allow the machine-dependent data definitions required in any programming for embedded systems.

Phase 3 would be full Ada except for tasking, the most important features being generics and overloading—two aspects of the same topic.

Phase 4 (tasking) would be the final layer, adding all aspects of this difficult and controversial feature. (A lot of disagreement has arisen about the desirability of the rendezvous method of tasking specified in the standard. Its primary use is for networks of computers. However, nothing forces a programmer to use Ada's tasking; individual variations can be created, if necessary.)

The kernel and minimal Ada could be implemented on an 8-bit machine. RR Software has demonstrated that with its Janus compiler. Task-

ing may be possible only on a 16-bit micro with a multitasking operating system, but interpreter/compiler/OS hybrids like FORTH might be able to manage it.

LARRY CARROLL
Pasadena, CA

Agreed: the much vaunted Department of Defense "control" over subsets of Ada may bring about the opposite of what it intended. Your approach would have been better. Alas, it's too late now.

This is probably the right place to mention an excellent new book, Software Engineering with Modula-2 and Ada, *by Richard Wiener and Richard Sincovec (Wiley, 1984). They give a good overview of what Ada is supposed to accomplish, as well as compare its approach with that taken by Modula-2.—Jerry*

REAL SOON NOW BLUES

Dear Jerry,

I want to contribute my recent experience with mail order as a warning to other readers.

In the August 1983 BYTE, I found a very tempting ad on page 75. A company called XperSystems promised a database system called Base 1 for $19.95. I called the toll-free number, ordered a copy for my 8-inch CP/M system, and charged it to my MasterCard. On August 10, XperSystems debited the $19.95 to my MasterCard account. At the end of October, I still had not received the product. I called the 800 number again, which turned out to be a secretarial service that just accepted phone orders. I was given the address of XperSystems: POB 22, Drescher, PA 19025. I sent a letter asking for the software or my money back before the end of November. Nothing happened. In early December, I called the 800 number once more. This time I was given the number of XperSystems: (415) 526-7110. I should ask for Karen Hall and request a refund.

Curious: the phone number is in Albany, California. After many unsuccessful tries, a woman finally answered on December 7. I explained my case, and she promised that Karen Hall would call me the next day. She called me two days later with a thousand excuses. The best one: "The boss of XperSystems is a very fast and effective programmer. He thought all other programmers would be that fast. But they were much slower. This is why we miscalculated the needed time to develop the software." Karen promised a letter within the next couple of weeks to all customers of XperSystems explaining the delay and a planned delivery schedule.

Another two months later and nothing has happened. If XperSystems does still exist and should ever advertise any products, remember my experience.

I do not mind waiting some time for software. I do mind, however, if someone takes my money months before sending the merchandise—if it even exists.

HANNS J. PROENEN
Culver City, CA

(*text continued on page* 404)

(text continued from page 403)

The other problem I find with Eaglewriter is that it doesn't label all the function keys and makes the user press two keys to use the powerful "indent" feature. And why Eagle allows the program to read and write files without making keys for the virtual-memory-architecture (g – get and gd – get done) commands, I have yet to figure out. Now that you have your Eagle PC, I suggest you get the SpellBinder manual.

Alas, it's a real problem: it will take months to get an advertisement in the pipeline. Surely, we'll have the software developed long before we get any orders, and we'll need the money as soon as we can get it.

Thus it's advertised; orders come; the product still isn't ready, but the programmers say it will be Real Soon Now . . .

I know. It has happened to me.

The only thing to do under those circumstances is tell the potential customer that the product isn't yet available.—Jerry

SOFTWARE GENEALOGY

Dear Jerry,

In a recent column you mentioned the "undocumented" features of Eaglewriter. Actually, there are quite a few if you depend on Eagle's rewrite of the SpellBinder manual. Frankly, I suggest that anyone who gains Eaglewriter with their purchase should write to Lexisoft, the creator of SpellBinder, and buy the SpellBinder manual. It is far clearer, consisting of two volumes: an easy-to-learn manual for the casual user and a more detailed notebook of all the features. It is worth the investment.

The version to get is 5.12, since that is the one used by Eagle. The new version, which I have not seen yet, is said to be far improved and for the first time is generic; instead of having to tell Lexisoft which of the 50 versions you want (because of specific key assignments with each), it allows the user to define all the keys to preference. I haven't heard if Eagle plans to move up to the new version or not, but I am sure Eagle or Lexisoft would be willing to confide in you if you ask.

But this letter is prompted by the comment by Paul Chisholm in your February column. Ye gods, where did he find Word/125. I saw it on the HP 125 a couple of years ago. It was a lousy implementation of the old SpellBinder 5.04, which must be a minimum of three years old.

As you probably know now from your use of Eaglewriter, Mr. Chisholm can delete in either command or edit mode. In edit mode he can select character, word, sentence, paragraph, or mark (a great feature) for mode forward, mode back, and mode delete. What could be easier? In command mode, if he wants to take out a line he only has to type ld (or how many lines he wants out) and it is done. Just like lp will print one line, etc. I suspect that he hasn't seen the manual or he is using Word/125 on something other than an HP 125.

In sum, perhaps it is about time to tell your readers that many manufacturers use older versions of word-processing software and then tell you it is "really" XYZ-brand. They just don't say why they were able to license it so inexpensively. Or, as in Eagle's case, it has tacked on a front end and done its own key assignments.

EDWARD F. SAYLE
Arlington, VA

Sigh.

Paul Chisholm was using a multiuser system at a major university; perhaps they need to be told to update?

Agreed: the latest SpellBinder is better than the older version of Eaglewriter. Eagle, fortunately, is doing an update, although I don't have it yet.

Some people love SpellBinder. Some just hate it. In my own case, if I had to use just one editor for everything (text creation, letters, documents, programming), SpellBinder would certainly be a major contender.—Jerry ■

Circle 204 on inquiry card.

Circle 27 on inquiry card.

B·Y·T·E W·E·S·T C·O·A·S·T

Lessons Learned

SoftOffice, the integrated software package that almost wasn't

BY EZRA SHAPIRO

SoftOffice is an amiable and powerful integrated software package for word processing, spreadsheets, and database management on the IBM PC or XT, IBM-compatible computers, and the PCjr. It uses character graphics to create icons of familiar desktop items that can be manipulated with a mouse (or "pseudomouse," simulated with cursor-control keys). Windows for raw text or referenced data can be opened and closed easily. Designed to be learned quickly by a novice, SoftOffice also offers options for handling data that allow for a wide range of applications within the shell of the program.

The program first presents you with a familiar screen of a stylized desktop. The display contains a selection of icons—a piece of paper for data entry, a filing cabinet for storage, a wastebasket, a supply closet for duplicate icons or ones that you don't need on a regular basis, a clock and a calculator, a printer (when you want to print something, you place its icon "into" the printer icon), and Max, the Office Assistant.

The program uses a limited number of commands, including GRAB, DROP, POINT, MOVE, COPY, and CLOSE. To exercise a command, you can either click the mouse buttons or press one of the remaining keys on the IBM's numeric keypad that do not control the cursor.

Let's run through a simple text-entry process. You would use the command POINT to specify one of the icons (the sheet of paper, say) by placing the cursor on it. To produce a fresh sheet for yourself you'd use the COPY command on the icon. Then you would execute the GRAB command and MOVE the copy to a convenient position on the screen, where you would DROP it. Next, you would OPEN it (create a window) and enter your text by typing it on the keyboard. To finish, you would CLOSE the window. If you decided that you did not like what you had done, you could DELETE your sheet of paper. You can have as many windows open at one time as you want. Simple, isn't it?

The commands are available for several levels of the program. POINT can be used to mark the beginning and end of a section of text that you can then MOVE or COPY within a document or between documents (of course, you could also DELETE the section). Using the OPEN command on a paragraph instructs the program to display a "dashboard," a short menu of formatting choices that can be used to modify the appearance of the paragraph. (SoftOffice assumes that you will want a basic format that will be changed infrequently. Once you have finished a paragraph with an unusual dashboard, the next paragraph reverts to the original styling guidelines.) Text re-forms with no intervention, and work is saved to disk automatically. (The program uses an algorithm that borrows small fractions of time from periods of keyboard inactivity to take care of maintenance.)

The program can handle two types of data, raw text and "data cells." You toggle between types by pressing the Insert key. Data cells can be indexed to one another and used to construct spreadsheets, databases, and form letters. What is more, data cells linked to other information can be dropped into text; it is possible, for example, to have a data cell in the middle of a paragraph related to spreadsheet data cells located well apart from the text (even in another document). Depending on how the formulas for the data cells are worded, changing the cell in text could cause automatic recalculation of the spreadsheet, or vice versa. The dashboard for data cells lets you enter formulas and references in straightforward, English-like syntax.

Items can be placed "inside" any container that makes sense; that is, you can open the filing cabinet and store a document in it, but you can't store the wastebasket in a document. Likewise, you can enter data in any logical spot—the front of the filing cabinet, a piece of paper, and so on. Max, the Office Assistant, is available for complex tasks; you can call on him to close all documents open on the screen and store them neatly in the filing cabinet. He also appears at appropriate moments to warn you of an impending calamity.

(text continued on page 406)

Ezra Shapiro is a technical editor at BYTE's West Coast bureau. He can be reached at McGraw-Hill, 425 Battery St., San Francisco, CA 94111.

'Venture capitalists turn you down by remaining enthusiastic forever, and that's essentially what happened to us.'

(text continued from page 405)

The History

SoftOffice wasn't always the integrated software package that it is now. In fact, the evolution of SoftOffice makes for an interesting case study of how things can change over the course of a software-development project. Late in 1982, Bruce Van Natta was introduced to a programmer from Orange County, California, who had an idea for an electronic-mail program that incorporated a fancy text editor with windows. Van Natta, a founder of IMSAI Corporation and later of MicroPro, had planned to retire but found that he couldn't stand not working. In addition, his complex tax picture required that he invest $100,000 in something—anything. So in early 1983 he assembled a six-person team for the project in his living room. A few days later, the group rented office space (with Van Natta's money) and became the SoftOffice Company.

One of Van Natta's first acts as president of the new firm was to recruit a former associate from MicroPro, Phoebe Williams, who had been instrumental in the design and documentation of Starburst, MicroPro's umbrella program for word and data processing. She was asked to participate in the development of the final specifications for the program and to help draft a business plan. Williams flew in from Oklahoma for what she thought would be a long weekend as a consultant; instead, she stayed on as part of SoftOffice.

Williams recalls, "When I saw what they were doing and talked to them, I was convinced that it was a real hit. Plus I really wanted to work with Bruce again.

"We set out to follow the classic path of writing a business plan, trying to get around to venture-capital guys and get $1.2 million and have a full-fledged company—develop the product, put a marketing team together, and have the thing introduced at COMDEX '83 in November. The programmer said that he and perhaps 8 or 10 other guys could make the product in 11 months.

"So we wrote a business plan and had it ready the third week of February, but by this time we had already discovered that part of our team was neither competent nor willing to be part of a venture like this." Two members of the group were fired at the end of February, and a third at the end of March. The team dwindled to Van Natta, Williams, the programmer, and one other staffer handling legal and administrative affairs.

"By now," Williams continues, "Bruce and I are trudging out full-time to talk to venture capitalists. Did we talk to them! I'll bet we talked to between 35 and 50 firms. We weren't smart enough to realize that the fact that we talked to that many meant we were already doomed. I mean, within the first half-dozen, somebody had said to somebody else in the finance community, 'These guys don't have the right stuff.' But it took us six months to figure that out. Somebody early on said that venture capitalists turn you down by remaining enthusiastic forever, and that's essentially what happened to us."

Both Williams and Van Natta attribute their failure to a lack of the "correct" executive background. Van Natta feels that his bid to be president of the firm was the major stumbling block. Though he had played a major role in both the launch of the IMSAI 8080, one of the first business microcomputers, and the WordStar word-processing program, and though he had held high-level positions at MicroPro in operations and corporate planning, he had not had direct profit-and-loss responsibility. The venture-capital firms wanted a president with "the right marketing credentials," says Van Natta, "somebody who had marketed this stuff before, successfully."

By June of '83, neither Van Natta nor Williams had been paid for six months, but the firm had spent the initial $100,000 and an additional $20,000 besides. Williams goes on, "So here we are—our furniture is being repossessed, we're sitting in our office at the end of June, there's not a shred of money in the bank, we have no hope of getting money to fund the company, none of us has any personal resources left, and this is the end of it, right? So everyone departs the scene."

That was very nearly the end of SoftOffice, but both Van Natta and Williams had become fascinated with the idea of the editor that was to have been the icing on the cake of a slick electronic-mail system. A week after closing down the office, the two of them decided to move operations to an unused porch at Van Natta's house, borrow money to live on, and try to complete the project.

Very little had been finished—a product description, a few nonfunctional demonstration disks, and a small amount of actual program code. The first real task was defining the philosophy of the new product. Van Natta and Williams had already established several points. SoftOffice was to be a visual editor that used icons, windows, and a mouse, not an electronic-mail system. In Williams's words, "Granted, electronic mail was real sexy, but first of all, there wasn't a lot of application (there weren't that many networks installed and so forth), and we didn't think that it was a particularly hard thing to do." The editor would use the desktop metaphor, and commands would be derived from what users did in real-life situations rather than from programming convenience. And every command would have an immediate, on-screen effect. If nothing happens that you can't see, Van Natta reasoned, there would be no complex problems for you to untangle.

The basic guideline the two used was that if they experienced difficulty describing what was supposed to happen, the action itself was overly complicated and should be rethought. There were to be no error messages. "Every time you run into something where you have to give the user an error message," says Van Natta, "you have some sort of unnatural limitation. So the solution is not to have pretty, easy-to-understand error messages but to not have limitations that people are going to run into so that you have error messages." Finally, all commands would work the same way on all levels of the program.

"We had some experience with the windowing part of it," Van Natta explains. "In other words, opening and closing windows, making them bigger and smaller—and we knew we could do that with very few commands, in a very natural way. The real open question was whether the same philosophy and the

(text continued on page 408)

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(*text continued from page* 406)
same commands and the same simplicity—and it *had* to be the same commands and the same simplicity and the same metaphors—could go all the way into the editor. So there wouldn't be this shock as you passed from the desk into the editor. . ."

". . . into the windows and doing your actual work," Williams interrupts. "That was the part we were scared about. Then one weekend we talked about it for several hours each day, and we accomplished the design. In two days we realized how to do it, and we saw that we could do it consistently." She adds, "We looked at the kinds of things people put on paper, and we came up with two categories. First, paragraphs, stuff that you were going to type in; it was pretty much just going to sit there—it should re-form, you should be able to format in different ways, set the line spacing on it and stuff like that—but it wasn't going to do anything special.

"Then there was something other than plain old text—something that could be told to behave in special ways, told to recalculate itself, told to go and sit somewhere else in the system. I don't know how to describe it—one thing's sort of vanilla and the other's sort of a traveling medicine show on a real small scale. We decided that the second thing would be called a 'data cell,' for want of a better term, and it would be almost a little island that could hold a text reference, information from somewhere else, a formula, a number, a date, a percentage. It could display itself in about seven or eight different ways. We can fit everything you could possibly write into those two categories."

As Williams worked on refining the design specs for the program, Van Natta began to write the code for it in Pascal. He hadn't done much coding for several years, but after about a month the components of the program began to take shape. Initially, he borrowed routines that the original programmer had contributed to the first stage of the project. As he went along, however, he found himself rewriting everything in simpler, tighter code. Work progressed, and Williams and Van Natta found two important things happening. First, their rules *did* work in all areas, and they could resolve any roadblocks by applying the rules carefully. Second, as the functionality of SoftOffice grew more complex, the actual program shrank in size.

"Instead of taking the easy way out and saying, 'Oh well, I guess we'll just have to have this edge be a little rough over here,' we just stayed at it until the problem solved itself inside the design criteria and the philosophies. We were pretty clear on what the philosophies were, which made it relatively easy to do things," says Van Natta.

The issue of error messages was a good case in point. In keeping with their general philosophy, there were to be no
(*text continued on page* 410)

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DEALER INQUIRIES INVITED

(text continued from page 408)

error messages because there were to be no obvious limitations on what the user could do. "An example of that is how long the name of a piece of paper can be," Van Natta says. "Well, I think there is some upper limit, something like 32 million characters. Nobody could type in that many. Why do you need that? Sixteen would have been plenty; Visi On gives you 12. The point is that if we don't have to have a limit, you never run into it, I don't have to have the code to check it, I don't have to have an error message, and I don't have to document it. The same philosophy is used throughout the entire system. We just don't have error conditions.

"A paragraph can be no longer than 32,000 characters. If somebody actually gets a paragraph longer than 32,000 characters, we're going to be in trouble. I don't think a single document can be longer than about 1500 pages. Of course, that would probably take up something like 7 megabytes—it would take a long time to get from one end to the other—but if someone put one in we might run into a bad error condition. It has limits way, way out there like that."

As Williams explains it, "We have what you probably consider 'warning conditions.' For instance, if you're running SoftOffice on a 128K-byte PCjr with a 360K-byte floppy, you're going to have more than one disk. You may run your office for a month on one disk, and then comes next month—you're full and it's time to move your office to another disk.

"The way the warning will occur is not that the machine will stop working and some error message will come up on the screen; what will happen is that Max will start waving his arms or pop up from beneath something on the screen. He'll have a piece of paper in his hand, and you'll open the paper and it will say, 'Disk is 92 percent full—you'd better do something about it now. Here's what to do—I'll help you.' And he will carry things from your current office disk to the next one."

Van Natta adds, "We wanted the system to be modeless, and we also wanted it never to trap you anyplace. If you're right in the middle of a paragraph doing something, you can move off and do something else and come back and you're right there. One of the problems

(text continued on page 412)

'The delay helped us make a better product because we were forced to think about it.'

(*text continued from page* 410)
with error messages is that, the way that they're normally done, you're trapped at the error message; you *must* do something to respond to that message before you're allowed to do anything else. When the office assistant jumps up, waves his piece of paper at you, and says, 'Disk is getting full,' you don't have to fix that problem right then. You can finish up what you're doing, and then—at a convenient time for you—solve the problem."

Williams adds, "There's no such thing as getting into the middle of something and not being able to leave it and do something else, which is true in no other program that I can think of. In SoftOffice, you're not required to finish something that you start. And if you leave it in the middle and come back, it'll be in the same state as when you left it."

"Internally, the way the system works is that keystrokes and commands sort of rain down on the objects," Van Natta explains. "The 'manager,' the code inside that manages this thing that you're typing into, every once in a while sees a character come at him and does something. Since he intrinsically doesn't have any sense of time, the fact that you went over and rained characters on another object—or went on vacation for a week—has no meaning for him.

"Because we've had everything work the same, I started off with 15 managers, and now there are just two—a manager that takes care of paragraphs and data cells, and a manager that takes care of papers, containers, everything else—objects. When the paper manager is over managing a piece of paper, he's not remembering he was over there and the next thing that needs to be done over there. He's a completely free-form manager, and he comes over here and picks up all the information here so that when this character rains down on this piece of paper, the system says, 'Okay, we're over a piece of paper. Let's call the paper manager and give him the character and tell him we're raining it on this particular object.' And if you move your cursor to another spot and rain over it, the system again just tells the paper manager, 'Here's your character, here's your object, now do it.' "

What started out as a program that required a hard disk and a large amount of RAM (random-access read/write memory) wound up as less than 128K bytes of compiled code that could conceivably (in cartridge form) run on a 64K-byte PCjr with no disk drives at all. Williams and Van Natta are excited about the possibilities of SoftOffice as a program for an environment with a larger computer, say a PC XT, as the mother to a cluster of satellite PCjrs. Because the program works the same way on any computer, they believe operators would experience little or no difficulty moving from one workstation to another. Electronic mail and networking, once the original purpose of the program, will be held back until the second or third version of SoftOffice hits the market—and at that time, they figure, networking with small machines will make SoftOffice a very attractive package.

The Finished Product

The story appears to have a happy ending. In March of this year, Van Natta and Williams were negotiating with a publisher interested in marketing the program and were confident that SoftOffice would appear as a finished product in midsummer, a bit less than two years after the first steps toward it were taken.

Looking back, Williams reflects, "We pretty much took the basic ideas that we'd developed during the first six months of '83 and started to build the design around those. It's now quite different from what the former programmer had originally conceived. But in a way, the delay—or what we think of as a crucial loss of six months' time—helped us to make a better product because we were forced to think about it. I'm sure that the design we had in the fall of '83 was far different from the one we had at the beginning of the year, and a far better one. We were forced into retreating to the basement, and now we're both glad of it and would do it that way again."

Van Natta comments, "If I had to do it over again, I would start off in the basement, with far fewer people. I might have gone to the venture-capital community, but only at the stage where the program was done developing." The lesson, and his advice to anyone with an idea for a program, is simple: "Learn a programming language, code it up, and find someone to publish it." ■

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(text continued from page 113)

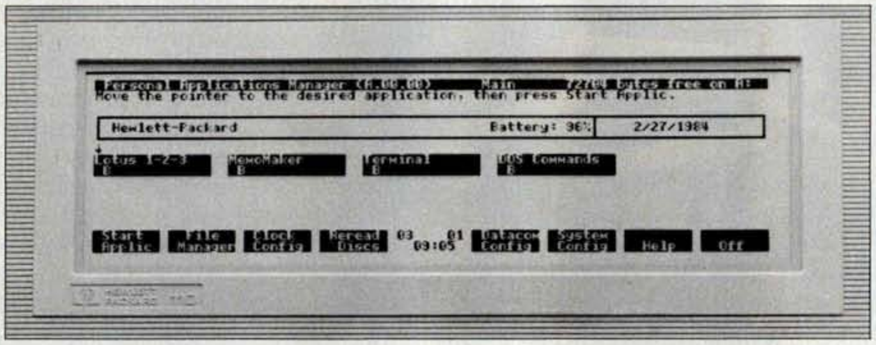

Photo 3: *The* HP 110*'s* Personal Applications Manager*, an operating-system shell for most configuration and file-manipulation functions. The blocks along the bottom of the screen are a map of the eight programmable soft function keys.*

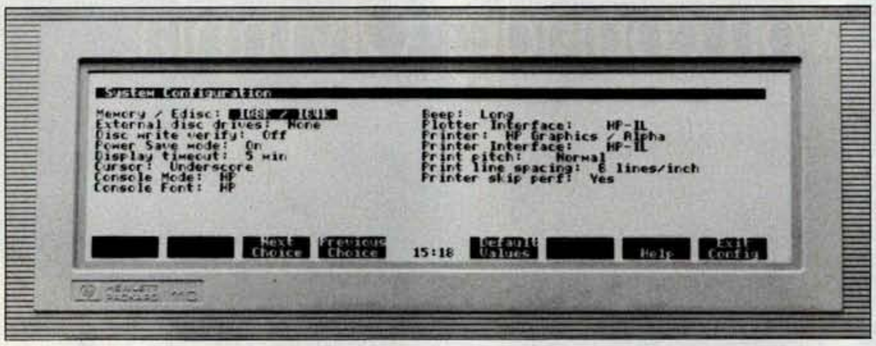

Photo 4: *The system configuration menu. Using the function keys, it's possible to toggle among a full range of choices for each topic.*

Photo 5: *Each of the* HP 110 *Help categories is supported with a full screen of information.*

(even the Lotus Help screens) exists in electronic memory, movement, recalculation, and graphics are all blindingly fast; in fact, the slowest part of the system is the LCD. Unless you're dealing with an extremely large spreadsheet and very complex formulas, chances are you'll wait longer for a screen update than for number crunching.

The Terminal program can be used for data transfer for all three of the HP 110's output interfaces, RS-232C, auto-dial/auto-answer modem, and HPIL.

The DOS Commands option lets you dispense with PAM entirely and operate the 110 as you would any standard MS-DOS machine.

You can, of course, load other software into the electronic disk—within reason (a large program that needs full system RAM would be impossible). The HP 110 is essentially a "generic" MS-DOS computer; any programs that use only operating-system calls, rather than direct calls to the system ROM BIOS (basic input/output system), *and* can be configured to use the 110's smaller screen size should run acceptably. Also, any programs that are written for other Hewlett-Packard MS-DOS computers (significantly, the HP 150), that can be configured for the screen, and that use only HP escape sequences should be okay. Thus, the 110 isn't fully compatible with any other machine; it bears a family resemblance to the 150, but it's not an identical twin. Many programs that run on the 150 should run on the 110, but there are no guarantees.

Hewlett-Packard claims to have done more market research on this product than on any other HP device before it; much of that study went into determining the software bundle. The company apparently believes that the current package will best suit the needs of today's portable computer user.

Although the ROM chips that will be distributed in the product will be permanent (unerasable), the ROMs used during prototype production and testing were EPROM (erasable programmable ROM) chips, and the company candidly admits that it is working with potential high-volume customers to help those firms develop customized software packages for their employees. There is no talk at present of optional software configurations for single users, but Hewlett-Packard representatives will not rule out the possibility. It stands to reason that a skilled hardware/software hacker or entrepreneur could implement alternative firmware for the HP 110.

System Peripherals

The 110's HPIL interface enables you to connect the computer to two battery-powered peripherals specifically designed to be part of a component system: the Thinkjet printer (see the April BYTE West Coast, page 82) and the new HP 9114 portable disk drive. Both units weigh about 6 pounds, have the same exterior dimensions, and operate for about eight hours of continuous use

(text continued on page 416)

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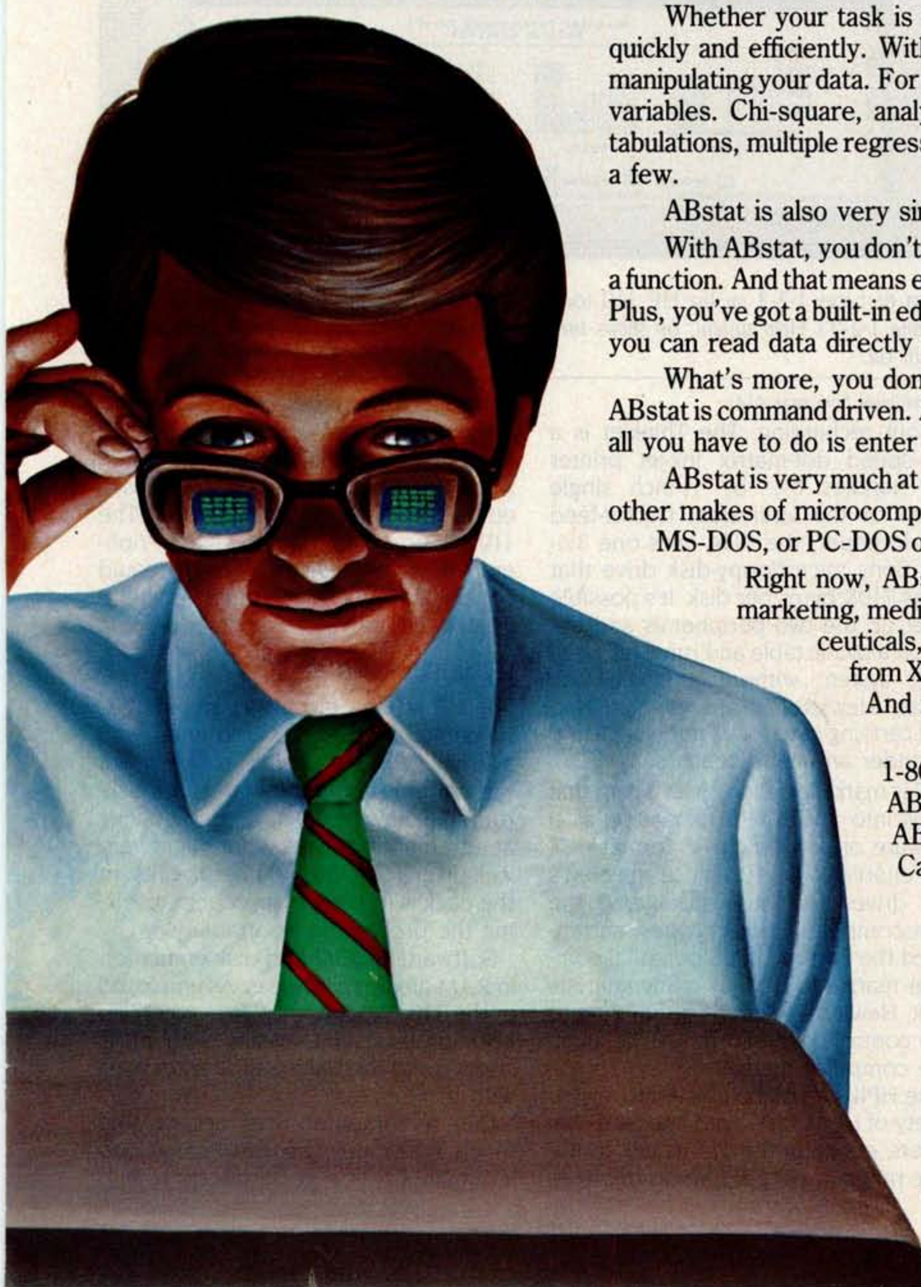

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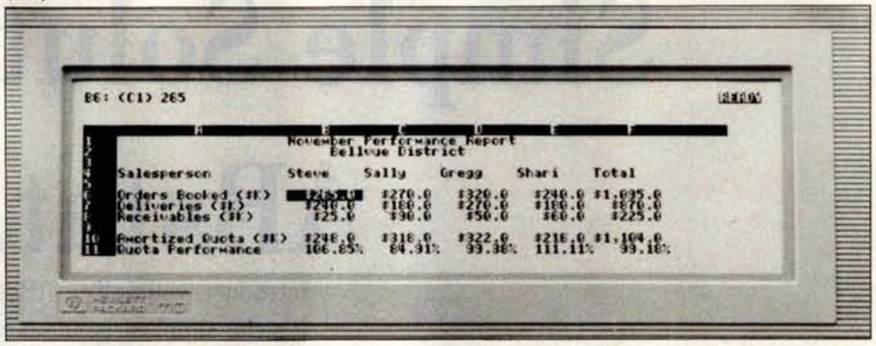
(6a)



(6b)

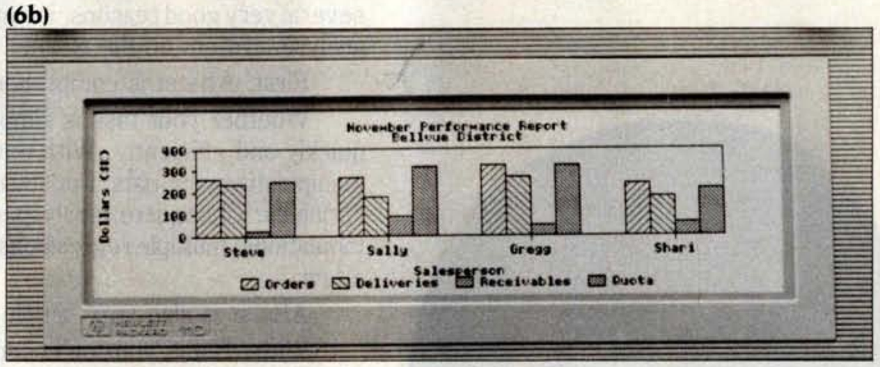


Photo 6: *Lotus 1-2-3 on the* HP 110 *(6a). All Lotus features are fully implemented, including 1-2-3's Help system. 6b shows the bit-mapped graphics chart produced from the table in 6a.*

(text continued from page 414)

without recharging. The Thinkjet is a high-speed dot-matrix ink-jet printer that handles 8½- by 11-inch single sheets or the equivalent tractor-feed fanfold paper; the 9114 uses one 3½-inch Sony microfloppy-disk drive that stores 710K bytes per disk. It's possible to set up the two peripherals and the 110 on a picnic table and run a full computer system without a single wall socket. Hewlett-Packard even sells a vinyl carrying case for all three units that fits under an airline coach seat.

HP is marketing (along with a card that drops into an IBM-PC expansion slot) software on a 5¼-inch PC format disk that enables the 110 to use the IBM's disk drives for mass storage. If the microcomputer industry has surrendered the Fortune 1000 personal computer market to IBM, as many analysts think, Hewlett-Packard is attempting to gain control of the Fortune 1000 portable computer market.

The HPIL can be connected to a wide variety of Hewlett-Packard interface converters, enabling the 110 to talk to the large range of HP peripherals (plotters, controllers, hard-disk drives, etc.) and devices designed to link to other HP computers. To make things even easier, the 110's Terminal program includes emulation of the HP 2621 terminal. The 110 can be linked to up to eight peripheral drives or devices; one 110 could conceivably use eight others as temporary disk drives.

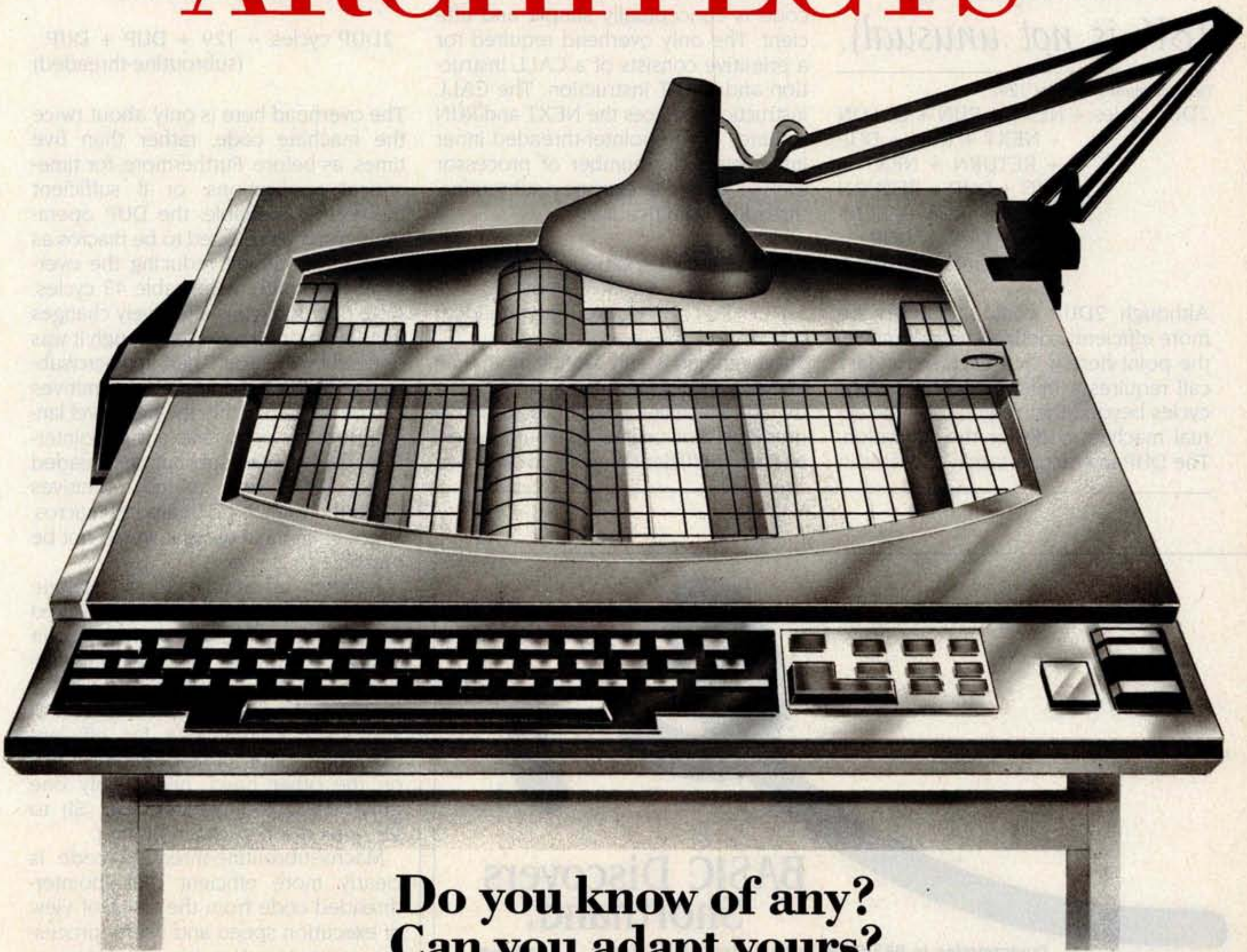
CONCLUSIONS

The HP 110 is a fast little computer, as functional as most desktop units, with a large line of peripherals available. But the portable computer market is mushrooming; new products are multiplying at a tremendous rate. What might very well distinguish the 110 from the rest of the pack is its simple approach to solving the problems of portability.

Software in ROM and disk emulation in RAM are not new ideas. As employed in the 110, though, they free you from both the constant fussing with mass storage and the waiting time associated with disk access.

Can a computer user accept that much freedom? The Hewlett-Packard 110 makes that a good question. ■

CAD SOFTWARE FOR ARCHITECTS



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The kernel of a typical TIL system is relatively small (8K is not unusual).

(text continued from page 129)

2DUP cycles = NEXT + RUN + COLON + NEXT + RUN + DUP + RETURN + NEXT + RUN + DUP + RETURN + NEXT + RUN + SEMI
= 358 + DUP + DUP
(pointer-threaded)

Although 2DUP could obviously be more efficiently defined as a primitive, the point here is that each secondary call requires a minimum of 358 clock cycles beyond that required by the actual machine code for the operation. The DUP instruction takes 32 cycles in 8088 code, so that the 2DUP secondary word takes about five times as long to execute as the equivalent assembly code. This ratio is probably typical for secondary words.

By contrast, subroutine-threaded code is conceptually simple and efficient. The only overhead required for a primitive consists of a CALL instruction and a RET instruction. The CALL instruction replaces the NEXT and RUN routines of the pointer-threaded inner interpreter. The number of processor cycles required to execute a subroutine-threaded primitive is:

primitive cycles = CALL + body + RET
= 43 + body
(subroutine-threaded)

This overhead is only slightly more than half of that required using the pointer-threaded technique. Moreover, a simple primitive that ordinarily would be extremely inefficient may be invoked as a macro. Doing so would eliminate the execution overhead entirely.

For secondary words there are similar savings. For example, the 2DUP word considered above would require three CALL/RET pairs for execution:

2DUP cycles = 129 + DUP + DUP
(subroutine-threaded)

The overhead here is only about twice the machine code, rather than five times, as before. Furthermore, for time-critical applications, or if sufficient memory is available, the DUP operations could be selected to be macros as mentioned earlier, reducing the overhead to a quite respectable 43 cycles. Note that doing this effectively changes 2DUP to a primitive, even though it was defined by the user. Thus, in macro/subroutine-threaded code, true primitives can be created within the high-level language; this is not possible with pointer-threaded or pure subroutine-threaded code. These user-created primitives could themselves be treated as macros, although in most cases it would not be practical to do so.

Another advantage of subroutine threading is that it uses fewer dedicated processor registers. As you can see in listing 1, the pointer-threaded language discussed by Loeliger requires four registers beyond the program counter (PC) and stack pointer (SP) for efficient operation. Subroutine-threaded code, on the other hand, needs only one other dedicated register (e.g., SI) to serve as the data stack pointer.

Macro/subroutine-threaded code is clearly more efficient than pointer-threaded code from the point of view of execution speed and use of processor resources. However, it does use more memory. The primitives in each form of threading use about the same amount of memory, but the secondary words of subroutine-threaded code without macros are about 50 percent larger than the equivalent secondary words of pointer-threaded code because one byte is required for each CALL instruction. The additional memory requirement for subroutine-threaded code may not be a significant problem for three reasons:

1) The kernel of a typical TIL system

(text continued on page 420)

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(text continued from page 418)

is relatively small (8K is not unusual for compiler/interpreter, editor, and assembler).

2) Many newer microcomputers can address much more memory than previously possible.

3) Memory is significantly less expensive now than it was when FORTH was first introduced.

However, if macro capability is included in the subroutine-threaded language, things can quickly get out of hand. Unless you are careful to define as macros only relatively short or infrequently used words, the repetition of machine code as new words are defined can expand the program memory considerably. For this reason a good rule of thumb might be to avoid treating user-defined words as macros.

(text continued on page 422)

Listing 1: *A translation of Loeliger's generic inner interpreter into 8088 assembly-language code.*

```
;Assignment of Loeliger's generic registers
to 8088 registers

    ;  I  —> DI    Instruction register
    ; WA  —> BP    Word address register
    ; CA  —> CX    Code address register
    ; RS  —> SI    Return stack pointer
    ; SP  —> SP    Data stack pointer
    ; PC  —> PC    Processor program
                   counter


; Loeliger's inner interpreter translated to
8088 code

COLON:  ; 39 processor cycles
        DEC SI
        DEC SI
        MOV [SI],DI
        MOV DI,BP
        JMP NEXT

SEMI:   ; 21 processor cycles
        DW OFFSET SEMI+2
        MOV DI,[SI]
        INC SI
        INC SI

NEXT:   ; 21 processor cycles
        MOV BP,[DI]
        INC DI
        INC DI

RUN:    ; 46 processor cycles
        MOV CX,DS:[BP]
        INC BP
        INC BP
        CALL CX

RETURN: ; 15 processor cycles
        JMP NEXT
```

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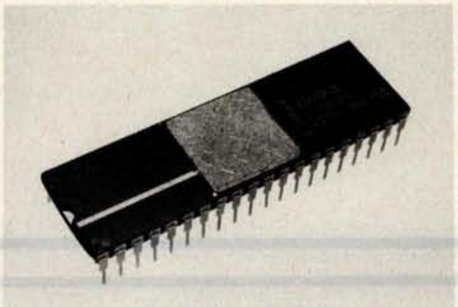

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(text continued from page 420)

Nevertheless, being able to selectively use macros is such a great advantage that it is probably worth choosing subroutine threading over pointer threading. Add to this the speed advantage and conceptual simplicity of hardware CALL/RET over the software inner interpreter, and a fairly strong case can be made for the choice of subroutine threading.

Comments on the Data Stack

Aside from the overhead of threading, the major limitation to program efficiency is the use of an in-memory stack. Consider, for example, the simple task of taking two numbers from memory, adding them together, and storing the result in memory. For simplicity, I assume that the two numbers and their sum are each 2 bytes long and previously have been given names in a data segment. The 8086/8088 assembly code might be:

```
MOV AX, NUM1    ;LOAD THE 1ST
                 NUMBER
ADD AX, NUM2    ;ADD THE 2ND
                 NUMBER TO
                 THE 1ST
MOV SUM,AX      ;PUT RESULT
                 INTO
                 MEMORY
```

This requires 53 cycles to execute on an 8088 processor.

Now consider doing the same thing with the intermediate use of the data stack. In FORTH the operation would be:

```
NUM1 @ NUM2 @ + SUM !
```

To illustrate the process in assembly language I'll use the mnemonics PUSHD and POPD to indicate pushing to or popping from the data stack. For pointer-threaded code these will be the same as the 8086/8088 PUSH and POP instructions. Listing 2 gives the translation of PUSHD and POPD for subroutine-threaded code. Using the stack for intermediate storage, an assembly-code translation of the above FORTH phrase might resemble listing 3.

This may be an extreme case, but it does illustrate the inefficiency of using the data stack in FORTH when data is frequently pushed to the stack and immediately pulled from it to perform an operation. Excluding overhead, 224 machine cycles are necessary for the 8088 processor, primarily because of the many memory references. If the efficiency of a stack-oriented TIL such as FORTH is to be further improved, it is imperative to speed up the stack operations or eliminate some of them entirely through the use of an optimizing incremental compiler. The latter alter-

(text continued on page 424)

Listing 2: PUSHD *and* POPD *instructions in 8088 assembly-language subroutine-threaded code. The* SI *register acts as the data stack pointer.*

```
;PUSHD register to data stack

DEC SI
DEC SI
MOV [SI],register


;POPD top of data stack to register

MOV register,[SI]
INC SI
INC SI
```

Listing 3: *Assembly language program using* PUSHD *and* POPD *mnemonics, illustrating use of the stack.*

```
                      ; Forth word NUM1
MOV BX,OFFSET NUM1    ; GET ADDRESS OF 1ST NUMBER
PUSHD BX              ; PUSH ADDRESS TO STACK
                      ; Forth word @
POPD BX               ; GET ADDRESS FROM STACK
PUSHD [BX]            ; PUSH 1ST NUMBER TO STACK
                      ; Forth word NUM2
MOV BX,OFFSET NUM2    ; GET ADDRESS OF 2ND NUMBER
PUSHD BX              ; PUSH ADDRESS TO STACK
                      ; Forth word @
POPD BX               ; GET ADDRESS FROM STACK
PUSHD [BX]            ; PUSH 2ND NUMBER TO STACK
                      ; Forth word +
POPD AX               ; GET NUM2 FROM STACK
POPD BX               ; GET NUM1 FROM STACK
ADD AX,BX             ; ADD NUM1 AND NUM2
PUSHD AX              ; PUSH RESULT TO STACK
                      ; Forth word SUM
MOV BX,OFFSET SUM     ; GET ADDRESS TO STORE RESULT
PUSHD BX              ; PUSH ADDRESS TO STACK
                      ; Forth word !
POPD BX               ; GET ADDRESS OF SUM FROM STACK
POPD AX               ; GET NUM1+NUM2 FROM STACK
MOV [BX],AX           ; STORE RESULT
```

Listing 4: *Modified* PUSHD *and* POPD *instructions. The data stack is now made up of the* SI, BP, CX, *and* ES *registers.*

```
; PUSHD register to data stack

MOV ES,CX
MOV CX,BP
MOV BP,SI
MOV SI, register


; POPD top of data stack to register

MOV register,SI
MOV SI,BP
MOV BP,CX
MOV CX,ES
```

Subroutine threading can reduce execution overhead and at the same time use fewer processor registers than pointer threading of code. It can also be adapted to any microprocessor.

(*text continued from page* 422)
native is beyond the scope of this article.

One way to increase the speed of stack operations is to use some of the 8086/8088 registers for the data stack. For example, the registers I have used in my own TIL are SI, BP, CX, and ES. Excluding the program counter and stack pointer, this leaves four general-purpose registers and three segment registers for coding the primitives of the language. These are sufficient for all but a very few primitive operations. If one or more of the dedicated registers is required for a particular operation, their contents can be temporarily saved on the return stack and recovered before the return to the calling routine. The code for the four-register PUSHD and POPD mnemonics mentioned above is given in listing 4. Using the dedicated registers, pushing data from one of the general-purpose registers to the data stack requires only 8 machine cycles, compared to 22 cycles for the subroutine-threaded PUSHD instruction of listing 2. The comparison for a POPD instruction is very similar.

A four-element data stack is sufficiently large to handle all standard FORTH single-precision primitives as well as the binary double-precision operations. With careful planning it is also large enough for virtually any high-level TIL program. If necessary, the four-register stack can be supplemented by defining two new primitives, << and >>. The << word pushes the two lowest elements of the data stack to the return stack for temporary storage. The >> word reverses this by pulling two 16-bit numbers from the return stack and storing them in the two lowest registers of the data stack. The only caution for using them is that << must be followed by >> before the end of a loop or end of the definition. This prevents other uses for the return stack, such as holding do-loop indexes, from being adversely affected. If a still faster stack is desired, and double-precision operations are not required, a three-register stack could be used, along with the << and >> words.

There are two additional advantages of using a register-based, three- or four-element data stack. First, it discourages the poor programming practice of stringing a lot of words together that push numbers to the stack, followed by a string of operators that act on those numbers. It is much easier to follow the flow of FORTH code in which only a few numbers are on the stack at any given time. The other benefit is that programming errors that overflow the stack do not halt processing, which sometimes occurs with stacks that are not limited in extent.

Evaluation and Conclusions

In order to evaluate the utility of the ideas discussed above, I modified the FORTH version of the Sieve of Eratosthenes program (see reference 2). In the modified program, the data stack contains no more than three numbers at any one time. This program was then run on a version of FORTH that uses macro/subroutine threading and a three-element data stack. Most of the primitives of the language used in the program were defined as macros. The program requires 21 seconds to execute 10 loops, compared to about 55 seconds for PC/FORTH and FORTH Level II (see text box). So far as I am aware, these two execute the FORTH Sieve program on the IBM PC faster than any other commercial versions. The improvement in execution speed by a factor of 2.5 results in a language that compares favorably with most of the C compilers presently available for the IBM PC (see reference 4). Other benchmark programs produce similar relative comparisons.

It is obvious that the two techniques that I have suggested for improving the execution speed of a TIL are successful. Subroutine threading is probably the more important of the two. It can reduce execution overhead and at the same time use fewer processor registers than pointer threading of code. It can also be adapted to any microprocessor. Programmers interested in designing their own TIL will likely find these techniques easy to work with since the program flow is controlled by hardware subroutine calls rather than an additional layer of software. Moreover, since the implementation is transparent to the user, FORTH can be written to use it without any required change to the language. Finally, a simple extension lets the user choose macro substitution for more rapid execution.

The other suggestion, using three or four registers for the stack, should also be seriously considered. Since it requires some modification of the standard, it may not be suitable for FORTH. It may, however, prove useful to programmers who want to construct their own TIL for a 16-bit, multiregister microcomputer. ■

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FORTH Level II *is available from* The Software Works, 1032 Elwell Court, Suite 210, Palo Alto, CA 94303.

PC/FORTH *is available from* Laboratory Microsystems Inc., POB 10430, Marina del Rey, CA 90295.

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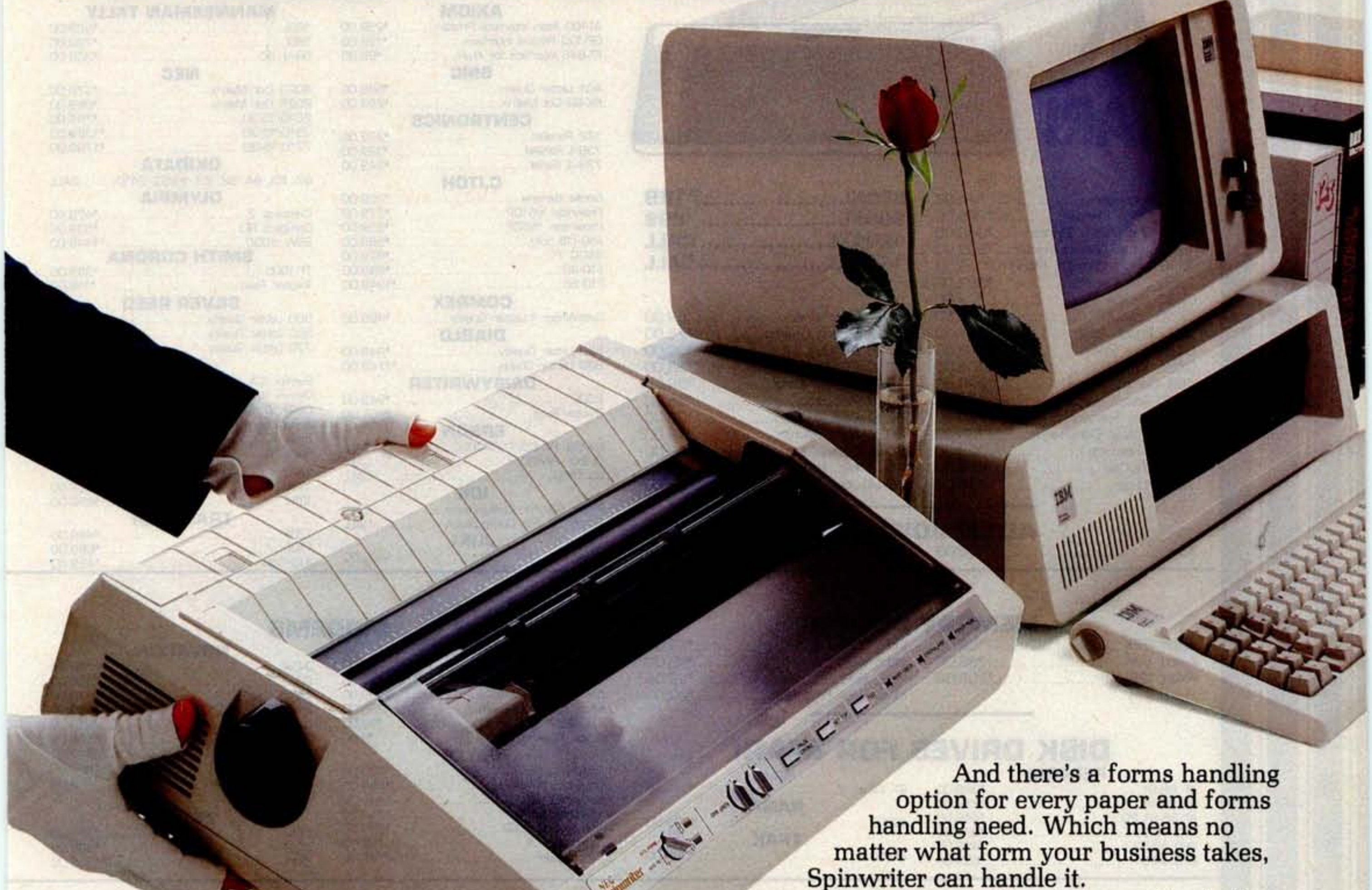

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(*text continued from page* 134)

```
   new_line;
 end hello;
```

This version of the **hello** program should display the same result as before: **Hello, world!**

VARIABLES, ASSIGNMENT, AND OUTPUT

Variables in Ada may have long names (as long as a line) but must fit on a single line. All variables must be declared explicitly in the declaration part of a program or in a package. Look at the following example.

```
-- var1.ada
-- Introduce variables
with text_io; use text_io;
procedure variable is
  -- for integer io
  package integer_io is
     new text_io.integer_io(integer);
  use integer_io;
  -- declaration for integer variable
  -- named age
  age : integer; -- declaration for integer variable named age
begin
  age := 40;
  put ("This year Sam is ");
  put (age,2);
  put(" years old. ");
  new_line;
end variable;
```

This program demonstrates several of Ada's features. First we tell the program we want to input and output integers. We do this by creating a new package, **integer_io**, based on the original **integer_io** package, a collection of subprograms in the package **text_io**. This original package can input and output data of all the integer data types—yes, there can be more than one integer data type. A statement that creates a package for a specific data type from a general package definition is called a *generic package instantiation*. The **use** statement **use integer_io** states that we want to use the new package.

The third statement in the declaration part of the program (before the **begin**) declares an integer variable named **age**. You must use the full name of the data type, not its abbreviation. The name of the variable comes first, then a colon (:), and then its data type. Integer is one of the predefined data types available in Ada as defined in the package **standard**. Other predefined data types are Boolean, float, character, and string. Package **standard** is always available to a user even though it is not called for in a **with** or **use** statement.

In the executable part of the program, the first statement assigns the integer value 40 to the variable named **age**. The assignment statement in Ada uses the combination of a : (colon) and an = (equal sign) to represent an assignment operator (e.g., **age := 40**).

Two forms of the **put** statement follow the assignment statement. The first form outputs a character string. The other

(*text continued on page* 430)

(text continued from page 428)

form, which has two parameters, outputs the value in **age** in two columns. The result of executing this program is:

```
This year Sam is 40 years old.
```

An Ada program rarely uses the plain integer data type for variables. In most cases, an integer **subtype** should be used instead to protect the program from erroneous data. When an integer data type is used, the variable can take on a wide range of values (e.g., −20,000,000 to +20,000,000). Such a large range is inappropriate for representing someone's age. A more typical range for this program might be 0 to 99. The following program shows how this is done.

```
-- var2.ada
-- Introduce variables and subtypes
with text_io; use text_io;
procedure variable is
   -- for integer_io
   package integer_io is
      new text_io.integer_io(integer);
   use integer_io;
   subtype age_type is integer range 0..99;
   -- declaration for age_type variable
   age : age_type;
begin
   age := 40;
   put ("This year Sam is ");
   put (age,2);
   put(" years old. ");
   new_line;
end variable;
```

The statement that begins with the declaration **subtype** defines an integer data type that has a restricted range (or *constraint*) between 0 and 99. The two periods in a row (..) are used to represent a range, as in Pascal. Because the basic data type is still integer, **integer_io** can still be used to display the value of **age**, which could not be assigned to a negative value or to a value beyond 99.

Looping with while and Incrementing

Here's a small looping program.

```
-- while1.ada
-- The while construct
with text_io; use text_io;
procedure while_loop is
   -- for integer io
   package integer_io is
      new text_io.integer_io(integer);
   use integer_io;
   subtype count_type is integer range 1..5;
   count : count_type;
begin
   count := 1;
   while count <= 4 loop          -- A
      put (count * 10, 2);        -- B
```

(text continued on page 432)

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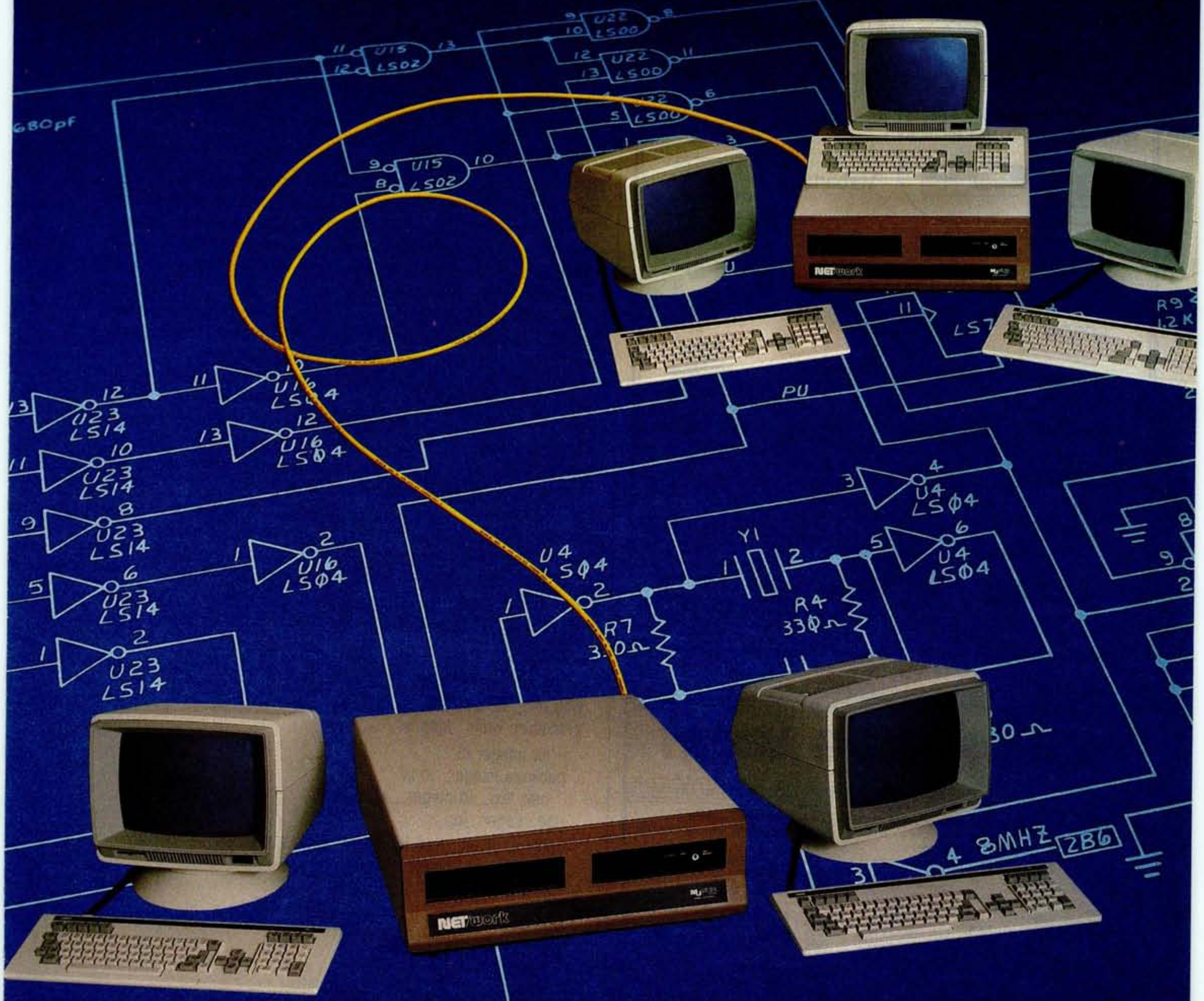

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(text continued from page 430)

```
      new_Line;
      count := count + 1;            -- C
    end loop;                        -- D
  end while_loop;
```

The loop consists of the statement between **loop** and **end loop** (beginning with the end of line A and ending with line D). Line A tests the expression **count<4**. The loop continues to execute as long as **count** is less than or equal to 4.

The three statements in the loop display a two-column number, move to the next line, and increment the variable count with an assignment statement. Note that the **put** subprogram can display an arithmetic expression, in this instance, **count * 10** . The asterisk signifies multiplication.

The alignment of **end loop** with **while** and indentation of the statements within the loop is a matter of style. For an experiment, remove the statement that sets **count** to 1 to see how Ada treats an undefined value. You should not end up with a runaway program because the subrange **count_type** limits **count** to values between 1 and 5.

The next version of the looping program **while2.ada** uses the **succ** operation in line C to increment **count**. The **succ** stands for the "successor operation," which takes the next available value for the type named before the prime '. Thus, **integer'succ(25)** has the value 26. This operation is particularly useful for enumerated types that are not integers.

```
-- while2.ada
-- The while construct
with text_io; use text_io;
procedure while_loop is
  -- for integer io
  package integer_io is
    new text_io.integer_io(integer);
  use integer_io;
  subtype count_type is integer range 1..5;
  count : count_type;
begin
  count := 1;
  while count <= 4 loop            -- A
    put (count * 10, 2);           -- B
    new_line;
    count :=
      count_type'succ(count);      -- C
  end loop;                        -- D
end while_loop;
```

LOOPING WITH for

Ada's **for** statement has two parts between the **for** and the **loop** keywords.

```
-- for1.ada
-- The for construct
with text_io; use text_io;
procedure for_loop is
  -- for integer io
  package integer_io is
    new text_io.integer_io(integer);
```

(text continued on page 434)

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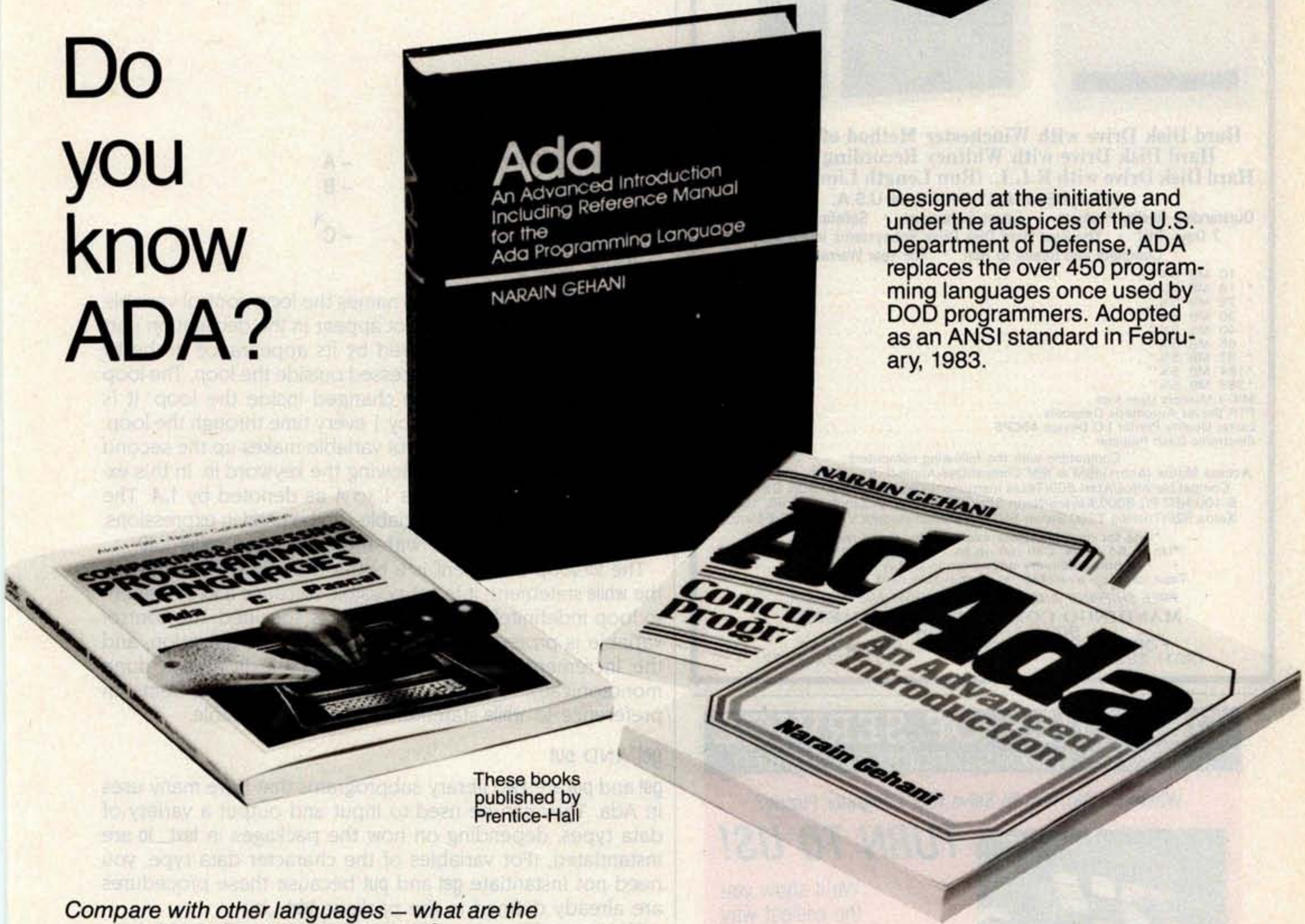

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(*text continued from page* 432)

```
    use integer_io;
 begin
     for count in 1..4 loop          -- A
       put (count * 10, 2);          -- B
       new_line;
     end loop;                       -- C
 end for_loop;
```

The first statement (line A) names the loop control variable **count**. Note that **count** does not appear in the declaration part of the program. It is declared by its appearance in the **for** statement and cannot be accessed outside the loop. The loop control variable cannot be changed inside the loop. It is automatically incremented by 1 every time through the loop. The range of the loop control variable makes up the second part of the **for** statement following the keyword **in**. In this example, the range of **count** is 1 to 4 as denoted by **1..4**. The value of the loop control variable can be used in expressions, as done in this example with the expression **count * 10**.

The **for** loop statement is a better looping statement than the **while** statement: it is not possible to cause a **for** statement to loop indefinitely since the range is specified, the control variable is protected against inadvertent modification, and the incrementing of the control variable is always done monotonically. You should try to use **for** statements in preference to **while** statements wherever possible.

get AND put

get and **put** are two library subprograms that have many uses in Ada. They can be used to input and output a variety of data types, depending on how the packages in **text_io** are instantiated. (For variables of the character data type, you need not instantiate **get** and **put** because these procedures are already defined in the package **text_io**.)

The procedure **get** receives a single item, which can be a character from standard input (usually a terminal keyboard); the procedure **put** sends a single item, which can be a character to standard output (usually a terminal's display).

The following program uses **get** and **put** to copy one character at a time from input to output until it finds an end-of-file indicator.

```
 -- copy1.ada
 -- Copy input to output
 with text_io; use text_io;
 procedure copy is
       c : character;               -- A
 begin
     loop                           -- B
       get(c);                      -- C
       put(c);
       if end_of_line then          -- D
         new_line;
       end if;
     end loop;
 exception                          -- E
    when end_error
```

(*text continued on page* 436)

(text continued from page 434)

```
    => null;
end copy;
```

The end-of-file indicator from a terminal under DEC's VMS operating system is a Control-Z. Thus, to get out of this program, you need only type a Control-Z.

Line A declares **c** as a character. In line B, a loop starts and will continue forever until an end-of-file marker causes an *exception*. An exception is something out of the ordinary. A predefined exception named **end_error** means an end-of-file has been reached. When this happens, the program transfers control to the statements following the exception, executes the statements in the **when** clause for the exception, and then exits the program. In the loop, line C reads a single character into variable **c**, and line D displays the value of variable **c**. Because Ada's **get** does not read the end-of-line character, there is a test for the end-of-line character that uses a built-in function. Also, because Ada does not read end-of-line or end-of-file characters but skips over them until the next character, we need to output the character that causes a new line to start with the built-in function **new_line**.

A number of useful Boolean functions such as **end_of_file** are already defined in **text_io**. Other useful functions are **end_of_line** and **end_of_page**. Such functions make a program more readable and have the advantage of being defined for every Ada compiler. Input and output have always made portability of programs difficult. Ada tries to improve this situation by specifying the same syntax for every computer.

It is quite likely that the same semantics will not occur, but at least we are getting one step closer to portability. One problem I have noticed with the NYU Ada/Ed compiler is the difficulty of keeping straight what it is trying to input and output.

In the example that follows, one Control-Z was not enough to cause the program to exit; it took two Control-Zs, and the order of input and output was confused. The program was an attempt to replace the exception with the use of the test for an end-of-file in a **while** loop. It still copied what was typed to the terminal. In part 2 of the Ada primer, I will discuss other ways to copy input to output to avoid this problem.

```
-- copy2.ada
-- Copy input to output
with text_io; use text_io;
procedure copy is
   c : character;
begin
   while not end_of_file loop
      if end_of_line then
         new_line;
      end if;
      get(c);
      put(c);
      if end_of_line then
         new_line;
      end if;
end loop;
```

(text continued on page 438)

(*text continued from page* 436)

```
end copy;
```

if AND else AND elsif

Ada's **if** statement looks much like *if* statements in other programming languages.

```
-- if1.ada
-- Illustrate the if
-- and else statements
with text_io; use text_io;
procedure if_statement is
   answer : character;
begin
   put (" Do you like Ada so far? ");          -- A
   new_line;
   put (" Type y for yes, or n for no: ");     -- B
   new_line;
   get (answer);
   if answer = 'y' or answer = 'Y' then
      put (" Glad to hear it!");
   else
      put (" Hope it changes.");
   end if;
end if_statement;
```

This example asks a leading question and prints a response depending upon the answer. Note the semicolon that's required after the **put** statement (just before the **else**) as a statement terminator. In this example, the equality test operator (=) and the logical operator **or** are used to check if the response is equal to **y** or **Y**.

It is possible in Ada to keep the logic of **if** statements quite clean by avoiding nesting. Although Ada allows nesting of **if** statements, most nesting constructs can be rewritten to use the **elsif** construct. The **elsif** keyword is used to perform an additional test if the test above it is false. An **if** statement can have several **elsif** tests, but only one **else**.

```
-- elsif1.ada                -- Illustrate use of if and elsif and else --
with text_io; use text_io;
package greeting is
   procedure greet;
end greeting;
package body greeting is
   procedure greet is
   begin
      put (" Do you like Ada so far?"); new_line;
      put (" Type y for yes, or n for no: "); new_line;
   end greet;
end greeting;
with text_io, greeting;
use text_io, greeting;
procedure elsif_statement is
   answer : character;
begin
   greet; -- greet the user
```

(*text continued on page* 440)

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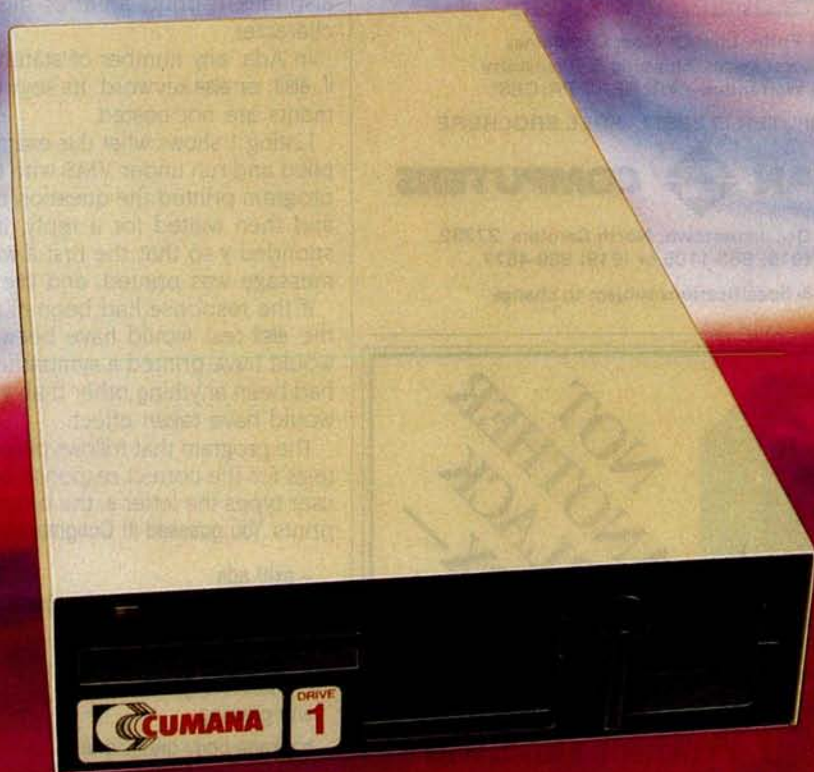

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(text continued from page 438)

```
   get (answer);
   if answer = 'y' or answer = 'Y' then
      put(" Glad to hear it! "); new_line;
   elsif answer = 'n' or answer = 'N' then        -- A
      put(" Sorry to hear that. Hope it changes. "); new_line;
   else
      put(" I don't understand "); put(answer); put(" . "); new_line;
   end if;
end elsif_statement;
```

Line A shows that if the reply character is not **y** or **Y**, the program should check whether the answer was **n** or **N**. If this test also fails, it prints an error message that echoes the input character.

In Ada, any number of statements can be placed after an **if**, **elsif**, or **else** keyword. Its keywords are lined up and **if** statements are not nested.

Listing 1 shows what this example looked like as it was compiled and run under VMS with the NYU Ada/Ed system. The program printed the question by calling the procedure **greet** and then waited for a reply. In this example, the user responded **y** so that the first **if** was satisfied, the appropriate message was printed, and the program ended.

If the response had been **n**, the first **if** would have failed, the **elsif** test would have been satisfied, and the program would have printed a sympathetic message. If the response had been anything other than **y**, **Y**, **n**, or **N**, the **else** statement would have taken effect.

The program that follows plays a simple guessing game that tests for the correct response by using an **if** statement. If the user types the letter **e**, the program "points" to the reply and prints **You guessed it! Congratulations!**

```
-- exit1.ada
-- Illustrate the if and exit statements
with text_io; use text_io;
package greeting is
   procedure greet;
end greeting;
package body greeting is
   procedure greet is
   begin
      put(" If you type a certain letter ");
      new_line;
      put(" I'll congratulate you for guessing it. ");
      new_line;
      put(" If you get bored, type control-z twice. ");
      new_line;
   end greet;
end greeting;
with greeting, text_io;
use greeting, text_io;
procedure exit_statement is
   c: character;
begin
   greet; -- display a greeting to the user
   while not end_of_file loop
      get(c);
```

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```
      if c = 'e' then                                  -- A
        put("^-- You guessed it! Congratulations! ");  -- B
        new_line;
        exit;                                          -- C
      end if;
    end loop;
  end exit_statement;
```

The statement on line A tests if the input character is an **e**. If the user has typed an **e**, the program executes the statements following the **then** keyword; line B prints the congratulatory message and points to the correct letter, **e**; and then line C causes an early **exit** from the loop. Some programmers do not think that the use of an **exit** statement is good programming practice; however, others believe that **exit** saves time in a loop and is a good statement to use. Ada provides both the **exit** statement and the **exit when** statement for loop exits and lets you make your own judgment.

Another version of the main part of this program that does not use the **exit** statement follows.

```
-- exit2.ada
-- Show how to eliminate an exit statement
with text_io; use text_io;
package greeting is
  procedure greet;
end greeting;
package body greeting is
  procedure greet is
  begin
    put(" If you type a certain letter ");
    new_line;
    put(" I'll congratulate you for guessing it. ");
    new_line;
    put(" If you get bored, type control-z twice. ");
    new_line;
  end greet;
end greeting;
with greeting, text_io;
use greeting, text_io;
procedure no_exit_statement is
  c: character := ' '; -- initialize to blank
begin
  greet; -- display a greeting to the user
  while c /= 'e' and not end_of_file loop
    get(c);
    if c = 'e' then                                  -- A
      put("^-- You guessed it! Congratulations! ");  -- B
      new_line;
    end if;
  end loop;
end no_exit_statement;
```

The argument in favor of this version is that the conditions for exiting the loop appear in one place: at the start of the loop in the **while** statement. A programmer testing or modifying this program does not have to search for **exit** statements. The major argument against this version is that there is an extra test on **c** every time the loop executes. This test occupies space and takes extra time. Another opposing argument is that the test in the **while** statement appears backward.

Listing 1: *An Ada program run under the* VMS *operating system with the* NYU *Ada/Ed compiler.*

```
    -- elsif1.ada Illustrate use of if and elsif and else
--

    with text_io; use text_io;
    package greeting is
      procedure greet;
    end greeting;

    package body greeting is
      procedure greet is
        begin
          put ("Do you like Ada so far?"); new_line;
          put ("Type y for yes, or n for no: "); new_line;
      end greet;
    end greeting;

    with text_io, greeting; use text_io, greeting;
    procedure elsif_statement is

      answer : character;

    begin

      greet; -- greet the user
      get (answer);

      if answer = 'y' or answer = 'Y' then
        put ("Glad to hear it!"); new_line;
      elsif answer = 'n' or answer = 'N' then
-- A
        put ("Sorry to hear that. Hope it changes.");
new_line;
      else
        put ("I don't understand"); put(answer);
put(" . "); new line;
      end if;

    end elsif_statement;

No translation errors detected
Translation time: 90 seconds

Binding time: 2.7 seconds

Begin Ada execution

Do you like Ada so far?
Type y for yes, or n for no:
>y

Glad to hear it!

Execution complete
Execution time: 6 seconds
I-code statements executed: 41
$
```

These Ada programs should give you a flavor of Ada program structure, Ada packages, basic input/output, variables and assignment, and control constructs such as **while**, **for**, **if**, **elsif**, and **else**. With a command of this much Ada, you can write small, useful programs.

Next month, in part 2 of this Ada primer, I will cover the more advanced topics of types, arrays, and communication between Ada programs, as well as show how a microcomputer subset of Ada performs.■

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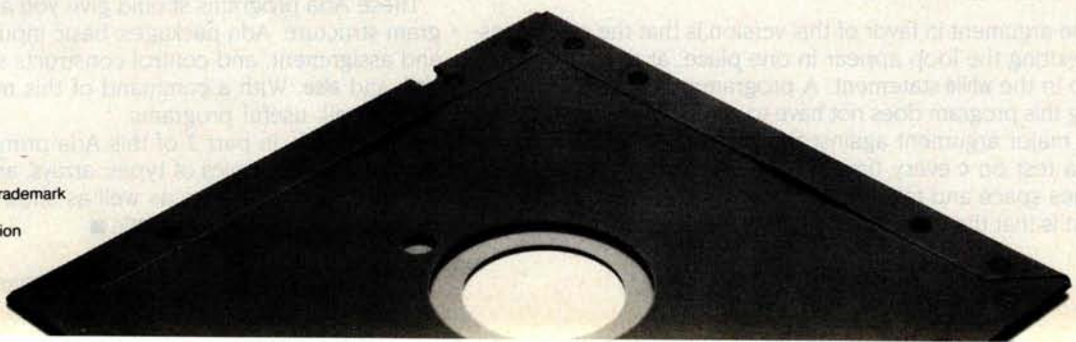

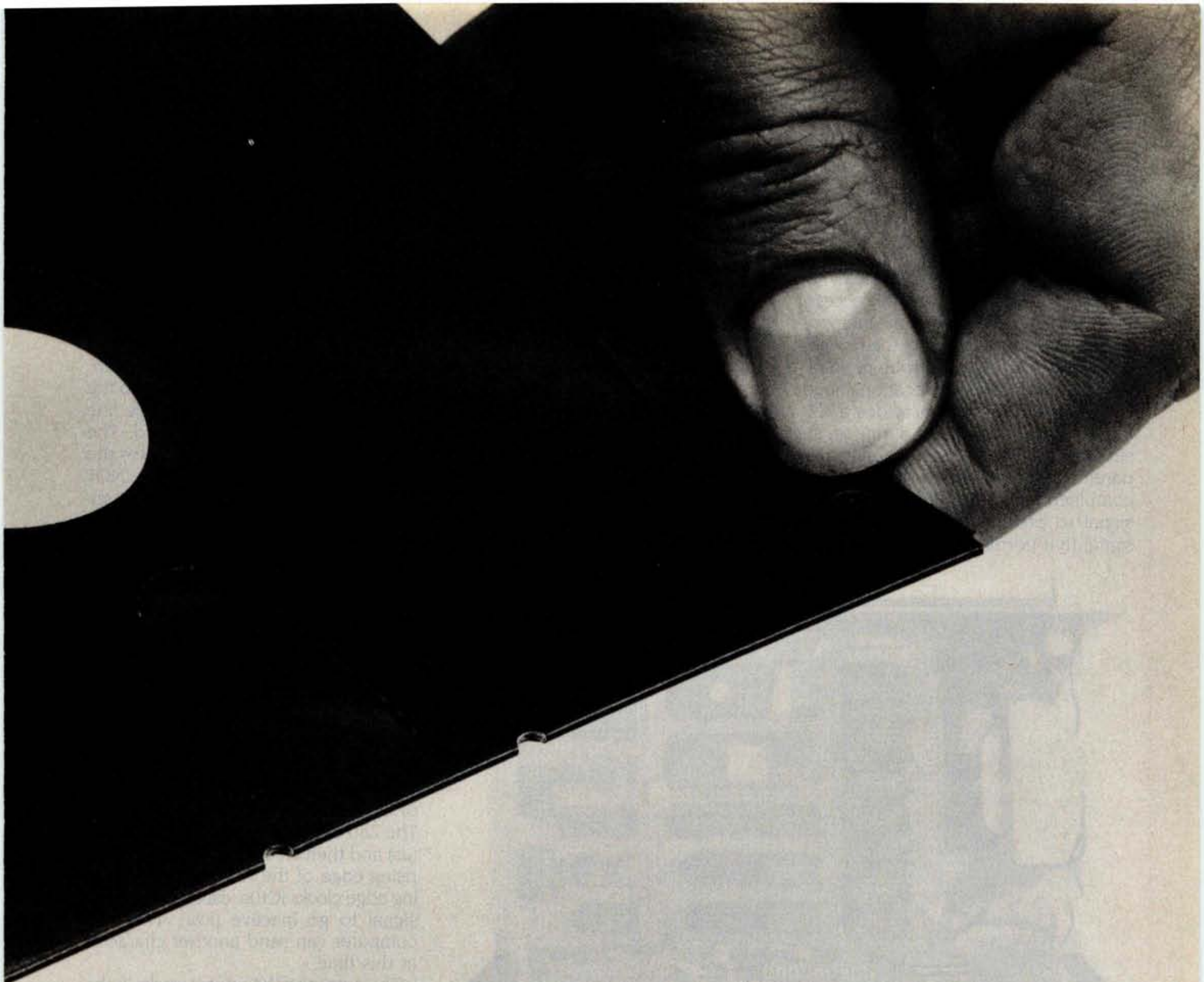

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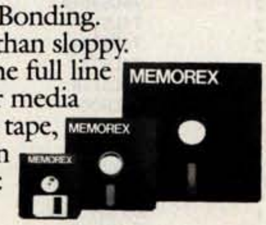

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(*text continued from page* 143)

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The interfaces to the host computer and printer are designed to be compatible with the Centronics protocol, which consists of the host computer sending the data byte and then the active low-data strobe. The printer sends back $\overline{ACK}$ (acknowledge) and BUSY signals.

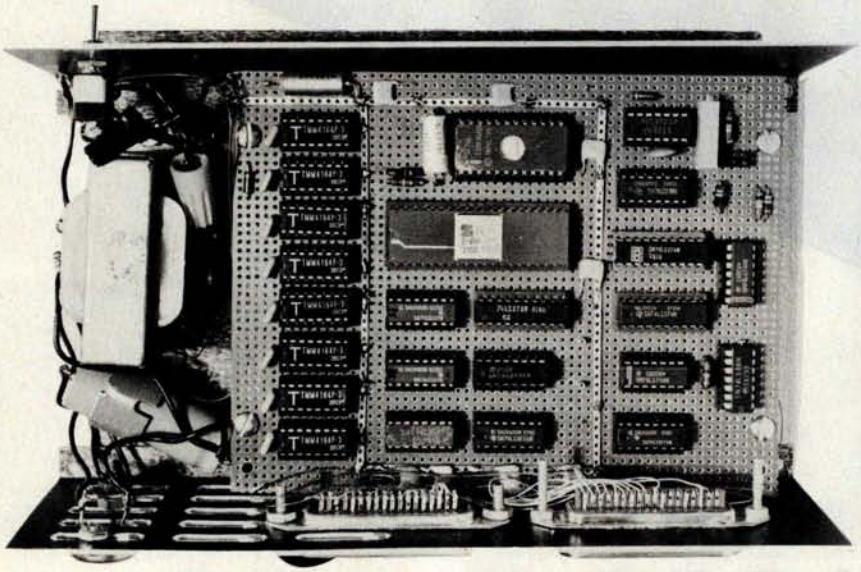

Photo 1: *The inside of the completed printer buffer.*

Quantity	Part Number	Description	Reference
1	MC4024	Clock Generator	IC1
1	Z80	Microprocessor	IC2
1	2716	EPROM	IC3
1	74LS151	Multiplexer	IC4
1	74LS373	Latch	IC5
2	74LS367a	3-State Buffer	IC6, IC14
2	74LS157	Multiplexer	IC7, IC8
2	74LS374	8-bit Flip-Flop	IC9, IC15
2	74LS74	Dual D Flip-Flop	IC10, IC24
2	74LS138	Decoder	IC11, IC13
1	74LS00	Quad NAND Gate	IC12
8	4164	64K-bit RAM	IC16–IC23
1	10,000 Ω	Potentiometer	
2	10,000 Ω, ⅛ W	Resistor	
1	10 µF, 15 V	Capacitor	
1	68 µF, 15 V	Capacitor	
1	0.001 µF	Capacitor	
18	0.1 µF	Bypass Capacitor	
1	57-20360	Connector	
1	57-10360	Connector	
1	JE200 (Jameco)	+5-V, 1-amp Power Supply	

Table 1: *This table contains the components for this printer buffer.*

IC13 is the decoder that provides the chip selects for the I/O (input/output) circuits. It is enabled whenever the Z80 does an I/O cycle. READ and WRITE signals are not used because separate addresses are used for the different I/O ports. IC9 is the 8-bit input-data latch. The host computer delivers data to the IC9 and then activates the strobe line causing the data to be latched. The strobe input going low also causes the 74LS74 flip-flop to be reset. The NOT $\overline{Q}$ signal goes back to the host computer as a BUSY signal from the printer buffer. The host computer then knows not to send another character. The BUSY signal can be read by the Z80 through three-state buffer IC14 to determine if a character has been received. When the BUSY signal is high, the Z80 knows that a character has been sent. The Z80 then reads the character by enabling IC9 to output data onto the data bus. When the character has been read, the IC10b flip-flop is reset. This produces the beginning, or falling, edge of the $\overline{ACK}$ signal to the host computer. The Z80 delays about 10 microseconds (µs) and then clocks IC10b, causing the rising edge of the $\overline{ACK}$ signal. The rising edge clocks IC10a, causing the BUSY signal to go inactive (low). The host computer can send another character at this time.

The output to the printer works in the same manner except that the printer buffer acts as the host instead of the printer. Data is clocked into IC15, which feeds it out to the printer. The Z80 then activates the decoder IC13 to output a data strobe to the printer through its G4 output. The printer's $\overline{ACK}$ signal clocks the IC24 flip-flop and can be read by the Z80 through the three-state buffer IC14.

SOFTWARE CONTROL

The printer buffer, like any microprocessor-based system, could not do anything without a control program. The control software stored in the 2716 EPROM is quite simple. All it has to do is load characters to RAM and send characters to the printer. Pointers to RAM determine where the next character will be stored and from where the next character will be fetched. Three conditions must be accounted for: an empty buffer, a full buffer, and reaching the top of RAM. For the last condition, the software must check to see if the

(*text continued on page* 448)

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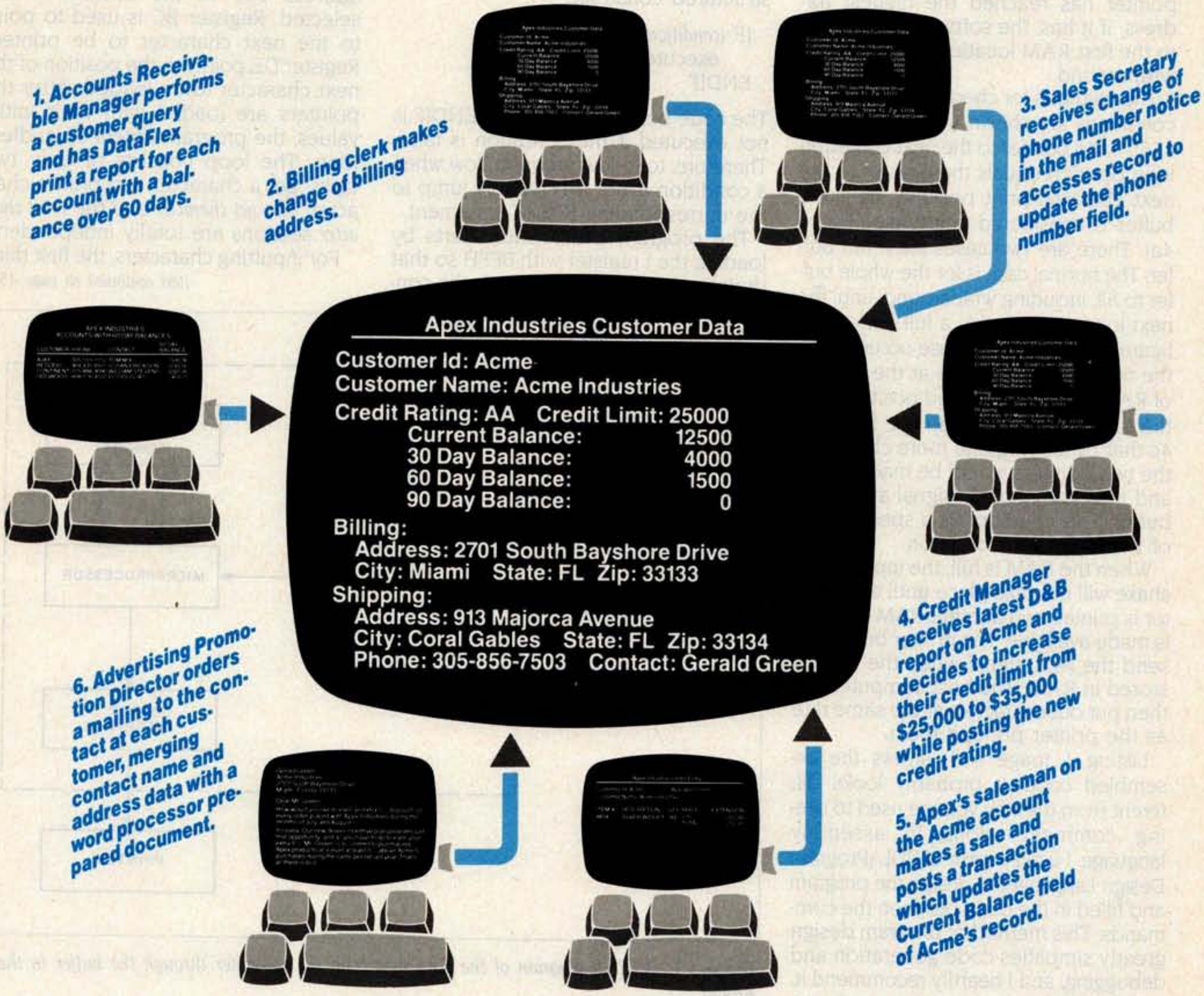

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(text continued from page 446)

pointer has reached the highest address; if it has, the software must set it to the first RAM location. This is called wraparound.

The methods for checking the first two conditions are shown in figure 4 (page 455). If the pointer to the next character-load position equals the pointer to the next character-print position, then the buffer is considered empty (see figure 4a). There are two cases for a full buffer. The normal case is for the whole buffer to fill, including wraparound, until the next load position (i.e., a full buffer, see figure 4b). The second case occurs when the next print location is at the bottom of RAM and the next load position is at the top of RAM. You can see in figure 4c that by loading one more character, the two pointers would be made equal and thus erroneously signal an empty buffer. This condition is a special case of the buffer-full condition.

When the RAM is full, the input handshake will not take place until a character is printed and another RAM location is made available. The printer buffer will send the $\overline{ACK}$ signal when the byte is stored in RAM. The host computer will then put out characters at the same rate as the printer printing them.

Listing 1 (page 453) shows the assembled code. It probably looks different from the way you are used to seeing comments done in assembly language. I used a form of PDL (Program Design Language) to design the program and filled in the code between the commands. This method of program design greatly simplifies code generation and debugging, and I heartily recommend it.

The comments give a sense of program flow because of the use of the structured construct:

```
IF (condition is true)
   execute this code
ENDIF
```

The code between the IF and ENDIF is not executed if the condition is false. Therefore, to follow program flow when a condition is not met, simply jump to the corresponding ENDIF statement.

The program initialization starts by loading the I register with 0FFH so that during refresh the Z80 outputs the contents of the I register on the high-address bus so the EPROM is not selected. Register BC is used to point to the next character to be printed. Register DE points to the position of the next character to be loaded. After the pointers are loaded with their initial values, the program enters an endless loop. The loop consists of only two tasks: get a character and print a character. The *get character* and the *print character* sections are totally independent.

For inputting characters, the first thing

(text continued on page 456)

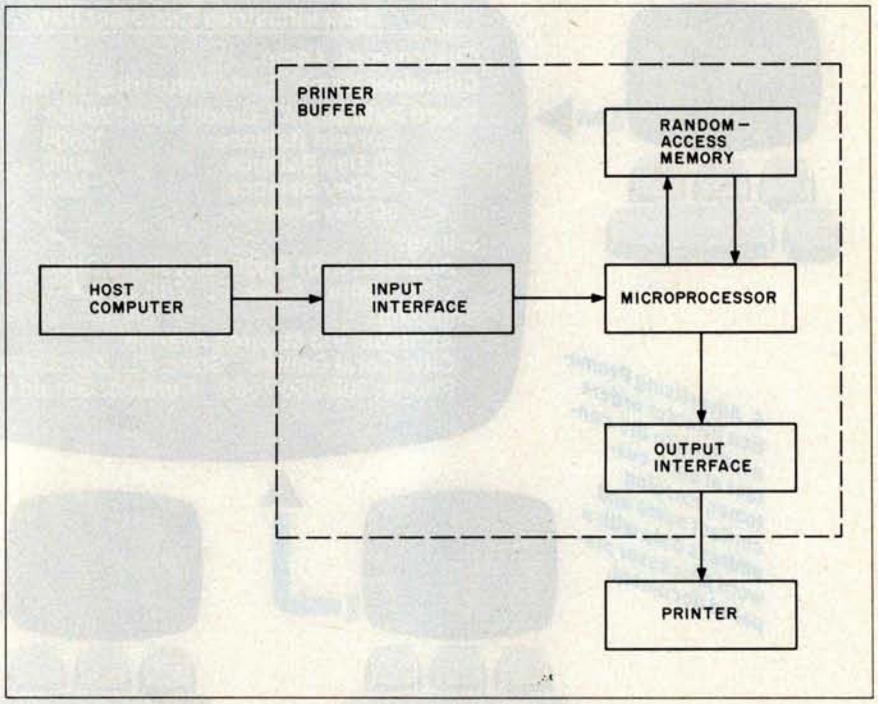

Figure 1: A *block diagram of the data flow from the computer through the buffer to the printer.*

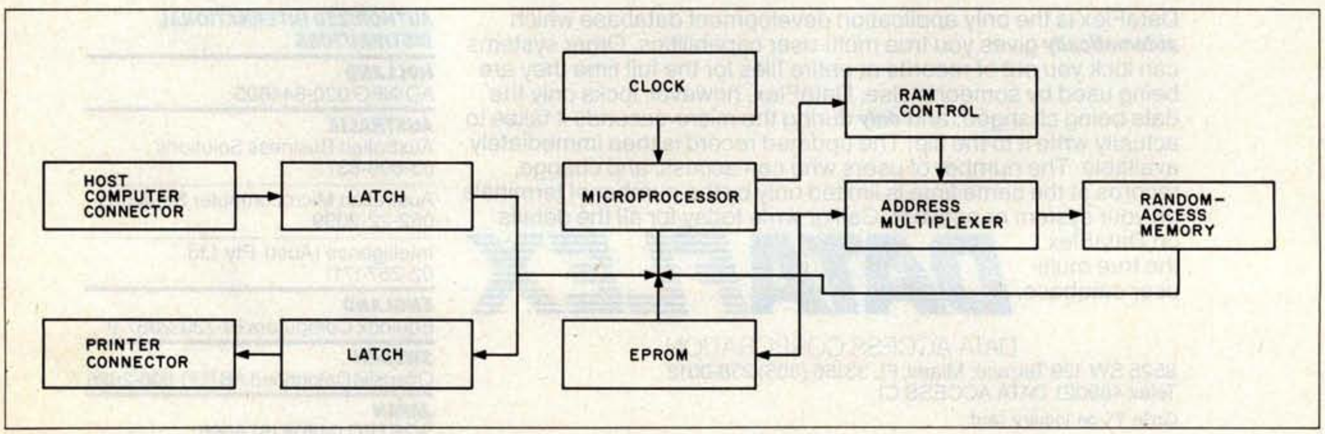

Figure 2: *This is a block diagram of the printer buffer itself. The microprocessor is a Zilog Z80.*

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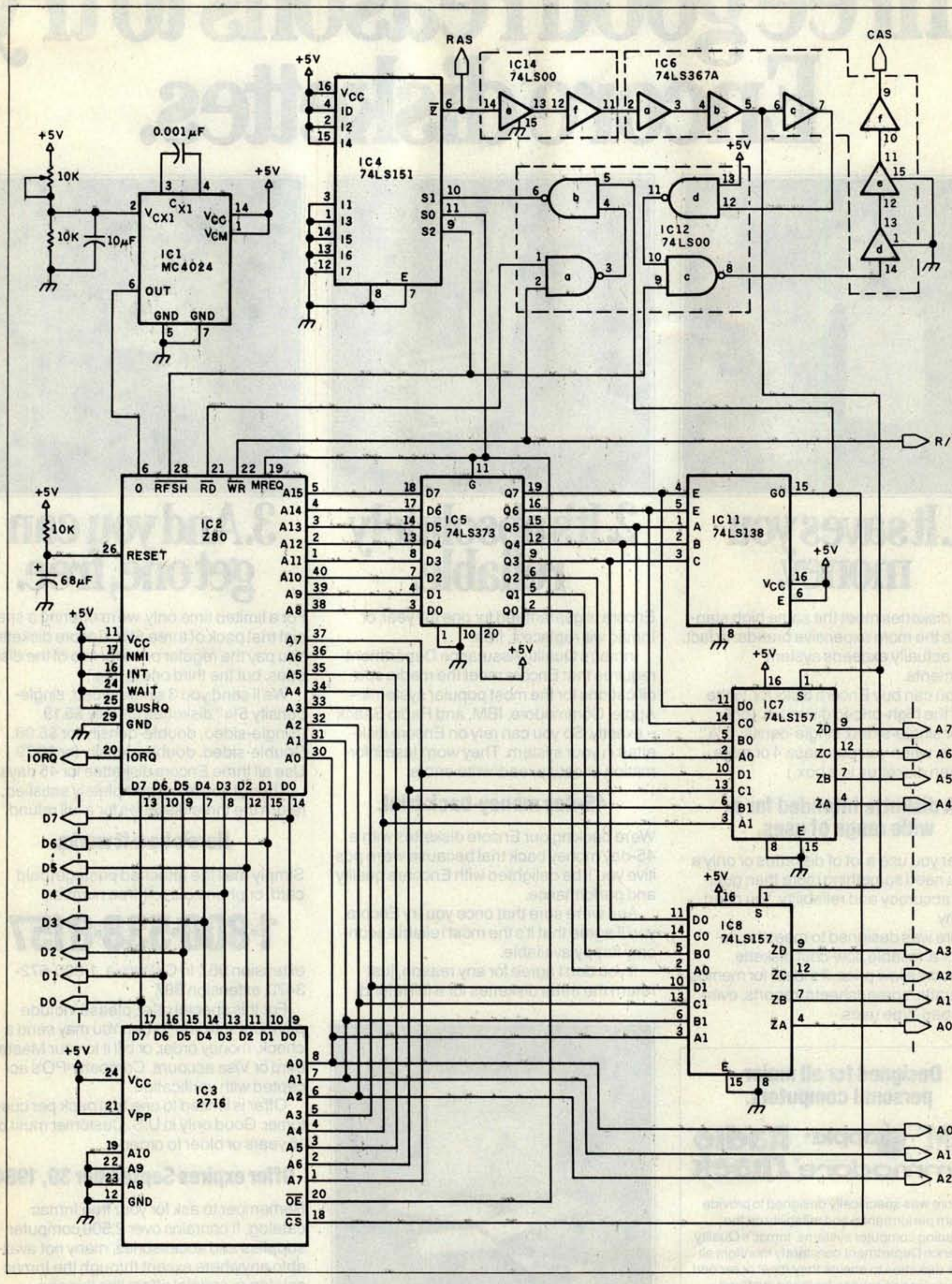

Figure 3a: *This section of the printer buffer schematic shows these components of the printer buffer: the clock, the central processing unit, the EPROM, and the multiplexers. This is the control circuitry for the buffer.*

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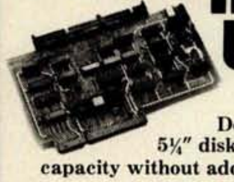

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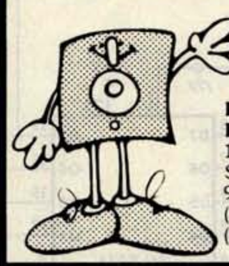

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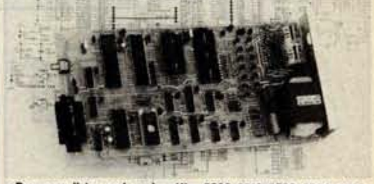

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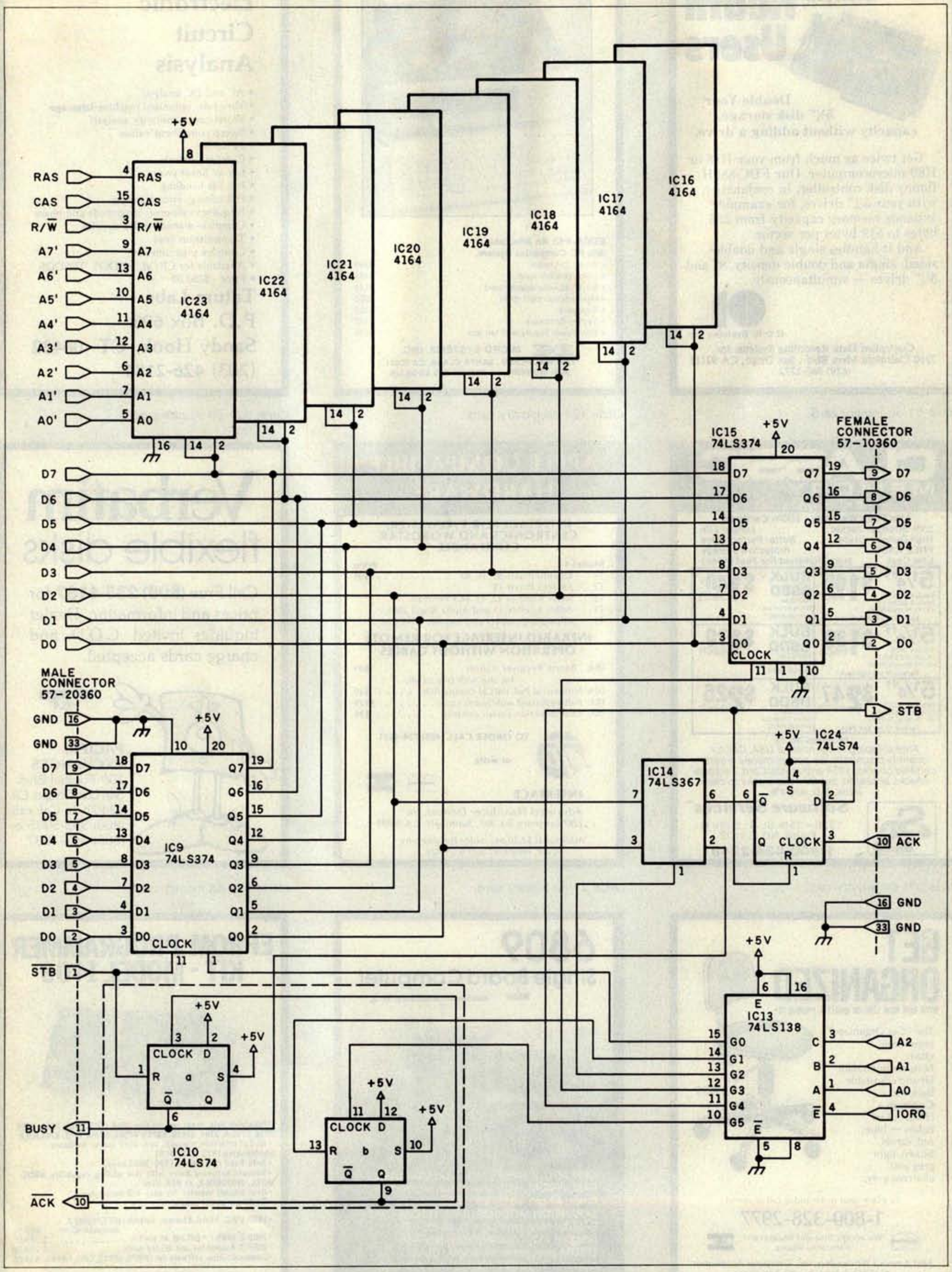

Figure 3b: *This section details: the decoder, the RAM, the data latches, and the connectors for the buffer's I/O.*

Listing 1: *This source-code listing in Z80 assembly language is the control software for the printer buffer. You will need to store the object code in a 2716 EPROM. (For more information on programming EPROMs, see "Build an Intelligent EPROM Programmer," by Steve Ciarcia, October 1981 BYTE, page 36.)*

```
ADDR B1 B2 B3 B4

                   ; FIFO.SRC
                   ;
                   ; LAST REVISED: 6/23/83
                   ;
0000               BYTEIN  EQU 0        ;INPUT PORT LOCATION
0001               ACKLO   EQU 1        ;BUSY FLIP-FLOP CLEAR
0002               STATUS  EQU 2        ;EXTERNAL STATUS SIGNALS
0003               BYTOUT  EQU 3        ;OUTPUT PORT LOCATION
0004               STB     EQU 4        ;OUTPUT PORT STROBE
0005               ACKHI   EQU 5        ;ACKNOWLEDGE F/F CLOCK
0006               PRACK   EQU 6        ;PRINTER'S ACKNOWLEDGE
                                         F/F
0800               MINRAM  EQU 800H     ;FIRST RAM LOCATION
FFFF               MAXRAM  EQU OFFFFH   ;LAST RAM LOCATION
0000
0000
0000
0000 3E FF                 LD   A,OFFH  ;I REG IS ON A8 -A15 DURING
0002 ED 47                 LD   I,A     ;REFRESH,SO AVOID CHIP
                                         SELECT
0004
0004
                   ;CLEAR BUSY FLIP-FLOP
0004 03 01                 OUT  (ACKLO),A
0006 D3 05                 OUT  (ACKHI),A
0008
                   ;RESET PRINTER'S ACKNOWLEDGE FLIP-FLOP
0008 D3 06                 OUT  (PRACK),A
000A
                   ;INITIALIZE POINTERS
000A 01 00 08              LD   BC,MINRAM   ;BC HOLDS NEXT PR
                                            ;NEXT CHAR TO BE
                                             PRINTED POS
000D 11 00 08              LD   DE,MINRAM   DE HOLDS NEXT LD
                                            ;NEXT CHAR TO BE
                                             LOADED POS
0010
0010
                   ;DO
                   LOOP
0010
                   ; IF NEXTLD+1 <> NEXTPR      (IF BUFFER NOT FULL)
0010 62                    LD   H,D
0011 6B                    LD   L,E
0012 23                    INC  HL
0013 37                    SCF
0014 3F                    CCF
0015 ED 42                 SBC  HL,BC
0017 CA 47 00              JP   Z,FULL
001A
                   ; IF (NEXTLD <> MAXRAM) or NEXTPR <> MINRAM)
001A 37                    SCF
001B 3F                    CCF
001C 21 FF FF              LD   HL,MAXRAM
001F ED 52                 SBC  HL,DE
0021 C2 2E 00              JP   NZ,OKAY
0024 37                    SCF
0025 3F                    CCF
006  21 00 08              LD   HL,MINRAM
0029 ED 42                 SBC  HL,BC
002B CA 47 00              JP   Z,FULL
002E
```

(listing continued on page 454)

(listing continued from page 453)

```
                         ;    IF CHARACTER RECEIVED
002E  DB 02        OKAY       IN    A,(STATUS)
0030  E6 01                   AND   01H
0032  CA 47 00                JP    Z,NOCHAR
0035
                         ;    GET CHARACTER
0035  DB 00                   IN    A,(BYTEIN)
0037
                         ;  SEND ACKNOWLEDGE
0037  D3 01                 OUT (ACKLO),A
0039  00                    NOP                    ;TIMING OF ABOUT 10 µS
003A  00                    NOP
003B  D3 05                 OUT (ACKHI),A
003D
                         ;  SAVE CHARACTER IN RAM
003D  12                    LD (DE),A
003E
                         ;  INCREMENT NEXTLD POINTER
003E  13                    INC DE
003F
                         ;  IF NEXTLD POINTER OVERFLOWED
003F  7A                    LD A,D
0040  63                    OR E
0041  02 47 00              JP NZ,ENDIF1
0044
                         ;   NEXTLD = MINRAM
0044  11 00 08               LD DE,MINRAM
0047
                         ;   ENDIF
0047               ENDIF1
0047
                         ;  ENDIF
                         ;  ENDIF
                         ; ENDIF
0047               FULL
0047               NOCHAR
0047
                   ; IF BUFFER NOT EMPTY (NEXTLD < > NEXTPR)
0047  62                    LD H,D
0048  6B                    LD L,E
0049  37                    SCF
004A  3F                    COF
004B  ED 42                 SBC HL,BC
004D  CA 65 00              JP Z,EMPTY
0050
                           IF PRINTER READY
0050  DB 02                 IN A,(STATUS)
0052  E6 04                 AND 04H
0054  C2 65 00              JP NZ,BUSY
0057
                         ;  SEND CHARACTER
0057  0A                    LD A,(BC)
0058  D3 03                 OUT (BYTOUT),A
005A
                         ;  SEND STROBE
005A  D3 04                 OUT (STB),A
005C
                         ;  INCREMENT NEXTPR POINTER
005C  03                    INC BC
005D
                         ;   IF NEXTPR POINTER OVERFLOWED
005D  78                     LD A,B
005E  B1                     OR C
005F  C2 65 00               JP NZ, ENDIF2
0062
                         ;   NEXTPR = MINRAM
0062  01 00 08               LD BC,MINRAM
0065
                         ;   ENDIF
```

(listing continued on page 455)

(listing continued from page 454)

```
0065            ENDIF2
0065
                : ENDIF
0065            BUSY
0065
                : ENDIF
0065            EMPTY
0065
                : ENDDO
0065  03 10 00      JP LOOP
0068            END
```

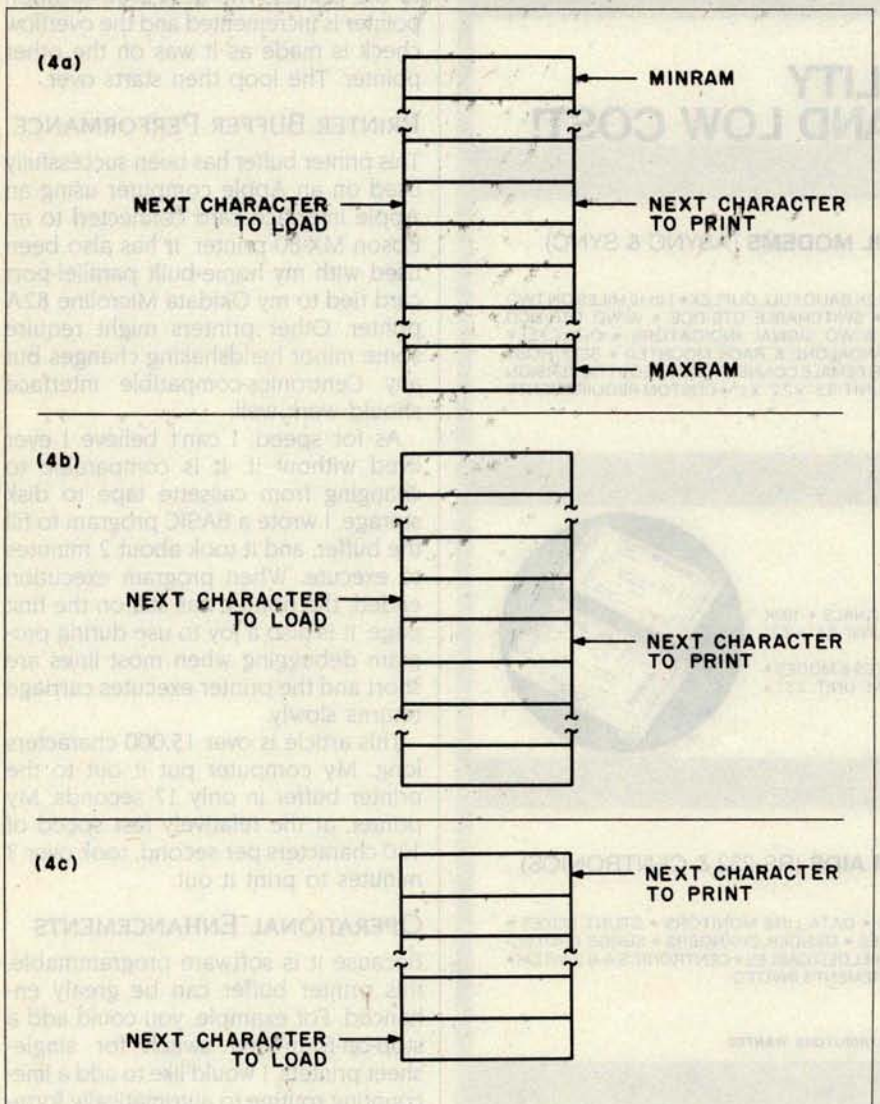

Figure 4: *These diagrams show how the control software determines where to load the next character into RAM. In 4a, both pointers are equal, which indicates that the buffer is empty. In 4b, the next load position is one address less than the next print position, which means that the buffer is full. Figure 4c is a special case of the buffer-full condition in which one must compensate for the "wraparound" effect (see text).*

(text continued from page 448)
to check is to see if there is room in RAM to store the character. If the buffer is full, then this section of code is skipped. The section will eventually be executed and, from the host computer's point of view, it will look like the buffer is taking a lot of time to respond (the way a printer handshakes). Assuming the buffer is not full, a check is made to see if a character has been sent. If no character has been loaded, then there is nothing to do but jump to the output section. When a character is in the input latch, it is input, the $\overline{ACK}$ signal is sent to the host computer, the character is stored in RAM, and the load-position pointer is incremented. The pointer is checked for overflow. Upon overflow the load position is set to the start of RAM at location MINRAM.

When the input section is complete, the output section begins. The output portion only cares about the buffer-empty condition. Checks are made for buffer-empty and printer-not-ready conditions. If either condition exists, execution returns to the input routine. If the printer is ready, a character is sent to the output latch. The data strobe is sent to the printer. The next print location pointer is incremented and the overflow check is made as it was on the other pointer. The loop then starts over.

Printer Buffer Performance

This printer buffer has been successfully used on an Apple computer using an Apple interface card connected to an Epson MX-80 printer. It has also been used with my home-built parallel-port card tied to my Okidata Microline 82A printer. Other printers might require some minor handshaking changes but any Centronics-compatible interface should work well.

As for speed, I can't believe I ever lived without it. It is comparable to changing from cassette tape to disk storage. I wrote a BASIC program to fill the buffer, and it took about 2 minutes to execute. When program execution ended, the printer was still on the first page. It is also a joy to use during program debugging when most lines are short and the printer executes carriage returns slowly.

This article is over 15,000 characters long. My computer put it out to the printer buffer in only 17 seconds. My printer, at the relatively fast speed of 120 characters per second, took over 3 minutes to print it out.

Operational Enhancements

Because it is software programmable, this printer buffer can be grealy enhanced. For example, you could add a stop-on-form-feed switch for single-sheet printers. I would like to add a line-counting routine to automatically form-feed the paper so program listings don't come out on page edges. Another option would be to change the interface from parallel to serial for printers requiring that format. This would be fairly easy if the rest of the system remained the same. ■

(listing continued from page 156)

```
1850 PRINT FNC$(HP%,VP%)W$(2)">"FNC$(HP%+L%(HZ%)+1,VP%)"<"W$(3):RETURN
1851 '
1852 ' delete left bracket
1860 PRINT FNC$(HP%,VP%)" ";:RETURN
1861 '
1862 ' delete right bracket
1870 PRINT FNC$(HP%+L%(HZ%)+1,VP%)" ";:RETURN
1894 '                    ##########
1895 '                    print values in bottom lines
1896 '                    ##########
1897 ' HZ%=horizontal field number, i.e. # of field where the brackets are positioned (1 to 7)
1898 ' VP%=vertical position of brackets on CRT screen (2 to 16)
1899 '
1900 IF TP%(HZ%)=0 THEN PRINT FNC$(22,20)"text   " ELSE PRINT FNC$(22,20)"numeric"
1920 GOSUB 300:PRINT FNC$(22,21)W$(1)FNC$(22,21)ARR$(P%,HZ%)
1950 PRINT FNC$(57,20)HZ% FNC$(71,20)VP%-(OFS%-1):RETURN
1995 '
1996 '                    ##########
1997 '                    Calculate percentage
1998 '                    ##########
1999 '
2000 IF TOT#=0 THEN GOSUB 950:PRINT"Operation not allowed "W$(3);:GOSUB 57000:
     RETURN
2020 GOSUB 750:GOSUB 2500:FOR I%=1 TO MAX%:IF ARR$(I%,2)=" " THEN I%=MAX%
     ELSE PERC(I%)=VAL(ARR$(I%,NN%))*100/TOT#
2040 NEXT I%:GOSUB 900:RETURN
2095 '
2096 '                    ##########
2097 '                    Display percentage values
2098 '                    ##########
2100 GOSUB 350:FOR P%=VMIN% TO VMAX%:IF ARR$(P%,2)=" " THEN P%=VMAX%
     ELSE GOSUB 320:PRINT FNC$(PO%(NN%)+15,PS%)USING"##.#";PERC(P%)
2120 NEXT P%:RETURN
2495 '
2496 '                    ##########
2497 '                    Calculate total
2498 '                    ##########
2499 '
2500 TOT#=0:FOR I%=1 TO MAX%:IF ARR$(I%,2)=" " THEN I%=MAX%
     ELSE TOT#=TOT#+VAL(ARR$(I%,NN%))
2520 NEXT I%:RETURN
4995 '
4996 '                    ##########
4997 '                    Zero array & fill 1st column
4998 '                    ##########
4999 '
5000 GOSUB 750:FOR I%=1 TO MAX%:ARR$(I%,1)=RIGHT$(STR$(I%),LEN(STR$(I%))-1)
5020 IF ARR$(I%,J%)<>" " THEN FOR J%=2 TO NN%:ARR$(I%,J%)=" ":NEXT J%
5040 NEXT I%:GOSUB 900:RETURN
5095 '
5096 '                    ##########
5097 '                    build/edit estimate
5098 '                    ##########
5099 '
6000 PRINT W$(0):GOSUB 5000: ' <— zero array
6015 '
6016 ' Initialize screen variables :SCR%=screen number  D$=scratch string
6017 ' VMIN%=# of first array line to be printed
6018 ' HP%=abscissa, i.e. distance from leftmost CRT column
6019 ' HZ%=field # VP%=current vertical position of secondary cursor
6020 VMIN%=1:HP%=0:HZ%=1:VP%=OFS%:D$="":SCR%=0
6040 GOSUB 1400:GOSUB 1800:'      <— display top & bottom titles
6060 GOSUB 1000:GOSUB 1500:'      <— display array, if existing
6080 GOSUB 1850:GOSUB 1900:'      <— print secondary cursor information
6100 PRINT FNC$(22,22)W$(2)STRING$(L%(HZ%),95)W$(3)W$(1)FNC$(22,22)"";:'
                                  <— print dashes for input
6200 GOSUB 730:'                  <— Wait for cursor control code or command
6218 '
```

(listing continued on page 458)

(listing continued from page 457)

```
6219 ' a new value has been entered -- display it and recalculate if necessary
6220 IF (T%=13 AND LEN(D$)>0) THEN GOSUB 1300:D$="":GOTO 6080
6233 '
6234 '                  ##########
6235 '                  2nd cursor routines
6236 '                  ##########
6237 '
6238 ' a single carriage return has been entered
6239 ' move brackets right or down depending on status of variable RD%
6240 IF (T%=13 AND D$="") THEN IF RD% THEN 7000 ELSE 6900
6258 '
6259 ' move brackets down (^X) or left (^S) or up (^E)
6260 IF T%=24 THEN 7000 ELSE IF T%=19 THEN 7100 ELSE IF T%=5 THEN 7200
6278 '
6279 ' wait for next command after entering a semicolon or go down to next row (^Z)
6280 IF T%=59 THEN 7400 ELSE IF T%=4 THEN 6900 ELSE IF T%=26 THEN 7250
6297 '
6298 ' backspace one character if rubout or left arrow has been hit or
6299 ' interpret character as new value and print it
6300 IF T%=127 OR T%=8 THEN GOSUB 400:GOTO 6200 ELSE IF T%>31 THEN 7300
6318 '
6319 ' wrong key
6320 PRINT BL$;:GOTO 6200
6898 '
6899 ' move brackets right
6900 IF HZ%=NN% THEN 7250 ELSE GOSUB 1860:HZ%=HZ%+1:HP%=HP%+L%(HZ%-1)
     +1:GOTO 6080
6991 '
6992 ' move brackets down, displaying next screen if necessary
7000 GOSUB 300:IF P%=MAX% THEN 7990 ELSE IF P%=VMAX% AND P%<MAX% THEN
     VP%=OFS%:GOTO 7500
7040 GOSUB 1860:GOSUB 1870:VP%=VP%+1:GOTO 6080
7091 '
7092 ' move brackets left
7100 IF HZ%=1 THEN 7990 ELSE GOSUB 1870:HZ%=HZ%-1:HP%=HP%-(L%(HZ%)+1):
     GOTO 6080
7191 '
7192 ' move brackets up, displaying previous screen if necessary
7200 GOSUB 300:IF VP%=OFS% and VMIN%=1 THEN 7990 ELSE IF VP%=OFS% AND
     SCR%>0 THEN VP%=GAP%+OFS%-1:GOTO 7600
7241 '
7242 ' move brackets to next row, displaying next screen if already at bottom
7250 GOSUB 300:IF P%=MAX% THEN 7990 ELSE GOSUB 1860:GOSUB 1870:HZ%=1:
     HP%=0
7260 IF P%=VMAX% AND P%<MAX% THEN VP%=OFS%:GOTO 7500 ELSE VP%=VP%+1:
     GOTO 6080
7291 '
7292 '                  ##########
7293 '                  Build up new value for single cell of array
7294 '                  ##########
7295 '
7300 IF TP%(HZ%)AND(C$<"-"OR C$>"9"OR C$="/")THEN 7990
7320 D$=D$+C$:PRINT C$;:IF LEN(D$)>L%(HZ%) THEN GOSUB 400:GOTO 7990 ELSE
     6200
7391 '
7392 '                  ##########
7393 '                  process command
7394 '                  ##########
7395 '
7400 GOSUB 950:PRINT V0$;:GOSUB 730:GOSUB 900:IF C$=" " THEN 6100
7420 T%=INSTR("HNP%YOIDMQ",C$):IF T%=0 THEN 7490 ELSE IF T%=10 THEN RETURN
7440 ON T% GOTO 7900,7500,7600,9000,8200,8400,9300,9400,9500
7481 '
7482 ' wrong command
7490 PRINT BL$;:GOTO 6100
7491 '
7492 ' N=display next page
7500 IF VMAX%>=MAX% THEN 7490 ELSE GOSUB 250:VMIN%=VMIN%+GAP%:SCR%=
     SCR%+1:GOSUB 1000:GOSUB 300:GOTO 6080
```

```
7591 '
7592 ' P=display previous page
7600 IF VMIN%=1 THEN 7490 ELSE GOSUB 250:VMIN%=VMIN%-GAP%:SCR%=SCR%-1:
     GOSUB 1000:GOTO 6080
7891 '
7892 ' H=display command menu
7900 PRINT FNC$(0,18)"——cursor movements——|——commands (: followed by)——"W$(1)
7920 PRINT FNC$(0,19)W$(2)"      ^E=up          | N=next page  P=previous page "W$(1)
7930 PRINT FNC$(0,20)" ^S=left   ^D=right       | %=calc. percent Y=print"W$(1)
7940 PRINT FNC$(0,21)"            ^X=down       | O=order      Q=quit"W$(1)
7950 PRINT FNC$(0,22)" ^Z=next row    CR=right/down
                                                | D=delete row I=insert row"W$(1)
7960 PRINT FNC$(0,23)"                          | M=modify paging parameters"W$(3);
7970 GOSUB 59000:PRINT FNC$(0,23)W$(1)::GOSUB 1800:GOSUB 1500:GOSUB 1600:
     GOSUB 1900:GOTO 6100
7981 '
7982 ' the screen limits have been reached
7990 PRINT BL$::GOTO 6200
8195 '
8196 ' Y=print estimate on hardcopy device
8200 GOSUB 2000:NOL%=0:PG%=1:GOSUB 8750:GOSUB 8850
8220 FOR I%=1 TO MAX%:IF ARR$(I%,2)=" "THEN I%=MAX%:GOTO 8300 ELSE T%=0
8240 FOR J%=1 TO NN%:T%=T%+L%(J%-1)+1:IF TP%(J%)THEN LPRINT TAB(T%+1)USING
     MSK$(J%);VAL(ARR$(I%,J%)); ELSE LPRINT TAB(T%+1)USING MSK$(J%);ARR$(I%,J%);
8260 NEXT J%:LPRINT TAB(PO%(7)+15)USING"##.#";PERC(I%)
8280 GOSUB 9200:IF QT% THEN I%=MAX%
8300 NEXT I%:IF QT%=0 THEN GOSUB 8900:GOSUB 9240
8320 GOTO 6080
8397 '
8399 ' O=toggle order (left/right or top/bottom)
8400 RD%=NOT RD%:GOSUB 1820:GOTO 6080
8747 '
8748 ' check if printer is turned on
8750 GOSUB 950:PRINT"Turn printer on & hit <space> to continue"::GOSUB 710:IF
     T%<>32 THEN 8750
8798 '
8799 ' & print centered title(s)
8800 GOSUB 950:PRINT"Title > "::GOSUB 700:IF C$=" " THEN RETURN ELSE LPRINT
     TAB((80-LEN(C$))/2)C$:NOL%=NOL%+1:GOTO 8800
8847 '
8848 ' Print top title
8850 LPRINT T1$:LPRINT T2$:NOL%=NOL%+2:RETURN
8898 '
8899 ' Print total
8900 LPRINT TAB(PO%(7))STRING$(13,45):LPRINT"Total——>>>"TAB(PO%(7))USING
     MSK$(7);TOT#:LPRINT TAB(PO%(7))STRING$(13,45):RETURN
8998 '
8999 ' %=calculate percentage
9000 GOSUB 2000:GOSUB 2100:GOTO 6080
9198 '
9199 ' Count # of lines printed on hardcopy device
9200 NOL%=NOL%+1:IF MXL%=0 OR NOL%<MXL% THEN RETURN ELSE GOSUB 9220:
     IF QT% THEN RETURN ELSE GOSUB 8850:RETURN
9219 ' Print page #
9220 LPRINT:LPRINT:LPRINT TAB(35)"Page #":PG%:LPRINT:LPRINT:GOSUB 59000:NOL%=0:
     PG%=PG%=PG%+1:RETURN
9239 ' Print page # on last sheet
9240 IF MXL%>0 OR NOL%<MXL% THEN FOR I%=1 TO MXL%-NOL%:LPRINT:NEXT:
     GOSUB 9220
9260 RETURN
9297 '
9298 ' I=insert new row
9300 GOSUB 58000:GOSUB 900:IF QT%=0 THEN 6080 ELSE GOSUB 300:GOSUB 61900:IF
     P%>CNT% THEN 7490 ELSE I%=CNT%
9320 WHILE I%>=P%:ARR$(I%+1,1)=RIGHT$(STR$(I%+1))-1):FOR J%=2 TO NN%:
     ARR$(I%+1,J%)=ARR$(I%,J%):NEXT J%:L%=I%-1:WEND
9340 ARR$(P%,1)=RIGHT$(STR$(P%),LEN(STR$(P%))-1):FOR J%=2 to
     NN%:ARR$(P%,J%)=" ":NEXT J%
9360 GOSUB 250:GOSUB 1000:GOTO 6080
```

(listing continued on page 460)

SPREADSHEET

(listing continued from page 459)

```
9397 '
9398 ' D=delete row
9400 GOSUB 58000:GOSUB 900:IF QT%=0 THEN 6080 ELSE GOSUB 300:GOSUB 61900:IF
     P%>CTN% THEN 7490
9420 I%=P%:TOT#=TOT#-VAL(ARR$(P%,7))
9440 WHILE I%<=CNT%:FOR J%=1 TO NN%:ARR$(I%,J%)=ARR$(I%+1,J%):NEXT J%:I%=I%
     +1:WEND
9460 GOSUB 250:GOSUB 1000:GOSUB 1600:GOTO 6080
9497 '
9498 ' M=modify paging parameters
9500 GOSUB 950:PRINT"# of lines per page (0=no paging):"MXL%,W$(3)FNC$(35,0)" "::
     GOSUB 700:IF C$<>"" THEN MXL%=VAL(C$)
9520 GOSUB 900:GOTO 6080
14995 '
14996 '                 ##########
14997 '                 Display main menu
14998 '                 ##########
14999 '
15000 PRINT FNC$(20,6)"Estimate — (c) '83 — R. Cerati, Arch."
15020 PRINT FNC$(2,12)"Main functions"FNC$(30,12)"Disk operations"FNC$(58,12)"Other"
      W$(2)FNC$(2,13)STRING$(75,45)
15040 PRINT FNC$(2,14)"<B>=build new estimate"FNC$(30,14)"<R>=read file from
      disk"FNC$(58,14)"<L>=load program"
15060 PRINT FNC$(2,15)"<E>=edit existing estimate"FNC$(30,15)"<W>=write file to
      disk"FNC$(56,15)"<esc>=exit"W$(3):RETURN
56995 '
56996 '                 ##########
56997 '                 Delay routine
56998 '                 ##########
56999 '
57000 FOR I%=1 TO DELAY%:NEXT:RETURN
57995 '
57996 '                 ##########
57997 '                 Verify routine
57998 '                 ##########
57999 '
58000 QT%=0:GOSUB 950:PRINT V$::GOSUB 710:IF C$="Y" OR C$="y" THEN QT%=-1
58020 RETURN
58995 '
58996 '                 ##########
58997 '                 Pause
58998 '                 ##########
58999 '
59000 GOSUB 950:PRINT"Hit <space> to continue "W$(3)::GOSUB 710:IF T%=27 OR T%
      =21 THEN QT%=-1 ELSE IF T%<>32 THEN PRINT BL$::GOTO 59000
59020 GOSUB 900:RETURN
59991 '
59992 '                 ##########
59993 ' Initialization of terminal dependent attributes :
59994 ' FNC$( )=direct cursor addressing via x-y corrdinates
59995 ' W$(0)=clear screen              W$(1)=erase to end of line
59996 ' W$(2)=reduced intensity display   W$(3)=normal intensity display
59997 '                 ##########
59998 '
60000 WIDTH 255:DEF FNC$(X%,Y%)=CHR$(27)+CHR$(61)+CRH$(Y%+32)+CHR$(X%+32)
60020 DIM W$(3):W$(0)=CHR$(27)+CHR$(42):W$(1)=CHR$(27)+CHR$(84):W$(2)=CHR$(27)+
      CHR$(41):W$(3)=CHR$(27)+CHR$(40)
60030 WIDTH LPRINT 132:ON ERROR GOTO 65000:'  <— setup hardcopy width & error
      trap for disk operations
60033 '
60034 '                 ##########
60035 '                 Initialize variables
60036 '                 ##########
60037 '
60038 ' Define commonly used values & prompts
60039 '
60040 DELAY%=2000:BL$=CHR$(7):VO$="Command: "+W$(3):V$="Verify (Y/N): "+W$(3):
      V1$=W$(2)+"- (^K=menu) "+W$(3)
60056 '
```

```
60057 ' Define max.# of array rows (MAX%), columns (NN%), col. length (L%)
60058 ' screen abscissas (PO%), formatting masks (MSK$) & type of data (TP%)
60059 '
60060 MAX%=100:NN%=7:DIM ARR$(MAX%,NN%),PERC(MAX%):' PERC=percentage
      values array
60080 DIM L%(NN%),PO%(NN%),MSK$(NN%),TP%(NN%)
60091 '
60092 ' Define initial parameter values :
60093 ' OFS%=offset to make room for prompts and titles
60094 ' SCR%=# of screen the cursor is currently at
60095 ' GAP%=# of displayable lines for each screen
60096 ' PG%=page #     NOL%=# of lines already printed on hardcopy device
60097 ' MXL%=Max. # of printable lines per page
60099 '
60100 OFS$=3:SCR%=0:GAP%=17-OFS%:NOL%=0:PG%=1:MXL%=50
60117 '
60118 ' Define title strings
60119 '
60120 T1$="   #   Code   Job type   u.m.   Unit cost   Quantity   Amount   %"
60140 T2$="------|------|----------|------|----------|----------|---------|-----"
60197 '
60198 ' Read screen parameters
60199 '
60200 FOR I%=1 TO NN%:READ TP%(I%),L%(I%),PO%(I%),MSK$(I%):NEXT I%
60219 '
60220 DATA 1,4,1,"###-":'                      <---Row number parameters
60230 DATA 0,5,6,"\-\":'                       <---Code          '
60240 DATA 0,16,12,"\              \":'        <---Job type      '
60250 DATA 0,3,29,"\\":'                       <---Unit of measure '
60260 DATA 1,13,33,"#########..##":'           <---Unit cost     '
60270 DATA 1,12,47,"########..##":'            <---Quantity      '
60280 DATA 1,13,60,"#########..##":'           <---Amount        '
60995 '
60996 '                 ##########
60997 '                 Process main menu command
60998 '                 ##########
60999 '
61000 PRINT W$(0)
61020 QT%=0:GOSUB 15000:' <---clear screen & print menu
61040 GOSUB 950:PRINT V0$;:GOSUB 710
61060 IF T%=27 THEN GOSUB 58000:IF QT% THEN PRINT W$(0):END ELSE 61020
61080 IF C$="L" THEN 63000
61100 T%=INSTR("BERW",C$):IF T%=0 THEN PRINT BL$;:GOTO 61040
61120 ON T% GOSUB 61200,61300,61400,61500
61140 GOTO 61000
61197 '
61198 ' B=build new array
61199 '
61200 GOSUB 58000:IF QT% THEN GOSUB 6000
61220 RETURN
61297 '
61298 ' E=edit existing array
61299 '
61300 PRINT W$(0):IF ARR$(1,2)=" " THEN GOSUB 950:PRINT"Empty array "BL$;:GOSUB
      57000:GOTO 61000 ELSE GOSUB 6020:RETURN
61397 '
61398 ' R=read values from disk
61399 '
61400 GOSUB 61800:IF QT% THEN RETURN ELSE GOSUB 5000:OPEN"I",#1,FIL$:INPUT#1,
      CNT%,TOT#
61420 FOR I%=1 TO CNT%:FOR J%=1 TO NN%:INPUT#1,ARR$(I%,J%):NEXT J%,I%:CLOSE
      #1:GOSUB 6020:RETURN
61497 '
61498 ' W=write values on disk
61499 '
61500 GOSUB 61800:IF QT% THEN RETURN ELSE GOSUB 750:GOSUB 61900:OPEN"O",#1,
      FIL$:WRITE#1,CNT%,TOT#
61520 FOR I%=1 TO CNT%:FOR J%=1 TO NN%:WRITE#1,ARR$(I%,J%):NEXT J%,I%:CLOSE
      #1:RETURN
```

(listing continued on page 462)

(listing continued from page 461)

```
61797 '
61798 ' select file for read/write operations — it will have .VAL extension
61799 '
61800 PRINT W$(0):GOSUB 950:PRINT"File name > "W$(2)"________"W$(3)FNC$(12,0)" "::
      GOSUB 700
61820 IF C$=" " THEN QT%=-1:RETURN
61840 IF (LEN(C$)>10)OR((MID$(C$,2,1)=":")AND((LEFT$(C$,1)<>"A")AND(LEFT$(C$,1)
      <>"B")))THEN PRINT BL$::GOTO 61800
61860 ' Calculate # of valid terms
61899 '
61900 CNT%=0:FOR I%=1 TO MAX%:IF ARR$(I%,2)=" "AND ARR$(I%,3)=" " THEN I%=
      MAX% ELSE CNT%=CNT%+1
61920 NEXT I%:RETURN
61987 '
62995 '
62996 '                 ##########
62997 '                 Load external program
62998 '                 ##########
62999 '
63000 PRINT W$(0):GOSUB 950:PRINT"Filename ? "W$(3)::GOSUB 700:IF C$=" " THEN
      61000
63020 IF(LEN(C$)>10)OR(MID$(C$,2,1)<>":"AND LEN(C$)>8)THEN 63100
63040 IF MID$(C$,2,1)=":"AND(LEFT$(C$,1)<>"A" OR LEFT$(C$,1)<>"B") THEN 63100
63060 GOSUB 750:CHAIN C$
63100 GOSUB 950:PRINT BL$"Invalid file name "::GOSUB 57000:GOTO 63000
64995 '
64996 '                 ##########
64997 '                 Error checking routine
64998 '                 ##########
64999 '
65000 IF ERR<>53 THEN 65100
65020 IF ERL=63060 THEN GOSUB 950:PRINT"Program not on disk "BL$::GOSUB 57000:
      RESUME 63000
65040 IF ERL=61400 THEN CLOSE#1:GOSUB 950:PRINT"File not on disk "BL$::GOSUB
      57000:RESUME 61400
65100 ON ERROR GOTO 0
```

B·Y·T·E'S B·I·T·S

Display Flicker

Flicker on monitor screens is preventing me from buying a computer! If you aren't bothered by it yourself, you may be able to see the flicker by looking off to one side so that the screen is in your peripheral vision; the corner of the eye seems more sensitive to flicker than the center. I've found, though, that while some people see the flicker peripherally, some still do not. Obviously there's a wide range of sensitivities.

The IBM PC monochrome screen and the PC Portable's amber monitor have enough flicker to make them uncomfortable for me. The Compaq appears to have very little; the Macintosh has a huge amount. This is extremely frustrating to me because I'm ready to buy a Macintosh for use in writing a book; but using MacWrite for 45 minutes left me a little queasy.

How much is due to the flicker of the ubiquitous fluorescent lighting is questionable. I've tried to view the various screens in the daylight from huge storefront windows, but the store lighting still contributes something, of course. Would the problem be less with the incandescent lighting at home? In case it's relevant, I am not subject to seizures of any sort.

On another subject, I want a machine that is powerful, user-oriented, and *humane*, one that doesn't get on my nerves or interfere with my thinking. In this context, I welcome the Macintosh. But even Mac has many of the common problems. Those that bother me most are noise, flicker, and keyboard feel. The noise of the Mac itself is commendably low, but like all printers, the Imagewriter is very annoying, not just in the sound level but in the character of the sound, that high-pitched metallic ripping noise. It's impossible to imagine having it near a workstation, unless an enclosure were constructed for it. The keyboard feel is something I'm probably extra-sensitive to, as a professional pianist. My Selectric II typewriter, *when properly adjusted*—and you almost never find one that is—feels very good. The Macintosh keyboard is much better than some. What they all seem to be missing, though, is a feeling of cushioned motion *after* the point of electrical contact.

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BOOKS RECEIVED

THE APPLE IIe USER'S GUIDE. Mark Andrews. New York: Macmillan Publishing Co., 1983; 128 pages, 13.5 by 20.8 cm, softcover, ISBN 0-02-008680-6, $5.95.

APPLYING SOFTWARE ENGINEERING PRINCIPLES. David Marca. Boston, MA: Little, Brown and Company, 1984; 288 pages, 18.5 by 24 cm, hardcover, ISBN 0-316-54574-0, $14.50.

BASIC FOR IBM PERSONAL COMPUTERS. Harriet Morrill. Boston, MA: Little, Brown and Company, 1984; 270 pages, 17.8 by 23.5 cm, softcover, ISBN 0-316-58402-9, $14.50.

BASIC TRICKS FOR THE APPLE. Allen Wyatt. Indianapolis, IN: Howard Sams & Co., 1983; 144 pages, 13.8 by 21.3 cm, softcover, ISBN 0-672-22208-6, $8.95.

THE BEST APPLE SOFTWARE, the editors of *Consumer Guide* and Roe R. Adams III. New York: Beekman House, 1984; 160 pages, 13.5 by 21 cm, softcover, ISBN 0-517-42475-4, $4.98.

THE BEST ATARI SOFTWARE, the editors of *Consumer Guide*. New York: Beekman House, 1984; 192 pages, 13.5 by 21 cm, softcover, ISBN 0-517-41474-6, $4.98.

THE BEST TEXAS INSTRUMENTS SOFTWARE, the editors of *Consumer Guide*. New York: Beekman House, 1984; 160 pages, 13.5 by 21 cm, softcover, ISBN 0-517-42476-2, $4.98.

THE BEST VIC/COMMODORE SOFTWARE, the editors of *Consumer Guide*. New York: Beekman House, 1984; 192 pages, 13.5 by 21. cm, softcover, ISBN 0-517- 42473-8, $4.98.

BUYING THE RIGHT COMPUTER THE FIRST TIME. Pablo E. Silverio. Miami, FL: Silma Data Research Inc., 1983; 152 pages, 14 by 21.5 cm, softcover, ISBN 0-913223-01-8, $9.95.

COLOR COMPUTER APPLICATIONS. John P. Grillo and J. D. Robertson. New York: John Wiley & Sons, 1983; 160 pages, 17 by 25.3 cm, softcover, ISBN 0-471-86922-8, $10.95.

THE COMMODORE 64 USER'S GUIDE. Jonathan Sacks with Mark Andrews. New York: Macmillan Publishing Co., 1983; 128 pages, 13.5 by 20.8 cm, softcover, ISBN 0-02-008690-3, $5.95.

COMPASS PROGRAMMING. Freeman L. Moore. Dubuque, IA: Gorsuch Scarisbrick Publishers, 1983; 240 pages, 21.5 by 27.8 cm, softcover, ISBN 0-89787-400-5, $16.95.

COMPUTER ALGEBRA. SYMBOLIC AND ALGEBRAIC COMPUTATION, 2nd ed. B. Buchberger, G. E. Collins, and R. Loos, eds. New York: Springer-Verlag/Wein, 1983; 294 pages, 17 by 24.3 cm, softcover, ISBN 0-387-81776-X, $24.50.

COMPUTER BUYERS PROTECTION GUIDE. L. J. Kutten. Englewood Cliffs, NJ: Prentice-Hall, 1983; 160 pages, 15.3 by 22.8 cm, softcover, ISBN 0-13-164187-5, $12.95.

COMPUTER GAME-PLAYING. M. A. Bramer, ed. New York: John Wiley & Sons, 1983; 306 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-470-27466-2, $59.95.

COMPUTER POWER FOR YOUR LAW OFFICE. Daniel Remer. Berkeley, CA: Sybex, 1983; 160 pages, 17.8 by 22.8 cm, softcover, ISBN 0-89588-109-8, $19.95.

COMPUTER-SECURITY TECHNOLOGY. James Arlin Cooper. Lexington, MA: D. C. Heath and Co., 1984; 192 pages, 17 by 23.5 cm, hardcover, ISBN 0-669-06436-X, $25.

COMPUTERS FOR BUSINESS, 2nd ed. Hugh J. Watson and Archie B. Carroll, eds. Plano, TX: Business Publications Inc., 1984; 440 pages, 16.5 by 23.8 cm, softcover, ISBN 0-256-03135-5, $15.95.

CONTROLLING FINANCIAL PERFORMANCE FOR HIGHER PROFITS. Dennis P. Curtin and Jeffrey R. Alves. Somerville, MA: Curtin & London, 1983; 200 pages, 21.5 by 27.8 cm, softcover, ISBN 0-930764-73-0, $17.50.

DATAPRO/MCGRAW-HILL GUIDE TO APPLE SOFTWARE. New York: Datapro/McGraw-Hill, 1983; 288 pages, 21.5 by 27.8 cm, softcover, ISBN 0-07-015403-1, $19.95.

DATAPRO/MCGRAW-HILL GUIDE TO CP/M SOFTWARE. New York: Datapro/McGraw-Hill, 1983; 264 pages, 21.5 by 27.8 cm, softcover, ISBN 0-07-015404-X, $19.95.

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DATATRAN. Harvey J. Gonzalez and Lois Feih. Englewood Cliffs, NJ: Prentice-Hall, 1984; 400 pages, 22 by 28.5 cm, hardcover, ISBN 0-13-196493-3, $32.50.

DECISION SUPPORT SYSTEMS. William C. House, ed. Princeton, NJ: Petrocelli Books, 1983; 480 pages, 15.5 by 23.5 cm, softcover, ISBN 0-89433-208-2, $20.

DESIGNING WITH THE 8088 MICROPROCESSOR. John Zarrella. Fairfield, CA: Microcomputer Applications, 1984; 304 pages, 15.3 by 22.8 cm, softcover, ISBN 0-935230-07-6, $19.95.

DICTIONARY OF COMPUTERS, DATA PROCESSING & TELECOMMUNICATIONS. Jerry M. Rosenberg. New York: John Wiley & Sons, 1984; 630 pages, 18 by 26 cm, hardcover, ISBN 0-471-87638-0, $29.95.

A DICTIONARY OF MINICOMPUTING AND MICROCOMPUTING. Philip E. Burton. New York: Garland STPM Press, 1983; 368 pages, 15.3 by 22.8 cm, softcover, ISBN 0-8240-7286-3, $17.95.

DIGITAL IMAGE PROCESSING. Gregory A. Baxes. Englewood Cliffs, NJ: Prentice-Hall, 1984; 192 pages, 21.5 by 27.8 cm, softcover, ISBN 0-13-214056-X, $14.95.

DR. C. WACKO'S MIRACLE GUIDE TO DESIGNING AND PROGRAMMING YOUR OWN ATARI COMPUTER ARCADE GAMES. David L. Heller, John F. Johnson, and Robert Kurcina. Reading, MA: Addison-Wesley, 1983; 244 pages, 18.8 by 23.5 cm, spiral-bound, ISBN 0-201-11490-9, $24.95. Includes floppy disk.

ELECTRONIC PROTOTYPE CONSTRUCTION. Stephen D. Kasten. Indianapolis, IN: Howard W. Sams & Co., 1983; 400 pages, 13.5 by 21.3 cm, softcover, ISBN 0-672-21895-X, $17.95.

ELEMENTARY PROGRAMMING FOR KIDS IN BASIC. Eugene Galanter. New York: A GD/Perigee Book, 1983; 208 pages, 18 by 23.5 cm, softcover, ISBN 0-399-50867-8, $7.95.

FAMILY COMPUTERS UNDER $200. Doug Mosher. Berkeley, CA: Sybex, 1984; 164 pages, 11 by 18 cm, softcover, ISBN 0-89588-149-7, $3.95.

FUZZY SETS, NATURAL LANGUAGE COMPUTATIONS, AND RISK ANALYSIS. Kurt J. Schmucker. Rockville, MD: Computer Science Press, 1984; 194 pages, 15.5 by 23.7 cm, hardcover, ISBN 0-914894-83-8, $32.95.

GOSUBS. Ewin Gaby and Shirley Gaby. New York: McGraw-Hill, 1984; 176 pages, spiral-bound, ISBN 0-07-022677-6, $9.95.

GRAPHICS FOR THE IBMPC. B. J. Korites. Duxbury, MA: Kern Publications, 1983; 288 pages, 17.8 by 22.5 cm, softcover, ISBN 0-940-254-31-X, $28.50. Floppy disk available, $21.50.

(text continued on page 464)

THIS IS A LIST *of books recently received at BYTE Publications. The list is not meant to be exhaustive; its purpose is to acquaint BYTE readers with current titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.*

BOOKS RECEIVED

(text continued from page 463)
HOME APPLICATIONS AND GAMES FOR THE ATARI HOME COMPUTERS. Timothy P. Banse. Boston, MA: Little, Brown and Company, 1983; 144 pages, 21.5 by 27.8 cm, softcover, ISBN 0-316-08044-6, $14.50.

IBM BASIC. Donald T. Payne and William R. Beck. Englewood Cliffs, NJ: Prentice-Hall, 1983; 240 pages, 15.3 by 22.8 cm, softcover, ISBN 0-13-448688-9, $15.95.

IBM PC BASIC PROGRAMMING. Richard Haskell and Glenn A. Jackson. Englewood Cliffs, NJ: Prentice-Hall, 1984; 190 pages, 21.5 by 27.8 cm, softcover, ISBN 0-13-448424-X, $13.95.

THE IBM PC-DOS HANDBOOK. Richard Allen King. Berkeley, CA: Sybex, 1983; 320 pages, 17.8 by 22.8 cm, softcover, ISBN 0-89588-103-9, $16.95.

INTERFACING TO THE TRS-80 COMPUTER MODELS I, III, AND 4. Jerry R. Lambert. Reston, VA: Reston Publishing Co., 1984; 222 pages, 15 by 22.5 cm, softcover, ISBN 0-8359-3115-3, $16.95.

INTRODUCTION TO THE COMPUTER, 2nd ed. Jeffrey Frates and William Moldrup. Englewood Cliffs, NJ: Prentice-Hall, 1984; 576 pages, 18.3 by 24.3 cm, hardcover, ISBN 0-13-480319-1, $23.95.

KAHN ON CODES. David Kahn. New York: Macmillan Publishing Co., 1983; 352 pages, 16.4 by 24 cm, hardcover, ISBN 0-02-560640-9, $19.95.

THE KISS PRINCIPLE. Ronald B. Smith. Princeton, NJ: Petrocelli Books Inc., 1983; 221 pages, 14.5 by 21.5 cm, hardcover, ISBN 0-89433-198-1, $19.95.

LEARNING LOGO ON THE APPLE II. Anne McDougall, Tony Adams, and Pauline Adams. Englewood Cliffs, NJ: Prentice-Hall, 1982; 264 pages, 17 by 23.5 cm, softcover, ISBN 0-7248-0732-2, $19.95.

LOCAL AREA NETWORKS. V. E. Cheong and R. A. Hirschheim. New York: John Wiley & Sons, 1983; 208 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-471-90134-2, $29.95.

MAKING INFORMATION SYSTEMS WORK FOR YOU. Trevor J. Bentley. Technical revision by Irvine H. Forkner. Englewood Cliffs, NJ: Prentice-Hall, 1983; 192 pages, 15 by 22.8 cm, softcover, ISBN 0-13-547216-4, $8.95.

MATHEMATICS APPLIED TO ELECTRONICS, 2nd ed., James H. Harter and Wallace D. Beitzel. Reston, VA: Reston Publishing Co., 1984; 688 pages, 18.3 by 24.3 cm, hardcover, ISBN 0-8359-4283-X, $24.95.

MECHANICS AND MATERIALS FOR DESIGN. Nathan H. Cook. New York: McGraw-Hill, 1984; 496 pages, 16.8 by 24 cm, hardcover, ISBN 0-07-012486-8, $31.95.

MECHANISM DESIGN: ANALYSIS AND SYNTHESIS, vol. 1. Arthur G. Erdman and George N. Sandor. Englewood Cliffs, NJ: Prentice-Hall, 1984; 544 pages, 18.3 by 24.3 cm, hardcover, ISBN 0-13-572396-5, $39.95.

MICRO COOKBOOK. MACHINE LANGUAGE PROGRAMMING, vol. 2. Don Lancaster. Indianapolis, IN: Howard W. Sams & Co. Inc., 1983; 458 pages, 13.5 by 21.5 cm, softcover, ISBN 0-672-21829-1, $15.95.

THE MICROSOFT BASIC IDEA BOOK. David H. Ahl. Morris Plains, NJ: Creative Computing Press, 1983; 152 pages, 13.8 by 21.3 cm, softcover, ISBN 0-916688-67-4, $8.95.

MOONLIGHTING WITH YOUR PERSONAL COMPUTER. Robert J. Waxman. New York: World Almanac Publications, 1984; 160 pages, 15.3 by 23.5 cm, softcover, ISBN 0-345-31652-5, $7.95.

MOSTLY BASIC: APPLICATIONS FOR YOUR ATARI, Book 2. Howard Berenbon. Indianapolis, IN: Howard W. Sams & Co. Inc., 1983; 264 pages, 21.5 by 28 cm, spiral-bound, ISBN 0-672-22092-X, $15.95.

MULTIPLAN MODELS FOR BUSINESS. Douglas Ford Cobb, Gena Berg Cobb, and Thomas B. Henderson. Indianapolis, IN: Que Corp., 1983; 288 pages, 18.5 by 23.5 cm, softcover, ISBN 0-88022-037-6, $14.95.

THE NEW ALCHEMISTS. Dirk Hanson. New York: Avon Books, 1982; 384 pages, 10.5 by 17.5 cm, softcover, ISBN 0-380-65854-2, $4.50.

THE OSBORNE/MCGRAW-HILL GUIDE TO YOUR APPLE III. Stanley M. Miastkowski. Berkeley, CA: Osborne/McGraw-Hill, 1983; 288 pages, 16.3 by 23.3 cm, softcover, ISBN 0-88134-101-0, $17.95.

OVERCOMING COMPUTER FEAR. Jeff Berner. Berkeley, CA: Sybex, 1984; 114 pages, 11 by 18 cm, softcover, ISBN 0-89588-145-4, $3.95.

A PARENT'S GUIDE TO PERSONAL COMPTUERS & SOFTWARE, the editors of *Consumer Guide* with Danny Goodman. New York: Simon & Schuster, 1983; 64 pages, 21 by 27.3 cm, spiral-bound, ISBN 0-671-49173-3, $6.95.

PASCAL AS A SECOND LANGUAGE. Vardell Lines. Englewood Cliffs, NJ: Prentice-Hall, 1984; 208 pages, 17.3 by 23.5 cm, softcover, ISBN 0-13-652925-9, $18.95.

PC DOS USER'S GUIDE. Chris DeVoney. Indianapolis, IN: Que Corp., 1984; 358 pages, 18.3 by 22.8 cm, softcover, ISBN 0-88022-040-6, $12.95.

PICTURE PERFECT PROGRAMMING IN APPLESOFT BASIC. Thomas Mason, Steve Payne, and Barbara Black. Reston, VA: Reston Publishing Co., 1984; 240 pages, 17.8 by 23.3 cm, softcover, ISBN 0-8359-5549-4, $14.95.

PLANNING AND BUDGETING FOR HIGHER PROFITS. Jeffrey R. Alves and Dennis P. Curtin. Somerville, MA: Curtin & London, 1983; 224 pages, 21.5 by 27.8 cm, softcover, ISBN 0-930764-74-9, $17.50.

PORTABLE COMPUTERS. Sheldon Crop and Doug Mosher. Berkeley, CA: Sybex, 1984; 128 pages, 15 by 22.8 cm, softcover, ISBN 0-89588-144-6, $7.95.

THE POWER OF: FINANCIAL CALCULATIONS FOR LOTUS 1-2-3. Robert E. Williams. Portland, OR: Management Information Source Inc., 1983; 176 pages, 21 by 27 cm, softcover, ISBN 0-943518-10-5, $14.95.

POWER SUPPLIES. Jeffrey D. Shepard. Reston, VA: Reston Publishing Co., 1984; 190 pages, 15.5 by 23.5 cm, softcover, ISBN 0-8359-5568-0, $21.95.

A PRACTICAL GUIDE TO THE UNIX SYSTEM. Mark G. Sobell. Menlo Park, CA: The Benjamin/Cummings Publishing Co., 1984; 448 pages, 15.8 by 23.5 cm, softcover, ISBN 0-8053-8910-5, $21.95.

PROBLEM SOLVING USING PL/I AND PL/C. Keith Harrow. Englewood Cliffs, NJ: Prentice-Hall, 1984; 464 pages, 17.3 by 23.3 cm, softcover, ISBN 0-13-711796-5, $19.95.

RS-232 MADE EASY. Martin D. Seyer. Englewood Cliffs, NJ: Prentice-Hall, 1984; 240 pages, 15.3 by 22.8 cm, softcover, ISBN 0-13-783472-1, $15.95.

THE SATELLITE TV HANDBOOK. Anthony T. Easton. Indianapolis, IN: Howard W. Sams & Co., 1983; 440 pages, 13.8 by 21.3 cm, softcover, ISBN 0-672-22055-5, $16.95.

SIMULATION OF WAITING-LINE SYSTEMS. Susan L. Solomon. Englewood Cliffs, NJ: Prentice-Hall, 1983; 464 pages, 18 by 24 cm, hardcover, ISBN 0-13-810044-6, $27.95.

STRAIGHT FORWARD BASIC. R. Barry Genzlinger, David L. Baker, John A. Devino, David D. Ressler, and Douglas J. Ryan. Burlington, VT: Champlain College Press, 1984; 168 pages, 18 by 25.5 cm, spiral-bound, ISBN 0-9612704-0-3, $12.95.

SUPERCALC HOME & OFFICE COMPANION. Elna Tymes and Peter Antoniak. Berkeley, CA: Osborne/McGraw-Hill, 1984; 304 pages, 21.3 by 27.5 cm, softcover, ISBN 0-88134-113-4, $15.95.

SYSTEMS RELIABILITY. MAINTAINABILITY MANAGEMENT. Balbir S. Dhillon. Princeton, NJ: Petrocelli Books, 1984; 288 pages, 16 by 24 cm, hardcover, ISBN 0-89433-195-7, $29.95.

TALKING CHIPS: IC SPEECH SYNTHESIS. Nelson Morgan. New York: McGraw-Hill, 1984; 192 pages, 15.8 by 23.5 cm, hardcover, ISBN 0-07-043107-8, $24.50.

TELEVISION THEORY AND SERVICING. Charles G. Buscombe. Reston, VA: Reston Publishing Co., 1984; 848 pages, 18.5 by 24.3 cm, hardcover, ISBN 8359-7544-4, $34.95.

THINGS TO DO WITH YOUR APPLE COMPUTER. Jerry Willis, Merl Miller, and Nancy Morrice. New York: The New American Library, 1983; 208 pages, 10.5

BOOKS RECEIVED

by 17.8 cm, softcover, ISBN 0-451-12848-6, $3.95.

Things To Do With Your Atari Computer, Jerry Willis, Merl Miller, and Nancy Morrice. New York: The New American Library, 1983; 240 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12850-8, $3.95.

Things To Do With Your Commodore 64 Computer, Jerry Willis, Merl Miller, and Deborrah Willis. New York: The New American Library, 1983; 192 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12843-5, $3.95.

Things To Do With Your Commodore VIC 20, Jerry Willis, Merl Miller, and Deborrah Willis. New York: The New American Library, 1983; 192 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12844-3, $3.95.

Things To Do With Your Osborne Computer, Jerry Willis, Merl Miller, and D. LaMont Johnson. New York: The New American Library, 1983; 192 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12852-4, $3.95.

Things To Do With Your TI-99/4A Computer, Jerry Willis, Merl Miller, and D. LaMont Johnson. New York: The New American Library, 1983; 192 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12842-7, $3.95.

Things To Do With Your TRS-80 Color Computer, Jerry Willis, Merl Miller, and D. LaMont Johnson. New York: The New American Library, 1983; 224 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12854-0, $3.95.

Things To Do With Your TRS-80 Model 4 Computer, Jerry Willis, Merl Miller, and Cleborne D. Maddux. New York: The New American Library, 1983; 224 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12845-1, $3.95.

TRS-80 Data File Programming, Leroy Finkel and Jerald R. Brown. New York: John Wiley & Sons, 1983; 316 pages, 17 by 25.3 cm, softcover, ISBN 0-471-88486-3, $14.95.

TRS-80 for Kids From 8 to 80, vol. 2, Michael P. Zabinski. Indianapolis, IN: Howard W. Sams & Co., 1983; 208 pages, 21.3 by 28 cm, softcover, ISBN 0-672-22070-9, $9.95.

The TRS-80 Model 100 Portable Computer, David A. Lien. El Cajon, CA: Compusoft Publishing, 1983; 576 pages, 17.8 by 22.8 cm, softcover, ISBN 0-932760-17-1, $19.95.

Turing's Man, J. David Bolter. Chapel Hill, NC: The University of North Carolina Press, 1984; 280 pages, 16 by 23.5 cm, hardcover, ISBN 0-8078-1564-0, $19.95.

The UNIX Book, Mike Banahan and Andy Rutter. New York: John Wiley & Sons, 1983; 224 pages, 17 by 25 cm, softcover, ISBN 0-471-89676-4, $16.95.

The UNIX Programming Environment, Brian W. Kernighan and Rob Pike. Englewood Cliffs, NJ: Prentice-Hall, 1984; 368 pages, 18.5 by 24.3 cm, hardcover, ISBN 0-13-937699-2, $26.95.

The UNIX System Guidebook, Peter P. Silvester. New York: Springer-Verlag, 1984; 224 pages, 15.5 by 23.3 cm, softcover, ISBN 0-387-90906-0, $14.50.

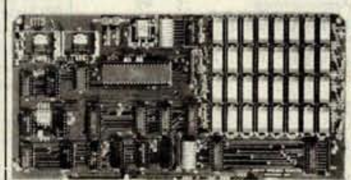
The VIC-20 Connection, James W. Coffron. Berkeley, CA: Sybex, 1983; 296 pages, 17.8 by 23 cm, softcover, ISBN 0-89588-128-4, $9.95.

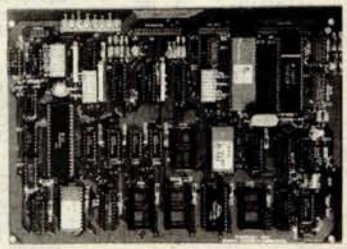
WordStar and CP/M Made Easy, John D. Lee. New York: John Wiley & Sons, 1983; 238 pages, 15 by 23 cm, softcover, ISBN 0-471-90188-1, $17.95.

Your IBM PC, Lyle J. Graham and Tim Field. Berkeley, CA: Osborne/McGraw-Hill, 1984; 608 pages, 16.3 by 23.3 cm, softcover, ISBN 0-88134-120-7, $17.95.

Your IBM PC Made Easy, Jonathan Sachs. Berkeley, CA: Osborne/McGraw-Hill, 1984; 448 pages, 18.5 by 23.3 cm, softcover, ISBN 0-88134-112-6, $12.95.

Your Telephone: Operation, Selection, and Installation, Martin Clifford. Indianapolis, IN: Howard W. Sams & Co., 1983; 336 pages, 13.5 by 21.3 cm, softcover, ISBN 0-672- 22065-2, $13.95. ■





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NEW SYSTEMS

Z80 and 80186 Built into Poly

A multiuser, dual-processor S-100 computer, the Poly 8/16 from PolyMorphic Systems is built with Z80 and 80186 microprocessors. A two-board set, the Poly 8/16's master board carries the 8-bit Z80 processor, 64K bytes of RAM, and the PC-DOS-compatible CP/M-80 operating system. The slave board uses the 8-MHz 16-bit Intel 80186 processor, provides 256K bytes of RAM (expandable to 1 megabyte), and runs under Concurrent CP/M-86.

The Poly 8/16 supports up to four users, each running 80186 slaves. Each additional 80186 slave card has 256K bytes of RAM, two serial ports, and a parallel port. (The 80186 single-board computers can be added to PolyMorphic computers installed since 1977.) Options include floppy-disk drives, printers, plotters, a CAD/CAM color terminal, UNIX, and half- or full-sized fixed-disk or removable-cartridge Winchester drives with storage capacities from 5 to 80 megabytes.

The basic Poly 8/16 comes with master and slave cards on a 5-slot motherboard, a half-height 800K-byte floppy-disk drive, four RS-232C/RS-422 serial ports, two parallel ports, a detached keyboard, and a serial terminal with a 14-inch monochrome display. Supplied software includes Digital Research's GSX graphics extension, CP/M-80, and CP/M-86. Prices start at $4495. Contact PolyMorphic Systems, 5330 Debbie Lane, Santa Barbara, CA 93111, (805) 967-0468.

Circle 750 on inquiry card.

Portable Has Hard and Floppy Drives

The C2600 portable computer from Jonos International comes with a 10-megabyte 3½-inch hard-disk drive and a 322K-byte 3½-inch floppy-disk drive. The C2600, which is designed around the 8-bit Z80B microprocessor, features 128K bytes of RAM, a 9-inch high-resolution display, and CP/M 3.0 Plus. Its I/O capabilities are made up of two serial RS-232C ports, a single parallel printer interface, and a composite-video jack. The C2600's detachable IBM Selectric-type keyboard is augmented with 10 function keys and a 10-key numeric pad. Its dimensions are 17¼ by 13¼ by 7¼ inches. It weighs 27 pounds.

For expansion, the C2600 has three STD bus slots. Currently the manufacturer offers controllers, graphics, modem, and memory cards. The list price is $5695. Contact Jonos International Inc., 1835 Dawns Way, Fullerton, CA 92631, (714) 999-6661.

Circle 751 on inquiry card.

Dual Processors Standard with Eve

Featuring Z80A and 6502 microprocessors, the $2195 Eve II Personal Computer comes with a monitor, a dot-matrix printer, a floppy-disk drive, and a bundle of software. Eve II, a 64K-byte system, runs under CP/M while offering AppleDOS compatibility. Its 12-inch orange monitor can produce 40- or 80-column by 24-line displays and generate 16 colors. The bidirectional printer operates at 80 cps and handles both fanfold and single-sheet paper through tractor- and friction-feed mechanisms.

Eve II has a standard QWERTY keyboard, eight programmable function keys, a self-test key, and separate numeric pad and cursor controls. Mass storage is provided by a 163K-byte single-sided, double-density floppy-disk drive. Additional hardware features include a digital clock and eight Apple-compatible expansion slots.

Word-processor, file-manager, financial-planning, and budgeting packages from Sam's Software are supplied.

Up to 256K bytes of RAM and a variety of peripherals and applications programs are optional. Contact Computer Technology International Inc., 200 Murray Hill Parkway, East Rutherford, NJ 07073, (201) 935-9300.

Circle 752 on inquiry card.

6-MHz Z80B at Heart of Computer

The Servo 8's Z80B runs at 6 MHz. It has 64K bytes of 150-nanosecond dynamic RAM and 2K bytes of monitor/debugger EPROM on board. A self-adjusting disk controller can handle four 5¼- and four 8-inch drives simultaneously. A parallel printer port, SASI bus, two serial ports with software-selectable data rates, and a 50-pin Servo expansion bus are provided. Either CP/M or OASIS serves as its operating system. Power requirements are 5 V at 1400 mA.

Options include 10- and 20-megabyte drives, two serial ports, a real-time clock/calendar, and a memory board with two 64K-byte banks of RAM. The single-unit price is $495. Contact Servo Computer Corp., 360B North Ellensburg St., POB 566, Gold Beach, OR 97444, (503) 247-2021.

Circle 754 on inquiry card.

16032 Multibus Computer

The GVC-16 Multibus computer is a 32-bit demand-paged, virtual-memory system using National Semiconductor's 10-MHz NS16032 microprocessor. This single-board computer combines the NS16000 chip set with up to 2 megabytes of RAM and a Winchester hard-disk interface. Its key specifications are 512K bytes of dual-ported RAM with parity, a 16081 floating-point unit, twin sockets for up to 32K bytes of EPROM, time-of-day clock with battery backup, 4 serial I/O ports, 16 vectored interrupts, 4 user-definable DIP switches, and an EPROM-based integer BASIC interpreter. A system monitor resides in ROM.

The basic configuration, which comes with 512K bytes of memory and an interrupt-control unit, costs $3295. Contact GVC Inc., 222 Third St., Cambridge, MA 02142, (617) 576-1804.

Circle 753 on inquiry card.

PERIPHERALS

Video-Capture System for IBM

A video-capture system for the IBM PC is available from Chorus Data Systems. The PC-Eye Series 1000 interface board seizes images from a video camera or recorder at speeds of up to eight frames per second. Images can be digitized with 1 or 2 bits of intensity for use with the IBM high-resolution graphics adapter, or they can be digitized with 4 bits (i.e., 640- by 400-pixel resolution) for use with PC-compatible graphics adapter boards. The standard resolution at 2 bits is 320 by 200 pixels, while at 1 bit it's 640 by 200 pixels. Other resolutions and partial image transfers can be achieved under program control.

The Series 1000 transfers images under DMA control directly to the PC's main memory at rates approaching 1 megabyte per second. Successive frames can be captured and stored for off-line comparison or postprocessing. Both noninterlaced and interlaced scanning are supported. A crystal-controlled clock and a digital driver ensure accurate timing and stable synchronization. Software support for hard-copy outputs, annotation, storage, comparison, compression, and transmission of video information is offered.

The PC-Eye Series 1000 requires PC-DOS 2.0, a single PC or PC XT expansion slot, and a camera or recorder with an EIA RS-170 or NTSC interface. Copy stands, graphics adapters, cameras, lenses, and applications software are optional. PC-Eye is $495, which includes the interface card, utility software, and documentation. Address inquiries to Chorus Data Systems Inc., POB 810, Hollis, NH 03049, (603) 465-2290.

Circle 755 on inquiry card.

Voice/Data Storage and Retrieval Line Unveiled

Dialogic Corporation recently unveiled a series of real-time voice and/or data storage and retrieval I/O boards for the IBM PC. Designed for voice-annotation of text, digital voice transmission, remote messaging and data entry, and computer/human interface applications, the Dialog family comes in three implementations: basic voice I/O, a version with auto-answer/auto-dial firmware, and a model with a 300-bps modem and digital-transmission firmware. Each board comes with a set of software drivers that digitize, store, and recreate sounds. Only one PC expansion slot is used.

Three data-sampling rates—4, 6, or 8 kHz—are standard. At 4 kHz, the maximum data storage requirement per second is 2K bytes, 1.5K bytes is typical, and 3 bytes is minimum. Polled or interrupt-driven handshake modes, 32-sample buffer, and eight selectable I/O addresses (two used) make up the Dialog-to-IBM interface.

Dialogic boards will accept, compress, and store on disk any sound that can be recorded on tape. Inputs are entered from a microphone, a telephone, or a local-network interface. Outputs can be directed to your PC's speaker, an external speaker, or earphones. Sounds are recreated in real time.

Demonstration programs and PC-DOS drivers for BASIC, Pascal, and C are supplied with each board. The basic system, Dialog/1, is $295. With a telephone interface and auto-answer/auto-dial capabilities, Dialog/2 is priced at $495. The fully configured Dialog/3 is $595. Further information can be obtained by contacting Dialogic Corp., 164 McKinley Ave., East Hanover, NJ 07936, (800) 221-0393; in New Jersey, (201) 386-0202.

Circle 757 on inquiry card.

(text continued on page 470)

New Low-End Terminal Boasts High-End Features

The Freedom 110 video display terminal from Liberty Electronics is an ergonomically styled unit with a 12-inch green or amber tilt/swivel monitor and a detached DIN-standard keyboard. The nonglare CRT displays 96 ASCII characters, 32 control characters, and 15 line-graphics characters in a 7- by 9-dot matrix format in a 9 by 12 field. Eight foreign-language character sets are also available.

Display size is 24 lines by 80 columns, with a twenty-fifth status line. A screen-saver feature will shut off power to the CRT, without loss of data, if fifteen minutes have elapsed with no activity. The keyboard has 94 keys, including a QWERTY layout, numeric keypad, 4 cursor movement keys, 6 editing keys, 8 command keys, and 10 nonvolatile programmable function keys that can be used in conjunction with the Shift key to produce 20 user-defined sequences totaling up to 256 bytes.

The unit has two independently configured RS-232C ports and supports both XON/XOFF and DTR handshaking at rates up to 19.2K bps. The Freedom 110 can be set up to emulate the TeleVideo 910, the Lear Siegler ADM-3A/5, the Hazeltine 1420, the ADDS Regent 25, and Liberty's higher-priced model, the Freedom 100. Nonvolatile setup parameters can be input from the keyboard using either a full-screen menu or the status line, or downloaded from the host computer. There is room in the base of the monitor for an additional printed-circuit board of about 7 by 11 inches that could be used for a single-board computer or other device. The Freedom 110 lists at $595 for the green-phosphor model; the amber display costs an additional $25. Further information is available from Liberty Electronics, 625 Third St., San Francisco, CA 94107, (415) 543-7000.

Circle 756 on inquiry card.

ADD-INS

Internal Modem for Portable PC

The PC Modem Half Card from Ven-Tel provides the IBM Portable PC with a very important accessory—an internal 300/1200 bps auto-dial/auto-answer modem that fits into one of the computer's half-length expansion slots. The product accepts the widely used Hayes Smartmodem control codes and is distributed with Crosstalk-XVI telecommunications software from Microstuf Inc. Buyers should note that this is ***not*** the same product as Ven-Tel's earlier PC Modem Half Card for the IBM PC XT (which has a similar card bus)—the two modems are not interchangeable. Retail price is $549. For more information, contact Ven-Tel Inc., 2342 Walsh Ave., Santa Clara, CA 95051, (408) 727-5721.

Circle 758 on inquiry card.

Combo S-100 Board Has Z80 and 286 Processors

Macrotech International has announced the MI-286, a dual-processor S-100 CPU board with both a Zilog Z80B and an Intel iAPX 80286. The board is designed as a replacement for earlier multitasking and multiuser dual-processor CPU boards running under the MP/M-8/16 operating system, such as the CompuPro CPU 8085/8088. Because of the increased addressing capability of the MI-286, the new board can support up to 16 megabytes of random-access memory. Single-unit price of the MI-286 is $1395; an optional upgrade including the 80287 math coprocessor and related PAL (programmed array logic) is available for $650. More information can be obtained from Macrotech International Corp., 9551 Irondale Ave., Chatsworth, CA 91311, (818) 700-1501.

Circle 759 on inquiry card.

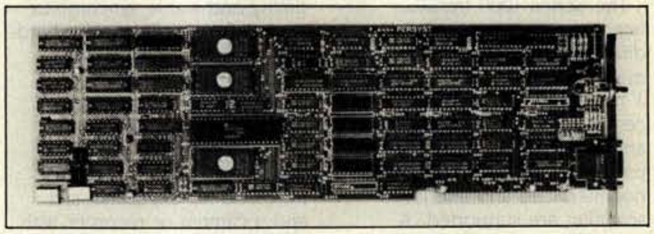
PC Color Graphics Adapter

Persyst has announced BoB (Best of Both), a color-display adapter board for the IBM PC and PC XT. A single-board adapter compatible with the IBM color-display adapter's features, BoB supports either a standard color mode with 16 colors or a black-and-white mode with 16 levels of gray. It produces an 8- by 12-dot character in a 10- by 16-dot grid. Two graphics screen modes are standard: 320- by 200-pixel medium resolution with four colors and 640- by 200-pixel high resolution with one color. For higher resolutions, it supports a 24.83-kHz horizontal rate that sustains 400 vertical-scan lines. DMA operations and access to display memory in any mode are permitted.

BoB has direct-drive intensity RGB and composite-video outputs, a light-pen interface, and provisions for up to 32K bytes of display memory. It supports the PC's user-selectable character attributes and the 256-character IBM set. Optionally, 320- by 400-pixel medium-resolution with four colors and 640- by 400-pixel high-resolution single-color graphics modes are available.

Prices begin at $425. Contact Personal Systems Technology Inc., Persyst Products, Suite A, 15801 Rockfield Blvd., Irvine, CA 92714, (714) 859-8871.

Circle 760 on inquiry card.



SOFTWARE • IBM PC

Linear Programming for the PC

LP88 is a general-purpose system for solving linear programs with up to 255 constraints and 2255 variables (including slacks). You can input linear programs as they are formulated without converting to a standard form. Both maximization and minimization problems are accepted, and LP88 accepts any combination of <=, >=, or = constraint relations. Applications include production, mixing, scheduling, inventories, cash management, transportation, and network problems. LP88 uses the Revised Simplex algorithm. It computes and stores the inverse of the matrix of basis columns as the linear program is solved.

LP88 can be configured at run time. Operator controls are exercised by means of function keys, and four menus provide options for input, solution, output, and interrupting execution. A display editor uses spreadsheet-like inputs and permits editing and modification of a problem's features. The Simplex algorithm can be interrupted during program execution.

Minimum requirements are a display, a single disk drive, a printer, DOS 1.1 or 2.0, and a 128K-byte IBM PC or PC XT. For large problems, 192K bytes and a RAM disk or hard disk are recommended. It costs $88. A version that supports the Intel 8087 costs $11 more. Contact Eastern Software Products Inc., 4804 Tarpon Lane, Alexandria, VA 22309, (703) 360-6942.

Circle 761 on inquiry card.

A Little Blues for the PC

The SongWright Music Processor for the IBM PC lets you compose, save, edit, transpose, play back, and print out music. It also aligns lyrics and chord notations with notes. SongWright features a two-octave range, seven key signatures, multiple time signatures, and chordal harmony. DOS 1.1 or 2.0 and an IBM or Epson graphics printer are required. The suggested price is $24.95. Contact SongWright, 928 Fillmore St., Denver, CO 80206, (303) 321-0481.

Circle 762 on inquiry card.

Talking PC Program

The PC Talking Program is a machine-language program that modifies the IBM PC so that it becomes a fully functional talking computer. The Talking Program lets you choose total or spelled speech, and it can identify uppercase and lowercase characters as well as line and column numbers. It can read or spell out an entire page, current line, or the character under the cursor. All its major functions are controlled by 10 function keys, and no hardware modifications are required.

To use the Talking Program, you need a 64K-byte IBM PC, an asynchronous RS-232C communications adapter, a speaker

SOFTWARE • IBM PC

or headphones, a specially configured RS-232C cable, and a Votrax Type 'N Talk, Echo PC, or other voice synthesizer. The talking program uses only about 2K bytes of memory. Also available is a version of the Talking Program that works with IDEAssociates IDEAComm 3278 board, which permits the talking IBM PC to emulate an IBM 3278. A Talking Proofreader can be obtained. The Talking Program can be obtained for Radio Shack computers and the Lobo MAX-80. Write Computer Conversations, 2350 North 4th St., Columbus, OH 43202, or call (614) 263-4324 after 6 p.m.
Circle 763 on inquiry card.

Building Blocks for Numeric Control

Novum Organum's C Building Blocks are a set of functions and subsystems suitable for such applications as numeric control and telecommunications. They interface with PC-DOS and provide access to all the features and peripherals on the IBM PC.

C Building Blocks I provides access to all system services and DOS features and control over peripherals. The database version handles keyed access to variable-length records, while the mathematics version gives you the most commonly used arithmetic functions. Communications Building Blocks allows data transfers with interrupt-driven ports control and protocol file transfer. Advanced Building Blocks extends Building Blocks I by allowing filed input, Julian dates, and data compression.

C Building Blocks are delivered on MS-DOS–compatible 5¼-inch floppy disks with comprehensive manuals. The source code is provided or available. Mathematics and Advanced Building Blocks cost $99 each. The others are $149. Add $4.50 for shipping ($6.50 for UPS air delivery). Contact Novum Organum, 29 Egerton Rd., Arlington, MA 02174, (617) 641-1650.
Circle 764 on inquiry card.

NAPLPS Software

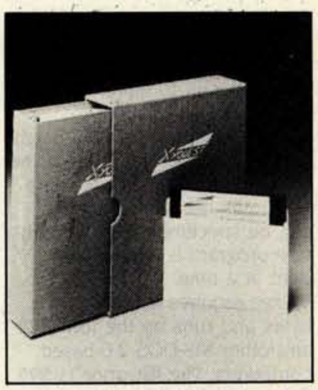
TVOntario's NAPLPS page/frame creation software, Createx-C, runs on the IBM PC. This program is said to generate graphics at high speed, make database storage more economical, and reduce transmission costs. Createx-C can scan a page to produce a shorter byte length while retaining the essential content suitable for both on-line and broadcast transmission. It can define up to 262,000 colors, limited only by the terminal. Because it uses NAPLPS blinks and color-mapping codes, Createx-C is suitable for animation. Other features include single-keystroke editing, access to NAPLPS text features, and full user control over character path, character rotation, and text size.

Createx-C requires a NAPLPS decoder and color monitor. It costs $1450 for the first license. Contact TVOntario, POB 200, Station Q, Toronto, Ontario M4T 2T1, Canada, (416) 484-2606.
Circle 765 on inquiry card.

Word Processor Merges Lists, Defines Keyboard

The XyWrite II-plus word processor lets you merge mailing lists and define the IBM PC's keyboard. With its mail-merge feature, you can integrate names, addresses, and data fields. The keyboard definition function proffers single-keystroke command-and-text combinations. XyWrite II-plus has horizontal and vertical split-screen displays, simultaneous multiple-file access, and horizontal scrolling. Editing functions include column moves, indexing, superscripts, subscripts, footnotes, endnotes, foreign-language and mathematics characters, pagination, and automatic word wrap. Background printing, directory call-up, and on-line help are provided.

For forms generation, XyWrite II-plus will protect fields. Preprinted forms and documents can be filled out. On-screen page and line indicators, page-break indicator, tab ruler and column indicator, micro-justification, underlining, and what-you-



see-is-what-you-get printing are other highlights.

XyWrite II-plus runs under PC-DOS versions 1.0, 1.1, 2.0, and 2.1. It's compatible with text files from assembly languages, BASIC, Lotus 1-2-3, Pascal, VisiCalc, and FORTRAN. It costs $295, plus $5 shipping, and is available from XyQuest Inc., POB 372, Bedford, MA (617) 275-4439.
Circle 766 on inquiry card.

SOFTWARE • IBM PCjr

Integrated Software for PCjr Has Windows

Alpha Software's Electric Desk, an integrated, multitasking software package with windows for the IBM PCjr, combines word processing, spreadsheet analysis, database management, and communications functions in a single package. Several functions can be operated simultaneously, and switching from one task to another or dividing the display screen into a pair of windows can be accomplished with two or three keystrokes.

An integral macro language lets you program frequently needed functions, such as a repetitive series of calculations, into two-keystroke commands. Data can be transferred to and from functions; disk-switching is not necessary.

Electric Desk's word processor provides the features available on most stand-alone word processing programs, while the 255-row by 255-column spreadsheet is said to match any electronic spreadsheet for the IBM PC. The database manager gives you extensive indexing and can accommodate up to 65,000 records. In addition to electronic mail and commercial database-access capabilities, the communications option lets you automatically dial telephone numbers stored in the database.

Electric Desk requires 128K bytes of RAM and a disk drive. Most of its code is on ROM cartridge. The list price is $295. Contact Alpha Software Corp., 30 B St., Burlington, MA 01803, (617) 229-2924.
Circle 767 on inquiry card.

Speaking Software

PC Speak jr. provides an audio display screen replacement. When coupled with the IBM PCjr and a speech synthesizer, such as the Votrax Type 'N Talk, PC Speak jr. will vocalize word processors, applications packages, games, and programming languages. It can say what is on the screen or be used to review the display. Individual lines or words can be selected, and it can echo data as it is input.

PC Speak jr. requires a disk drive, the PCjr's serial adapter, PC-DOS, and a voice synthesizer. An optional parallel printer adapter can be used. It costs $149. Contact Solutions By Example, POB 307, New Town Branch, Boston, MA 02258, (617) 244-5880.
Circle 768 on inquiry card.

(text continued on page 472)

SOFTWARE • IBM PCjr

Program-Chaining Monitor for PCjr

Exec implements program chaining using the PC-DOS loader. It permits programs in one language to effectively chain programs written in another language or DOS batch file. A common data area of the size necessary to transfer data structures between programs can be specified, although only one program is memory resident at a time.

Exec requires less than 9K bytes and runs on the IBM PCjr and other MS-DOS 2.0-based computers. The list price is $95. Contact Blaise Computing Inc., 2034 Blake St., Berkeley, CA 94704, (415) 540-5441.

Circle 769 on inquiry card.

Pascal Compiler for Jr

A Pascal language compiler for the IBM PCjr, Turbo Pascal is available from Borland International. This high-level language features a single-pass native-code compiler, bit/byte manipulation, direct access to the central processor's memory, dynamic strings, include files, and random-access files. It can compile more than 2000 lines of code per minute. Turbo Pascal's combination compiler/editor occupies 33K bytes of the PCjr's memory.

The list price for Turbo Pascal for the PCjr is $49.95. Contact Borland International, 4113 Scotts Valley Dr., Scotts Valley, CA 95066, (408) 438-8400.

Circle 770 on inquiry card.

SOFTWARE • OTHER COMPUTERS

Word Processor Links Rainbows to PDP

CT*OS/86 is a word processor that lets you transfer word-processor files from DEC VAX and PDP-11 host computers to the Rainbow. When in its image-transfer mode, CT*OS/86 maintains full document and message-format compatibility between computers running any member of the CT*OS family. This menu-driven system provides global search and replace, cut and paste, list processing, a spelling corrector, ASCII file handling, 132-column document width, stored text libraries, right-justified margins, scientific character set, and user-defined function keys.

A single-user license is $950. Contact Compu-Tome Inc., 234 East Colorado Blvd., Pasadena, CA 91101, (213) 796-9371.

Circle 775 on inquiry card.

Keyed Files for Rainbow

Applications BASIC gives the DEC Rainbow keyed-file access, which facilitates the preparation of business applications programs. This utility provides file- and data-handling functions, programming aids, and debugging tools. Its file-handling feature has dynamically allocated files that can be accessed by a 1- to 58-character alphanumeric keyword. The file-handling capabilities support ISAM; random and serial files with automatic field separation to accommodate up to 65,535 records per file; more than 32,760 characters per record; and over 32,760 fields per record. Up to 63 files can be simultaneously open.

Its data-handling abilities include automatic variable passing to other program segments, automatic decimal rounding, 32,767 character-string lengths, and numeric-to-string conversion.

Applications BASIC is $395. Contact Soft Gold Inc., POB 2718, Newport Beach, CA 92663, (714) 476-3004.

Circle 776 on inquiry card.

SOFTWARE • APPLE

Apple in Print Shop

The Print Shop from Broderbund Software lets you write, design, and print your own greeting cards, stationery, letterhead, signs, and banners with your Apple II+ or IIe. It offers eight different type styles in two sizes and in solid, outline, and three-dimensional formats. The Print Shop has nine border designs, 10 abstract patterns, and more than a dozen pictures and symbols with which to work. A built-in graphics editor lets you create your own symbols and modify the supplied ones. You can print illustrations generated with other programs.

The Print Shop will produce a greeting that has messages both inside and outside and full-page signs. Its text-editing features include automatic centering, left and right justification, and proportional spacing.

This program comes with an assortment of pin-feed paper and matching envelopes. It requires 48K bytes of memory and a printer. It costs $49.95. Contact Broderbund Software, 17 Paul Dr., San Rafael, CA 94903, (415) 479-1170.

Circle 771 on inquiry card.

MasterFORTH on Your Apple

MasterFORTH for the Apple II series meets all the provisions of the FORTH-83 International Standard. It comes with a built-in macro assembler with local labels, a screen editor, and a string-handling package. Its I/O streams are fully redirectable. Floating-point and high-resolution are options.

MasterFORTH costs $100 to $160, depending on options. It's supplied with a FORTH textbook, reference manual, and a full listing of the MasterFORTH nucleus. Contact MicroMotion, Suite 506, 12077 Wilshire Blvd., Los Angeles, CA 90025, (213) 821-4340.

Circle 772 on inquiry card.

PractiCalc Spreadsheet for Apple II

PractiCalc II is a spreadsheet program for 48K-byte Apple II+ and IIe computers. In addition to traditional spreadsheet functions, PractiCalc has word-processing capabilities, advanced editing functions, variable column widths in all columns, automatic and manual recalculation, the ability to do long labels, and an on-screen default menu. When running on the Apple IIe, it has 80-column, uppercase and lowercase data-entry, and printing capabilities. Other features include alpha and numeric sorting and search, prompts for entry during calculation, and printing of list formulas.

PractiCalc II costs $69.95. Contact Micro Software International, The Silk Mill, 44 Oak St., Newton Upper Falls, MA 02164, (617) 527-7510.

Circle 773 on inquiry card.

CAD Program for Apple

Cascade I is a CAD system for Apple computers. It features a 0 to 255 "level" range that allows you to place up to 256 different overlays on the system and display each one separately. It has the ability to group objects into a conglomerate, move objects as a group, add or delete objects to or from the group, and perform other tasks. Pan and zoom capabilities are provided.

Drawings can incorporate aligned, directional, and multi-directional text. Its drafting/graphics menu has more than 20 items, each with multiple options. It has six ways to input arcs; full, quarter, or half eclipses; four ways to input circles; and three line configurations.

Cascade I is £656. It runs on the Apple II+ and IIe. Contact Cascade Graphics Development Ltd., 185 Lower Richmond Rd., Richmond, Surrey TW9 4LT, England; tel: (01) 878-7661; Telex: 929964.

Circle 774 on inquiry card.

SOFTWARE • TANDY / RADIO SHACK

E-COM Interface for Tandy 2000

Flash-COM interfaces your Tandy 2000 to the U.S. Post Office's E-COM electronic mail service. It comes with such modules as word/text-processing, forms/screen file management, mailing-list manager, and communications. Also provided are more than a dozen standard business letters and forms. Flash-COM works with applications written in a variety of productivity tools, including Lotus 1-2-3, dBASE II, WordStar, Volkswriter, and Perfect Writer.

Flash-COM is $299, which includes a tutorial for first-time users. It's also available for the Apple II/II+, IBM PC and PCjr, Sanyo MBC550, and CP/M-80 systems. Contact Omni Computer Systems Inc., POB 162, Chestnut Hill, MA 02167, (617) 825-6700.

Circle 777 on inquiry card.

Mail-List Manager for TRS-80

The Mail Pro program is designed for small businesses or clubs that maintain their mailing lists on a Radio Shack TRS-80 Model I or III. It's particularly suited for those lists that exceed a single disk because its report- or label-printing abilities can span records on more than one drive. Mail Pro can read identical filenames on different disk drives and multiple names on the same drive. It can sort and print a master list or set of labels from nine different lists on up to four drives. User-defined sorts can be on any field or within a defined range. The multiple-access sort creates its own file while maintaining the individual file's integrity. Once a sort is completed, subsequent printings do not require a new sort, except if new information is added.

Mail Pro features five- and nine-digit ZIP codes and Canadian codes, batch addition mode, a repeat key, global search and replace, machine sort for individual files, two remark code fields, and a B-Tree file structure. The capacity is 1400 names per 40-track double-density disk. The list price is $39.95. Contact Cushman Publishers, 7720 Brandeis Way, Springfield, VA 22153.

Circle 779 on inquiry card.

Super-Bug for CoCo

Super-Bug is a relocatable machine-code generator for the Radio Shack Color Computer. Suitable for novices and experts alike, Super-Bug features hexadecimal and alphanumeric memory display and modify; character string search; a memory-test facility; a mini object-code disassembler; and a 64K-byte mode setup.

Super-Bug is available on cassette and floppy disk for $29.95 and $32.95, respectively. Documentation is supplied. A 16K-byte or larger system is required. Contact Mark Data Products, 24001 Alicia Parkway #207, Mission Viejo, CA 92691, (714) 768-1551.

Circle 780 on inquiry card.

Reference List Program

Bib/Rite helps you prepare reference lists quickly and accurately. With Bib/Rite, you can enter citations randomly and later sort them by author or category. You can add, delete, and merge citations as well as edit individual citations. Bib/Rite also provides automatic paging and margins, menus and prompts, and semiautomatic entry of frequently cited journals or magazines. Its capacity is 100 to 150 citations.

Bib/Rite requires a printer and a minimum of 32K bytes of memory. Versions of Bib/Rite will be available for the following computers: Radio Shack TRS-80 Models I, III, and 4, Apple, IBM PC, and CP/M systems. It's offered on disk or tape for the TRS-80. The single-user price is $45.95, plus $2.50 for handling. For multiple users, it's $150. The manual is $3.50, plus $1 for handling. Order directly from Robert Litke, 432 Cottage Ave., Vermillion, SD 57069, (605) 624-2948.

Circle 778 on inquiry card.

SOFTWARE • CP/M / MS-DOS

MC68000 Cross-Assembler Package

A68K, a cross assembler for the Motorola 68000 series, comprises an assembler, linker, and library utility. The assembler and linker are source- and object-compatible with the VERSAdos assembler and linker used in Motorola's development systems. A68K accepts all the op codes and extensions as defined in the MC68000 users manual, and it supports nested macros, nested conditional assembly, nested structured programming constructs, absolute and relocatable code generation, and a nested include facility. The size of source files is not limited because the symbol table overflows to disk when the main memory capacity is exceeded.

A disk-resident macro library (not supported by Motorola assemblers) can be created with the library utility. The library provides for the interactive editing of macro or object libraries. Any number and size of macros can be used in a single assembly, permitting the assembly of arbitrarily large files on small machines.

The linker accepts a control file that determines how the load file is to be constructed. Its commands determine which object files are to be included and what areas of memory are to be assigned to relocatable sections of code. Any number of object-library files created by the library utility can be used in a single link. The linker produces Motorola S records, Intel Hex records, or a binary format. A memory map and the version and modification levels from IDNT directives in the source-assembly modules are produced. On CP/M-86 and PC-DOS systems, the time and date of assembly is listed.

A68K comes on 5¼- or 8-inch disks for CP/M-80, CP/M-86, and IBM PC-DOS. The CP/M-80 version is $200; the others are $250. Contact Farbware, 1329 Gregory, Wilmette, IL 60091.

Circle 782 on inquiry card.

Scientific Subprograms

Three ANSI-standard FORTRAN subprograms for scientific applications are available: Linear Least Squares (LLSQ), Large-Integer Programming (LIPS), and Linear Programming (LPSUBS).

LLSQ provides routines for singular-value decompositions, banded or constrained least-squares problems, and Householder's method for linear least squares. For applications that must arithmetically manipulate integers with many digits, LIPS has routines to perform addition, subtraction, multiplication, division, modular exponentiation, and order relations. LPSUBS lets you use the mathematical methods in the interactive LP-2000 Linear Programming System in your own applications.

MS-DOS is required. LPSUBS is $99; the others are $80. Contact Software Designs 2000, Mathematical Products Division, POB 13238, Albuquerque, NM 87192, (505) 294-2165.

Circle 781 on inquiry card.

(text continued on page 474)

PUBLICATIONS

UNIX Software Directory

Onager Publishing has announced the availability of the second edition of the *UNIX Applications Software Directory*. This edition lists more than 400 packages in 27 categories. Information on the cost, hardware requirements, and the name, address, and telephone number of the suppliers for each package is provided. Other pertinent details necessary to obtain the package are given. The directory also includes a cross-reference matrix where software is listed by function and application. Among the categories are DOSes, diagnostic tools, graphics, word/text processors, network handlers, database managers, spreadsheets, and BASIC, C, COBOL, and Pascal compilers.

The *UNIX Applications Software Directory*, second edition, is $50. Contact Onager Publishing, 6451 Standridge Court, San Jose, CA 95123, (408) 225-3541.
Circle 783 on inquiry card.

UNIX and C Journal from Down Under

An Australian UNIX and C journal, */USER* includes a regular section on medical informatics on systems running UNIX. Annual overseas subscriptions are $30. Australian subscriptions are $24. Contact Structured Language Resources, 121 Borg St., Scoresby 3179, Victoria, Australia.
Circle 785 on inquiry card.

Indicator/Lamp Catalog

A full-color, short-form catalog covering a complete range of miniature lamps and indicators for printed-circuit boards, instrument panels, push-button switches, legend illumination, telephones, switchboards, control panels, and industrial controls is available free of charge. Contact Ledtronics Inc., 4009 Pacific Coast Highway, Torrance, CA 90505, (213) 373-5437.
Circle 786 on inquiry card.

Guide Lists Nearly 24,000 ICs

Nearly 24,000 different integrated circuits are profiled and cross-indexed in the I. C. *Functional Equivalence Guide* from D.A.T.A. Inc. Chips are grouped on the basis of a pin-for-pin equivalence, which simplifies selection, substitution, and purchasing. The primary specifications for each device are listed, and devices with the same technologies and electrical characteristics are batched together. Categories include gates, latches, flip-flops, counters, RAMs, ROMs, shift registers, interfaces, memory/clock drivers, logical buffers/drivers, and digital multiplexers.

A one-year, two-edition subscription costs $95. Contact D.A.T.A. Inc., POB 26875, San Diego, CA 92126, (800) 854-7030; in California, (619) 578-7600. In Canada, call (800) 268-7742, operator 83.
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Power Conditioners Described in Catalog

Oneac Corporation has produced a 16-page catalog that discusses power-supply problems and provides detailed descriptions of its power conditioners. This two-color catalog presents product specifications in easy-to-read charts illustrated by photographs. A chart of applications and detailed information on sizing conditioners for different applications are supplied. Illustrations showing plugs and receptacles serve as an aid to finding a power conditioner compatible with your system.

The conditioners outlined in the catalog, Oneac's Condition One and Conpact, are said to be suitable for all computers and computerized telecommunications and test equipment. Contact Oneac Corp., 2207 Lakeside Dr., Bannockburn, IL 60015, (312) 295-2800.
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Apple Software Book for 1984

The Book of Apple Software, 1984 edition, is available from The Book Company. This reference and review guide describes, evaluates, and rates more than 100 programs for the Apple II and IIe. It has reports on recently introduced programs as well as updated reviews on the latest versions of previously announced packages. Programs are graded in such areas as ease of use, documentation, value for the money, and vendor support. In addition, overall grades are assigned to each program. Evaluations and ratings are performed by independent reviewers, each purported to be an expert in her or his field. Also included is a list of software vendors and advice on obtaining maximum use of your Apple.

The Book of Apple Software is available at bookstores and computer retailers. The suggested price is $19.95. Other publications offered by The Book Company cover Atari and IBM PC software and Commodore 64 color graphics. For further information, contact The Book Co., 11223 South Hindry Ave., Los Angeles, CA 90045, (213) 410-9466.
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Capitol is manufacturing the Platinum Series to exceed ANSI standards and warrants them "forever, if maintained properly." Suggested price for a box of 10 disks is $55. For more information, contact Capitol Data Systems, 1750 North Vine St., Los Angeles, CA 90028, (213) 462-6252; in California, (800) 821-7140.
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WHERE DO NEW PRODUCT ITEMS COME FROM?
The new products listed in this section of BYTE are culled from the thousands of press releases, letters, and telephone calls we receive each month from manufacturers and distributors. The basic criteria for selection for publication are a) does a product match our readers' interests, and b) is it new or simply a "reintroduction" of an old item. If you want your product to be considered for publication (at no charge), send full information about it, including its price and an address and telephone number where a reader can get more information. Send this to the New Products Editor, BYTE, POB 372, Hancock, NH 03449.

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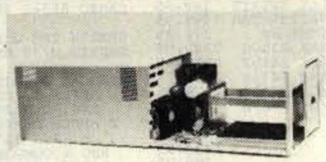

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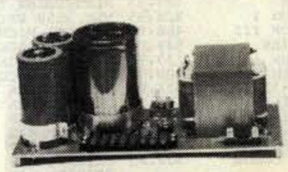

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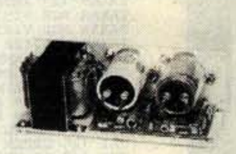

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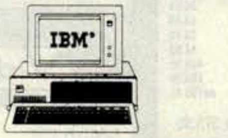

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General Products- cont.

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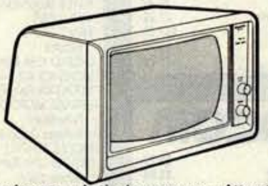

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MegaPak 128K (not upgradable)	225
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I/O Plus II with clock calendar and serial port *(parallel, game, or second serial port optional)*	115
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Connectall connector bracket	15
Amdek	
MAI Board	459
Hercules Computer	
Hercules Graphics Card *(with parallel port)*	339
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Typewriter style keyboard(KB5150)	call
Deluxe keyboard	call
Koala Touch Tablet w/software *(Connects to game port)*	95
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Floppy Disk Controller	175
Floppy Disk Controller *(with parallel port)*	229
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Persyst	
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Quadisk *(various size to 72 meg)*	call
STB	
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FX-80 160 cps 10" crg	call
FX-100 160 cps 15" crg	call
Tractor for FX-80	30
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Okidata	
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Gemini 15X 120 cps 15" crg	379
Delta 10 160 cps 10" crg	419
Delta 15 160 cps 15" crg	589
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MAX-12 12" Amber monochrome *(for IBM)*	189
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Taxan	
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RGB 420 *Super hi-resolution* RGB	479
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Compaq or Compaq plus portable	call
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NEC	
APC color & monochrome systems	call
NEC 8201 *portable computer*	599
Tava *PC compatible system*	call

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Applications software training packages specify the application	*each only* 55
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Database Manager II	199
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Ashton Tate	
dBase II	385
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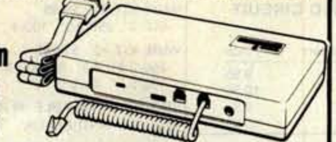

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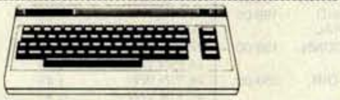

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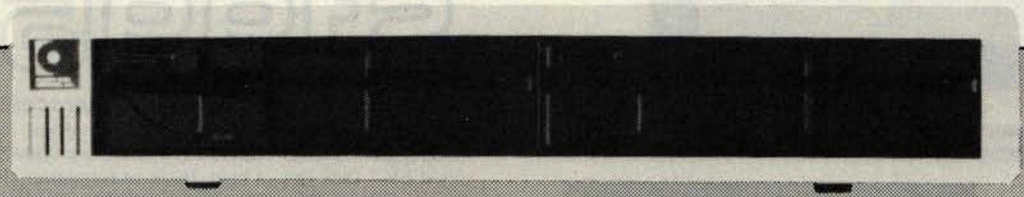

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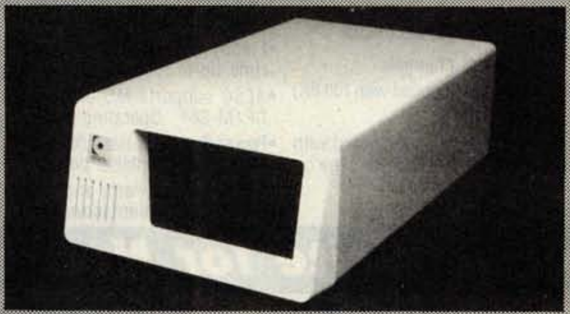

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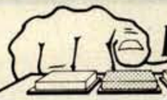

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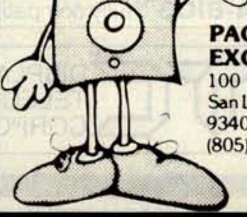

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74LS08	.27	74LS112	.38
74LS09	.28	74LS113	.38
74LS10	.24	74LS114	.38
74LS11	.34	74LS122	.44
74LS12	.34	74LS123	.78
74LS13	.44	74LS124	2.85
74LS14	.58	74LS125	.48
74LS15	.34	74LS126	.48
74LS20	.24	74LS132	.58
74LS21	.28	74LS133	.58
74LS22	.24	74LS136	.38
74LS26	.28	74LS137	.98
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74LS28	.34	74LS139	.54
74LS30	.24	74LS145	1.15
74LS32	.28	74LS147	2.45
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74LS49	.74	74LS158	.58
74LS51	.24	74LS160	.68
74LS54	.28	74LS161	.64
74LS55	.28	74LS162	.68
74LS63	1.20	74LS163	.64
74LS73	.38	74LS164	.68
74LS74	.34	74LS165	.94
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74LS76	.38	74LS168	1.70
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74LS83	.59	74LS170	1.45
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74LS193	.78	74LS367	.44
74LS194	.68	74LS368	.44
74LS195	.68	74LS373	1.35
74LS196	.78	74LS374	1.35
74LS197	.78	74LS377	1.35
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7812K	1.34	7915K	1.44
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4.0	2.69
5.0	2.69
5.0688	2.69
5.185	2.69
5.7143	2.69
6.0	2.69
6.144	2.69
6.5536	2.69
8.0	2.69
10.0	2.69
10.738635	2.69
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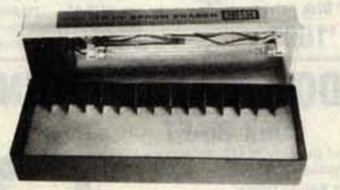

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64K RAMS

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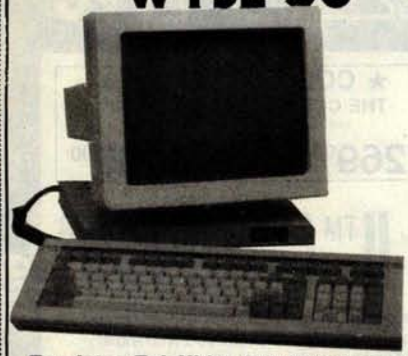

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BFGBT52012	M-Drive/H 512K RAM Disk A&T	$1475.00	$ 894.25

Vector

Manufactured by Vector Electronic Co. under license from CompuPro

BFVCT8800GFB	Interfacer 1, 2-Serial (A&T)	$295.00	$219.00
BFVCT8800GF2B	Interfacer 2, 3-Par., 1-Ser. (A&T)	$325.00	$239.00
BFVCT8800GR17B	RAM 17 64K 10MHz Static RAM (A&T)	$450.00	$389.00

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BFSDS38095	SBD-300 4MHz Z80A CPU A&T	$ 741.00	$ 619.00
BFSDS38092	SBD-300 6MHz Z80B CPU A&T	$ 825.00	$ 689.00
BFSDS38007	Z80 Starter System A&T (Not IEEE/696)	$ 450.00	$ 399.00
BFSDS38088	ExpandoRAM IV 256K A&T	$1145.00	$ 975.00
BFSDS38089	ExpandoRAM IV 256K w/EDC A&T	$1990.00	$1675.00
BFSDS38097	ExpandoRAM III/696 256K	$ 825.00	$ 749.00
BFSDS38076	PROM-100 w/software A&T	$ 285.00	$ 219.00
BFSDS38082	RAM Disk 256K A&T	$ 875.00	$ 775.00
BFSDS38081	ROM Disc 128K A&T	$ 350.00	$ 319.00
BFSDS38096	I/O-8 4-Port Async Ser. A&T	$ 600.00	$ 549.00
BFSDS38093	I/O-8 8-Port Async Ser. A&T	$ 695.00	$ 589.00
BFSDS38094	I/O-8 4 Sync, 4 Async, Serial I/O A&T	$ 795.00	$ 699.00
BFSDS38099	Versafloppy III	$ 895.00	$ 759.00
BFPDBVF339145*	w/5¼″ unbanked CP/M® 3.0	$1083.00	$ 888.00
BFPDBVF339146*	w/8″ unbanked CP/M® 3.0	$1083.00	$ 888.00
BFPDBVF339147*	w/5¼″ banked CP/M® 3.0	$1083.00	$ 888.00
BFPDBVF339148*	w/8″ banked CP/M® 3.0	$1083.00	$ 888.00
BFSDS38098	Versafloppy II/696 (A&T)	$ 400.00	$ 344.00
BFPDBVF239141*	w/5¼″ unbanked CP/M® 3.0	$ 588.00	$ 424.00
BFPDBVF239142*	w/8″ unbanked CP/M® 3.0	$ 588.00	$ 424.00
BFPDBVF239143*	w/5¼″ banked CP/M® 3.0	$ 588.00	$ 424.00
BFPDBVF239144*	w/8″ banked CP/M® 3.0	$ 588.00	$ 424.00

*CP/M-Plus™ (3.0) configured for the SBC-300

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BFADCSUP6128	Super Six 6MHz 128K Master w/1 ADC PS1 RS232 Serial Adapter	$995.00	$849.00
BFADCSPRSLV6128	Super Slave 6MHz 128K	$695.00	$595.00
BFADCSBC15	Super Quad for 5¼″ drives	$750.00	$695.00
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Software & I/O Port Adapters For Above CPUs

BFADCPS1	PS/Net1 RS232 Serial Adapter	$ 35.00
BFADCCPSP	Centronics Parallel Port Adapter	$ 35.00
BFADCCPM22*†	Advanced Digital CP/M® 2.2	$150.00
BFADCCPM30*†	Advanced Digital CP/M Plus™ (3.0)	$350.00
BFADCTDOS4U*†	TurboDos® 1, 2, or 4 Multi-user	$550.00

*Replace * with **Q** to specify Super Quad; **S** for Super Six

† Replace † with **8** for 8″ IBM® 3740 format, **48** for 5¼″ 48 TPI format or **96** for 5¼″ 96 TPI format

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BFADCHDC10015	ST506 5¼″ Winchester Cont.	$500.00	$395.00
BFADCHDC10018	8″ Winchester Cont.	$500.00	$395.00
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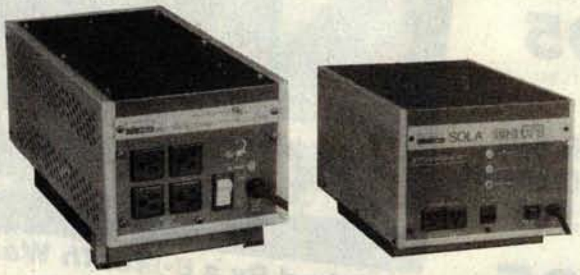

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BFQMETRAK842	Qume Full Height DS (18 lbs.)	$459.00
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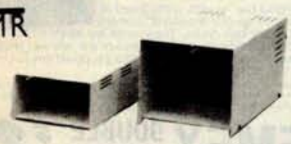
BFTNDTM8482	Tandon ½-Height DS (9 lbs.)	$399.00

JMR



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BFJMR1C5	Single Drive Cabinet (5 lbs.)	$ 79.00
BFJMR2C5	Dual Drive Cabinet (9 lbs.)	$ 99.00
BFJMR2C5C	Dual w/Internal Data Cable (9 lbs.)	$115.00

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Dual 8" Disk Enclosures

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FDE002. Economical design for two standard size 8" floppies. Hinged lid for easy drive access. Power supply 5V@4A, -5V@.8A, +24@3A.

DTL002. Cabinet for two ½-height 8" drives or 1 full height 8" floppy or Winchester. Includes Shugart type AC power cable.

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BFIIIFDE002	FDE002 Dual Enc. (35 lbs.)	$359.95	$325.00
BFIIIDTL002SHU	DTL002 Dual Thin Line (12 lbs.)	$225.00	$175.00
BFIIIDTLMPIKIT	MPI ½-Height DTL adapter kit		$ 24.95
BFIIICBLSQN304FM	Shugart to Qume AC Cable		$ 4.95

BUY CABINETS WITH DRIVES AND $AVE!

Combinations with FDE002

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BFPDBIIIFDE2M2	w/2 MFM289463BS Drives	$1049.00
BFPDBIIIFDE2Q2	w/2 QMETRAK842 Drives	$1199.00
BFPDBIIIFDE2851	w/2 SHU851R Drives	$1239.00
BFPDBIIISIE	w/2FDD1008 Drives	$ 499.00

Combinations with DTL002

BFPDBIIITND1	w/2 TNDTM8481 Drives	$ 879.00
BFPDBIIITND2	w/2 TNDTM8482 Drives	$1039.00

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BFTNDTM501	Tandon 6 Mb (9 lbs.)	$ 699.00
BFTNDTM502	Tandon 12 Mb (9 lbs.)	$ 795.00
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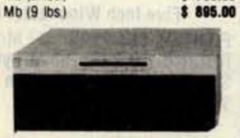

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All of the necessary power for two TANDON TM500 series or equivalent hard disk drives. Just imagine, you can have 100Mbytes of storage using two of the Micropolis 5¼" Winchester disk drives and this cabinet! Power supply: +5V@6A and +12V@6A. The rear panel is punched for two 20, two 34, and one 50 pin header connector. Fan cooled.

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BUY CABINET WITH DRIVES AND $AVE!

BFPDB501HD5	w/2 TM501 Drives	$1599.00
BFPDB502HD5	w/2 TM502 Drives	$1899.00
BFPDB503HD5	w/2 TM503 Drives	$2149.00

Disk drives will be shipped separately from cabinets. Don't forget to include shipping for each disk drive cabinet.

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DUAL SIEMENS FDD1008's with IIIFDE002 Cabinet

$499.00

SAVE $84.00!!

BFPDBIIISIE

(Drives are shipped separate from cabinet. Package shipped in 3 containers.)

SIEMENS

FDD1008 8" Drive Single Sided Double Density

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BFSIEFDD1008 (Be sure to include $7.00 per drive for shipping)

ADD-ON DRIVE FOR IBM PC™

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TM1002-1 Full Height 5¼" 40 Track 48 TPI Drive DOUBLE SIDED!

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California Digital has agreed to act as exclusive agent for North America in an effort to assist The Tano Corporation in reducing their overstock. For a limited time California Digital can offer the Dragon computer for only $139.

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Second Drive or Monitor

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IBM COMPATIBLE
$895

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PRINTERS $277

Star Gemini

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Star Gemini Delta 10, 160 Char/sec	STR-D10	399.00
Star Coex 80FT friction & tractor	VST-C80FT	195.00
Toshiba P1350, 192 char/sec. letter quality	TOS-1350	1495.00
Okidata 82A serial & parallel 9½" paper	OKI-82A	347.00
Okidata 92A parallel interface, 160 char/sec.	OKI-92A	427.00
Okidata 83A & parallel 15" paper	OKI-83A	567.00
Okidata 84A & parallel 15" paper	OKI-84A	997.00
Okidata 2350 (new) 350 char/sec	OKI-2350	1995.00
Epson RX-80 10" 120 Char/sec.	EPS-RX80	317.00
Epson FX80, 10" 160 char./sec. with graphtrax	EPS-FX80	529.00
Epson FX100 15" 160 char./sec with graphtrax	EPS-FX100	719.00
Epson MX100 with graphtrax, 15" paper	EPS-MX100	589.00
NEC8023A parallel 9½" paper, graphics	NEC-8023A	389.00
Anadex 9501B high speed with graphics	ADX-9501B	1029.00
Anadex 9620B 200 char/sec. par'l & serial	ADX-9620B	1129.00
Qume 7030 correspondence quality 180 char/sec.	QTX-7030	1599.00
Prowriter 8510 parallel 9½" paper	PRO-8510P	359.00
Prowriter II, parallel 15" paper, graphics	PRO-2P	689.00
Dataproducts B-600-3, band printer 600 LPM	DPS-B600	6985.00
Printronix P300 high speed printer 300 lines per minute	PTX-P300	4250.00
Printronix P600 ultra high speed 600 lines per minute	PTX-P600	5795.00

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NEC7710 55 char/second, serial interface	NEC-7710	1979.00
NEC7730 55 char/sec. par'l interface	NEC-7730	1979.00
NEC3550 popular printer designed for the IBM/PC	NEC-3550	1799.00
NEC2050 designed for IBM/PC 20 char/sec. par'l	NEC-2050	995.00
Silver Reed EXP500, 14 char/sec. par'l interface	SRD-EXP500	459.00
Silver Reed EXP550 17 Char/sec par'l interface	SRD-EXP550	659.00
Diablo 630 40 char/sec. serial	DBL-630	1765.00
Diablo 620, proportional spacing, horz & vert. tab. 20 cps.	DBL-620	879.00
Juki 6100, 18 char./sec. graphic mode	JUK-6100	495.00
Brother HR1A daisy wheel, parallel interface	BTH-HR1P	695.00
Brother HR1A serial interface	BTH-HR1S	695.00
Starwriter F10 serial, 40 char/sec.	STR-F10S	1125.00
Starwriter F10 parallel, 40 char/sec.	PRO-F10P	1125.00
Comrex CR1 word processing printer, serial intr.	CRX-CR1S	729.00
Comrex CR2, 5k buffer, proportional spacing, par'l	CRX-CR2P	495.00

MONITORS

BMC 12A green phosphor 15 MHz. composit video	BMC-12A	79.00
BMC 12" high resolution, 20MHz.	BMC-12EN	134.00
Zenith ZVM122 Amber Phosphor 12" 40/80 column switch.	ZTH-122	99.00
Zenith ZVM123 green phosphor 12" 40/80 column switch.	ZTH-Z123	99.00
NEC JB1201 green phosphor 18 MHz. composit video	NEC-JB1201	169.00
NEC JB1260 commercial grade composit.	NEC-JB1260	129.00
USI Amber screen 12" composit monitor.	USI-12A	99.00
Motorola 23" open frame blk/white composit video	MOT-BW23	159.00
Motorola 12" open frame requires horz sync. and power	MOT-BW12	69.00
Conrac 9" open frame requires horz sync. & 12v. supply	CON-BW9	59.00
COLOR		
BMC AU9191U Color composit video with sound	BMC-9191	249.00
BMC 9191M RGB designed for use with the IBM computer	BMC-9191M	399.00
NEC JC1203DM, RGB color monitor	NEC-1203	699.00
NEC JC1201 color composit.	NEC-JC1201	339.00
Zenith ZVM134 RGB color suitable for IBM PC	ZTH-Z134	379.00
Comrex color composit with sound	COM-6500	329.00
Amdek Color 1, composit video	AMK-100	329.00

MODEMS

DIRECT CONNECT $75

Hayes Smart Modem 1200 baud, auto answer, auto dial	HYS-212AD	499.00
Hayes 1200B for use with the IBM/PC, 1200 baud	HYS-1200B	449.00
Hayes Smartmodem, 300 baud only, auto answer, auto dial	HYS-103AD	229.00
Hayes Micromodem II, 103 Apple direct connect	HYS-MM2	279.00
Hayes Micromodem 100, S-100 auto answer, auto dial	HYS-100	319.00
Hayes Chronograph, time & date	HYS-CHR232	199.00
U.S. Robotics 212A 300/1200 baud, auto dial/answer	USR-212A	439.00
U.S. Robotics Password 300/1200 baud	USR-PW212	389.00
Pennil 300/1200 auto dial autolog	PEN-1240	695.00
Universal Data 103LP, line power, answer & originate	UDS-103LP	169.00
Universal Data 103LPJ, Auto answer	UDS-103LPJ	219.00
Universal Data 202, 1200 baud, half duplex only	UDS-202LP	219.00
Universal Data 212LP, full 1200 baud duplex, line power	UDS-212LP	359.00
Novation J Cat, direct connect, auto answer	NOV-JCAT	115.00
Novation Cat, acoustic connect	NOV-CAT	159.00
Novation SmartCat 103, auto answer, auto dial	NOV-SC103	219.00
Novation SmartCat 103/212, 1200 baud auto dial	NOV-SC212	529.00
Signalman Mark 1, direct connect with terminal cable	SGL-MK1	75.00

TERMINALS

California Digital has recently purchased an OEM liquidation, of new Hazeltine 1420 video terminals. These units feature direct cursor addressing, full 62 key keyboard with numeric cluster, RS-232C with baud rates selectable to 9600. Self diagnostics and escape sequences function mode make this terminal an excellent value at only $299.00. HZL-1420

$299

Hazeltine 1420 Video Display Terminal	HZL-1420	299.00
Freedom 100, split screen, detatchable keyboard	LIB-F100	495.00
Qume 102 green phosphor terminal	QUM-102	539.00
Visual 50 Green screen	VSL-50G	650.00
Ampex Dialogue 125 green screen,	APX-D125G	675.00
Ampex Dialouge 175 amber screen, two page, func. keys	APX-D125A	719.00
Wyse 50, 14" green phosphor	WYS-50	595.00
Wyse 100, horz & vert. split screen, metal enclosure	WYS-100	795.00
Wyse 300, Eight color display, split screen	WYS-300	1159.00
Televideo 910 Plus, block mode	TVI-910P	575.00
Televideo 925, detatchable keyboard, 22 function keys	TVI-925	759.00
Televideo 950, graphic char., split screen, 22 func	TVI-950	950.00
Televideo 970, 14" green screen, 132 column, European	TVI-970	1095.00
Zenith 29 terminal, VT52 compatible, detatchable keyboard	ZTH-Z29	765.00

APPLE $929

Apple II/e, 64K computer only	APL-2E	$989
Apple II/e starter kit, monitor, disk, 80 col. card.	APL-2ESK	1365
Advanced Business Tech. 13 Key Pad	ABT-13B	109
Calif. Computer 7710A Async. Serial Interface	CCS-7710	125
Calif. Computer 7710B same but for modem	CCS-7710B	125
Calif. Computer 7114A 12K PROM module	CCS-7114	99
Calif. Computer 7720A parallel interface	CCS-7720	99
Calif. Computer 7724A Calandar/clock modual	CCS-7724	99
Calif. Computer 7729A Centronics interface	CCS-7729	99
Calif. Computer 7740A programmable timer	CCS-7740	99
California Digital 16K card for standard Apple II	CAL-A16	39
Hayes Micromodem II for Apple II	HYS-MM2	279
Kensington Micro, System saver fan	KEN-SF1	75
Microsoft Softcard with CP/M; Z-80	MSF-SFTCD	239
Mountain Computer "The Clock"	MTN-TCLK	225
Mountain Computer AD/DA 16 input, 8bit	MTN-ADDA	269
Mountain Computer ROM Plus with keybd. filter	MTN-RMF	169
Mountain Computer ROM writer/socket socket	MTN-ROMW	139
Orange Micro "GRAPPLER" parallel interface	OMS-G2	135
Sorrento Valley 8" controller double side D/D.	SVA223	395
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6810	2.95
6820	4.35
6821	2.95
6828	14.95
6840	12.95
6843	34.95
6844	25.95
6845	14.95
6847	11.95
6850	3.25
6852	5.75
6860	7.95
6875	6.95
6880	2.25
6883	22.95
68047	24.95
68488	19.95

6800 = 1MHZ

68B00	10.95
68B02	22.25
68B09E	29.95
68B09	29.95
68B10	6.95
68B21	6.95
68B40	19.95
68B45	19.95
68B50	5.95

68B00 = 2 MHZ

6500

1 MHZ

6502	4.95
6504	6.95
6505	8.95
6507	9.95
6520	4.35
6522	6.95
6532	9.95
6545	22.50
6551	11.85

2 MHZ

6502A	6.95
6522A	9.95
6532A	11.95
6545A	27.95
6551A	11.95

3 MHZ

6502B	9.95

DISC CONTROLLERS

1771	16.95
1791	24.95
1793	26.95
1795	29.95
1797	49.95
2791	54.95
2793	54.95
2795	59.95
2797	59.95
6843	34.95
8272	39.95
UPD765	39.95
MB8876	29.95
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1691	17.95
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8000

8035	5.95
8039	5.95
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8085	4.95
8085A-2	11.95
8086	24.95
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8088	29.95
8089	89.95
8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	29.95
8748	24.95
8755	24.95

CRT CONTROLLERS

6845	14.95
68B45	19.95
HD46505SP	15.95
6847	11.95
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	19.95
CRT5037	24.95
TMS9918A	39.95
DP8350	49.95

8200

8202	24.95
8203	39.95
8205	3.50
8212	1.80
8214	3.85
8216	1.75
8224	2.25
8226	1.80
8228	3.49
8237	19.95
8237-5	21.95
8238	4.49
8243	4.45
8250	10.95
8251	4.49
8253	6.95
8253-5	7.95
8255	4.49
8255-5	5.25
8257	7.95
8257-5	8.95
8259	6.90
8259-5	7.50
8271	79.95
8272	39.95
8275	29.95
8279	8.95
8279-5	10.00
8282	6.50
8283	6.50
8284	5.50
8286	6.50
8287	6.50
8288	25.00
8289	49.95
8292	14.95

Z-80

2.5 Mhz

Z80-CPU	3.95
Z80-CTC	3.95
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	3.95
Z80-SIO/0	11.95
Z80-SIO/1	11.95
Z80-SIO/2	11.95
Z80-SIO/9	11.95

4.0 Mhz

Z80A-CPU	4.49
Z80A-CTC	4.95
Z80A-DART	9.95
Z80A-DMA	12.95
Z80A-PIO	4.49
Z80A-SIO/0	12.95
Z80A-SIO/1	12.95
Z80A-SIO/2	12.95
Z80A-SIO/9	12.95

6.0 Mhz

Z80B-CPU	9.95
Z80B-CTC	12.95
Z80B-PIO	12.95
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Z80B-SIO/2	39.95

ZILOG

Z6132	34.95
Z8671	39.95

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MM5375	4.95
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74LS00

74LS00	.24	74LS173	.69
74LS01	.25	74LS174	.55
74LS02	.25	74LS175	.55
74LS03	.25	74LS181	2.15
74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	1.29
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	1.39
74LS113	.39	74LS374	1.39
74LS114	.39	74LS375	.95
74LS122	.45	74LS377	1.39
74LS123	.79	74LS378	1.18
74LS124	2.90	74LS379	1.35
74LS125	.49	74LS385	3.90
74LS126	.49	74LS386	.45
74LS132	.59	74LS390	1.19
74LS133	.59	74LS393	1.19
74LS136	.39	74LS395	1.19
74LS137	.99	74LS399	1.49
74LS138	.55	74LS424	2.95
74LS139	.55	74LS447	.95
74LS145	1.20	74LS490	1.95
74LS147	2.49	74LS624	3.99
74LS148	1.35	74LS640	2.20
74LS151	.55	74LS645	2.20
74LS153	.55	74LS668	1.69
74LS154	1.90	74LS669	1.89
74LS155	.69	74LS670	1.49
74LS156	.69	74LS674	14.95
74LS157	.65	74LS682	3.20
74LS158	.59	74LS683	3.20
74LS160	.69	74LS684	3.20
74LS161	.65	74LS685	3.20
74LS162	.69	74LS688	2.40
74LS163	.65	74LS689	3.20
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
74LS166	1.95	81LS97	1.49
74LS168	1.75	81LS98	1.49
74LS169	1.75	25LS2521	2.80
74LS170	1.49	25LS2569	4.25

74S00

74S00	.32	74S124	2.75	74S197	1.49
74S02	.35	74S132	1.24	74S201	6.95
74S03	.35	74S133	.45	74S225	7.95
74S04	.35	74S134	.50	74S240	2.20
74S05	.35	74S135	.89	74S241	2.20
74S08	.35	74S138	.85	74S244	2.20
74S09	.40	74S139	.85	74S251	.95
74S10	.35	74S140	.55	74S253	.95
74S11	.35	74S151	.95	74S257	.95
74S15	.35	74S153	.95	74S258	.95
74S20	.35	74S157	.95	74S260	.79
74S22	.35	74S158	.95	74S273	2.45
74S30	.35	74S161	1.95	74S280	1.95
74S32	.40	74S162	1.95	74S287	1.90
74S37	.88	74S163	1.95	74S288	1.90
74S38	.85	74S168	3.95	74S289	6.89
74S40	.35	74S169	3.95	74S301	6.95
74S51	.35	74S174	.95	74S373	2.45
74S64	.40	74S175	.95	74S374	2.45
74S65	.40	74S181	3.95	74S387	1.95
74S74	.50	74S182	2.95	74S412	2.98
74S85	1.99	74S188	1.95	74S471	4.95
74S86	.50	74S189	6.95	74S472	4.95
74S112	.50	74S194	1.49	74S474	4.95
74S113	.50	74S195	1.49	74S570	2.95
74S114	.55	74S196	1.49	74S571	2.95

VOLTAGE REGULATORS

7805T	.75	7905T	.85
78M05C	.35	7908T	.85
7808T	.75	7912T	.85
7812T	.75	7915T	.85
7815T	.75	7924T	.85
7824T	.75		
		7905K	1.49
7805K	1.39	7912K	1.49
7812K	1.39	7915K	1.49
7815K	1.39	7924K	1.49
7824K	1.39		
		79L05	.79
78L05	.69	79L12	.79
78L12	.69	79L15	.79
78L15	.69		
		LM323K	4.95
78H05K	9.95	UA78S40	1.95
78H12K	9.95		

C, T = TO-220 K = TO-3
L = TO-92

SOUND CHIPS

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76488	5.95	AY3-8912	12.95
76489	8.95	MC3340	1.49
SSI-263	39.95		

7400

7400	.19	74123	.49
7401	.19	74125	.45
7402	.19	74126	.45
7403	.19	74132	.45
7404	.19	74136	.50
7405	.25	74143	4.95
7406	.29	74145	.60
7407	.29	74147	1.75
7408	.24	74148	1.20
7409	.19	74150	1.35
7410	.19	74151	.55
7411	.25	74153	.55
7413	.35	74154	1.25
7414	.49	74155	.75
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7425	.29	74163	.69
7427	.29	74164	.85
7430	.19	74165	.85
7432	.29	74166	1.00
7437	.29	74167	2.95
7438	.29	74170	1.65
7442	.49	74173	.75
7445	.69	74174	.89
7446	.69	74175	.89
7447	.69	74177	.75
7448	.69	74181	2.25
7451	.23	74184	2.00
7473	.34	74185	2.00
7474	.33	74191	1.15
7475	.45	74192	.79
7476	.35	74193	.79
7482	.95	74194	.85
7483	.50	74195	.85
7485	.59	74197	.75
7486	.35	74198	1.35
7489	2.15	74221	1.35
7490	.35	74246	1.35
7492	.50	74247	1.25
7493	.35	74259	2.25
7495	.55	74273	1.95
7497	2.75	74276	1.25
74100	1.75	74279	.75
74107	.30	74366	.65
74109	.45	74367	.65
74116	1.55	74368	.65
74121	.29	74393	1.35
74122	.45		

BYPASS CAPS

.01 UF DISC	100/6.00
.01 UF MONOLITHIC	100/12.00
.1 UF DISC	100/8.00
.1 UF MONOLITHIC	100/15.00

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SPECTRONICS CORPORATION

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		9	8,000	83.00
PE-14T	X	9	8,000	119.00
PE-24T	X	12	9,600	175.00
PL-265T	X	30	9,600	255.00
PR-125T	X	25	17,000	349.00
PR-320T	X	42	17,000	595.00

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8T28	1.89
8T95	.89
8T96	.89
8T97	.89
8T98	.89
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DP8304	2.29
DS8833	2.25
DS8835	1.99
DS8836	.99
DS8837	1.65
DS8838	1.30

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DAC0806	1.95	DAC1020	8.25
ADC0809	4.49	DAC1022	5.95
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RS232 Female	3.25
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XR 2208	3.75
XR 2211	5.25
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INTERSIL

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ICL7107	12.95
ICL7660	2.95
ICL8038	3.95
ICM7207A	5.59
ICM7208	15.95

9000

9316	1.00
9334	2.50
9368	3.95
9401	9.95
9601	.75
9602	1.50
96S02	1.95

LINEAR

LM301	.34	LM348	.99	LM567	.89	LM1812	8.25
LM301H	.79	LM350K	4.95	NE570	3.95	LM1830	3.50
LM307	.45	LM350T	4.60	NE571	2.95	LM1871	5.49
LM308	.69	LM358	.69	NE590	2.50	LM1872	5.49
LM308H	1.15	LM359	1.79	NE592	2.75	LM1877	3.25
LM309H	1.95	LM376	3.75	LM709	.59	LM1889	1.95
LM309K	1.25	LM377	1.95	LM710	.75	LM1896	1.75
LM310	1.75	LM378	2.50	LM711	.79	ULN2003	2.49
LM311	.64	LM379	4.50	LM723	.49	LM2877	2.05
LM311H	.89	LM380	.89	LM723H	.55	LM2878	2.25
LM312H	1.75	LM380N-8	1.10	LM733	.98	LM2900	.85
LM317K	3.95	LM381	1.60	LM741	.35	LM2901	1.00
LM317T	1.19	LM382	1.60	LM741N-14	.35	LM2917	2.95
LM318	1.49	LM383	1.95	LM741H	.40	LM3900	.59
LM318H	1.59	LM384	1.95	LM747	.69	LM3905	1.25
LM319H	1.90	LM386	.89	LM748	.59	LM3909	.98
LM319	1.25	LM387	1.40	LM1014	1.19	LM3911	2.25
LM320 (see 7900)		LM389	1.35	LM1303	1.95	LM3914	3.95
LM322	1.65	LM390	1.95	LM1310	1.49	LM3915	3.95
LM323K	4.95	LM392	.69	MC1330	1.69	LM3916	3.95
LM324	.59	LM393	1.29	MC1349	1.89	MC4024	3.95
LM329	.65	LM394H	4.60	MC1350	1.19	MC4044	4.50
LM331	3.95	LM399H	5.00	MC1358	1.69	RC4136	1.25
LM334	1.19	NE531	2.95	MC1372	6.95	RC4151	3.95
LM335	1.40	NE555	.34	LM1414	1.59	LM4250	1.75
LM336	1.75	NE556	.65	LM1458	.59	LM4500	3.25
LM337K	3.95	NE558	1.50	LM1488	.69	RC4558	.69
LM337T	1.95	NE561	24.95	LM1489	.69	LM13080	1.29
LM338K	6.95	NE564	2.95	LM1496	.85	LM13600	1.49
LM339	.99	LM565	.99	LM1558H	3.10	LM13700	1.49
LM340 (see 7800)		LM566	1.49	LM1800	2.37	MPQ2907	1.95

H = TO-5 CAN T = TO-220 K = TO-3

RCA

CA 3023	2.75	CA 3082	1.65
CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3160	1.19		

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
LF357	1.40		

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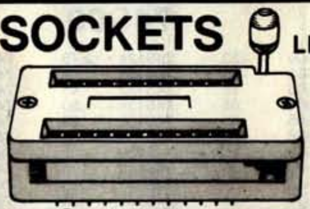
SPECIALS END 7/31/84

ZIF SOCKETS

ZIF = Zero Insertion Force



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40	10.95

OPTO-ISOLATORS

4N26	1.00	MCA-7	4.25
4N27	1.10	MCA-255	1.75
4N28	.69	IL-1	1.25
4N33	1.75	ILA-30	1.25
4N35	1.25	ILQ-74	2.75
4N37	1.25	H11C5	1.25
MCT-2	1.00	TIL-111	1.00
MCT-6	1.50	TIL-113	1.75

RESISTORS

¼ WATT 5% CARBON FILM
ALL STANDARD VALUES
FROM 1 OHM TO 10 MEG OHM

50 PCS. SAME VALUE	.025
100 PCS. SAME VALUE	.02
1000 PCS. SAME VALUE	.015

BYPASS CAPS

.01 UF DISC	100/6.00
.01 UF MONOLITHIC	100/12.00
.1 UF DISC	100/8.00
.1 UF MONOLITHIC	100/15.00

CAPACITORS

TANTALUM

	6V	10V	15V	20V	25V	35V
.22uf						.40
.27						.40
.33						.40
.47				.35		.50
.68						.45
1.0			.40	.40	.45	.45
1.5				.45		.50
1.8						.75
2.2		.35	.40	.45		.65
2.7		.40	.45			.90
3.3		.45	.50	.55	.60	.65
3.9			.45			
4.7	.45	.55		.60	.65	.85
6.8			.70		.75	
10	.55	.65	.80	.85	.90	1.00
12	.65		.85	.90		
15	.75	.85	.90			
18			1.25			
22		1.00	1.35			
27			2.25			
39		1.50				
47	1.35					
56	1.75					
100		3.25				
270	3.75					

DISC

10pf	50V	.05	470	50V	.05
22	50V	.05	560	50V	.05
25	50V	.05	680	50V	.05
27	50V	.05	820	50V	.05
33	50V	.05	.001uf	50V	.05
47	50V	.05	.0015	50V	.05
56	50V	.05	.0022	50V	.05
68	50V	.05	.005	50V	.05
82	50V	.05	.01	50V	.07
100	50V	.05	.02	50V	.07
220	50V	.05	.05	50V	.07
330	50V	.05	.1	12V	.10
			.1	50V	.12

MONOLITHIC

.1uf-mono	50V	.18	.47uf-mono	50V	.25
.047uf-mono	50V	.15	.01uf-mono	50V	.14

ELECTROLYTIC

RADIAL			AXIAL		
.47uf	50V	.14	1uf	50V	.14
1	25V	.14	4.7	16V	.14
2.2	35V	.15	10	16V	.14
4.7	50V	.15	10	50V	.16
10	50V	.15	22	16V	.14
47	35V	.18	47	50V	.20
100	16V	.18	100	15V	.20
220	35V	.20	100	35V	.25
470	25V	.30	150	25V	.25
2200	16V	.60	220	25V	.30
			330	16V	.40
			550	16V	.42
			1000	16V	.60
			1500	16V	.70
			6000	16V	.85

COMPUTER GRADE

44,000uf 30V 3.95

TRANSISTORS

2N918	.50	MPS3706	.15
MPS918	.25	2N3772	1.85
2N2102	.75	2N3903	.25
2N2218	.50	2N3904	.10
2N2218A	.50	2N3906	.10
2N2219	.50	2N4122	.25
2N2219A	.50	2N4123	.25
2N2222	.25	2N4249	.25
PN2222	.10	2N4304	.75
MPS2369	.25	2N4401	.25
2N2484	.25	2N4402	.25
2N2905	.50	2N4403	.25
2N2907	.25	2N4857	1.00
PN2907	.125	PN4916	.25
2N3055	.79	2N5086	.25
3055T	.69	PN5129	.25
2N3393	.30	PN5139	.25
2N3414	.25	2N5209	.25
2N3563	.40	2N6028	.35
2N3565	.40	2N6043	1.75
PN3565	.25	2N6045	1.75
MPS3638	.25	MPS-A05	.25
MPS3640	.25	MPS-A06	.25
PN3643	.25	MPS-A55	.25
PN3644	.25	TIP29	.65
MPS3704	.15	TIP31	.75
		TIP32	.79

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call

ST = SOLDERTAIL

8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80

WW = WIREWRAP

DIODES

1N751	5.1 volt zener	.25
1N759	12.0 volt zener	.25
1N4148	(1N914) switching	25/1.00
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MAN 74	.3"	CC	.99
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FND-507 (510)	.5"	CA	1.49
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7 POSITION	.95
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- ★ Color matches Apple
- ★ Fits standard 5¼" drives, inc. Shugart
- ★ Includes mounting hardware and feet

CABINET #2 $79.00
- ★ Complete with power supply, switch, line cord, fuse & standard power connector
- ★ Dimensions: 11½ x 5¾ x 3¹⁵⁄₁₆"
- ★ +5V @ 1 AMP, +12V @ 1.5 AMP
- ★ Please specify gray or tan

NOTE: Please include sufficient amount for shipping on above items.

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TEAC

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20	.65	5.70	1.25	11.00
25	.75	6.60	1.32	11.60
26	.75	6.60	1.32	11.60
34	.98	8.60	1.65	14.50
40	1.32	11.60	1.92	16.80
50	1.38	12.10	2.50	22.00

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CRT Controller's Handbook	9.95
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CBASIC User Guide	15.00

SYBEX

Z-80 Applications	15.95
IBM PC PRO DOS Handbook	16.95
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S-100 ST	3.95
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72 pin ST	6.95
72 pin WW	7.95
50 pin ST	4.95
44 pin ST	2.95
44 pin WW	4.95

DIP CONNECTORS

DESCRIPTION	ORDER BY	8	14	16	18	20	22	24	28	40
HIGH RELIABILITY TOOLED ST IC SOCKETS	AUGATxx-ST	.99	.99	.99	1.69	1.89	1.89	1.99	2.49	2.99
COMPONENT CARRIERS (DIP HEADERS)	ICCxx	.65	.75	.85	1.00	1.25	1.25	1.35	1.50	2.10
RIBBON CABLE DIP PLUGS (IDC)	IDPxx	---	1.45	1.65	---	---	---	2.50	---	4.15

(Columns 8–40: CONTACTS)

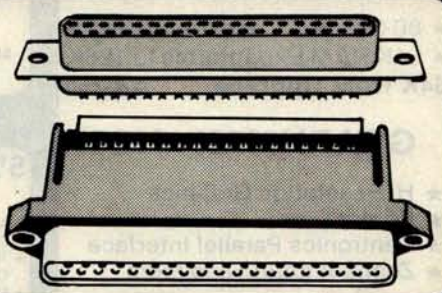
For order instructions see "IDC Connectors" below.

D-SUBMINIATURE

DESCRIPTION		ORDER BY	9	15	25	37	50
SOLDER CUP	MALE	DPxxP	2.08	2.69	2.50	4.80	6.06
SOLDER CUP	FEMALE	DBxxS	2.66	3.63	3.25	7.11	9.24
RT. ANGLE PC HOLDER	MALE	DBxxPR	1.65	2.20	3.00	4.83	---
RT. ANGLE PC HOLDER	FEMALE	DBxxSR	2.18	3.03	4.42	6.19	---
IDC RIBBON CABLE	MALE	IDBxxP	3.37	4.70	6.23	9.22	---
IDC RIBBON CABLE	FEMALE	IDBxxS	3.69	5.13	6.84	10.08	---
HOODS	BLACK	HOOD-B	---	---	1.25	---	---
HOODS	GREY	HOOD	1.60	1.60	1.25	2.95	3.50

(Columns 9–50: CONTACTS)

MOUNTING HARDWARE - $1.00 For order instructions see "IDC Connectors" below.

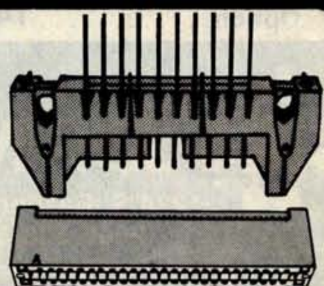


IDC CONNECTORS

DESCRIPTION	ORDER BY	10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RT. ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WW HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RT. ANGLE WW HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	1.15	1.86	2.43	3.15	3.73	4.65
RIBBON HEADER	IDMxx	----	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	2.25	2.36	2.65	3.25	3.80	4.74

(Columns 10–50: CONTACTS)

ORDERING INSTRUCTIONS: Insert the number of contacts in the position marked "xx" of the "order by" part number listed. **Example:** A 10 pin right angle holder style header would be IDH10SR.



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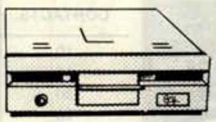

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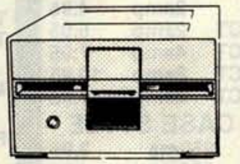
MA SYSTEMS FD-35 DISK DRIVE



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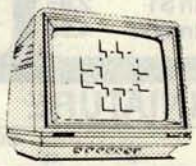

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WANTED: Tax-exempt, nonprofit organization seeks computer, disk drives, printers, or whatever peripherals are available to institute listing and cross-indexing of individuals needing food, clothing, and shelter in their areas. References and IRS information available on request. Jesse F. Estlock, 132 Franklin St., Tiffin, OH 44883.

WANTED: Nonprofit organization that provides inexpensive, wholesome meals to the elderly and incapacitated in their own homes in the Germantown area of Philadelphia, needs a donation of a small computer to do payroll and inventory control. Help in learning to use it also needed. IRS information and references on request. Meals on Wheels Inc., c/o Margaret Steigner, 32A Brookside Dr., Lansdale, PA 19446, (215) 362-6197.

WANTED: Teacher of 20 educable, mentally disabled students with less than a $200 budget per year, needs a computer to help teach students. George Tassey, Windsor Forest High School, 12419 Largo Dr., Savannah, GA 31499.

WANTED: Tax-exempt, nonprofit Chamber of Commerce seeks tax-deductible donations of computers, modems, printers, and terminals. Certified receipts can be furnished. Indianola Chamber of Commerce, 201 West Salem, Indianola, IA 50125, (515) 961-6269, call Alan collect.

WANTED: Apple IIe or equivalent for church use. Parts or complete system. Receive a tax deduction; we pay shipping. Rev. David Massey, First-Meridian Heights Presbyterian Church, Indianapolis, IN 46205.

NEEDED: The National Institute for Adult Education in Yucatan, Mexico, will receive any hardware or textbooks in English and Spanish to initiate computer education. Alan Handleman, Apartado Postal #422, Merida, Yucatan, Mexico.

WANTED: An Apple users club in the vicinity of Riverton, Wyoming. I cannot connect by modem. Rod Ahlbrandt, 1104 Big Horn, Riverton, WY 82501.

WANTED: Student would greatly appreciate an unwanted, new, or used copy of *6502 Assembly Language Programming* (L. Leventhal) and/or a copy of *Beneath Apple DOS* (Worth & Lechner). Willing to pay shipping. Michael Whitman, American Embassy—Buenos Aires, APO Miami, FL 34034.

FOR SALE: Wicat 150-3, three-user system, CRT, floppy disk, ½-megabyte memory, graphics board, MCS operating system, 10-megabyte disk, recently upgraded, 90-day factory-warranty intact: $14,100 list, asking $10,000 or best offer. Ed Neugass, Apt. A-1707, 1400 South Joyce, Arlington, VA 22202, (703) 892-4225 evenings.

WANTED: BYTE #4 (December 1975). Gary Case, 585 Big Sky Court, Colorado Springs, CO 80919, (303) 599-0744.

WANTED: Nonworking 9-wire printhead for Centronics 737/739 printer. I need the round magnet that rotates under the Hall-effect transistor. Bob Swirsky, POB 122, Cedarhurst, NY 11516, (516) 295-4344.

FOR SALE: Z-80 starter kit with manual and expansion bus, very good condition: $200. Would also like to correspond with other 6800 people. Robert Smith, POB 41-10016, Michigan City, IN 46360.

WANTED: Would like to digitize pictures for educational applications. Have Shiba black-and-white video camera (Model AV15) and an Apple IIe. Need to know what hardware we need, and where and how to get it. T. Rapp, c/o Summit School Inc., 611 East Main St., Dundee, IL 60118.

FOR SALE: IBM 3101 terminal. Two years old, excellent condition: $800. Dr. Neer, Massachusetts General Hospital, Mineral Metabolism Unit, Bulfinch 4, Boston, MA 02114 (617) 726-3288.

WANTED: People to form an international Apple III user group. George H. Buch, c/o Buchan, Ravnsborggade 19, Copenhagen 2200 N, Denmark.

FOR SALE: IBM Selectric typewriter, Model 745 (Redactron), complete with transistor drivers and solenoids. Also includes 10-pitch type element, IBM Selectric I/O typewriter manual, maintenance manual, Redactron interface-building instructions, and Redactron Interface EPROM. Selling for $375 or best offer. Dennis Kamin, 104 Timber Lane, Collinsville, CT 06022, (203) 693-0043 evenings.

FOR SALE: S-100 computer system, CP/M, 5-slot, SD Systems 3-card set, 64K, dual 8-inch drives, one serial, Centronics parallel with manuals: $1500. Also, 200-LPM—Tally 2200 Line Printers, full 132-column, upper- and lowercase, ASCII, Centronics parallel interface: both for $1500; one in perfect condition, other needs work. Frank Bennett, 5758 East Willowview Dr., Camarillo, CA 93010, (805) 987-9879.

FOR SALE: Three unused Multi-Tech modems, Model 212A, 1200/300 switchable data rate, originate, answer, auto-answer, full-duplex, synchronous, or asynchronous. Over $700 each new, will sell for $400 each. George F. Weiss, 127 Michael Dr., Red Bank, NJ 07701, (201) 530-9553.

WANTED: APL mathematics public-domain programs that may be in cassettes for a recently acquired IBM 1500 D with 64K to solve polynomial equations with complex coefficients that will plot simultaneous equations (f(x,y)=0, plot x=f(t), and y=g(t)). Harry D. Ruderman, 2624 Davidson Ave., New York, NY 10468, (212) 933-933-2650.

FOR SALE: Brother EP-20 personal electronic printer (5 by 7 dot matrix, correction, extra ribbons, and protective cover) brand new, barely used: asking $125, negotiable. Willing to exchange for Atari equipment especially interface module or other parallel printer interface or Votrax SC-01-based speech-synthesis system. Ravi Subrahmanyan, Electrical Engineering Department, Duke University, Durham, NC 27706.

WANTED: High school student wishes to buy new or used Mountain Computer Music Boards for Apple. Price negotiable. Also interested in other computer and electronic music paraphernalia like music boards, keyboards, and synthesizers. I pay postage. Eric Rose, 18 Floral Dr., Hastings-on-Hudson, NY 10706, (914) 478-1418 weekdays after 5 p.m.

FOR SALE: TI-99 and TI-99/4A cassette-interface cables: $10. Send check or money order. Tim Anderson, 215 3rd Ave. S., Saint Cloud, MN 56301.

WANTED: Any unwanted computers or peripherals, for Apple IIe or a TRS-80 Model III. I will pay for shipping and handling. Christopher C. Caron, Stonewall Lane, Madison, CT 06443.

FOR SALE: Seawell maxi-motherboard (hobby version for AIM, SYM, SIM); Seawell 16K RAM board; Seawell floppy-disk controller and Problem Solvers 8K Memory Board. Will sell separately or as a package ($600) or will exchange for IBM PC boards. J. Hofstee, Box 108, Windmill Point, Cornwall, Ontario K6H 4Z1, Canada, (613) 933-6080 ext. 334.

FOR SALE: Back issues of BYTE 1977 through 1983 (volumes 2 through 8) except January and September 1979, and November 1982. All in excellent condition: $100 plus shipping. J. E. Burchfield, 6 Bonus Hill Dr., Scotch Plains, NJ 07076, (201) 757-9441.

FOR SALE: LNW computer Model II equivalent, recently factory reconditioned. Two 5¼-inch drives (40t Lobo, 80t Tandon), dual Shugart 8-inch drives, BMC KG-12C monitor, FACIT (Data Royal 9001) printer, 5/8 switch: $3600. Bruce Armstrong, 423 South Poplar St., Centralia, IL 62801, (618) 533-3009.

FOR SALE: TRS-80 Model II with 64K memory and 416K storage, plus Radio Shack Model 500 high-speed printer: $3200 or best offer. Loren Chinea, 313 West 105th St., New York, NY 10025, (212) 841-2475 days, (212) 866-5404 evenings.

WANTED: Information exchange with users of TRS-80 MC-10 computer. Jim Robinson, Apt. 220, 2915 Baseline Rd., Boulder, CO 80303, (303) 444-4437 after 2 p.m.

WANTED: High school student would like donated computer equipment, cards, peripherals, and any high-tech electronics. I will pay all postage. Bernard Boivin, 691 Rue des Cormiers, Dolbeau, Quebec G8L 1B4, Canada, (418) 276-2402.

WANTED: WordStar Customization Notes to buy or borrow. Need to patch WordStar for Dvorak keyboard layout—change menus, echos on menu selections, and CTRL key entries. Ben Cohen, Box 1674, Chicago, IL 60690.

FOR SALE: HP 87 personal computer 288K RAM, 5-megabyte Winchester disk drive, 5¼-inch floppy-disk drive, dot-matrix printer, direct-connect modem, RS-232C serial interface, plotter, and I/O ROMs. Covered by HP services contract. Originally over $10,000, asking $6250. R. G. Adelson, Burlington Woods Dr., Burlington, MA 01803, (617) 229-2440 days.

FOR SALE: Four Tandon TM100-1A disk drives, $88 each, any or all. Qume QVT-102 terminal, green: $475. Like new. L. Bassat, 9639 Dorothy Ave., South Gate, CA 90280, (213) 567-8758.

FOR SALE: Optimal Technology EP-2A-88 stand-alone EPROM programmer. Makes up to four copies of a master EPROM. 2732 and 2732A modules included; will program many other types: $400. Martin Kennedy, 309 Rena Dr., Lafayette, LA 70503, (318) 233-8240 ext. 509.

FOR SALE: Back issues of BYTE, 1976 to present: $1 per issue plus postage. Available for 50¢ per issue: *Interface Age*, *Kilobaud Microcomputing*, *QST*, *Ham Radio*, and *73*. Send SASE. Joe Dubner, 865 South Haskett St., Mountain Home, ID 83647, (208) 587-9383.

WANTED: College student seeks computer and peripherals. Will pay shipping charges. Ed Crowley, 602 College Ave., Columbia, MO 65201, (314) 875-9061.

WANTED: Would like to trade noncopyrighted software for the TRS-80 Model 100 or Model III. Mark Deavult, Box 105, Churchview, VA 23032, (804) 758-2865.

FOR SALE: Heath H-27 floppy-disk subsystem: dual 8-inch drives, cabinet, power supply, controller, interface board for DEC LSI-11, cable: $200 freight collect. Paul Abrahams, 214 River Rd., Deerfield, MA 01342, (413) 774-5500.

FOR SALE: Apple II+, 48K, 16K (4116's) RAM card, Apple drive with controller, DOS 3.3, manuals: $950 or will sell separately. Also, modified MEK 6800D2 kit, with 6802 MPU, 1-MHz crystal, 2716 EPROM programmer, employing a 6846 counter-timer—I/O and Z-I-F socket, fully buffered, MPU board fully socketed, fully documented revisions: $350. Nate Wright, 3244 Blaisdell Ave. S #202, Minneapolis, MN 55408, (612) 827-3314.

FOR SALE: Paper Tiger 440 dot-matrix printer plus Apple II parallel-interface card. Includes printer ribbons, cables, and all documentation: $300 or best offer. Also, Trendcom 100 thermal printer plus Apple II interface card and cable: $100 or best offer. Art Mena, 10414 Rutgers Court, Cypress, CA 90630, (714) 761-2585.

FOR SALE: Apple Extended 80-column cards for Apple IIe: $99 each. 16K RAM cards with cable: $49 each. Dynamic RAMs 4164-200ns: $4.50 each. 4116-200ns: $1 each. IC sockets 16-pin high-quality solder-tail: 100/$10. All items are new and are in original packages. Ersin Caner, 2330 North Oliver #516, Wichita, KS 67220, (316) 683-2619.

UNCLASSIFIED POLICY: *Readers who have computer equipment to buy, sell, or trade or who are requesting or giving advice may send a notice to BYTE for inclusion in the Unclassified Ads section. To be considered for publication, an advertisement must be noncommercial and nonprofit (individuals or bona fide computer clubs), typed double-spaced, contain 60 words or less, and include name and address. This is a free service; notices are printed as space permits. Your confirmation of placement is appearance in an issue of BYTE as we engage in no correspondence. Please allow at least four months for your ad to appear. Send your notices to BYTE, Unclassified Ads, POB 372, Hancock, NH 03449.*

B·O·M·B

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THE WINS OF MARCH

Jerry Pournelle's User's Column (beginning this issue, retitled Computing at Chaos Manor), "New Machines, Networks, and Sundry Software," won top billing in BYTE's March tally. $100 will be delivered to the prolific author. The Circuit Cellar project on how to "Build a Third-Generation Phonetic Speech Synthesizer" placed second, providing Steve Ciarcia with the $50 bonus. In third place is Peter R. Sørensen's "Simulating Reality with Computer Graphics." "Computer Simulation: What It Is and How It's Done" by Richard Bronson placed fourth in the March countdown, and in fifth place is Stan Miastkowski's review on "Microsoft Flight Simulator." BYTE congratulates these authors.

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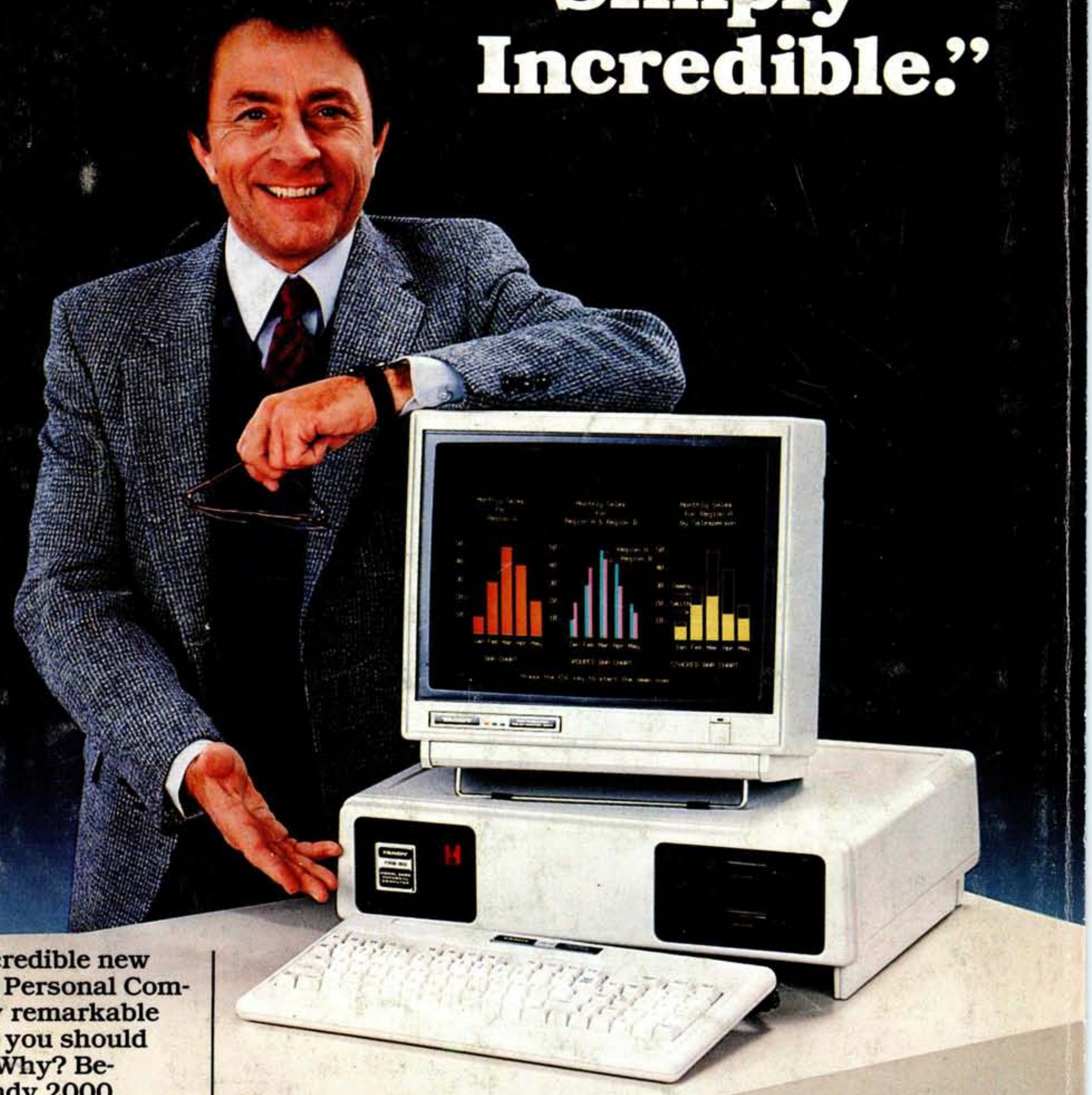

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