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# BYTE®

the small systems journal

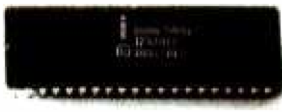
MAY 1984 Vol. 9, No. 5
$3.50 in U.S.A.
$4.25 in Canada/£2.10 in U.K.
A McGraw-Hill Publication
0360-5280


Computers and the Professions

# Introducing Macintosh. What makes it tick. And talk.

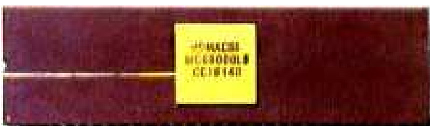
Well, to begin with, 110 volts of alternating current.

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.

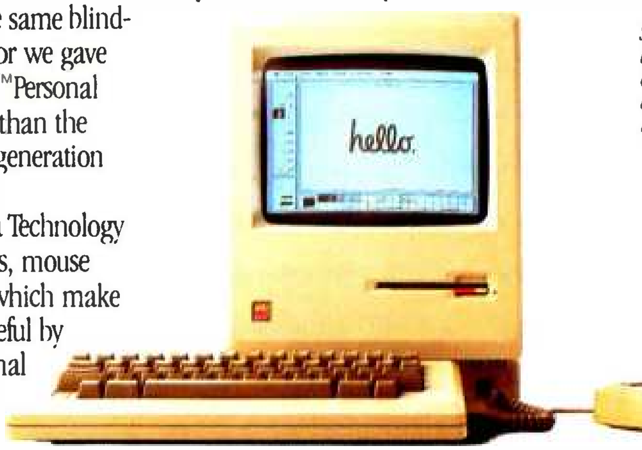
## Now for some small talk.

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.*

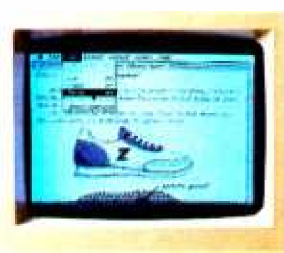
*Some mice have two buttons. Macintosh has one. So it's extremely difficult to push the wrong button.*

*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.)

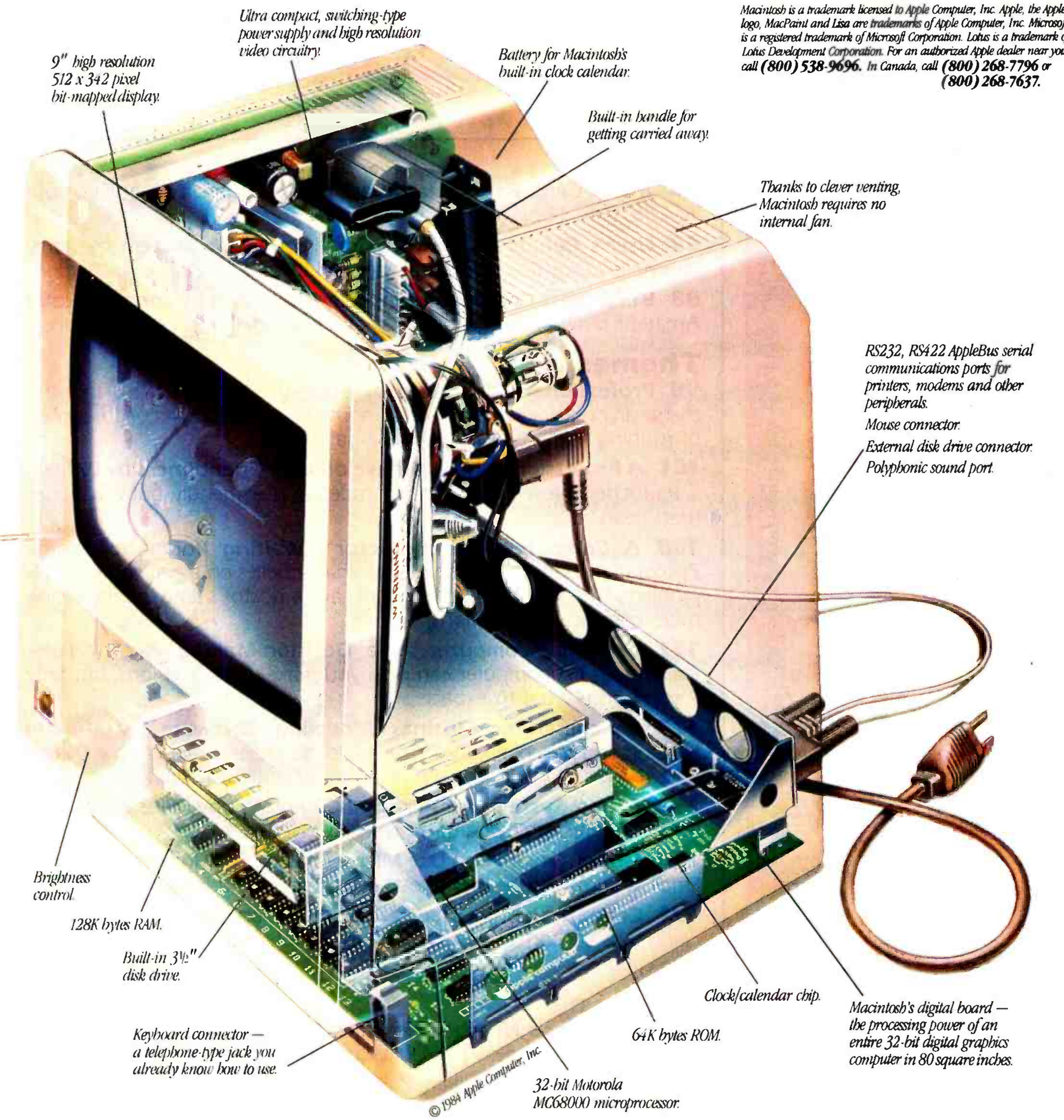
Should you wish to double Macintosh's storage with an external disk



*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.**

# In The Queue

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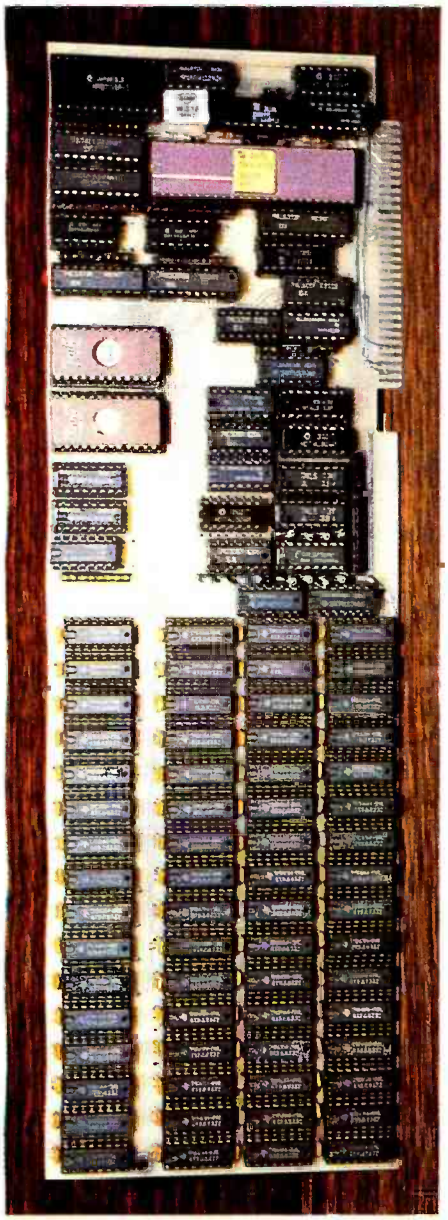

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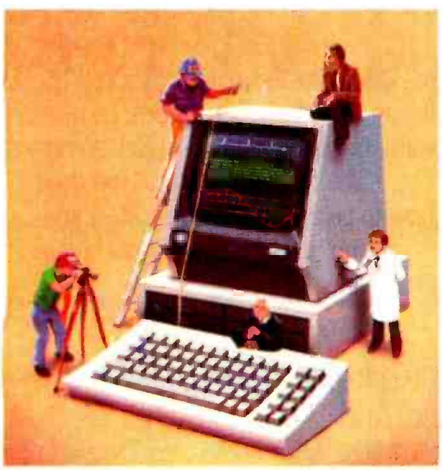

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## Columns



## Themes



## Reviews



BYTE is published monthly by McGraw-Hill Inc. Founder: James H. McGraw (1860-1948). Executive, editorial, circulation, and advertising offices: 70 Main St., Peterborough, NH 03458, phone (603) 924-9281. Office hours: Mon—Thur 8:30 AM — 4:30 PM, Friday 8:30 AM — 1:00 PM, Eastern Time. Address subscriptions to BYTE Subscriptions, POB 590, Martinsville, NJ 08836. Postmaster: send address changes, USPS Form 3579, undeliverable copies, and fulfillment questions to BYTE Subscriptions, POB 596, Martinsville, NJ 08836. Second-class postage paid at Peterborough, NH 03458 and additional mailing offices. USPS Publication No. 528890 (ISSN 0360-5280). Postage paid at Winnipeg, Manitoba. Registration number 9321. Subscriptions are $21 for one year, $38 for two years, and $55 for three years in the USA and its possessions. In Canada and Mexico, $23 for one year, $42 for two years, $61 for three years. $53 for one year air delivery to Europe. 17,100 yen for one year surface delivery to Japan. $37 surface delivery elsewhere. Air delivery to selected areas at additional rates upon request. Single copy price is $3.50 in the USA and its possessions, $3.95 in Canada and Mexico, $4.50 in Europe, and $5 elsewhere. Foreign subscriptions and sales should be remitted in United States funds drawn on a U.S. bank. Please allow six to eight weeks for delivery of first issue. Printed in the United States of America.

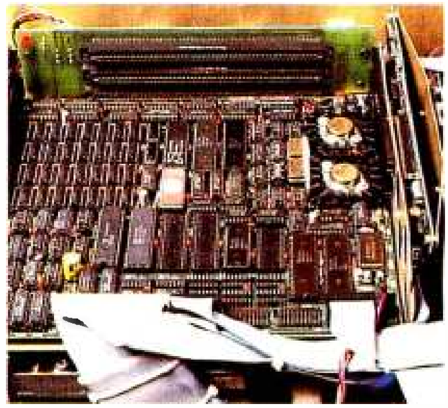
## Features



## Nucleus



Cover painting by Robert Tinney



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the small systems journal

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## Editorial

# The BYTE Reader: Who You Are

We do a lot of research about our readers and your interests, and we thought you might enjoy knowing more about the group you join when you subscribe to BYTE.

You are very well educated. More than 93 percent have gone beyond high school, with about 78 percent completing college, 23.5 percent holding master's degrees, 10 percent holding Ph.D.s, and 2.8 percent holding professional degrees. In all, about 40 percent have some graduate education.

Your fields of study in college are varied. Almost 25 percent of BYTE subscribers majored in electrical engineering, 5.2 percent in mechanical engineering, and 7.8 percent in other engineering specialties. Another 15 percent majored in sciences, 7.8 percent in computer science, and 6.8 percent in social sciences.

Of those BYTE subscribers who did graduate work, 14.8 percent studied business administration, 10.7 percent pursued electrical engineering, and 13.8 percent explored other areas of engineering, while 9.2 percent studied computer science, 13.3 percent physics or chemistry, 7.7 percent mathematics, 4.6 percent social sciences, and 9.2 percent other sciences.

Your occupations reflect your high levels of education and skills. About 15 percent of you are engineers in computers or electronics, 17 percent are engineers in other fields, 5.5 percent are computer scientists, 8 percent are in other fields of science, 13 percent are computer analysts or programmers, 11 percent are managers or administrators, 4.5 percent are students (though this number is growing fast), 4.5 percent are self-employed, and 6 percent are educators.

Some 47.3 percent of you have responsibilities including management and administration, 39 percent have responsibilities in product design and development, 37 percent in research and development, 37 percent in data processing, 14 percent in purchasing.

You use computers in many ways. About 75 percent of you use computers for personal, nonbusiness purposes, and 83.5 percent use microcomputers for business. As to your primary involvements with computers, some 23 percent cite involvement in hardware or software technology, while 20 percent cite use of computers as a management tool or in business applications. Half of you plan to buy a personal computer for nonbusiness purposes in the next year. In personal, nonbusiness use, the leading applications are programming (72 percent), word processing (70 percent), designing hardware or software (68 percent), followed by games, databases, personal finance, and spreadsheets (43 percent). In business, some 80 percent of you or your businesses use microcomputers for word processing, 63 percent for engineering or scientific applications, 63 percent for accounting, 38 percent for industrial control and processing, 37 percent for sales and marketing, 34 percent for electronic mail, 30 percent for investment management, and 28 percent for tax management.

Your favorite articles are about new technology, new hardware, new software, software applications, new peripherals, programming languages, operating systems, telecommunications, and computer graphics. You are also fond of hardware and software reviews.

# 68000-based systems. Just tell us what you need.

### 68000-based systems to fit your application.

Right from the pages of our catalog, we can deliver 68000-based supermicro systems to match virtually any application.

Including yours.

Here's how.

Built on the IEEE-696 (S-100) bus, Cromemco systems offer up to 21 board slots. And a family of 35 boards — CPU, memory and specialized I/O — to fill the slots any way you choose.

At the heart of each system is our 68000/Z-80 dual processor. Backed by as much as 16 Mb of error-correcting RAM. Full multi-tasking capability. I/O to handle up to 16 terminals.

And that's just the beginning.

You can select single or dual floppies, 5¼" or 8." A 21 Mb 5¼" Winchester hard disk. And a nine-track tape drive.

We can accommodate your taste for the exotic, too. With boards like our SMD interface that supports up to 1200 Mb of disk storage. An NTSC standard color graphics interface. A TV camera digitizer. A/D and D/A converters. An IEEE-488 bus interface. Communications. And more.

### Intelligent workstations.

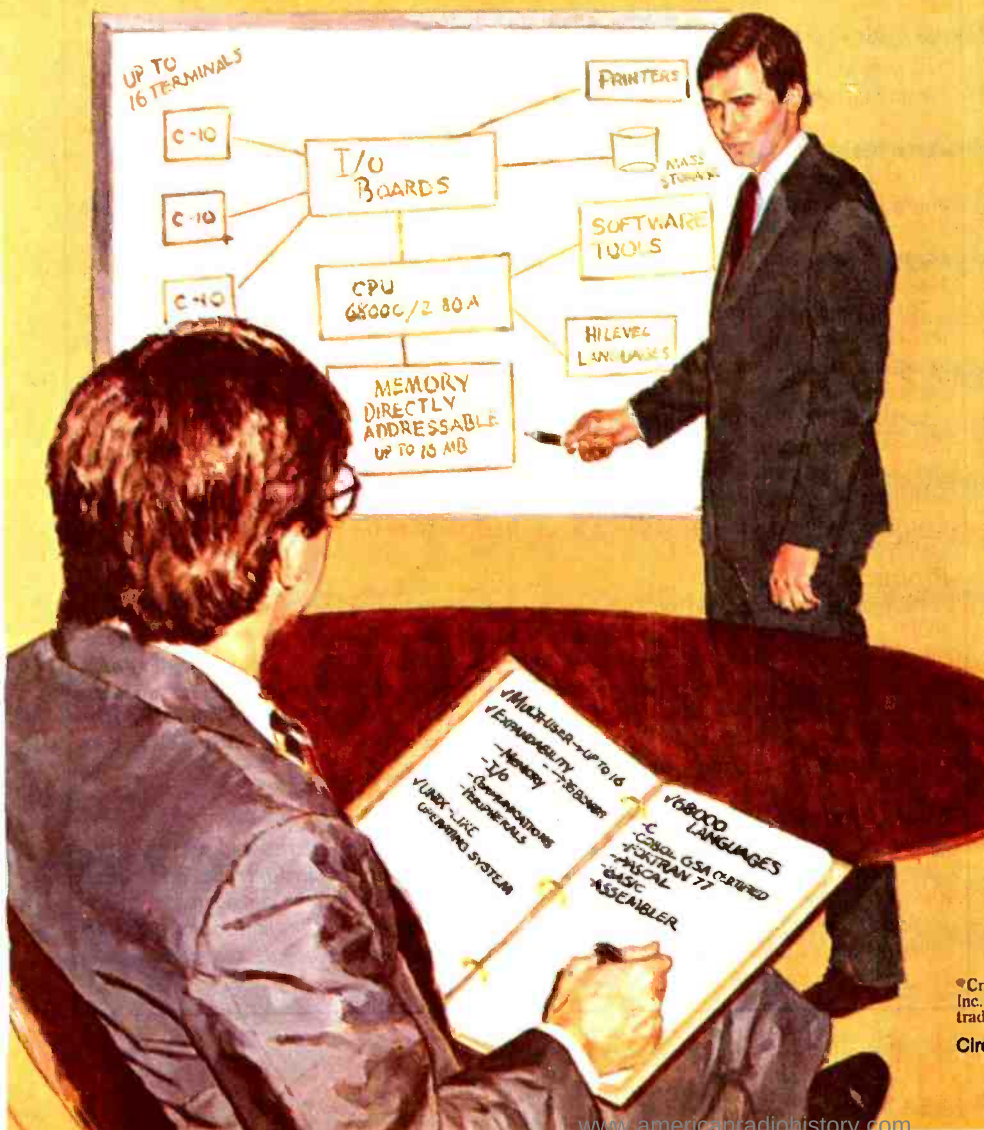
Then, if you're designing a distributed processing system, you'll want to take a look at our C-10 personal computer. The Z-80-based C-10 can serve our 68000-based systems as a powerful intelligent workstation in a distributed processing mode. Or as an independent personal computer with its own floppy storage.

### High-level languages and applications software.

That brings us to software. It starts with CROMIX,® our UNIX™-like operating system that you're free to tailor to your application.

CROMIX can execute both 68000- and Z-80-based programs. So right along with your 68000-based packages, your system will accommodate a wide selection of CP/M® software written for the Z-80.

And our high-level language support is second to none. From a 68000 Macro Assembler. To 68000 FORTRAN 77, PASCAL, GSA-certified high-level COBOL, C and BASIC.




### Cromemco means business. Your business.

You see, when we say, "Just tell us what you need," we're not kidding.

You won't find another family of 68000-based microcomputers that can fit your needs as exactly as ours.

So if you're in the business of providing specialized computing solutions, you really should be doing business with Cromemco.

For a copy of our Systems Catalog, contact: Cromemco, Inc., 280 Bernardo Avenue, P.O. Box 7400, Mountain View, CA 94039. (415) 964-7400.

In Europe: Cromemco/GmbH, 6236 Eschborne 1, Frankfurter Str. 33-35, P.O. 5267, Frankfurt Main, Germany or Cromemco Ltd., The Cambridge House, 178-182 Upper Richmond Rd., Putney, London SW15 England.

**Cromemco®**



Circle 117 on inquiry card.

Not surprisingly, you know a great deal about computers and have valuable information to share (if you want to share your knowledge by writing for BYTE, see the text box below). Almost 50 percent of you describe your skills in personal computing as advanced, and another 40 percent call your skills intermediate; the remaining 10 percent are college students and other bright novices who want to learn a lot fast.

You cite the comprehensiveness and depth of BYTE's coverage of personal computing as distinguishing it from other magazines. We consider that the supreme compliment.

We do research in order to make sure that BYTE continues to focus on your interests and needs. Since our staff shares your interests and matches your profile, we hope not only to do a good job, but also to enjoy it.

### A Note on the BYTE Computer Shows

The first BYTE Computer Show takes place May 10 through 12 (Thursday through Sunday) at McCormick Place in Chicago, with the second to follow on June 14 through 17 (Thursday through Saturday) in Los Angeles. BYTE shows won't be industry exhibitions where manufacturers and distributors make deals, but regional gatherings for users of personal computers, and especially for BYTE subscribers (who get an all-day pass to all exhibits and conferences for $7.50, as opposed to $15 for nonsubscribers).

At the BYTE Shows, you will have the chance to meet Steve Ciarcia, Jerry Pournelle, Gregg Williams, Rich Malloy, Mike Vose, Richard Krajewski, and other BYTE editors. You can attend conferences on subjects of greatest interest to personal computer users, such as 32-bit microprocessors, languages, graphics, programming environments, personal robots, notebook computers, idea processing, AI gateways to natural languages, and voice recognition. You can share information with other subscribers (users' report on low-cost 1200-bps modems, languages forum, homebrew databases, etc.) and get more involved in BYTE by participating in meetings on reviewing and writing for BYTE.

Equally important, the BYTE Shows are not just tempting "don't touch" exhibitions; they are fairs at which you can buy products from exhibitors if you find the machine of your dreams or the board, peripheral, or program you've been living without for too long.

We think the separate elements assembled under one roof—the conferences, the equipment and software on exhibit, the chance to meet fellow subscribers, and the opportunity to shop for a variety of personal computer products—will combine to make the BYTE Shows enjoyable for all BYTE subscribers and others who find personal computers as fascinating as we do.

See you at the Shows.

*—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.*

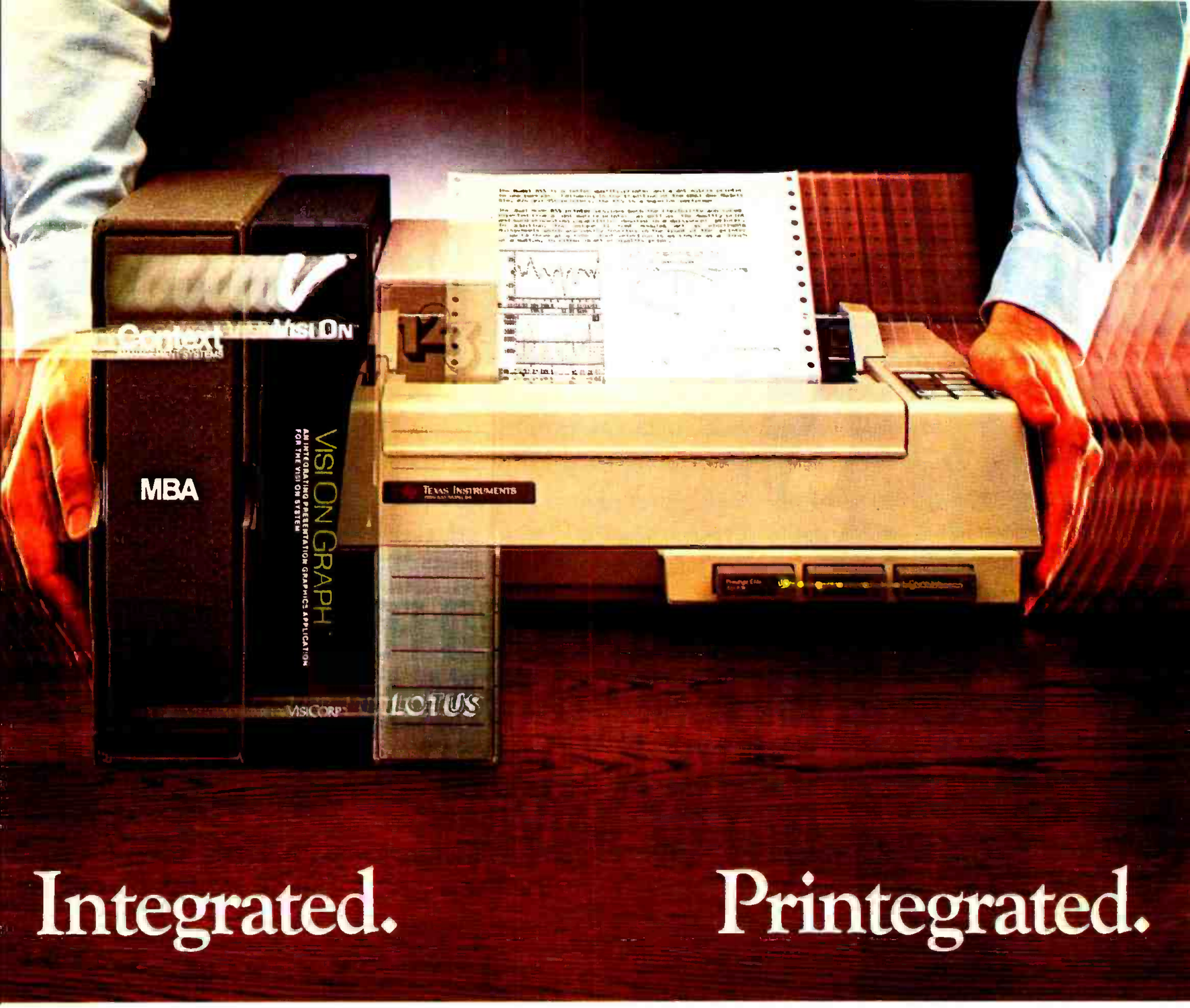
### Product Reviews

*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.* ■




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.

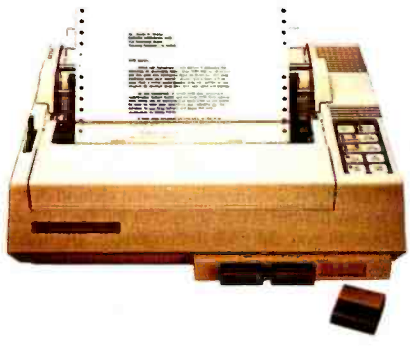
**It prints rough drafts ten times faster** than daisy wheel printers... faster than most any other dot matrix printer.

**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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# MICROBYTES

Staff-written highlights of late developments in the microcomputer industry.

## AT&T UNVEILS COMPUTERS

AT&T announced a line of computers in late March, ranging from a $9950 multiuser microcomputer to a $340,000 supermini. The computers use the UNIX System V operating system.

The 3B2/300 microcomputer uses Western Electric's WE 32000 CMOS microprocessor and includes one 720K-byte 5¼-inch floppy-disk drive, a 10-megabyte hard-disk drive, 512K bytes of RAM, four expansion slots, and ports for two users. Optionally, the computer can be expanded to 2 megabytes of RAM and a 32-megabyte hard disk. AT&T's optional I/O expansion card includes a parallel port and four RS-232C serial ports (which use an 8-wire modular jack), so that up to 18 terminals and four printers can be attached. While the base price of $9950 doesn't include a terminal, AT&T will sell its 5410 "dumb" terminal for about $600. AT&T's $6100 5620 terminal, which allows up to six windows to operate concurrently, can also be used, though a maximum of three can access a single 3B2. The 3B2 does not support color graphics.

AT&T also announced a PC interface, allowing the IBM PC to act as a workstation for the 3B2 using RS-232C, Omninet, or Ethernet communications. It also announced that its 3B Net will be available for any of its computers.

While some details and pricing were uncertain at the time of the announcement, AT&T said it would publish the bus and interface information for its computers and would encourage third-party hardware and software development.

AT&T also introduced larger computers. The 3B5 Models 100 and 200 include four to eight WE 32000 microprocessors and are priced from $57,000 to $73,000. The 3B20A, 3B20S, and 3B20D superminicomputers, priced from $230,000 to $340,000, use a real-time version of UNIX and have microprogrammed CPUs, using WE 32000s only for I/O and memory management.

## ASHTON-TATE ANNOUNCES INTEGRATED SOFTWARE

Ashton-Tate, manufacturer of dBASE II, has unveiled an integrated software package called Framework. Using an outline structure with multiple frames (windows), the program allows elements of the outline to be spreadsheets, graphs, databases, text, or other outlines. Numerous functions are available throughout Framework. Print enhancements such as boldface and italic can be used in the spreadsheet or database as well as the word processor. Because the program includes its own programming language, programmers can develop specific applications using Framework. The program was developed by Forefront Corp., but Framework will be distributed by Ashton-Tate, beginning in July, for $695.

## OLIVETTI, SORD INTRODUCE NOTEBOOK-SIZE COMPUTERS

Olivetti Corp. will begin selling its M-10 notebook-size computer in the U.S. With 8K bytes of RAM, a built-in 300-bps modem, and an 8-line by 24-column LCD that tilts for easy viewing, the M-10 will sell for $799; a 24K-byte version will cost $999. This computer is made in Japan by Kyocera, which also builds the Radio Shack Model 100 and the NEC 8201. Previously, the M-10 had been available only in Europe, due to a patent dispute among Olivetti, Kyocera, and Radio Shack.

Sord Computer also introduced a notebook-size computer, the IS-11 Consultant, which includes 32K bytes of RAM (expandable to 64K), a CMOS Z80A processor, and an 8-line by 40-character display. Integrated software for word processing, spreadsheets, graphics, communications, and window-management features is included on a 64K-byte ROM chip. The IS-11 will be available this month for $995; a version with a built-in 300-bps modem will cost $1095 later this year. Sord plans to offer 64K-byte ROM-pack-based applications software later as well as external monitor and disk-drive options.

## TWO COMPANIES SEEK TO SELL AI-BASED SOFTWARE TOOLS

Texas Instruments announced it will license the NaturalLink Software Technology it used to develop software to access Dow Jones News/Retrieval, using plain English instead of complex codes. TI hopes software developers will pay $8000 to use the natural-language software technology to develop programs for the TI Professional Computer.

Expert Systems Inc., New York, and Jeffrey Perrone & Associates, San Francisco, are selling Expert-Ease, an expert systems generator. After information is entered into the system, the program makes decisions based on that information, ideally simulating the thought process of the "expert" who entered the information. Expert-Ease sells for about $2000.

## PLASMA DISPLAY UNVEILED BY FORMER BURROUGHS DIVISION

Plasma Graphics Corp., Warren, NJ, a joint venture of Burroughs Corp. and Telex Computer Products, has introduced an 80-character by 25-line plasma display. The 3-pound unit has a 7.2- by 3.7-inch display, the equivalent of a CRT display with an 8.1-inch diagonal measure. Plasma Graphics says the display's current $1795 evaluation price should drop to a volume price of $300 to $400 in a few years.

## CORVUS, AST ANNOUNCE CHANGES TO THEIR LOCAL-AREA NETWORKS

Corvus Systems Inc. announced Omnishare, a program allowing computers networked with Corvus Omninet to share the hard disk on an IBM PC XT. Previously, Omninet required a separate Corvus hard-disk file server. Corvus also introduced its new OmniDrive line of hard-disk drives with a built-in Omninet connection. Prices range from $1995 for a 5.5-megabyte drive to $4995 for 45.1 megabytes, plus $495 for Corvus Constellation II network software.

AST Research introduced PC-Net II. The twisted-pair network can use an XT or Tallgrass hard disk for shared files and includes a print-spooler feature. A starter kit, with manuals, cables, and two cards for the IBM PC, costs $1290; additional PC-Net II cards are $595.

Microsoft is also reportedly developing a new version of its MS-DOS operating system with multiuser/networking features.

## BASIS GETS NEW DISTRIBUTOR, INTRODUCES LOW-COST VERSION OF 108

Basis is introducing a lower-cost version of the Basis 108 (reviewed in the January 1984 BYTE). The computer will include 128K bytes of RAM, Z80 and 6502 processors, and two 5¼-inch disk drives for about $1500. Basis is also preparing a hard-disk version of the Basis 108 as well as 16- and 32-bit systems. (Communical Inc. [1400 Grant Ave., Novato, CA 94948, (800) 421-6594 or (408) 892-7139] is now the U.S. representative for Basis.)

## NANOBYTES

**IBM** announced Displaywrite , a word-processing program for the IBM Personal Computer. An abridged version is available for $95, or all features are included for $299. IBM also announced a $13,000 low-end version of its System 36 computer with a 30-megabyte hard disk . . . . Both **IBM** and **Commodore** have been licensed to produce Intel's 8088 processor . . . . **International Data Services Inc.**, San Jose, CA, has announced Unx-II, a $900 version of UNIX System III for the IBM PC . . . . **Uniform Software Systems Inc.** plans to introduce a version of the UNIX operating system that can run MS-DOS and UNIX software concurrently . . . . **Zilog** has licensed **NEC Corp.** to produce Zilog's Z80000 microprocessor . . . . **IBM** has made a grant to University of New Hampshire professor James Weiner to convert a Prolog interpreter developed at UNH to run on the IBM PC. Weiner predicts the interpreter will be available by August through UNH for less than $300 . . . . **Macrotech International Corp.**, North Hollywood, CA, introduced a $1395 S-100 processor board using Intel's iAPX286 and Zilog's Z80B . . . . **Casheab**, San Francisco, CA, introduced a music-synthesizer board for the IBM PC. The board will sell for $795 in late summer . . . . **Daisy Systems Holland**, Torrance, CA, introduced the QuietWrite printer, which it says is quieter than other daisy-wheel printers . . . . . **Capitol Data Systems**, a division of Capitol Records, has entered the premium-quality disk business with a line of 5¼-inch floppy disks. Capitol plans to add 3½-inch disks soon . . . . **Synetix Inc.**, Seattle, WA, announced the PC-Handler, an expansion card for the IBM PC, allowing up to four IBM PC or Apple II computers to share files and peripherals. A Z80 processor, two serial ports, four parallel ports, and 64K bytes of RAM are included for $795 . . . . **Information Appliance**, a Palo Alto firm headed by Jef Raskin—originator of Apple's Macintosh—is developing a new product of its own . . . . **Borland International**, Scotts Valley, CA, has introduced a version of its $49.95 Turbo Pascal compiler for the IBM PCjr . . . . **Atari** has dropped its Atari Program Exchange, through which it sold third-party software . . . . **Apple Computer** will rely on third-party vendors to introduce peripherals for its Applebus low-cost local-area network for the Macintosh and Lisa 2. While Apple plans to introduce shared hard disks and laser printers, it does not presently plan to introduce additional low-cost Applebus peripherals . . . . A number of colleges are now offering course credit for **TeleLearning**'s "electronic university" courses, which download and upload course materials, exams, and teacher-student messages . . . . **Workman and Associates** is finally shipping WRITE for CP/M-86 . . . . **Creative Solutions Inc.**, Rockville, MD, has announced MacForth for Apple's Macintosh. MacForth Level 1 costs $149; Level 2, with an assembler and additional functions, is $249.

# Get A HeadStart™ On The Other Guys.



## HeadStart Features:

Size: 15" wide. 11" deep. 10½" high.

Weight: 25 lbs.

Processors: Z80A (8 bit) and 8086 (16 bit).

Memory: 128K to 1MB depending on model. All models are expandable.

Disk Storage: 500K to 1MB (unformatted) on a 3½" Micro-Disk.

Display: 12" (diagonal) P31 phosphor non-glare screen. 25 lines x 80 or 132 columns.

Keyboard: Detachable with 105 total keys. An optional portable version snaps onto the front screen area for easy transportability.

Disk Operating Software: *CP/M 80 for 8 bit. **MS DOS for 16 bit. LAN DOS for multi-user 8 or 16 bit operation.

Networking: Up to 255 HeadStart VPUs may be connected via coaxial interface into one of 2 optional data storage systems.

Interfaces: One RS449/RS232 compatible serial port. One Centronics compatible parallel printer port. External data bus. Coaxial communications interface. External disk I/O interface.

Optional Data Storage Systems: 2 models available. A 10MB. 5¼" system is expandable to 20MB. A 50MB. 8" system (25MB fixed. 25MB removable) is expandable to 200MB.

*CP/M is a registered trademark of Digital Research.
**MS DOS is a registered trademark of Microsoft.

Intertec's HeadStart is the smallest, smartest, fastest, most powerful business computer money can buy.

And the most expandable (it's networkable up to 255 user stations).

## Great Ideas Come In Small Packages.

Instead of three bulky components, HeadStart needs only two—the keyboard and CRT. There's no need for a cumbersome disk and processor cabinet. With HeadStart, it's all in the CRT enclosure.

HeadStart's small but powerful 3½" disk drive offers as much storage as larger 5¼" disks. Its 8 *and* 16 bit processors make software availability no problem.

And HeadStart's small size permits easy transportability with no sacrifice in performance. Each Video Processing Unit (VPU) comes with its own easy-carrying handle. A portable keyboard option is also available.

## How Fast Is Fast?

HeadStart's RAM Disk, an electronic emulation of the typical second drive, responds up to fifty times faster than conventional microcomputers.

Depress a key and you get a response within a split second. Literally before your finger leaves the key.

And HeadStart is incredibly powerful, too. Up to one megabyte of internal memory can tackle even the most sophisticated applications.

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Because HeadStart is designed to be both a single *and* multi-user computer, you buy only as much computer as you need today.

But as your business grows, it grows with you.

Each HeadStart Video Processing Unit comes with its own memory, processors, disk and multi-user interfaces.

Just add a 10 or 50 megabyte Data Storage System and up to 255 users can share a common data base in an incredibly powerful, multi-user network.

HeadStart is available in three different models. All offer full performance, transportability, and are easily expandable.

Unlike conventional, single-user-only computers, HeadStart is here today with the designed-in technology to be here tomorrow.

So get a HeadStart on the other guys. For more information, call (803) 798-9100 or write: Intertec, 2300 Broad River Road, Columbia, SC 29210.

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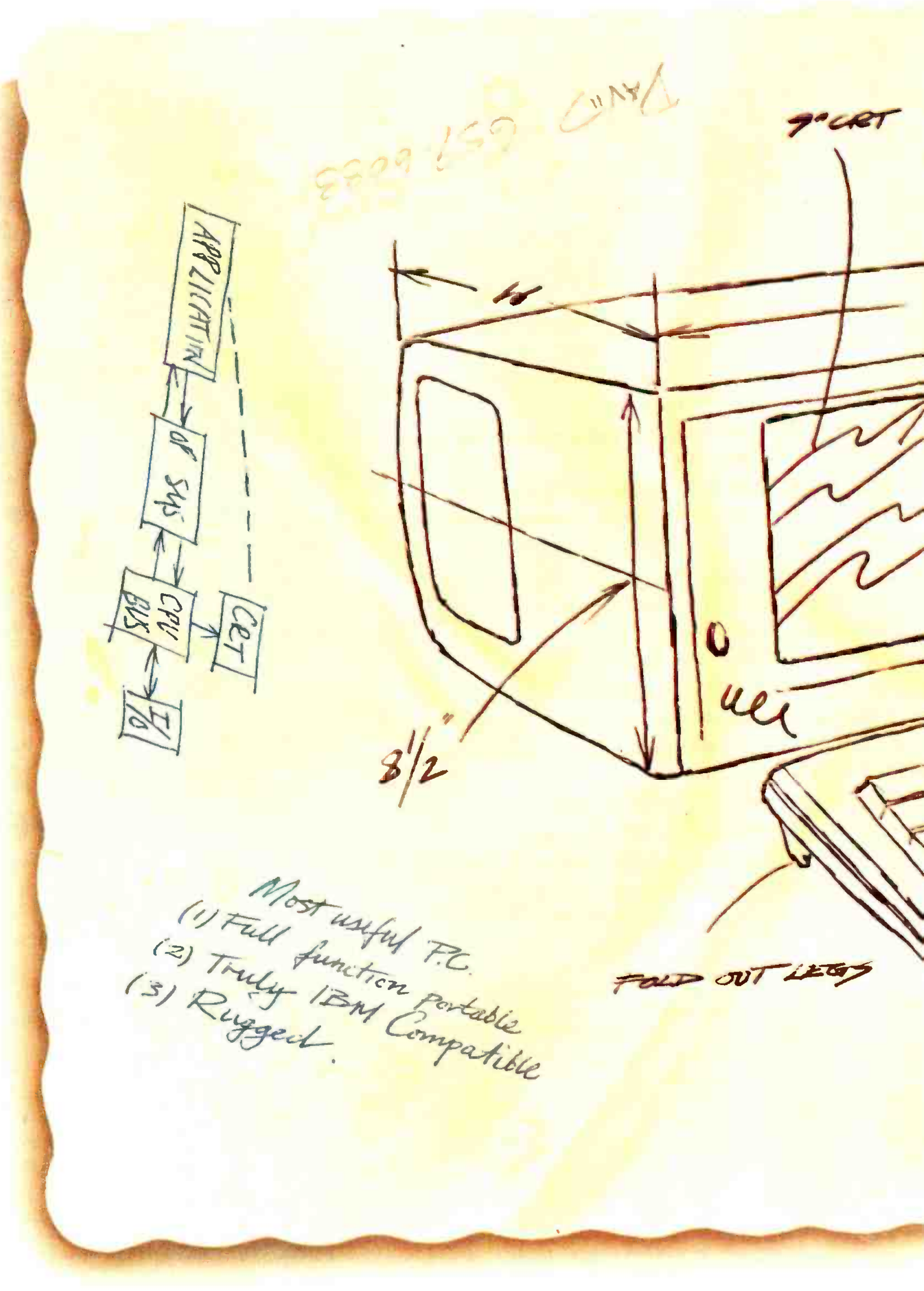


# A picture worth $111,000,000.

## A User Looks at Mac

As an old-school microcomputer person (my first experience with a micro was in December 1977 on a Commodore Pet 2001), I'd like to give a more jaded view of the Apple Macintosh computer.

First, the Mac is an IBM PCjr competitor, not a PC competitor, as Gregg Williams states in "The Apple Macintosh Computer" (February, page 30). Compare both machines' capabilities. The Macintosh has a maximum of 128K bytes of memory, one internal minifloppy drive, and a monitor. It is lightweight and portable, has no hardware expandability, and its software is upwardly compatible to the Lisa 2. The PCjr also has a maximum of 128K bytes of memory and one internal floppy drive. It too is lightweight and portable, has minimal hardware expandability, and its software is upwardly compatible to the PC.

On the other hand, the IBM PC (and variants) have 64K to 128K bytes of memory (expandable to 640K bytes), massive hardware expandability, and multiple floppy and hard disks.

Second, anyone who has worked seriously with computers knows that if speed is the top priority, then tight assembly language is required—but you pay for that speed by having code that is virtually incomprehensible to anyone who did not write it. Forcing software developers to write tight assembly-language code (just to fit memory limitations) will slow the amount of software reaching the market—and raise its price. As Steve Jobs points out ("An Interview: The Macintosh Design Team," February, page 58), once software is developed, it is paid for. So, if Apple plans to sell 10 million Macintosh computers, it obviously expects to sell 10 million copies of Mac BASIC, Mac Paint, and Mac Write. If Apple makes $50 profit a shot, then the company makes at least an extra $500 million. (Who said there's no attention paid to quarterly profits at Apple?)

My third complaint is that the Mac is not expandable. What do I do when I outgrow my machine? I would have no choice but to scrap the $2500 machine and buy a $3500 system. However, Apple will point out that you get to keep your software.

I know everybody will complain that I am ignoring the wonderful software that makes Mac the machine it is. But how much are you willing to pay for that software? The Mac is potentially more powerful than the PC, but Apple has so hobbled it that it is not much more powerful than the PCjr.

For the record, I think Mac and Lisa 2 have some wonderful software; but if you really want the software, buy the Lisa 2. At $3495, it is probably the best mass-produced high-end computer on the market today. For only $1000 more than you would pay for Mac, you get the expandability that was cut out of Mac (such as large memories and hard disks). In addition, you get another 384K bytes of memory thrown in (the price differential is only what IBM would charge for 384K bytes in chips). As a final bonus, you can get either Mac's or Lisa's operating system. However, you should buy a Lisa 2 quick, because once the differences become evident, Apple will probably raise the Lisa 2's price because of the skyrocketing demand.

**George Snoga**
**1910 Harpers Ferry**
**San Antonio, TX 78245**

*Gregg Williams replies:*

*Your points about the Macintosh's similarities to the IBM PCjr are well taken; however, I am puzzled by your insistence that the Macintosh is not expandable. My article speaks of the "virtual slot" scheme that makes future peripherals possible and announces the availability of a keypad, a second disk drive (soon), and a 512K-byte memory update (by the end of the year). These alone make the Macintosh more similar to an IBM PC than a PCjr. At the Macintosh announcement date, about 30 third-party vendors announced dozens of software and hardware packages, including two hard disks, two telephone/modems, a printer buffer, and numerous software packages; other vendors have joined since, and some products are already available. Once the Macintosh has 512K bytes of RAM, the powerful operation set of the 68000 and the 128K-byte "toolbox" of routines make it possible to argue that the Macintosh is computationally superior to an IBM PC with 640K bytes of RAM.*

*I agree with you, though, that I'd rather have a Lisa 2 than a Macintosh for my office. Whatever expansion the Mac has, the Lisa 2 will have more, and its ability to run all Macintosh software ensures its vitality.*

## More Mac Reactions

After interminable months of speculation and rumor, the Macintosh has arrived. Apple's "secret weapon" has been released with a flurry of expensive prime-time advertising touting the Macintosh's icon-oriented, mouse-implemented user interface. With the introduction of the Mac has come a plethora of new terminology to be added to the already burgeoning inventory of high-tech buzzwords. In the wake of Macintosh, words such as "icon," "desktop metaphor," and "pull-down windows" are becoming ever more common.

As is to be expected with any new product, especially one that promises to turn the increasingly staid world of personal computing on its ear, the Macintosh has not been uniformly well received. One prominent and oft-repeated criticism is the Macintosh's lack of "compatiblity." This indictment, of course, refers to Apple's deliberate choice not to give the Macintosh the capability to run software that is currently in vogue. Several reviewers, most notably Peter McWilliams, have cited this "problem" and stated that the Macintosh is doomed to failure because of it. To dismiss Macintosh for this reason is to sacrifice utility at the altar of uniformity.

It cannot be denied that CP/M and its progeny have carved out a substantial following. Likewise, no one can question that the IBM Personal Computer has become the de facto standard by which all other hardware is measured. Assuming all of this, one nagging question remains: why have these products become so prominent? The answer lies in the meaning of the phrase "de facto." CP/M and the IBM PC have literally stepped into the breach. They have created a standard through blood, sweat, and tears. Quality and performance have been cast aside in the search for conformity. The fear of being different has seized the personal computer industry and has transformed innovators into imitators.

Instead of being ostracized, the Macintosh should be welcomed as a breath of a fresh air in an atmosphere that has become cloistered and stagnant. Were it not for the people involved in developing the Macintosh, personal computer users would still be mired in a swamp of incomprehensible keyboard sequences



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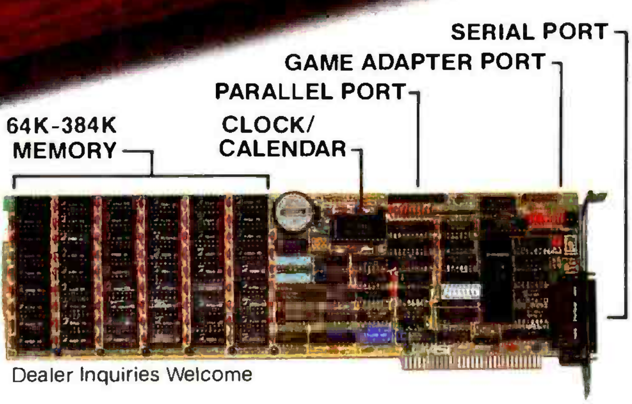
4. A Clock-Calendar with battery backup, featuring an easily replaceable Lithium battery and a quartz-controlled timebase for a high degree of accuracy.

5. An optional IBM-compatible Game Adapter port, for use with an IBM-type joystick. In conjunction with application programming, this game port may be used for cursor control, in generating graphics or for playing games at the end of your work day!

6. Every **SixPak** comes with an AST *Super-Pak* utility diskette which includes SuperDrive and SuperSpool, the most powerful disk emulator and print spooler software you can get. These programs will greatly enhance the throughput of your PC or PC-XT by emulating disk drive and printer access at RAM speeds rather than the normal slower speed of mechanical devices. SuperPak is the first of such software to be compatible with both DOS 1.1 and DOS 2.0.

Most important of all, the **SixPak** comes with the AST "Plus," AST's unsurpassed reputation for quality, reliability, after-the-sale support, and overall design excellence that gives our products the best price/performance ratio in the industry! Hence the name, **SixPakPlus**!

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and unintelligible system commands. "Point and click" has become the means by which everyone can enjoy the versatility and power of state-of-the art microprocessor technology.

Ideally, hardware manufacturers and software developers should be oriented toward a common goal. The goal is simple: to put the greatest amount of information-processing power in the hands of the greatest number of people. This objective will not be achieved without a drastic restructuring of the status quo. To the vast majority of this country's population, personal computing remains a dark art. Perpetuating the existence of this arcane science will only benefit those who seek to monopolize and, therefore, control the flow of information in our society.

When Apple first began to advertise the Macintosh, they used a "1984" theme, with Big Brother obviously being played by IBM. In fact, the theme that was used might not be too far from the truth. With the follow-the-leader approach that is being taken by nearly everyone in the personal computing industry, there is a very real chance that the vitality and creativity of that endeavor may be extinguished. This cannot be allowed to happen.

Instead of being criticized for refusing to follow the crowd, Apple Computer and the developers of Macintosh should be commended for their efforts. People can only remain a slave to their machines for so long.

**J. Edward Chor**
**1307 W. Addison St.**
**Chicago, IL 60613**

The Apple Macintosh, previewed in February, looks like a fine computer with its powerful 68000 microprocessor and sophisticated system software.

However, I think the Macintosh development team committed a fundamental design error when, having exhausted ROM space, they placed their floating-point software in RAM. Software running out of RAM executes approximately 25 percent more slowly on the Macintosh than does software running out of ROM.

It would have been more appropriate for them to have moved some of their user-interface or I/O software to RAM instead. Software that deals with mice, keyboards, and printers can run more slowly than 6 MHz (the effective RAM-based clock rate) before there is any perceptible loss in speed of a program running on a single-user system.

Obvious as this mistake is, it is also easily corrected. I hope that Apple moves to correct it before the company floods the market with its current system. I discussed this matter over the phone with one of Apple's technical-support people, but I am not certain I got my point across. Your publishing this letter might alert potential users to the problem. The Macintosh, with its excellent graphics and high-speed peripheral interface, looks like it would be a good machine for engineering and scientific applications, as well as for personal and business use. It is a shame to see its computational speed unnecessarily diminished.

As for the floating-point software itself, I inquired whether Apple had implemented the complete IEEE double-precision package. The answer I got—after cross-country phone calls to five different offices—was to send $150 for a draft copy of Apple's manual *Inside Macintosh*, plus another $100 for the first bound edi-

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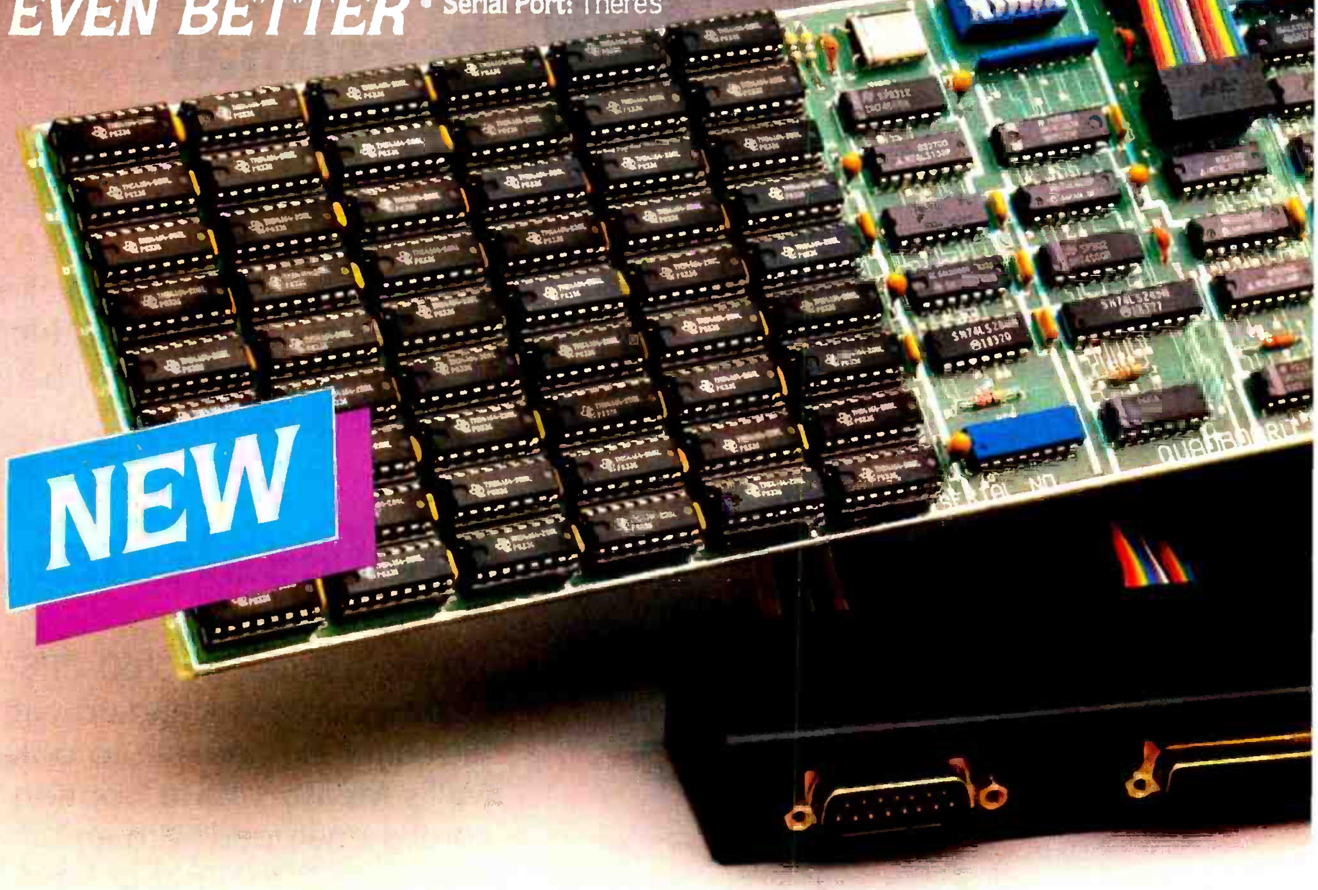


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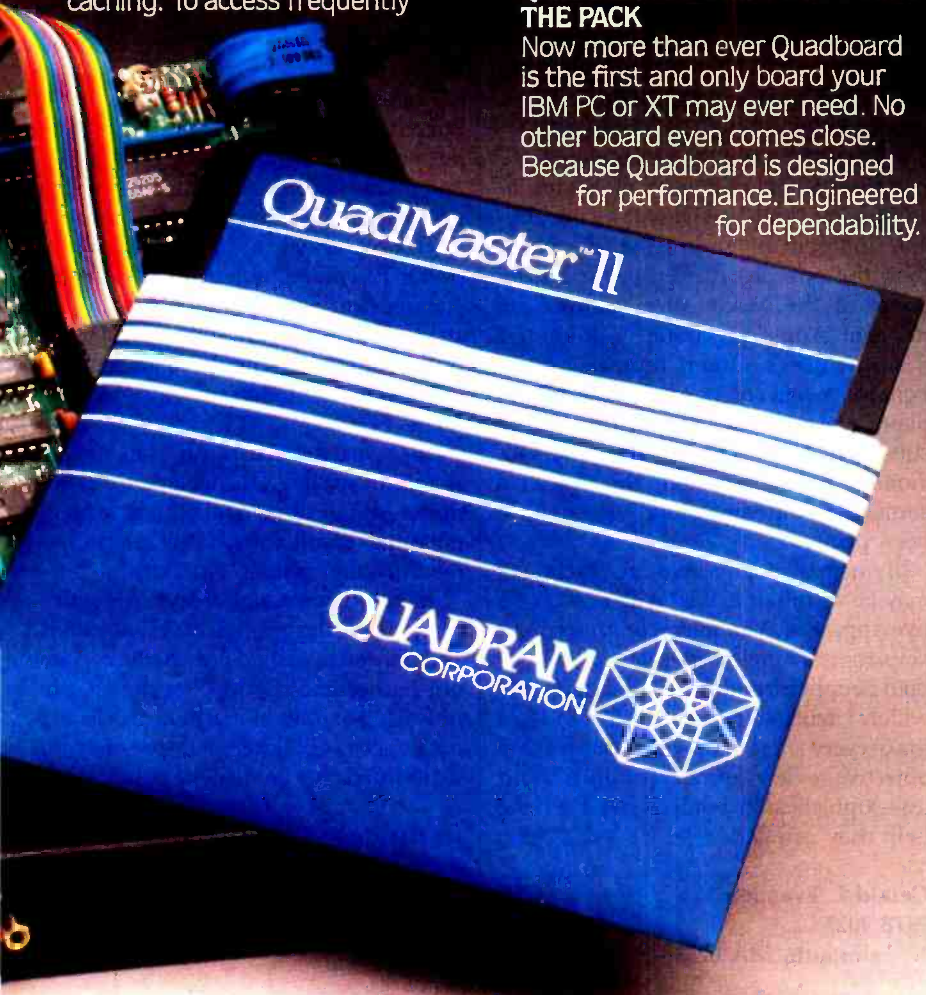


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tion (publication date uncertain), plus another $50 for updates.

Apple is promoting the Macintosh as an "open" system (the meaning of this term seems to be deteriorating with time), but it sure is charging a lot for the key.

**Robert Lurie**
**8 Tingley Rd.**
**Morristown, NJ 07960**

I found Mr. Williams's article on Apple's Macintosh disturbing because of the unfettered and naive enthusiasm displayed toward the product and, for that matter, the manufacturer. This material would be expected from a manufacturer or his representative but not from a member of your editorial staff. Journalism of this type severely reduces the credibility of your magazine in presenting unbiased and knowledgeable reviews of new products.

I have 25 years of professional experience as an end user of computer equipment, and I arrived at a considerably different picture of the Macintosh than the one described in your article. Some of the Macintosh's features are more in Apple's corporate self-interest than the user's. Others represent questionable design criteria, and some are just plain "gee-whiz" features with no more substance than tail fins and chrome. Obviously, if I had written the article, a somewhat different story would have been printed.

My negative opinion of the Macintosh may be as unfair as Mr. Williams's positive appraisal. The microcomputer marketplace is a jungle with many pitfalls for both neophytes and pros. It behooves any widely circulated publication like BYTE to make every effort to provide balanced and objective reviews of new products. Your less-sophisticated readers need all the help they can get!

**Gerald I. Evenden**
**POB 1027**
**N. Falmouth, MA 02556**

*Gregg Williams replies:*

*Permit me to add some perspective to your evaluation of my article. In many ways, I have an enviable job in that I have been able to review some of the best products our industry has produced. Because of this, they get largely positive reviews (less worthy products would not deserve to be on the cover of BYTE and other magazines). Still, I did point out a number of important areas of dissent: the single built-in disk drive, the unbundling of Macintosh prices, and the "hyping [of] a machine that easily stands on its own merits" in calling the Macintosh a 32-bit machine. In addition, the article took over six weeks to research and write and contains much technical information and commentary that has not been included in any other Macintosh article. For further perspective on the Macintosh, see my article, "Update on Apple Macintosh and Lisa 2," on page 339.*

I was disappointed that your industry-leading magazine missed what nontechnical magazines such as *Time* and *Rolling Stone* reported about the origins of the Macintosh computer. As they pointed out, the Macintosh concept—a low-cost, monochromatic bit-mapped, small, and extremely friendly computer—was my creation.

The original team that I put together to build it included Burrell Smith, hardware designer, Bud Tribble, software designer, and Brian Howard, an unsung hero of the project who contributed to the concept, software and hardware design, and the overall feel of the project. Brian (who, for some reason, was not mentioned in your article) and Burrell are still with Mac, but Bud went back to school and got his M.D. I became C.E.O. of Information Appliance Inc.

I also gave the Macintosh its name. The change in spelling was not an error as you reported, but done deliberately to avoid potential conflict with the electronics manufacturer named "McIntosh."

Interestingly enough, Steve Jobs actively opposed the project at its inception, and only after we had proved the concept did he become the Macbooster that he now is. Reading the BYTE article one might get a very different impression and would not give credit where it is due.

**Jef Raskin**
**Information Appliance Inc.**
**530 University Ave.**
**Palo Alto, CA 94301**

## Bus Widths

I am writing in regard to "The Apple Macintosh Computer" by Gregg Williams (February, page 30). In his article, Mr. Williams points out that although Apple refers to the MC68000 as a 32-bit processor, he believes that it is generally regarded as a 16-bit processor.

Although no one has been able to come

# THE PRINTER TO PICK WHEN THE PACE QUICKENS.

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Okidata's Pacemark 2350 and 2410 dot matrix printers.

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Take throughput. The 2350 and 2410 can quickly get you out of the waiting game to where you're *really* cranking it out. And with flexibility, too: up to 5 pages per minute.

But wait. Cranking *what* out, you may ask? A single, restrictive printing mode? No way. The 2410 can give you DP, draft, and a correspondence quality that truly rivals the daisywheel.

And the 2350 and 2410 can both print at up to 350 cps. While producing 120 to 420 lines a minute for you. With bidirectional printing and short line seeking logic. And both high speed horizontal and vertical slew.

## PC COMPATIBILITY. SOFTWARE COMPATIBILITY.

The 2350 and 2410 use industry standard interfaces making them hardware compatible with most mini and microsystems on the market today. In addition, they are supported on the menus of most of the important software being offered to microsystem users like Visicalc, Lotus 1, 2, 3, DBASE 2, Peachtree 500 and General Ledger, Multi-Mate WP, Wordstar, etcetera, etcetera.

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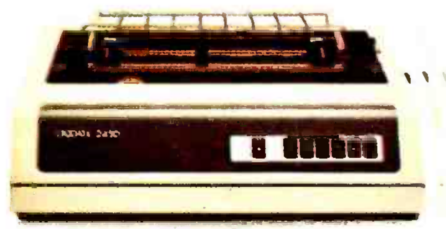

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up with a concrete way to determine the bit size of any given processor, there are two commonly used methods. The first is to rate the processor by the width of the external data bus, and the second is to rate it by the width of the internal data bus. Mr. Williams makes the assertion that the correct way to determine size is to rate the processor by the maximum size of a multiplicand in arithmetic operations. Let me address each of these methods individually.

Determining the size by examination of the external data bus was, until IBM entered the microcomputer marketplace, the most commonly accepted method of rating processor size. It is still probably the best way because most microprocessor systems' speed is limited by the data bus bandwidth (memory accesses per second times size of data bus).

IBM, through its PC advertising, has endorsed rating the processor size by using the internal data bus size. This allows them to call the 8088, which has an 8-bit external data bus, a 16-bit processor. It is interesting to note that Intel, the designer and manufacturer of the 8088, refers to this processor as an 8-bit unit (source: 1982 *IC Master*, page 1083).

Mr. Williams's contention that the size is determined by the maximum multiplicand size is absurd. Rating a processor by this method results in both the 8080A and 6502 processors being 0-bit micros, which I am sure even Mr. Williams will admit is untrue.

Comparing the sizes of some common microprocessors using the above criteria brings about the results shown below.

| Processor | Int Width/ Ext Width | Multiplicand Width |
|---|---|---|
| 8080A | 8/8 | 0 |
| 6800 | 8/8 | 0 |
| 6502 | 8/8 | 0 |
| 8088 | 16/8 | 16 |
| 8086 | 16/16 | 16 |
| 68000 | 32/16 | 16 |

As I stated, I believe that the measure of the external data bus is the most valid method of determining processor size. Using the width of the internal bus results in the 8088 and 8086 being the same size, which, although true from a software point of view, is not true for the hardware. Because most people use the processor size as a relative indicator of computational speed, the external data bus width is the measure that has the most bearing.

Unfortunately, IBM has set the (de

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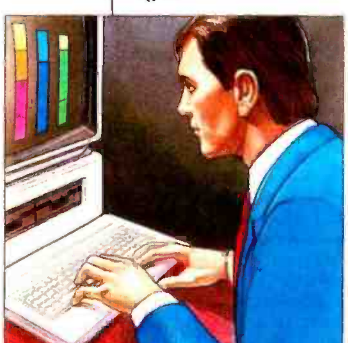

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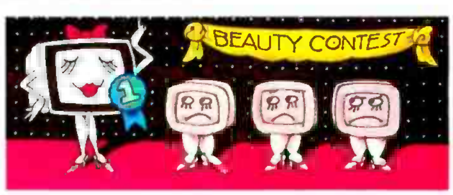


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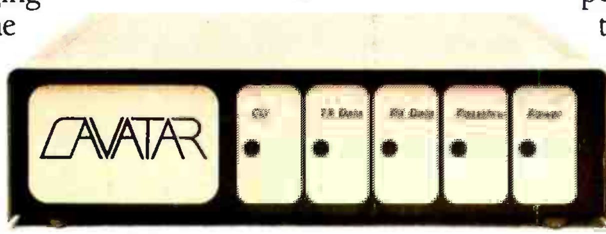


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| | AVATAR PA1000 vs. | IRMALINE™ |
|---|---|---|
| Easy to install | YES | YES |
| Q/A installation | YES | NO |
| English language commands | YES | NO |
| Help screens | YES | NO |
| Keyboard types | 5 | 1 |
| Remote dial-in/ security password | YES | YES |
| Dual host access | YES | NO |
| Local screen printout | YES | NO |
| 3278 status line modes | 3 | 1 |
| Price | $995 | $1395 |
| Availability | Immediate | (?) |

Two hosts are better than one. So in addition to the coax connection to IBM, the

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# cing The t Thinks.

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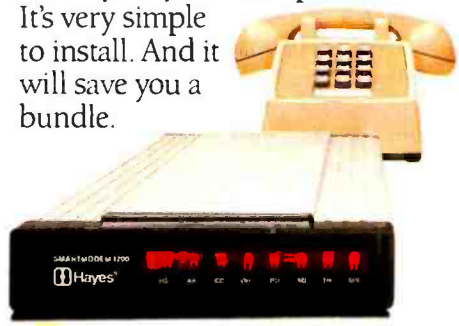


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facto) standard for measuring size and has elected to use the internal data bus size for its measurements. Because it would be unfair to measure the Apple by any other criterion, Mr. Williams must concede that the Macintosh is a 32-bit machine.

**Mike Sauve**
**1024 52nd Street, SE**
**Kentwood, MI 49508**

*Gregg Williams replies:*

*Thank you for your letter. It summarizes discussions that have gone on here at BYTE since I wrote the Macintosh article. We have decided that the situation is too complex to be accurately specified by one descriptor: the multiplicand does not describe the Intel 8080 well, nor does the internal-bus descriptor describe the 8088 (which runs 10 to 40 percent slower than an equivalent 8086—see my article, "Benchmarking the Intel 8086 and 8088," July 1983, page 147) well. In addition, even the external-bus descriptor falls short. Consider the National Semiconductor NS16008; even though it has an 8-bit external data bus, it is a 32-bit architecture internally, including a 32-bit by 32-bit multiply instruction. Surely, this kind of power puts the NS16008 in a different class from, say, the 8080.*

*Another descriptor that I have just discovered is that of the bus width of the arithmetic logic unit (ALU), that area of the microprocessor chip that performs all the arithmetic and logic functions that the chip allows. The ALU bus width feels intuitively right—it is the ultimate measure of how much data the microprocessor works on at a time. Does this help us? Hardly, because once we get to this level of detail, the philosophies of chip design muddy the water. The NS16000 family has 32-bit ALU buses. The Motorola family is more complex: the 68000 (16-bit external bus), 68008 (8-bit), and 68010 (16-bit) have three 16-bit ALUs, while the 68032 (with a 32-bit external data bus) has three 32-bit ALUs.*

*Finally, to complicate the issue even more, let me relate another possible descriptor mentioned by our editor in chief, Phil Lemmons. Things change if you look at the problem of describing the "power" of a computer from a user's point of view. A user doesn't care what operating system is running or whether the microprocessor has an 8- or a 16-bit data bus—this person just wants to know, "Will it run fast enough so I don't have to wait too long?" and "What software does it run?" Computation speed can often be improved by using a chip with a higher clock frequency, but software complexity is determined by the address space of the microprocessor—a feature that is usually fixed, especially on 8-bit chips that are not part of a family of similar products. (We are assuming that software is easier to use if it has Help screens, a sophisticated user interface, and other features that make programs more complex and, therefore, larger.) From this reasoning, we can argue that the address bus, which measures the total amount of memory that a microprocessor can address, is a good descriptor of a microprocessor's power. Many popular programs need more than 64K bytes to run in (the limit of traditional 8-bit microprocessors). As memory gets cheaper and we find ways to fill it up, there may be a very real difference between microprocessors that can address 1 megabyte of memory (20-bit address bus) and 16 megabytes of memory (24-bit address bus). In addition, if a microcomputer has been designed to use less memory than the microprocessor itself allows, we should make note of that fact as well.*

*As a result, in BYTE we will state both bus widths—for example, we will describe the 8088 as a "16/8-bit microprocessor (16-bit internal data bus, 8-bit external)" and the 68000 as a "32/16-bit microprocessor." In recognizing that the value of a commercial product is determined by more than just these descriptors, we will try to give all the information that presents a product in the most accurate way. In the "At a Glance" text boxes that accompany our reviews, we will place more emphasis on the internal and external data paths and the maximum amount of memory the computer can address.*

## Clock-Time Benchmarks

I generally enjoy benchmark articles and thus found the February BYTE full of interesting comparisons. I feel compelled to comment on one aspect of Avram Tetewsky's article, "Benchmarking FORTRAN Compilers" (page 218). The author goes to great lengths to obtain "true" results for the larger multiuser systems in the comparisons, the VAX 11/780 and the IBM 3081D. Thus, Tetewsky reports only CPU time, runs benchmarks in the early morning hours so there won't be other tasks slowing the system, and

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even removes the I/O time of a slow terminal.

I wish to question the fairness of comparisons in which one class of computers is judged by clock time and another is judged by some mythical "true" time. As a computer user I go by clock time to measure job turnaround. If multiuser systems have a large overhead in dealing with multiple tasks, why shouldn't that be reflected in the benchmark times?

I have a number of Pascal programs that I run on both an IBM 3033 and an Apple II using the UCSD p-System. I typically get results from my Apple 5 to 30 minutes faster than from the IBM. Admittedly, the IBM 3033 runs the programs in several hundredths of a second, but one can spend a long time in both the exec and printer queues.

I suggest that all future benchmark articles that refer to both microcomputers and mainframe systems use the same standard for judging both, namely *clock time*.


**Philip B. Ender, Ph.D.**
**UCLA**
**Graduate School of Education**
**Los Angeles, CA 90024**


## Thinktank

I wish to thank Mr. Lemmons for bringing Thinktank to the attention of your readers in "Beyond the Word Processor" (January, page 53).

I used an early version of Thinktank on the Apple II, running under Apple Pascal. FYI, as it was called then, quickly became my most important program (after my word processor and spelling checker). I used it as a reminder program, an outline maker for reports and stories, and as a general aid to thinking. For people who think in headlines and fill in the spaces afterward, it is an idea database without equal. I highly recommend it if you have an Apple, a Macintosh, or an IBM PC.

My only regret is that Living Videotext chose to expand in the direction of MS-DOS, rather than modifying Thinktank to work under UCSD Pascal IV. I miss the program and wish it would run on my Sage II.


**Gerald Perkins**
**643 Channing Ave.**
**Palo Alto, CA 94301**

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Phil Lemmons's essay "Beyond the Word Processor" (January, page 53) is an excellent piece of writing/thinking. The comparison to spreadsheets was a crisp and striking illustration of his idea. He targeted the most crucial and relevant limitation and challenge for current text-editing software. What was exciting and valuable about word processing for the writer was the way in which it rendered manageable the physicality of the text—it transformed the "hard" actuality of written work into a "soft" virtual existence and thereby eliminated much of the busywork involved in preparing a text. But current software is geared to the product rather than the process of writing. The word processor is the writer's secretary. It is interesting to reflect on how the writing process itself is being transformed by what the computer makes possible.

Mr. Lemmons's call for writers to express their needs and dreams is an invitation to experiment with the very process of writing/thinking. Good article!

**John Glazer**
**616 Pearl St.**
**Ypsilanti, MI 48197**

## George Orwell and 1984

I am at a loss to understand why, in an otherwise balanced and penetrating article, G. Michael Vose would choose to "rewrite" the history of George Orwell and his most famous work ("1984 and Beyond," January, page 100). His description of Orwell (Blair) as a fanatic anticommunist conjures up a caricature, a half-mad mixture of Joe McCarthy and Doctor Strangelove. Mr. Vose then limits Orwell's portrait of a dismal future to one dominated by "fascists." All of this implies that Orwell was an unbalanced individual, describing a threat from only one source.

Yet Orwell and his book were no such thing. He was anticommunist certainly, but also an idealist, humanist, and passionate socialist, and one who in no way considered himself part of the "right," fanatical or not. Neither did he take the easy way out in constructing the government of the future, one that would have conveniently ignored the tyranny growing beyond the Elbe. Orwell was opposed to any system that enslaved both the individual and society and labeled such systems with the more useful and inclusive term *totalitarianism*.

As Mr. Vose correctly notes, the personal computer may prove an aid in preventing such a future. You can bet computers won't be a mass-consumer item in any totalitarian society, fascist or communist.

**John C. Ruane**
**USS Wabash AOR-5**
**FPO San Francisco, CA 96683**

## Penny-Wise

In the February BYTE, Jerry Pournelle's User's Column (page 113) addressed the use of the "Disk Doubler" to enable the use of the back side of disks on single-sided drives. I was glad to see that he recommended against using this tactic, but I feel that he left out the most important reason for not using it.

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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 can be released back onto the disk. Premature failure of the disk, or at least loss of data, is virtually guaranteed.

I have long recommended that this is not a worthwhile savings tactic; the potential of lost data far outweighs the small dollar savings in disks.

**Larry C. Hansford**
**Creative Computer Consultants Inc.**
**POB 66**
**New Carlisle, OH 45344**

## "In Defense of Luddism"

I was disappointed to find that you felt the editorial urge to reprint the narrow-minded and reactionary opinion of the *Wall Street Journal* article, "The Luddite Answer to Unemployment," by Bruce Bartlett, in your Editorial on page 4 of the January issue. Mr. Bartlett may be an economist with impressive credentials, but he is no historian, and he seems to be a poor social analyst as well.

It is a historical cliché, and an inaccurate one, that the Luddites of early 19th century England broke machines because they were "afraid" of technology, or even that they hoped to save jobs of workers. The true mission of the Luddites was pointed out clearly by MIT historian David Noble in a series of articles entitled, "In Defense of Luddism," that appeared in the most recent three issues of the political journal *Democracy*. Noble shows that the Luddites were primarily concerned with the control of the workplace at the point of production. These skilled English craftsmen were resisting the introduction of machine technology that made their skills obsolete, and which forevermore turned over the control of the production of their product to a capitalist owner. The Luddites correctly perceived that the industrial revolution was generating a two-class system of owners of machines and laborers *on* machines, a system that placed little value in skill or in the relationship between a producer and his product. Noble also pointed out that the Luddites were not simple-minded "machine-smashers" who bashed looms and other devices out of some irrational, primitive anger. On the contrary, the Luddites chose their targets carefully after some rather sophisticated analysis on the social effects of machine technology.

The issue that the Luddites truly addressed (not what Bartlett would have us believe they represented) is still with us today. The important issue that traces its roots to the Luddites is not fear of technology, but the pressing question of who controls the workplace. Are we to have an economy that persistently excuses its abuses of humans by saying that "technology is neutral" and "we can't stand in the way of Progress"? What is progress if it does not serve human needs? And human needs are not entirely encompassed by employment. The Luddites understood that the battle for control of the workplace necessarily includes a battle for dignity, political rights, equality, and freedom. And they were right—they lost the battle, and the next hundred years of the western world we remember chiefly through the dark writings of





Circle 226 on inquiry card.

## Letters

Dickens and the solemn warnings of Marx.

There are no intellectuals or pundits who are "creating unnecessary fears and anguish among workers," as Bartlett writes, as if workers were frightened children. Workers have legitimate grievances and demands of the system they have built, and they will deal with them as they see fit. They may be, and in some cases are, following the lead of the Luddites by smashing machinery. But this is no more an irrational response to technology than is putting millions out of work without knowing what to do with them. There has been and may always be an overtly *political* battle over the nature of work and its rewards. The Luddites were the opening volley of this battle in our time, and it may be time to listen to what they were really saying.


**Gary Chapman**
**Department of Political Science**
**Stanford University**
**Stanford, CA 94305**


### X-raying Disks

I am currently part of a team working on a large application project to run on an IBM PC. We have had to do a lot of traveling by air and, consequently, our disks have been sporadically "zapped."

Based on my limited memory of high school physics, I do not think that X rays could have damaged the disks. I believe that the magnetic fields of the X-ray equipment power supplies are the culprits. Although we remove the disks from our carry-on luggage prior to entering the X-ray machines, we still sustain occasional damage. I believe this happens at the entry point to the machines where we stop to unload the disks. That is, the magnetic fields extend a significant distance around the equipment.

Now my tactics are as follows: (1) I put each box of disks in a lead-foil film pouch (although I doubt that this really offers protection against magnetic fields). (2) I carry backup sets of disks. This has allowed me to recover on all occasions.

I would be interested to know how the hard disk will react to airport X-ray systems, and I would appreciate any information on this subject.


**Steven A. Green**
**2393 Traymore Rd.**
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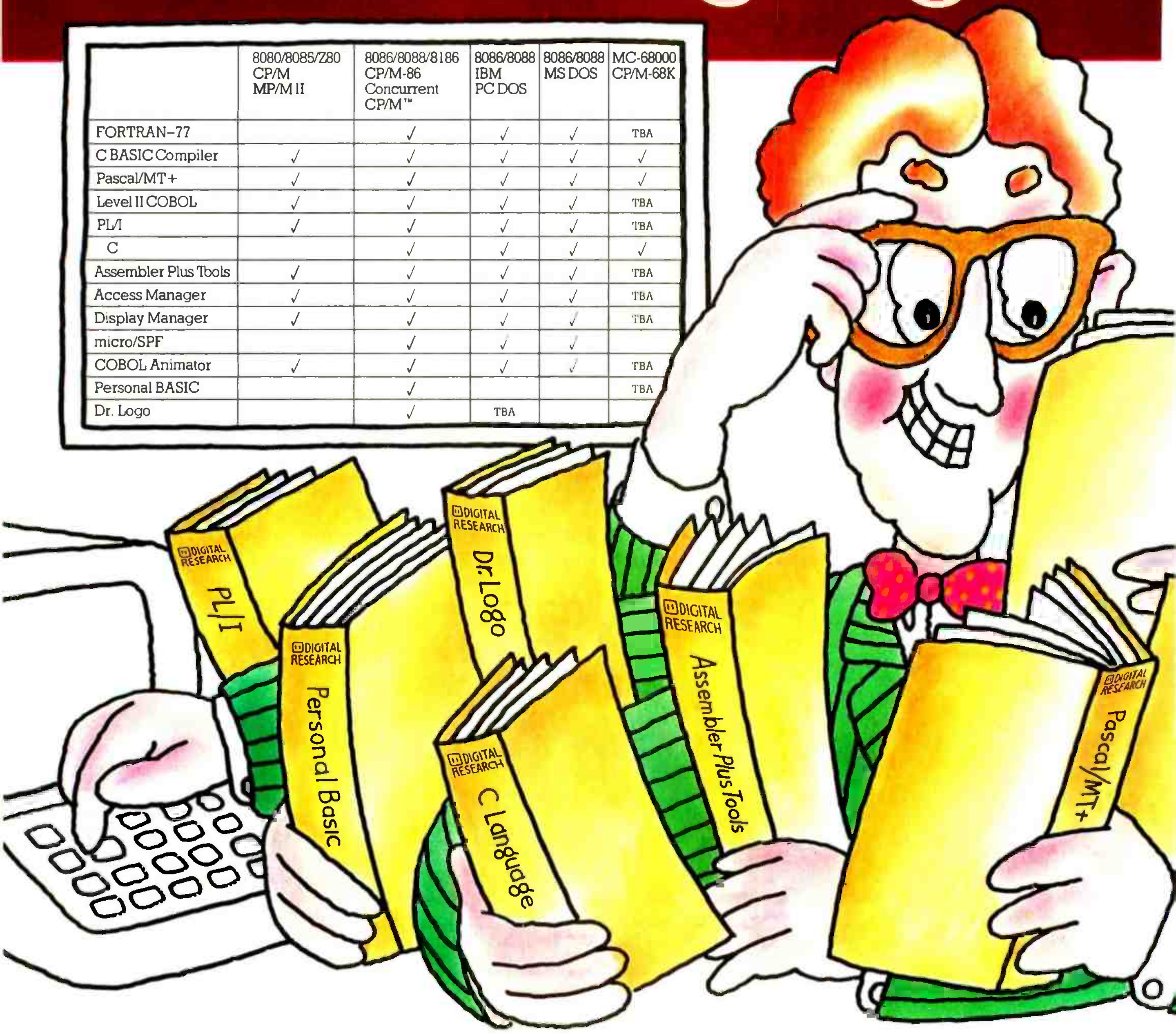

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# Trump Card

## Part 1: Hardware

*Speed up your IBM PC with 16-bit coprocessing power*

**Steve Ciarcia**
**Consulting Editor**

When asked what computer language I prefer, I generally reply, "Solder." This response is not an effort to be cute but rather to express a preference for dealing in the terms I know best. I don't avoid software. I just try to minimize my involvement.

When it is necessary to write simulation and test programs, I bite the bullet. Unless the function is time-critical, I most often choose BASIC because it comes closest to being a universal programming language. Virtually all personal and business computers support it, and if I confine my command choices to the more common instructions, the demonstration programs that I compose on an IBM PC should also run on your Cromemco Z2.

With few exceptions, you can compute your accounts receivable or type in and play a game equally well with an Apple or IBM PC using BASIC. The fact that one has a 6502 microprocessor and the other uses an 8088 is irrelevant. The output will be the same.

The value of high-level languages is that they isolate the user from microprocessor peculiarities and facilitate transportable software. Unfortunately, the average ROM (read-only memory)-resident BASIC interpreter was never written with perfor-



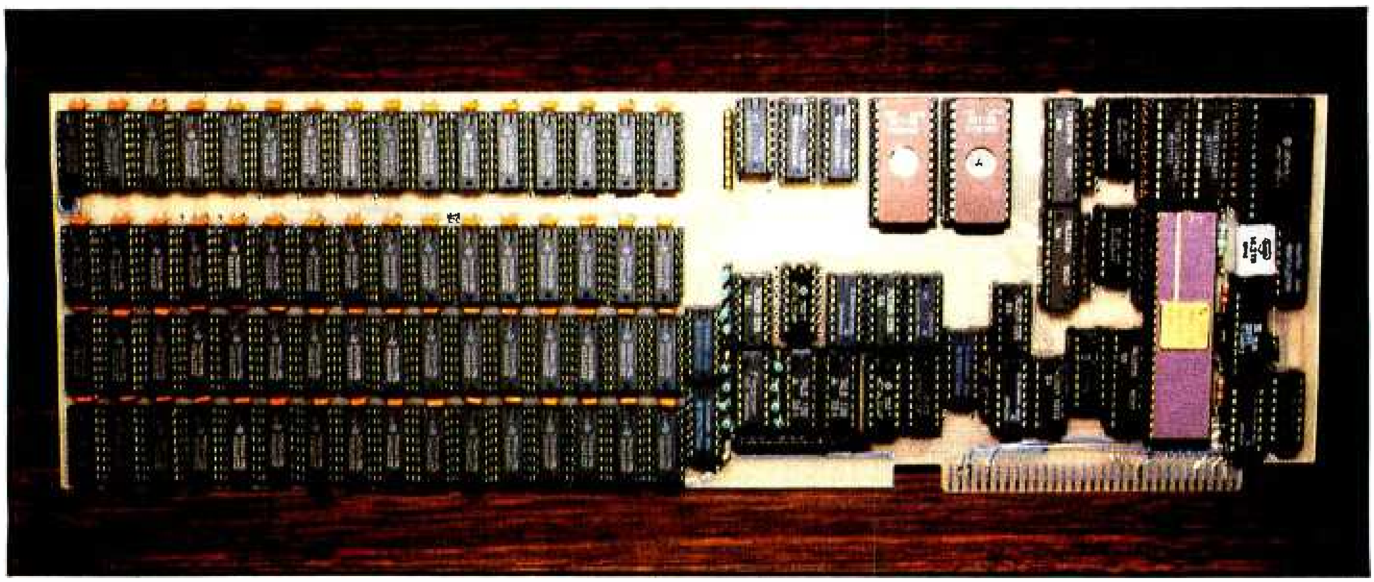


**Photo 1:** *The wire-wrapped prototype of the Trump Card, shown from the front. The left side of the board contains 512K bytes of type-4164 dynamic RAM; the right side contains the Zilog Z8001 and an interface to the IBM PC I/O-expansion bus.*

mance in mind. Usually taking 5 to 10 milliseconds (ms) to execute an individual instruction, it can seem like forever when running long programs.

As a writer, I have grown to appreciate the universality of BASIC, even with its shortcomings. By treating the computer as a black box with I/O (input/output) ports and BASIC, I have been able to provide projects that can be implemented on most systems directly. As an engineer/designer, however, I am aggravated by its slowness and feel no animosity toward critics who have converted to languages such as Pascal or C to gain processing speed.

Rather than make further excuses, I decided to solve the problem in classic Circuit Cellar tradition—simply build a black box that improves system throughput and runs BASIC programs faster.

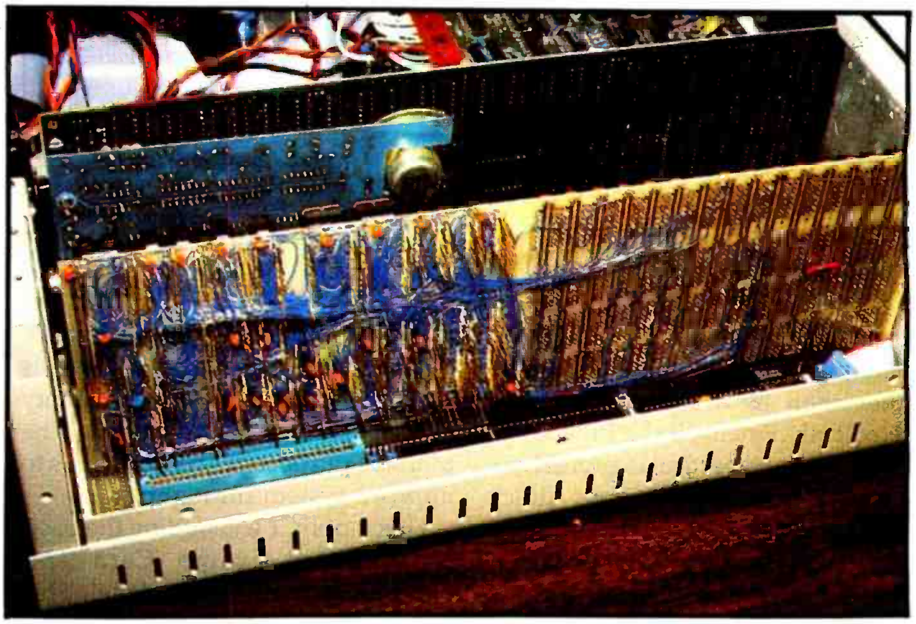


**Photo 2:** *The rear of the Trump Card prototype. To save time, the memory section was laid out as a printed-circuit board, with wire-wrapping saved for the processor side. As shown here, the Trump Card is installed for testing in an MPX-16 computer, which has I/O slots compatible with the IBM PC.*

## Processors and Performance

Generally speaking, most people confuse microprocessor benchmarks with system throughput. The comparison of microprocessor-instruction execution speeds is not really indicative of a computer's capabilities. Performance is more often governed by the operating system and magnitude of the application program. It is a false assumption that all software written for a 16-bit microprocessor will necessarily run faster than on an 8-bit microprocessor. Machine-language fast Fourier transforms (FFT) run quickly on a 6502, but an accounting package that has to constantly interleave a program into and out of disk may be encumbered by 64K bytes of operational memory in the Apple. In all likelihood, large spreadsheets and accounting programs will run more efficiently in the larger memory space provided on an 8088 system such as the IBM PC.

Raising the performance of a high-level language such as BASIC takes more than raising a microprocessor's clock rate. Instead, it involves a combination of decisions that can ultimately affect the entire system throughput. We can expand the memory available to application programs in an effort to limit repeated disk accesses and configure a portion of memory as a RAM (random-access read/write memory) disk drive to expedite disk operations when they are required. We can optimize the effi-

**(3a)** **(3b)**

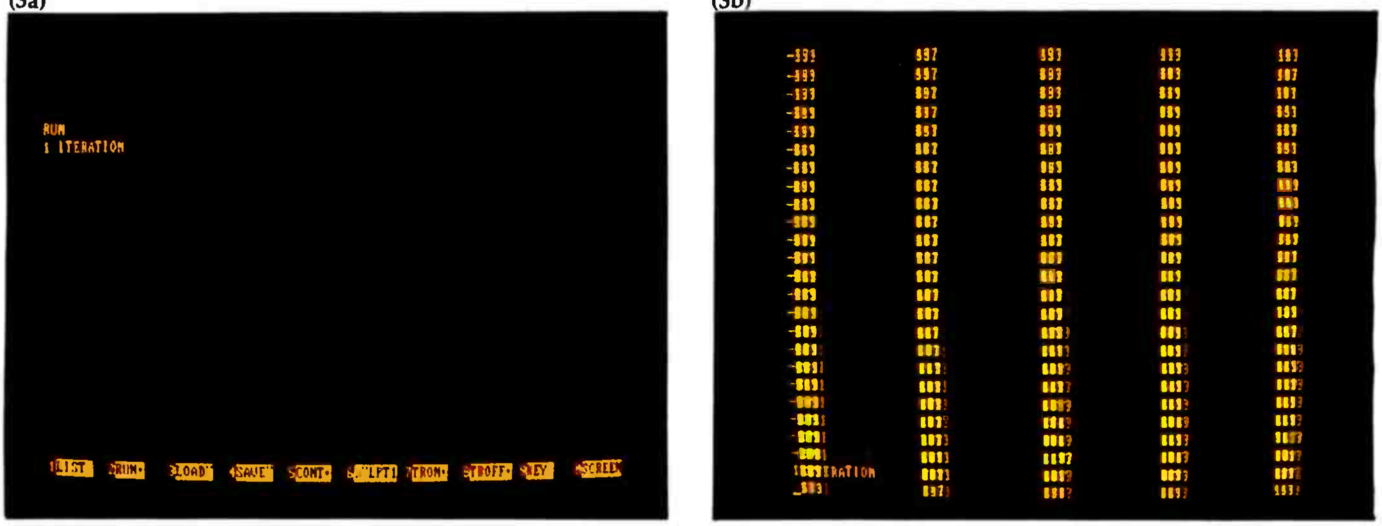



**Photo 3:** *Execution-time visual comparison. (3a) Without Trump Card—a two-second exposure of the display while running the BASICA program in listing 1. The program has executed the PRINT statement and still is dimensioning the arrays. (3b) With Trump Card—the same two-second exposure of the program execution (with PRINT statement added) shows the arrays have been dimensioned and the prime numbers are being overprinted so fast that they blur.*

| Apple II | Apple III | TRS-80 Model II | IBM PC | IBM PC (with Trump Card) |
|---|---|---|---|---|
| 224 | 222 | 189 | 190 | 2.4 |

**Table 1:** *A comparison of execution times (in seconds) of the benchmark program in listing 1.*

**Listing 1:** *Sieve of Eratosthenes prime-number-generator program.*

```
  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"
```

ciency of the high-level language by operating it in a compiled mode rather than as a repeatedly interpreted task. Finally, if the functional throughput of a particular application becomes dependent upon direct microprocessor intervention, for those tasks, substitute a faster microprocessor or help it with a coprocessor.

## A Black Box Called Trump Card

This article is not about building a classic speed-up board for the IBM PC. The word "speed-up" implies replacing the 8088 with an 8086 or 80186. Instead, visualize your PC as a black box with an input, output, and crank. Rather than simply turning the crank faster, think of adding another black box, in the same path between input and output, that performs selective tasks more efficiently and faster than the 8088 alone. To increase the relative throughput of the system, I have designated an alternate path for specific program functions.

I've named this separate box Trump Card. It is a functionally independent 10-MHz Zilog Z8001-based computer with its own 512K bytes of memory. Designed specifically as a compiled high-level-language computer, Trump Card is addressed as an I/O device that communicates through the expansion bus (see photos 1 and 2).

Among the specific functions that Trump Card supports are BASIC, C, CP/M-80, text editing, Z8000 assembly-language programming, and a RAM disk. It does not directly execute programs written in 8088 assembly code, such as Lotus 1-2-3. It instead executes programs written in high-level languages such as BASIC or C (a Pascal compiler and 8088-to-Z8000 translator are in the works). Alternatively, it can enhance the function of programs such as 1-2-3 by expanding available memory and speeding disk functions. The ultimate purpose of Trump Card is to improve system throughput.

This month, I will outline the basic functions of Trump Card and describe its hardware in detail. This is, of course, a Circuit Cellar construction project, and you are encouraged to build your own Trump Card. More on that later. Next month, I'll describe some of the software in detail and do a little benchmarking.

First, a little about Trump Card and the Z8001.

## Trump Card

Trump Card is a peripheral board that plugs into any expansion slot on an IBM PC or PC-compatible computer. It contains a 10-MHz Z8001 and up to 512K bytes of memory. To use it, you simply load a BASIC, CP/M-80, or C program from PC-DOS and type "RUN." Its memory can also be used as a RAM disk.

Trump Card comes with software that translates existing BASIC and other high-level-language programs to run with reduced overhead. To speed the execution of BASICA, Trump Card compiles the code with a special version of BASIC called TBASIC. Unlike other compilers, this has no separate compiled-code disk files (unless you specifically want them) and no long delays. TBASIC instantly compiles the program in a few tenths of a second when you load the file into Trump Card. In appearance, it looks like any old, slow interpreted BASIC, but it runs with the speed of a compiler.

TBASIC is PC BASICA-compatible. You can use either the Trump Card screen editor or BASICA's editor to write your programs. Then run the same program using either Trump Card or BASICA. Depending upon the instructions you use, Trump Card provides a tenfold to hundredfold increase in program performance (see photo 3). Table 1 shows typical results of what Trump Card can do with the prime-number Sieve of Eratosthenes program (September 1981 BYTE, page 180) frequently used to benchmark computer systems (see listing 1).

Though I conceived of Trump Card initially as a BASICA enhancement, it didn't take me long to realize that a Z8001 with 512K bytes of memory has some real computing power and deserves proper support. For that reason, the software supplied with this project is much more extensive than usual. With the utilities and languages included, you should have little trouble using the vast software base of Z80 and Z8000 programs.

Trump Card includes the following software:

BASIC Compiler—TBASIC is PC BASICA-compatible. The differences between the BASICA interpreter and the TBASIC compiler are minimal. Most instructions are implemented without modification.

CP/M-80 Emulator—Trump Card can run your CP/M-80 Z80 assembly-language programs directly without special disk headers or translation programs. Simply download your Z80 programs and run them.

C-Compiler—Trump Card includes the industry standard version of C that is described in *The C Programming Language* by Kernighan and Ritchie.

Debugger—Intended to aid in program development. With it, you can examine and replace memory and register contents, set breakpoints, or single-step through programs.

Screen Editor—Incorporating many of the features included in word processors, the editor enables you to write or examine ASCII text files for either the PC or Trump Card's use.

Multilevel Language Compiler—This is a structured assembler that allows Pascal-like control and data types, arithmetic expressions with automatic or specified allocations of registers, and procedure calls with parameter passing.

RAM Disk—Trump Card can allocate 128K to 387K bytes of its on-board memory to function as an intelligent RAM disk (DOS 2.0 only). This memory is separate from and in addition to any already existing on the PC bus. Trump Card's other functions can run concurrently.

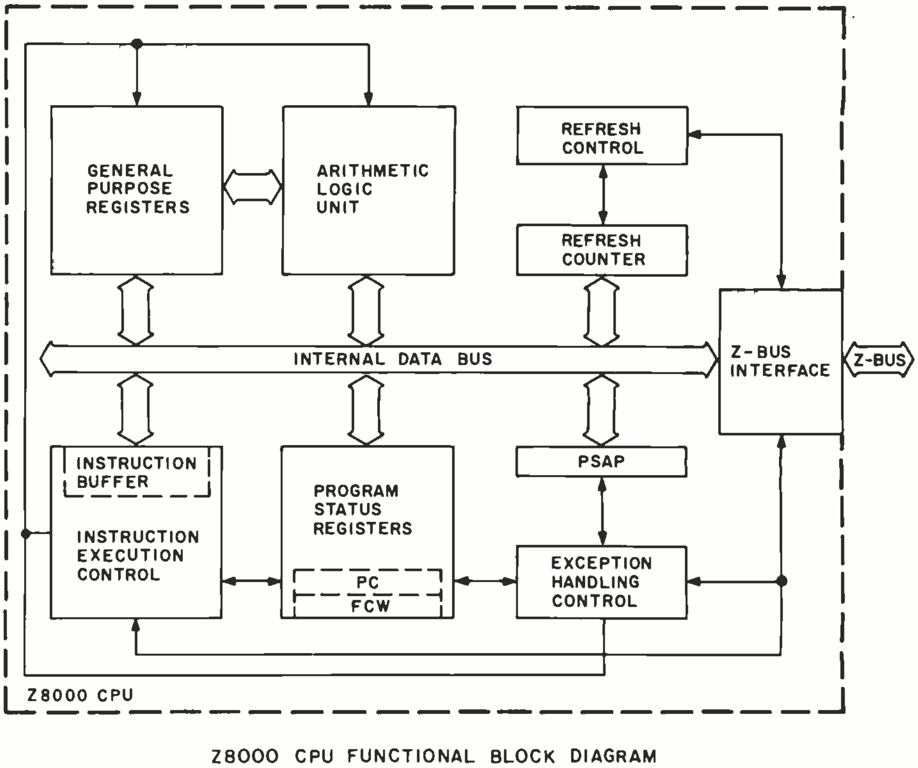



**Figure 1:** *Block diagram of the internal structure of the Zilog Z8000 family of microprocessors.*

## The Z8000 Microprocessor

A block diagram of the Z8000's internal structure appears here as figure 1. As the programmer sees it, the Z8000 contains sixteen 16-bit general-purpose registers (for addresses or data) that may also be used in groups to form as many as eight 32-bit registers or four 64-bit registers. The low-order halves of the registers may be used for byte operations, thus the Z8000 is able to manipulate data in 8-, 16-, 32-, and 64-bit pieces.

The eight addressing modes are register, indirect-register, direct-address, indexed, immediate, base-address, base-indexed, and relative-address. The instruction set utilizes data types ranging from single bits to a 32-bit-long word. The processor executes 110 distinct instruction types that, when permuted by all the addressing modes and data types, create a set of more than 400 instructions.

The Z8000 has two different modes of operation: system and normal. Which mode of operation is in effect is controlled by a bit in the flag-and-control word (FCW). The main difference between the operating modes is that some of the control/interrupt and I/O instructions work only in the system mode. To simplify the design of the Trump Card, I chose to use only the system mode.

The Z8001 (see photo 4) is the memory-segmented version of Zilog's chip; it comes in a 48-pin DIP (dual-

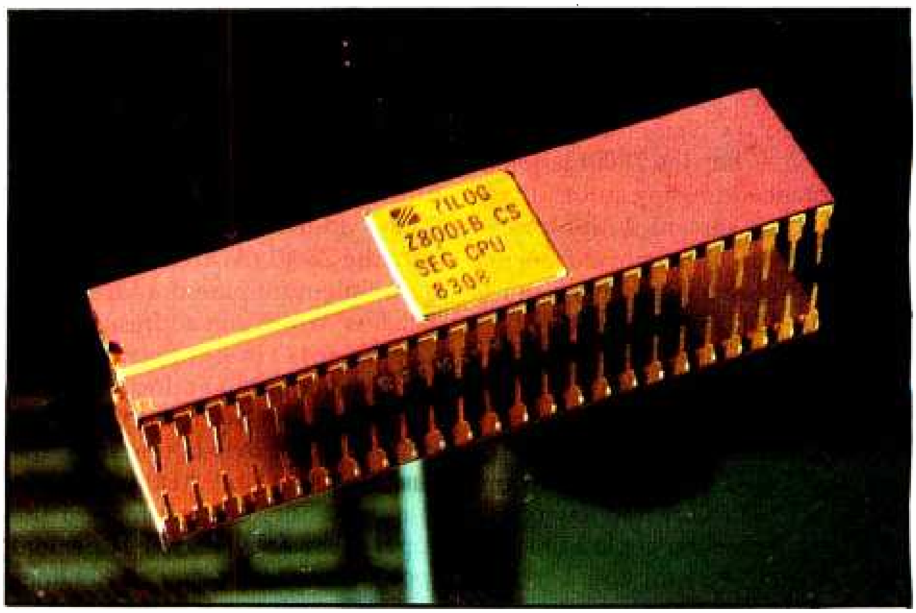



**Photo 4:** *The 48-pin dual-inline package that houses the Zilog Z8001 microprocessor, the heart of the Trump Card.*

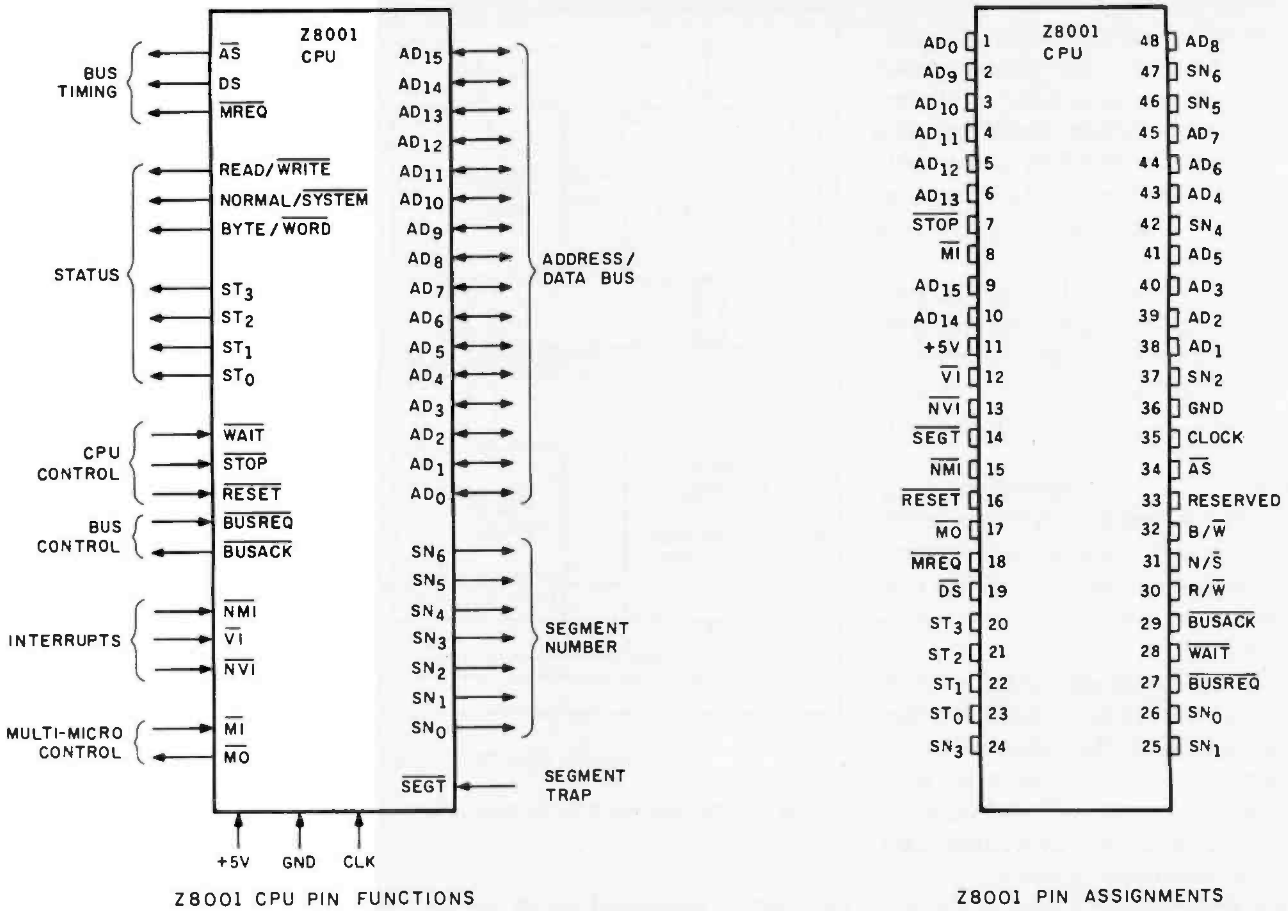



**Figure 2:** *Pinout arrangement of the Z8001 memory-segmented version.*

inline package), the pinouts of which are shown in figure 2. (The nonsegmented 40-pin version is called the Z8002.) By memory segmentation, the directly addressable 8-megabyte memory space is divided into as many as one hundred twenty-eight 64K-byte regions. Seven segment-selection lines coming out of the Z8001 control the high-order memory addressing. When the Z8001 is reset, the segment addressing automatically reverts to segment 0, the lowest 64K-byte block of memory. Transfer of control between segments is done by jumps, calls, and returns.

## Inside the Trump Card

The schematic diagram of figure 3 shows the Trump Card's circuitry. It can be plugged into any expansion slot of an IBM PC or into any other computer with compatible I/O slots and operating system.

Five of the Z8001's seven segment-selection lines, SN0 through SN4, are used in the Trump Card to decode addresses for up to 1 megabyte of RAM (512K bytes fit on the board) and 4K bytes of ROM (read-only memory). Segment line 4 selects between the ROM, mapped into segments 0 through 15, and the RAM, residing in segments 16 through 31. The states of the segment lines are latched by IC3; segment line 4 is named RAM/$\overline{\text{PROM}}$.

## Address/Data Bus

The address/data lines coming from the Z8001 (AD0 through AD15) are a time-multiplexed address and data bus, which can address a range of 65,536 (64K) bytes of memory or a like number of I/O addresses. Since the Z8001 can form addresses at either word or byte boundaries, the least significant bit AD0 is used in byte operations to determine if the upper or lower byte is to be operated upon. The address on the AD lines becomes valid when the Z8001 asserts the $\overline{\text{AS}}$ (address strobe—active low) line; it remains that way for a short hold time after $\overline{\text{AS}}$ returns to its idle high state. The address from the Z8001 is latched by two type-74LS373 transparent latches, IC5 and IC6, that are always enabled. The use of transparent latches allows for maximum address-setup time to the memories.

The latched addresses (LA0 through LA15) come out of the 74LS373s with LA0 combined with the signal B/$\overline{\text{W}}$ (byte or word address) to form the $\overline{\text{EVEN}}$ or $\overline{\text{ODD}}$ byte-bank-select signal for memory. When B/$\overline{\text{W}}$ is low, it signifies that a 16-bit memory word is being referenced; this causes the outputs of the two AND gates at IC8 pin 3 and IC8 pin 6 to be active irrespective of the state of LA0. By doing byte operations in this manner, it is possible for the Z8001 to do single-byte memory writes without first reading an entire word location.

The Trump Card contains a pair of type-2716 EPROMs (erasable programmable read-only memories),

*Text continued on page 50*

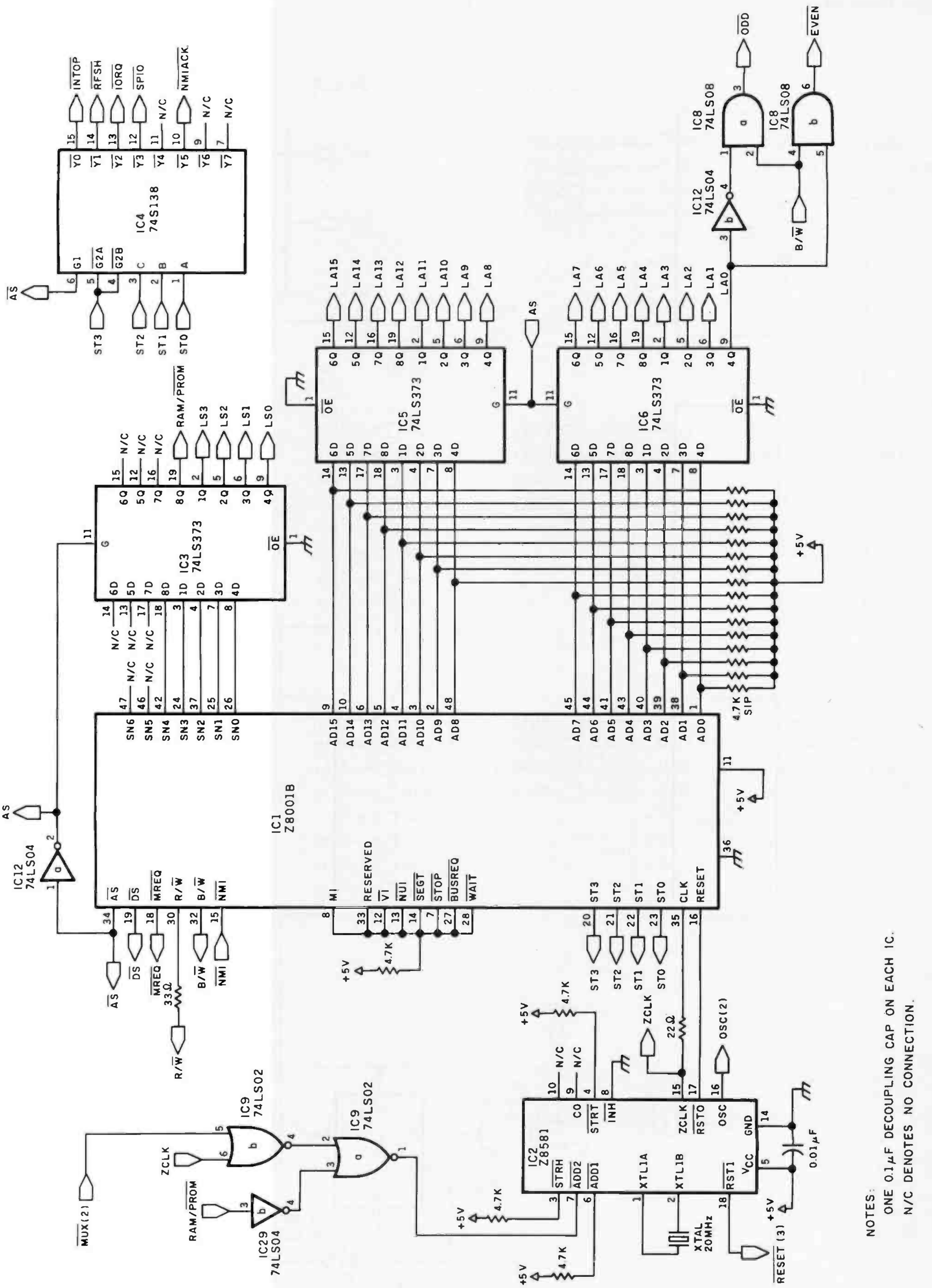



*Figure 3 continued on page 46*

**Figure 3:** *Schematic diagram of the Trump Card. Support is provided for 512K bytes of dynamic RAM in the form of type-4164 chips. If a 6-MHz Z8001A is used, the crystal frequency must be reduced to 12 MHz.*

*Figure 3 continued:*

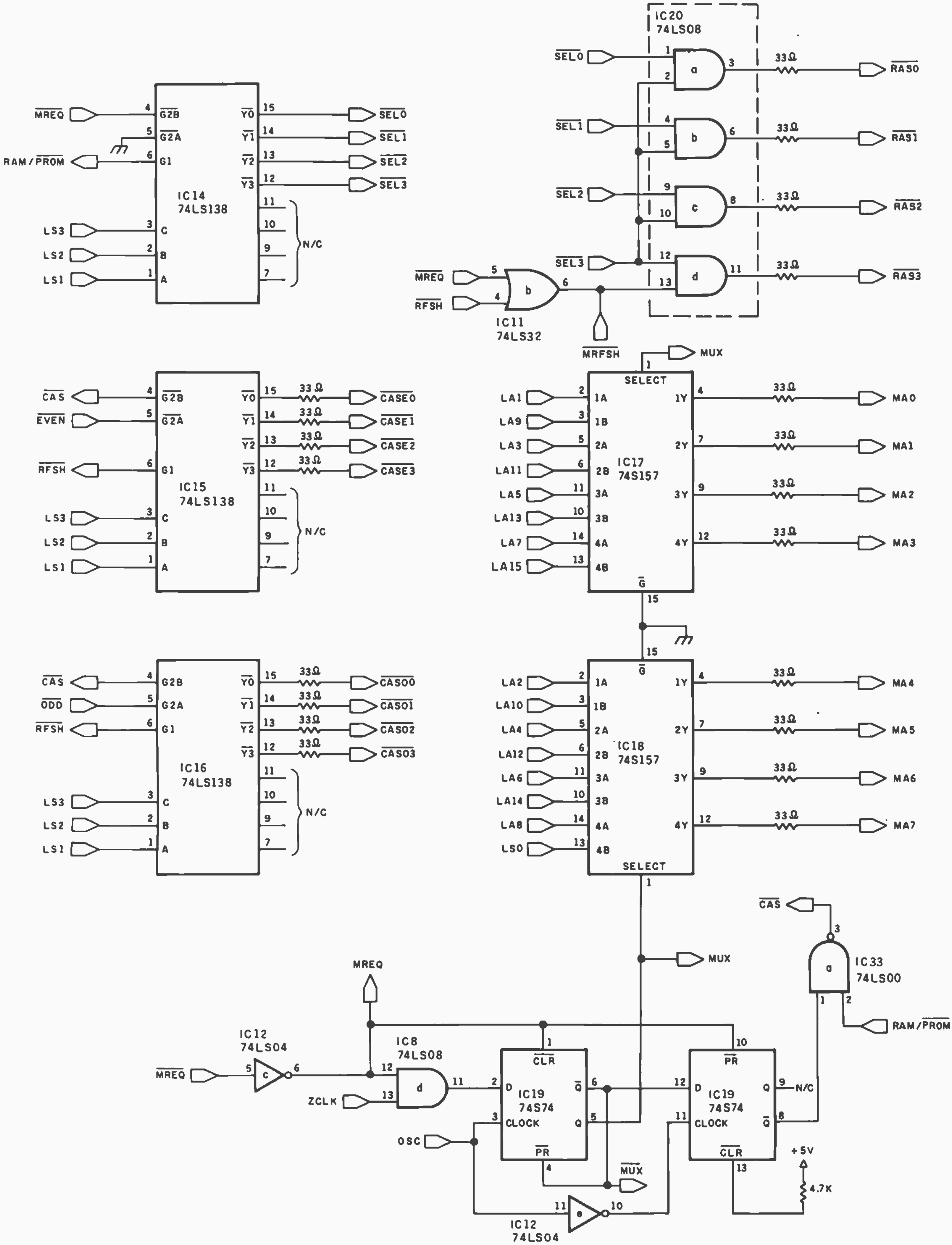



*Figure 3 continued on page 47*

*Figure 3 continued:*

NOTE: IC's IN THIS SECTION ARE CONSECUTIVELY NUMBERED FROM IC36 UPPER LEFT CORNER TO IC99 LOWER RIGHT CORNER. IC's ARE ALL 4164's.

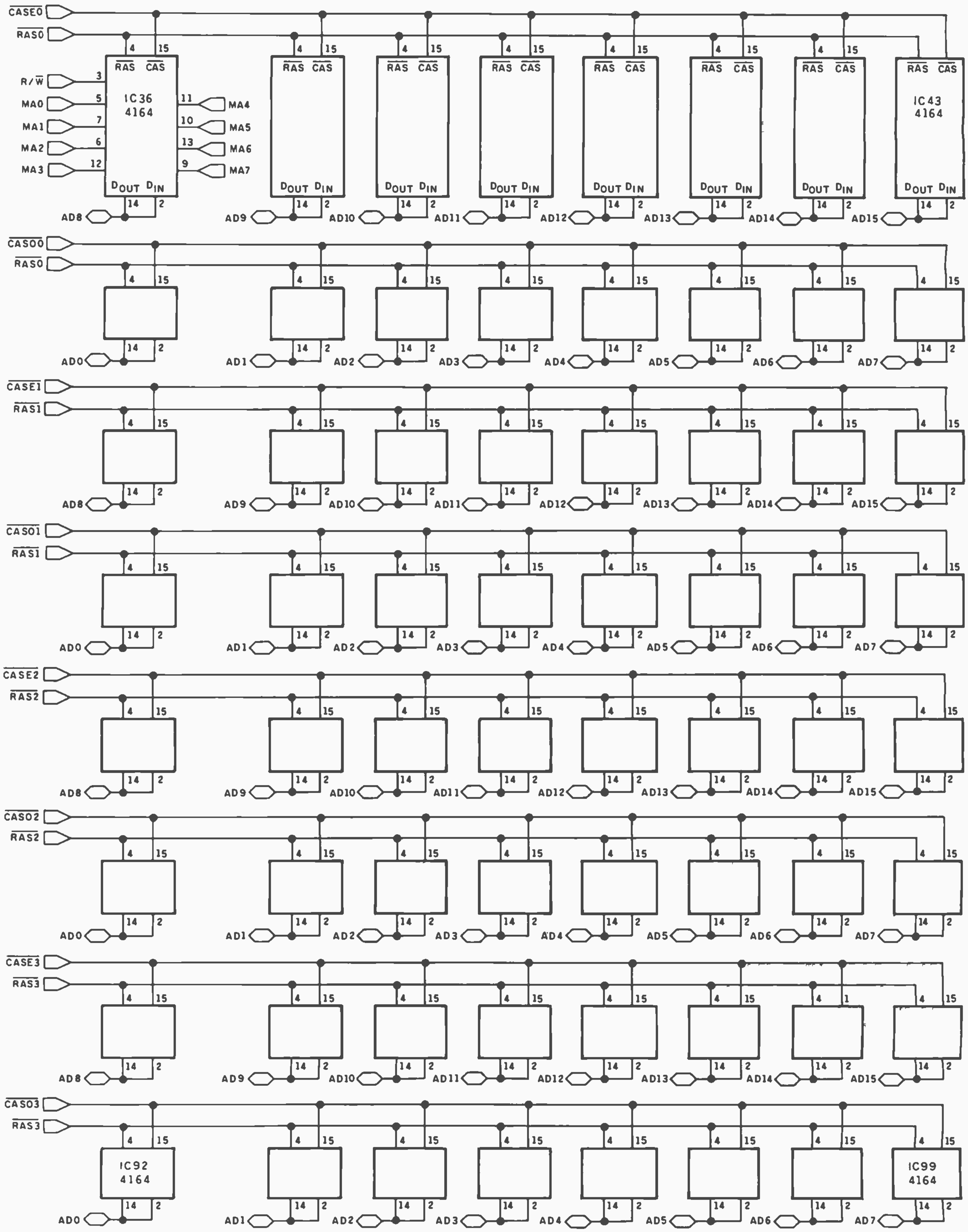



*Figure 3 continued on page 48*

*Figure 3 continued:*

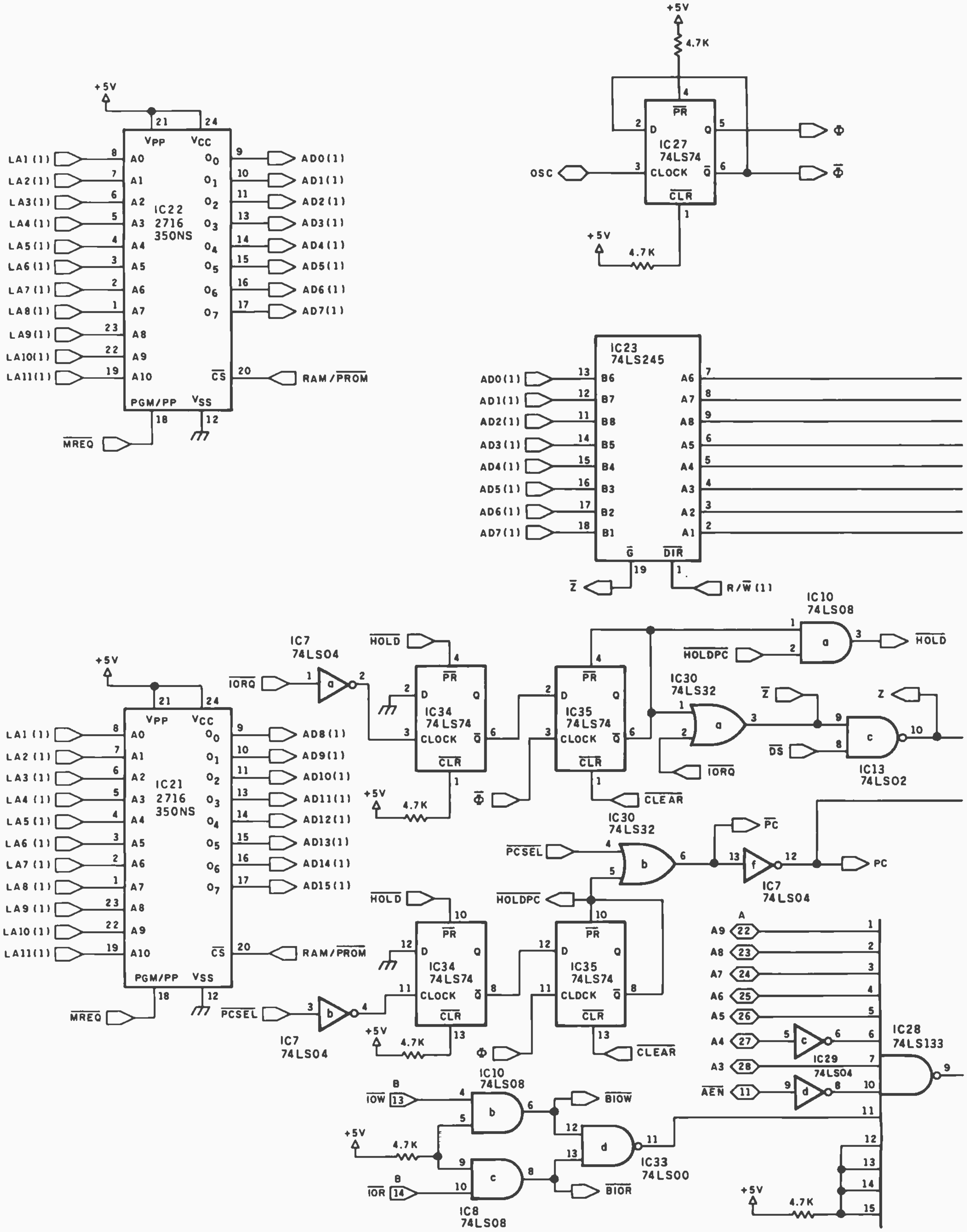
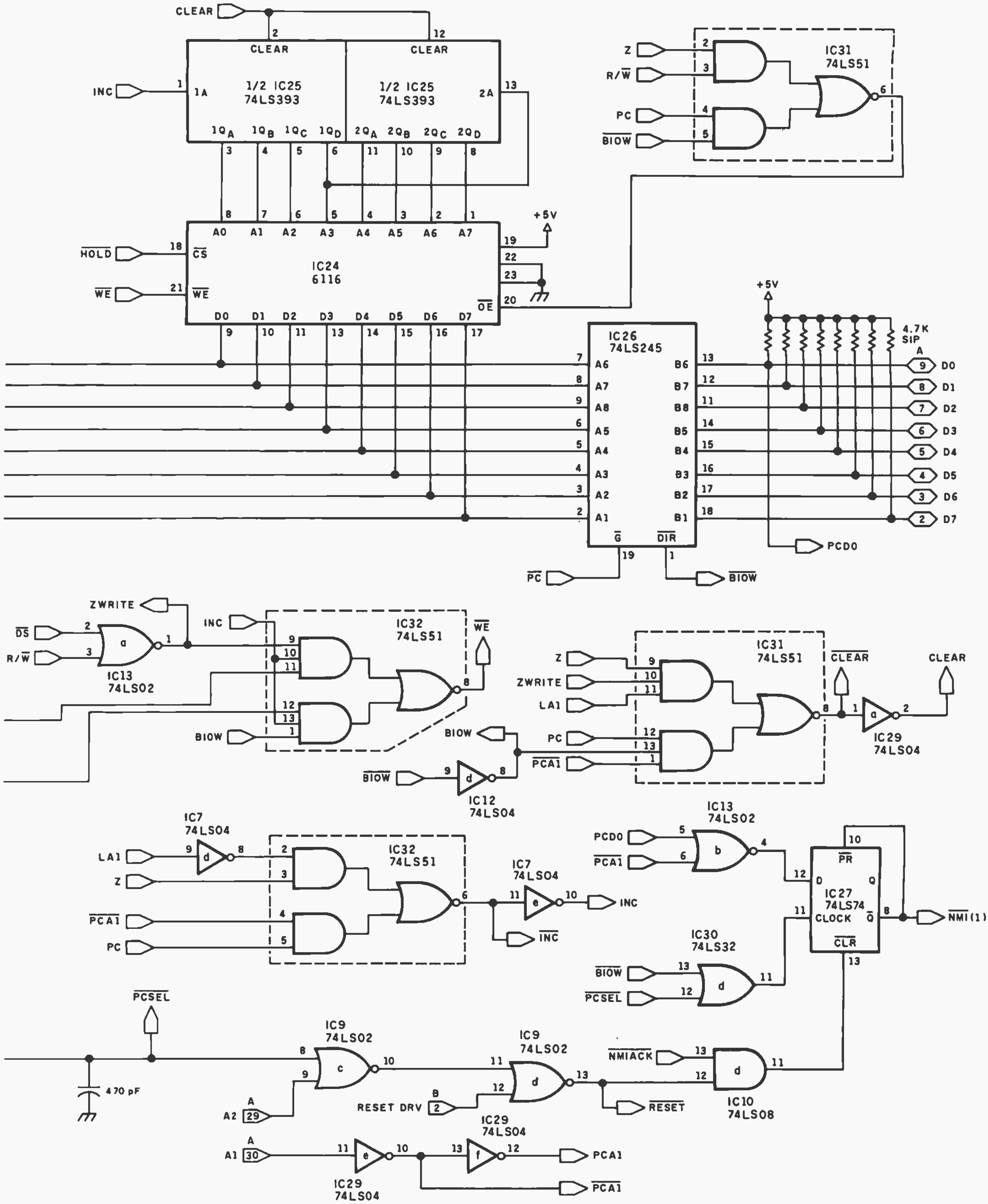



*Figure 3 continued on page 49*

*Figure 3 continued:*



| Number | Type | +5 V | GND |
|---|---|---|---|
| IC1 | Z8001B | 11 | 36 |
| IC2 | Z8581 | 5 | 14 |
| IC3 | 74LS373 | 20 | 10 |
| IC4 | 74S138 | 16 | 8 |
| IC5 | 74LS373 | 20 | 10 |
| IC6 | 74LS373 | 20 | 10 |
| IC7 | 74LS04 | 14 | 7 |
| IC8 | 74LS08 | 14 | 7 |
| IC9 | 74LS02 | 14 | 7 |
| IC10 | 74LS08 | 14 | 7 |
| IC11 | 74LS32 | 14 | 7 |
| IC12 | 74LS04 | 14 | 7 |
| IC13 | 74LS02 | 14 | 7 |
| IC14 | 74LS138 | 16 | 8 |
| IC15 | 74LS138 | 16 | 8 |
| IC16 | 74LS138 | 16 | 8 |
| IC17 | 74157 | 16 | 8 |
| IC18 | 74157 | 16 | 8 |
| IC19 | 74S74 | 14 | 7 |
| IC20 | 74LS08 | 14 | 7 |
| IC21 | 2716 | 24 | 12 |
| IC22 | 2716 | 24 | 12 |
| IC23 | 74LS245 | 20 | 10 |
| IC24 | 6116-3 | 24 | 12 |
| IC25 | 74LS393 | 14 | 7 |
| IC26 | 74LS245 | 20 | 10 |
| IC27 | 74LS74 | 14 | 7 |
| IC28 | 74LS133 | 16 | 8 |
| IC29 | 74LS04 | 14 | 7 |
| IC30 | 74LS32 | 14 | 7 |
| IC31 | 74LS51 | 14 | 7 |
| IC32 | 74LS51 | 14 | 7 |
| IC33 | 74LS00 | 14 | 7 |
| IC34 | 74LS74 | 14 | 7 |
| IC35 | 74LS74 | 14 | 7 |
| IC36 | 4164-15 (150 ns) | 16 | 8 |
| . | | | |
| . | | | |
| IC99 | 4164-15 | 16 | 8 |

*Power wiring table for figure 3.*

| PC Address | Trump Card Port | Function |
|---|---|---|
| 03EE | 3 | A "write" to this port by the processor that has current use of the bucket will cause the 8-bit address counter, IC25, to be reset to 0. It will also release the bucket for use by the other processor. If bit 0 of the data bus is set to a 0 when this write is performed by the 8088 processor, a nonmaskable interrupt (NMI) is also issued to the Z8001. Reading this port allows either processor to see data at the current address of the counter without incrementing the counter. If the bucket is not available, a read operation to this port will return an FF. |
| 03EC | 1 | A read operation to this port by the processor that has the bucket reserved will return the data at the current address of the counter and increment the counter at the end of the read operation. A read by the processor that does not have the bucket will return a value of hexadecimal FF and will not increment the counter. A write to this port by the processor that has reserved the bucket will enter data at the current address of the counter and increment the counter at the end of the operation. A write by the processor that does not have the bucket will not enter data and the counter will not be incremented. |
| 03E8 | x | This port is not used for data transfer by the Z8001. A write to this port by the 8088 will issue a reset to the Trump Card. |

**Table 2:** *Communication between the Z8001 and the 8088 is through the "bucket," a FIFO buffer made from a type-6116 static-memory chip and support components. Shown here are the three basic bucket functions and the addresses and codes for each.*

*Text continued from page 44:*
which contain a bootstrap loader for cold-start-up and system-diagnostic routines. Address lines LA1 through LA11 are connected to the EPROMs, IC22 (even byte) and IC23 (odd byte). There is no need to use the $\overline{\text{ODD}}$ or $\overline{\text{EVEN}}$ bank-select lines since no data is ever written into the EPROMs. The signal RAM/$\overline{\text{PROM}}$ is connected to the $\overline{\text{CS}}$ pin on the 2716s. The $\overline{\text{MREQ}}$ (memory request) signal from the Z8001 is also connected to pin 18 ($\overline{\text{OE}}$ or output enable) of the 2716s, to inhibit the possibility of bus contention during I/O cycles.

### Status Signals

Various status signals tell the rest of the system about the processor's condition and the type of information that is appearing on the address/data bus. The status signals are as follows:

*Read/$\overline{Write}$*: The R/$\overline{\text{W}}$signal is used to indicate the direction of the current bus transaction. When high, the direction of data is toward the Z8001. Data is clocked into the processor at the occurrence of a positive-going pulse on $\overline{\text{DS}}$ (data strobe). When $\overline{\text{DS}}$ is low, data flows from the processor outward.

*Normal/$\overline{System}$*: The N/$\overline{\text{S}}$ signal indicates whether the processor is operating in the system (supervisory) mode or normal (user) mode of operation. This control line is used when there is a multitasking and/or multiuser type of environment to segregate system functions and memory. The line is unused in the Trump Card.

*Byte/$\overline{Word}$*: The B/$\overline{\text{W}}$ line is provided to enable the Z8001 to perform byte operations on memory. When high, it indicates that a byte operation is to take place; a low state indicates word operations. This signal is also used in the $\overline{\text{ODD}}$ or $\overline{\text{EVEN}}$ memory-select logic.

*Status Lines*: Lines ST0 through ST3 are utilized to define the exact type of transaction occurring on the bus. Only 4 of the 16 possible codes are required for operation of the Trump Card. The first status code, 0000 (Internal Operation), is decoded but unused. The second operation code, 0001 (Memory Refresh), is output by the internal Z8001 memory-refresh timer and is used in refreshing the on-board dynamic RAM. (This signal is ANDed with $\overline{\text{MREQ}}$ and is used as one of the two select signals in the row-address-strobe generation logic.) The third operation, 0010 (Standard I/O Reference), is used in the process of communicating with the host 8088 processor. The fourth operation code, 0011 (Special I/O), denotes I/O associated with the signal $\overline{\text{SPIO}}$ and is reserved for future expansion.

### Clock Generation

The basic clock rate for the Z8001 on the Trump Card is provided by IC2, a Zilog Z8581 clock generator and controller (CGC). The Z8001's clock-input maximum voltage must come within a certain range of the power-supply potential (precisely $V_{cc}$ − 0.4 V) and have a maximum rise and fall time of 10 nanoseconds (ns). Such requirements are difficult to meet with standard oscillators and

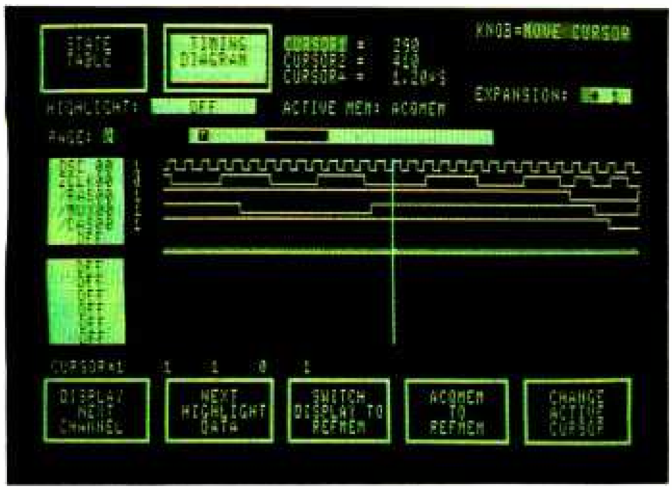



**Photo 5:** *A typical display on the Tektronix 1240 logic analyzer: the column-address-strobe/row-address-strobe timing of the Trump Card.*

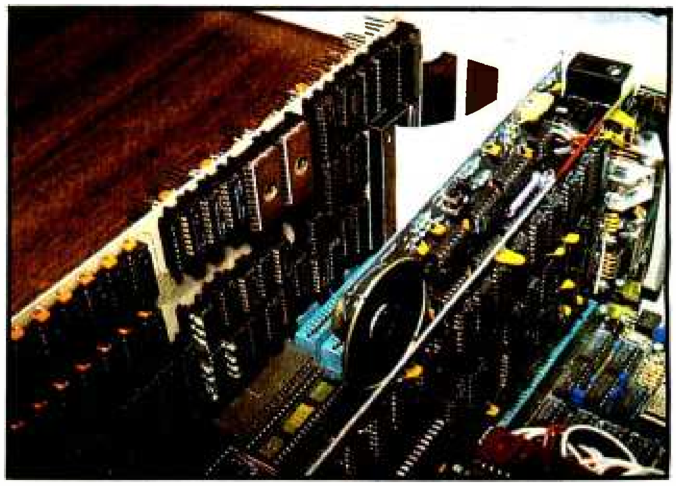


**Photo 6:** *To aid in my initial development, a Zscan-8000 emulator is plugged by a ribbon cable into the Z8001 socket on the Trump Card. In emulation mode, the Zscan-8000 can run diagnostic programs and exercise all functions of the Trump Card at 4 MHz. Hardware debugging is greatly simplified because all sections of the hardware need not be working to use the emulator.*

TTL (transistor-transistor logic), but they are easily met by the CGC. The Z8581 also provides an easy and effective means of adjusting the processor's bus cycles to the speed of available memory devices.

The CGC is used on the Trump Card to stretch specific bus cycles. As used on the Trump Card, the Z8001 does three different basic categories of operations: internal operations, memory access, and input/output operations. The timing of the ZCLK signal emitted by the CGC depends on which of these bus activities is taking place. The Z8581 can be configured to add wait states that enable the use of 150- and 200-ns RAM chips.

### Trump Card/Host Communication

The "bucket" is the communications interface between the PC and Trump Card. This FIFO (first-in/first-out)-type dual-port memory configuration consists of a 6116 static memory (IC24), an 8-bit address counter (IC25), two data-bus buffers (ICs 23 and 26), and the necessary control logic to arbitrate access. Programs and instructions are passed between the two computers via this FIFO circuitry. As far as the PC is concerned, the bucket appears as two I/O port addresses. A system of software handshaking between the computers determines which has reserved and is using the bucket. Table 2 shows the port addresses and their functions.

It is not possible for both processors to have use of the bucket at the same time. With the processors running asynchronously, arbitration is necessary. It is provided by four D-type flip-flops: two for access requests and two for access reservations. The two access-request flip-flops are clocked by the transition of an access-request signal from either processor ($\overline{IORQ}$ for the Z8001 and $\overline{PCSEL}$ for the 8088). The preset inputs of these flip-flops are connected to the $\overline{HOLD}$ signal, which is active whenever one of the processors has succeeded in reserving the use of the bucket. When $\overline{HOLD}$ is active, it prevents the other processor from gaining access.

The Z8001 communicates through the bucket for all its normal I/O by activating the $\overline{IORQ}$ line. The 8088 selects the bucket when it performs either an IOW (I/O write) or IOR (I/O read) in the range of the IBM's regular memory-address space from hexadecimal 03E8 to 03EE. Accesses to these addresses are decoded by IC28 to generate the Trump Card's $\overline{PCSEL}$ signal.

The two access-reserve flip-flops sample the output of the request flip-flops 180 degrees out of phase with each other. This is done to prohibit simultaneous requests from being honored. These flip-flops are cleared by a reset command issued from the reserving processor.

The $\overline{Q}$ outputs from these flip-flops are combined by a logical AND function with the processor request to form the active select states used by the bucket: $\overline{Z}$ ANDed with $\overline{DS}$ for the Z8001 and $\overline{PC}$ for the 8088. Whenever either request flip-flop is active, the $\overline{HOLD}$ signal is active and is used as the chip-select input on the 6116 memory. The FIFO memory, however, is written to by the Z8001 only when a "write bucket with increment" command is used.

The $\overline{WE}$ signal, connected to the write-enable input of the 6116 memory, is active during either a Z8001 I/O request (with R/$\overline{W}$ low and $\overline{DS}$ active) or an 8088-generated write to the bucket (with $\overline{PC}$ and INC active and $\overline{BIOR}$ inactive). The INC signal is active whenever the processor that has control of the bucket sets bit 1 of the address low. The CLEAR signal is active when bit 1 of the address generated by the selected processor is high and a write operation is occurring.

A nonmaskable interrupt to the Z8001 is generated when the 8088

**Listing 2:** *Bootstrap initialization program for the Trump Card written in Z8000 assembly language.*

```
0000            00  DW                       - Reserved control word
D000            02  DW                       - Flag and control word
0000            04  DW                       - Segment Register
0008            06  DW                       - Segment Offset
2100 9E01       08  LD R0,#%9E01             - Set refresh freq and enable
1404 0003 0001  0C  LDL RR4,#%0003 0001      - Set port addresses
7D0B            12  LDCTL REFRESH,R0         - Load refresh value
3E40            14  OUTB @R4,RH0             - Set R4 as reset-bucket port
3C40            16  INB RH0,@R4              - Read bucket without increment
A800            18  INCB RH0,#1              - Increment input value
E6FC            1A  JR 0 EQ,%0014            - Repeat if equal to 0
3C40            1C  INB RH0,@R4              - Read bucket
8A80            1E  CPB RH0,RL0              - Compare bucket value to 01
EFF9            20  JR NC UGE,%0014          - Do again if not > 01
C803            22  LDB RL0,#%03             - Load R0 with bucket available #
3E58            24  OUTB @R5,RL0             - Load bucket with R0
8400            26  ORB RH0,RH0              - Set zero flag if RH0 is 0
E6F5            28  JR Z EQ,%0014            - Restart boot, else continue
3C52            2A  INB RH2,@R5              - Read bucket and save in register
3C53            2C  INB RH3,@R5              - Read bucket and save in register
3C5B            2E  INB RL3,@R5              - Read bucket and save in register
3C51            30  INB RH1,@R5              - Read bucket and save in register
3C59            32  INB RL1,@R5              - Read bucket and save in register
3A50 0120       34  INIRB @RR2,@R5 R1        - Read bucket into memory
F013            38  DBZNZ RH0                - Decr RH0 and at 0 goto 0014
3E40            3A  OUTB @R4,RH0             - Reset bucket
AB35            3C  DEC R3,#6                - Decrement value in R3 six times
                                               to set up first addr of code
1E28            3E  JP @RR2                  - Jump to loc defined in RR2
```

performs a write operation to the bucket with address bit 1 and data bit 0 both low. This interrupt is latched in a D-type flip-flop and is not cleared until the Z8001 issues a Nonmaskable-Interrupt Acknowledge (status decode 5) or until the host computer resets the Trump Card. (See table 2 for more detail.)

## Booting Trump Card

When you plug the Trump Card into a slot in the IBM PC and turn on the computer, the Trump Card automatically executes the bootstrap-loader routine contained on board in EPROM. The loader routine is only 31 words (62 bytes) long; its assembly code is shown in listing 2.

I used two 2716 EPROMs instead of bipolar PROMs to store the bootstrap loader because they are both cost-effective and easier to program than bipolar PROMs. Two byte-wide memory devices are required because the Z8001 is a processor with a 16-bit word length. Each machine-language instruction (expressed as four hexadecimal digits) is separated into high- and low-order bytes (or "even" and "odd," if you prefer); the high and low bytes are stored in separate EPROMs. When you examine a particular 16-bit memory location, you are actually viewing the information provided from two 8-bit sources.

## Using Trump Card

Trump Card is transparent to normal PC operation. To start Trump Card, you run a program stored under PC-DOS called LDZSYS. This is the Trump Card communications software that runs on the 8088. If you always want Trump Card features available, you can add this program to your regular AUTOEXEC batch file. When LDZSYS has completed initialization, it returns to the PC-DOS A> prompt to wait further instructions.

At this point, I generally configure part of Trump Card's memory as a RAM disk, using a program called SETRMDSK. This is done as follows:

```
A> SETRMDSK 4
A>
```

SETRMDSK configures the additional C drive to your existing system under DOS 2.0. The number following SETRMDSK determines how many 64K-byte blocks you wish to reserve as a RAM disk. In this case, I set up a 256K-byte drive. The RAM-disk size can be 128K to 387K bytes, depending upon the amount of memory on the Trump Card board. (While you can set a 128K-byte RAM disk in a 256K-byte board, you might have problems running large BASIC or C programs concurrently.)

The memory that I've set as a RAM disk is completely separate and in addition to the regular IBM PC memory. Even if you have a 640K-byte PC, up to 387K bytes of Trump Card's memory would be available as additional RAM-disk configured storage space.

I used the RAM disk to speed up the process of writing these articles. Many word processors, like the Volkswriter I use, make extensive calls to the disk for help files and command-execution files. After a while, the noise and delay get aggravating. To remedy this situation, I run the SETRMDSK 4 sequence just described to create the 256K-byte RAM drive C and then add the following:

```
A> COPY *.* C:
A> C:
C>VW
```

This copies the entire contents of the Volkswriter distribution disk to the RAM disk, sets it as the default drive (C), and starts the word processor. When I now press a function key the action is instant and silent. To guard against power interruptions, drive B is designated as the hard-storage location and periodically I store the article file to it.

Trump Card's other features are equally simple to use. BASIC, C, Z80, and editing files can be stored on the same disk and executed with similar ease. While I'll explain it in greater detail next month, a possible sequence of Trump Card operations is shown in table 3.

## Rewarding Diligence

I've been having a lot of fun with Trump Card. I haven't done much assembly-language or C programming yet, but it has renewed my faith in BASIC.

Trump Card is not an easy project to build. Compared to other Circuit Cellar projects, however, it's manageable. I was surprised at the number of readers who hand-wired the 121-chip MPX-16 PC-compatible computer that I presented last year. Their letters suggested that the motive was neither money nor masochism. In-

| | |
|---|---|
| A> LDZSYS | (initialize Trump Card) |
| A> | (return to PC-DOS or use Trump Card) |
| A>G | (turn over PC operation to Trump Card) |
| : | (Trump Card prompt) |
| : EE *filename* | (edit a file) |
| or | |
| : Z80EM *filename* | (emulate CP/M-80 and run Z80 programs) |
| or | |
| : C *filename* | (compile and run a C program) |
| or | |
| : Y *filename* | (compile and run Z8000 assembly language) |
| or | |
| : BASIC *filename* | (compile and run BASICA programs) |
| : // | (return to PC-DOS) |
| A> | |

**Table 3:** *A Trump Card operating sequence.*

stead, building these projects enabled them to experiment with digital circuitry yet be secure in the knowledge that their project would work. I hope this project elicits a similar response, and I'd like to reward such enthusiasm in advance.

Esoteric peripherals such as Trump Card depend a great deal on sophisticated software to fully exercise their capabilities. Unfortunately, when experimenters build rather than purchase boards, they often have to use great ingenuity to obtain software.

More than five man-years of development effort went into the present support packages for Trump Card. Some, like TBASIC and the RAM disk, were contracted by me, while others, like the C compiler and Y (a Z8000 assembler), were written by Zilog. Combined with the CP/M-80 emulator, Z8000 operating system, and telephone-book-size documentation, it is a formidable package that is difficult to independently price.

I want to encourage you to build your own Trump Card if that is your choice. If you send me a picture of the completed unit, I will send you a copy of the complete software and the documentation (provided it is for personal, noncommercial use) for the cost of duplication and shipping

*The following items are available from*

*Sweet Micro Systems Inc.*
*50 Freeway Dr.*
*Cranston, RI 02910*
*(800) 341-8001 for orders*
*(401) 461-0530 for information*

1. *Trump Card, including IC sockets, assembled and tested with 256K bytes of the 512K-byte RAM space populated. Includes TBASIC compiler, C compiler, Z8000 Y assembler, CP/M-80 emulator, RAM-disk driver, and documentation. Software supplied on a PC-DOS 2.0 disk unless otherwise specified.*
   *256PCB ........................ $995*

2. *Trump Card, assembled and tested with 512K bytes of dynamic RAM installed. Includes support software described above and documentation. Software supplied on a PC-DOS 2.0 disk unless otherwise specified.*
   *512PCC ........................ $1325*

3. *Partial kit for Trump Card. Includes fully socketed wave-soldered printed-circuit board, bootstrap EPROMs, 10-MHz Z8001, and Z8581. Includes software and documentation described above. Other integrated circuits not included. Software supplied on a PC-DOS 2.0 disk unless otherwise specified.*
   *0KPCA ........................ $525*

*Please add $10 for shipping and handling in the continental United States. Please add $20 for shipping to other locations. Rhode Island residents please add 6 percent sales tax.*

($30). The software houses and other parties in this project have waived all royalties as a gesture of support for the Circuit Cellar.

### Next Month:

*In June's article, I'll describe the software in detail and do a little benchmarking.* ■

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**Editor's Note:** *Steve often refers to previous Circuit Cellar articles. Most of these past articles are available in reprint books from BYTE Books, McGraw-Hill Book Company, POB 400, Hightstown, NJ 08250.*

Ciarcia's Circuit Cellar, Volume I *covers articles that appeared in BYTE from September 1977 through November 1978.* Ciarcia's Circuit Cellar, Volume II *contains articles from December 1978 through June 1980.* Ciarcia's Circuit Cellar, Volume III *contains articles from July 1980 through December 1981.* Ciarcia's Circuit Cellar, Volume IV, *soon to appear, will contain articles from January 1982 through June 1983.*

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| Printer Port | YES | OPTIONAL | YES | OPTIONAL |
| Communication Port | YES | OPTIONAL | YES | YES |
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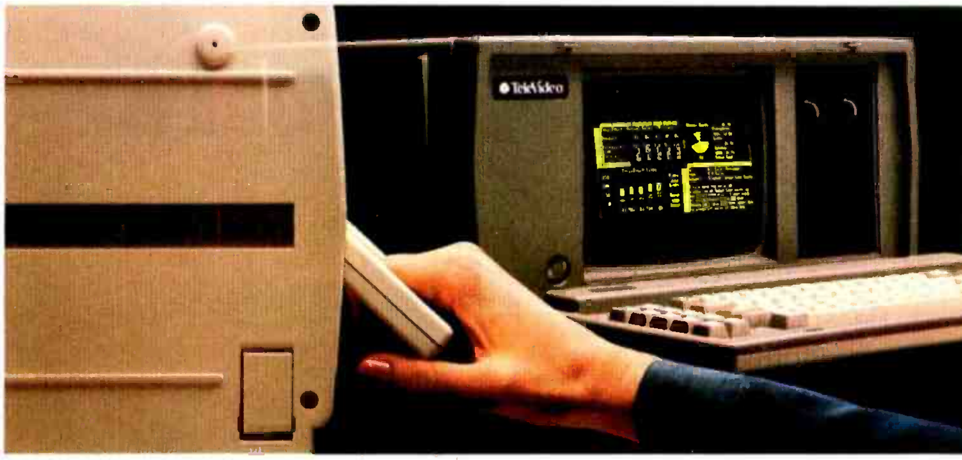


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# Chaos Manor's Hard-Disk System

*Dirty filters, 8/16-land, views of the future, and inevitably more*

**Jerry Pournelle**
**Consulting Editor**

At Chaos Manor everything happens at once. I have 10 pounds of mail set aside because the letters raise questions better answered in this column than in BYTE's User to User; from where I sit I can see a raft of new books; we're getting to know and love the Diser machine; I've heard from the Modula Research Institute; and I've just returned from the Sage Faire, where I learned that the Motorola 68000 chip is alive and well and hiding in Reno, Nevada. Meanwhile, I'm working with the new Compupro 40-megabyte disk and 8/16 operating system, and I have word that Jim Hudson has his 8087 math-chip board for the Z-100. Clearly, the Intel 8086 and follow-ons are as healthy as the 68000 products.

So just where are we going? What will the supermicros look like when they arrive, and how can users be sure they won't invest in dead-end equipment and software? Is it to be the 8086 or the 68000?

I'll get back to that after we look at the latest hardware in Chaos Manor.

## Compupro Hard Disk

For years I've resisted hard disks. Although faster than floppies, they just didn't seem worth the effort. I've heard too many horror stories of how bad software managed to blow a hard disk's directory, or how a sudden power failure brought on disaster. There seemed to be considerable risk, and the rewards just weren't that great—until recently, hard disks didn't hold *that* much more than my 1.1-megabyte 8-inch floppies, while RAM (random-access read/write memory) disk drives were faster.

From time to time I'd hear about a new hard-disk system and wonder if I ought to install one, but there was always some problem sufficient to keep me away.

That all changed a couple of weeks ago when the Compupro hard disk arrived. I love it, but Chaos Manor has been even more chaotic ever since.

First was the problem of where to *put* the new disk. The Compupro 40-megabyte system is physically the same size as the Compupro "boat-anchor" system: not small. One natural place to put it is to stack it with the main computer box, and most people will do that. Compupro normally packages an 8-inch double-sided double-density disk in with the hard-disk drive; this provides both backup and a way to get programs into the computer. However, I insist on keeping both of my 8-inch drives, so my hard disk arrived with a blank piece of metal instead of a floppy drive. Taped to the blank spot was a card that read "Five-inch drive goes here . . ."

A story goes with that. Compupro has the 5¼-inch drives, a controller to run them, and software to drive the controller; what it doesn't have just at the moment is the black metal cutout to hold 5¼-inch drives in place. There are plenty of bezels for 8-inch drives, and by the time you read this I should have the 5¼-inch drive running; but for the moment that's in the Real Soon Now category.

There was only one catch to the hard disk: Chaos Manor has become a test site for the new 8/16 software that drives it. Of course, that wasn't supposed to be any real hardship. Tony Pietsch had been running the new software with his hard disk for weeks. I was only supposed to be a sort of final test site, in case there were any minor bugs left.

It's as well that Compupro is thorough. I do a lot of things that Tony doesn't. There definitely were bugs. Some weren't so minor, either; there was a time there when I was muttering that hard disks should be confined to hackers, who undoubtedly deserved them; they weren't for ordinary users. However, as each bug showed up, Tony dug into the BIOS (basic input/output system) and other esoterica, and pretty soon, Lo!, the system began to work quite well.

There are still some annoyances. Some are fixable, others probably are not. No matter: already the advantages outweigh the disadvantages by a lot.

I now keep my accounting system, editors, address book, mail lists, disk catalog, utility programs, CB-80 compiler, RMAC macro assembler, lots of program sources, spelling checker and dictionaries, and the *entire text* of the new Niven and Pournelle novel *Footfall* in various places on that hard disk. No more getting up to find the right floppy disk. It's all here. Sure, I have to find the right floppy to put safety copies onto—I don't feel my work is safe until I have a copy in a nonmagnetic box in the other room—but I can do that while The Word Plus is checking spelling or the compiler is compiling.

I find that I get a lot more done now. Example: I thought of a fast modification to the accounting program. Normally I wouldn't bother, at least not until I had the program sources out. With the source, text editor, and compiler already on line, *it* took only a few minutes to make the needed changes.

For the first time I find having an on-line address book worth bothering with. Oh, sure: I have always kept mailing lists and stuff like that on disks. Every now and then I get ambitions for new name and address software, and there's a new flurry of activity; but, I blush to say, I've always gone back to a battered green address book held together largely with Sno-Pake and tape. The address book took less time than loading in the data-retrieval program, finding the data disk, and searching for the data. (Larry Niven stores his addresses and phone numbers in a text file and uses the Search function in WRITE; that works, but somehow I never got in the habit of it.) With data and the retrieval program all on hard disk, computer retrieval is faster than searching for the address book among the litter on my desk and credenza.

This gives me an idea for a new program: one that searches through all my electronic-mail files, extracts the names and addresses, and inserts them into a database. The only difficulty would be teaching the machine to recognize what a valid name and address look like. This would be no problem for letter files; now all I have to do is figure out how to tell the machine which files really contain letters and which are something else hiding on the letters' disks.

I may or may not get around to such a program. The point is that the program would be valuable now, and it wouldn't have been without the hard disk.

### Want to Bet?

When Tony installed the new Compupro hard disk and Disk Three controller, my 8085/8088 Dual Processor ceased to work. This caused considerable consternation.

The first supposition was that the disk itself had been damaged in shipment, and examination of the shipping box showed that it had indeed been dropped; some of the tape seams had split. However, it hadn't been damaged. Not only does Compupro lock the disk head in place, but on power-down it's retracted to a dedicated "landing zone" first. Those Quantum disks are rugged.

"We've overloaded the bus," Tony decided. We did, after all, have all 20 slots filled in my Compupro boat-anchor box. In addition, we have Jim Hudson's 8087 math-chip board piggyback on the 8085/8088 Dual Processor's processor board—and that's no ordinary 8087, it's an 8-MHz chip, which gets hot enough to fry eggs on.

Certainly the box was full. There were old memory boards, three different interface boards, and a mess of other stuff; although the Dual Processor has become the main computing machine here, it still retains some residual equipment from the days when it was an experimental system.

Tony removed a number of superfluous boards. A few minutes later Bill Godbout called about something else.

"We finally managed to overload the bus on a boat anchor," I said.

"Nope. Don't believe you," said Dr. Godbout.

"Eh? Tony says—"

"Tell him I'll bet him the value of his house," Bill said. "And I'll buy the system from you."

"But—"

"Have you looked at the fan filter?"

Sure enough, the filter was clogged with dust. I cleaned it. Just to see, I put all the extra boards back in: no problems.

"We've tried to overload the bus," Dr. Godbout explained. "I suppose you could do it, but the problem is usually the fan filter. Once we had a system failure just before tax time. There was a panic, but it was the filter."

Actually, I expect he doesn't have as much dust, now that Compupro has moved to modern headquarters in Hayward; but when the company was in the old WW II "temporary" buildings at Oakland Airport, I well imagine dust would frequently clog the filters.

We even speculated about modifying the operating system so that on the second Wednesday of each month the system would display a "CLEAN THE FILTER" message, then cease to work for five minutes. After all, there is a real-time clock/calendar on the System Support Board.

I doubt it will ever come to that, but do clean your air filters regularly.

### System 8/16

One of the nice things about the new hard-disk system is CP/M-8/16. My Dual Processor now runs both 8-bit and 16-bit programs. Both varieties are present on the hard disk, and I don't have to worry about which ones are which; I just run the program I want, same as I always did. The computer figures out whether it's supposed to run this as 16-bit software under CP/M-86 or as an 8-bit program under CP/M 2.2, in which case it gets assistance in disk operations from the 16-bit 8088 chip.

There's a large bonus for 8-bit programs. Disk operations are handled by the 8088 chip, leaving a great deal more free memory. In our case, the Temporary Program Area (TPA—the practical workspace for the program)

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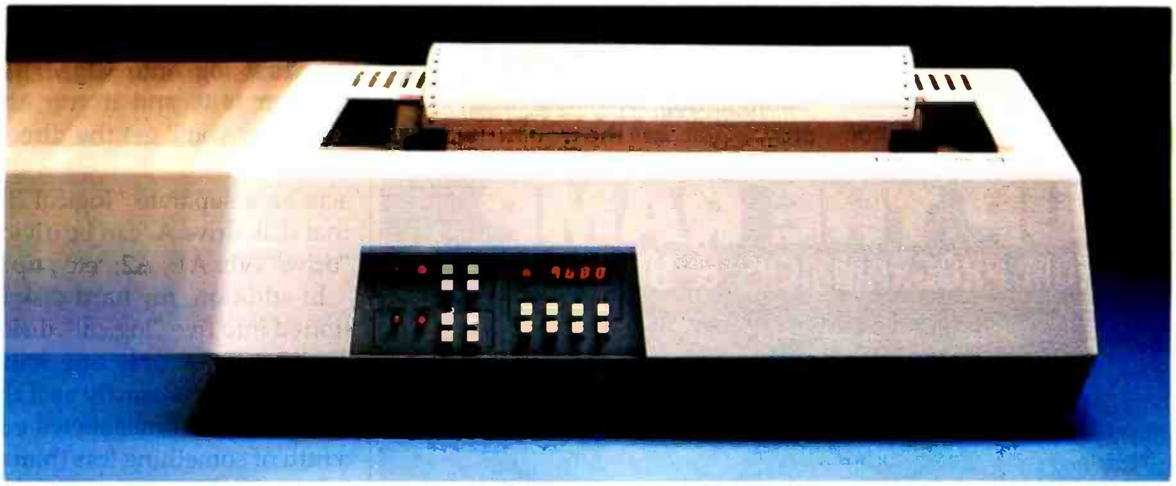

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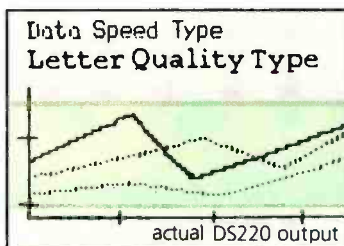


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has increased by 25 to 30 percent. Floppy-disk operations are *much* faster, too. Meanwhile, hard-disk loads and saves are so fast that although I have a full 2 megabytes of RAM disk, I find that I hardly ever bother to use it. The hard disk is not much slower.

I don't entirely trust the hard disk: every now and then I transfer all the new work to a floppy, and if the work is important enough, I do that again onto a different floppy at the end of the work session. So far I have not needed those backups, but I'm a firm believer in saving early and often.

### Annoyances

Clearly, I like CP/M-8/16, and I can enthusiastically recommend the new Compupro hard disk and 8/16 operating system. However, it's not all smooth sailing.

Some difficulties are inherent in CP/M. User numbers are vital: without them, you'd never be able to partition a big hard disk into useful areas. That was the trouble with PC-DOS 1.1 on the Eagle 1620: no directory structure, so that everything was in one interminable directory listing. PC-DOS 2.0 fixed that for the Eagle. CP/M-8/16 doesn't have a tree structure. You have to rely on user numbers, which are vital; but they're not really very convenient.

User numbers control user areas on both floppy and hard disks. Each user area has its own directory. When you first log onto CP/M, the user number is 0, and if you ask for a directory, you'll get the directory for User 0 and no other. Each user area acts as a separate "logical disk," so that disk drive A: can be divided into "drive" A0:, A1:, A2:, etc., up to A15:.

In addition, my hard disk is partitioned into five "logical" disk drives. That is, there's only one actual hard disk, but it acts exactly as if there are five, four of 10 megabytes each and a fifth of something less than 4 megabytes. These are designated drives A:, B:, C:, D:, and E:. Drive M: is the RAM disk. Drives F: and G: will be 5¼-inch floppies, and drives I: and J: are 8-inch double-sided double-density 1.1-megabyte floppies. Thus, I could have programs at, say, C12: and B9: in addition to A0:, etc.

Keeping track of just which programs are in which disk area is no easy task, since under CP/M there's no global directory command. That is, if you have files on disk D: under User 13, you'll never be able to list them unless you specifically ask for the D13: directory, and even then you may miss it if you've designated those files as System or "hidden."

When we first installed the hard-disk system, we did a lot of tests, including exercising the random-access capabilities. One program that does very complicated random-access disk I/O is my accounting system, so we went to unused user areas and did a lot of journalizing and posting. When I was done, I had no idea of where we'd put those no longer wanted account files. I was prepared to log onto each logical disk and patiently go from User 0 to User 15 looking for directories, but that seemed a bit tedious. Better, perhaps, to read the instructions.

Alas, the Digital Research CP/M


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manuals say very little about user areas. There's no discussion, and what information that does exist is scattered through the USER, PIP, and STAT command explanations. The USER command discussion tells you that command STAT USR: will tell you which user numbers have files on a particular disk. Of course, since this is Digital Research documentation, the little *CP/M-86 Command Summary* book doesn't mention USR: in the USER command section, so I'd missed it. It was only when I sat down to write this that I discovered that the full DR *CP/M-86 User's Guide* does mention a command STAT USR:. It would have saved me considerable time if it had been in the *Command Summary* book.

That command is fine, except that apparently you have to log onto each disk in turn to find out which user areas have files. This isn't very convenient. In fact, it's even worse than you think.

CP/M-8/16 has one great feature. Command files that are stored on as System files on disk drive A: under User 0 are accessible to *all* disk drives and *all* user numbers. Thus, I can put XD.COM, WRITE. COM, and other programs I use all the time onto the A: drive, and even though I'm now working with data on the C: drive under User 3, I have immediate access to the A0 command programs.

Alas, the version of CP/M-8/16 that I have has one lousy feature: the "A: User 0" access feature works only with .COM, i.e., 8-bit command files. If I want to use a .CMD (16-bit) command file, it must be present in user area 0 on the disk I'm logged onto. In particular, STAT.CMD must be present on disks B:, C:, D:, and E: if I want to log onto one of those disks and find out which user areas have files stored in them. Moreover, if PIP.CMD isn't on each logical disk, I have to go back to logical disk A: to transfer files from one place to another.

It's no good using PIP.COM and STAT.COM either. They get confused easily in a 16-bit environment. It's best simply to erase them, because you should use PIP.CMD and STAT.CMD.

Sigh. I carefully transferred STAT.CMD to each of the logical disks, then logged onto each in turn and did STAT USR:, which worked fine, although it wasn't very convenient. Then I had an idea. There was no entry under USR: in the index, but careful reading of Digital Research's *User's Guide* entries for STAT turned up the command syntax STAT {d:}USR:. Although there was no example, and I thought B:USR: a very strange command form indeed, when I tried it, I found it worked. Now I have a SUBMIT file called STATUSE.SUB that does STAT USR: for all the logical areas of my hard disk. Wheee!

If I seem a bit sarcastic, BYTE's managing editor has just received a very biting letter from the manager of the Digital Research documentation shop, who says I'll have nothing to write about if I stop unjustly accusing DR of bad documentation. He invites BYTE to require me to look at the Digital Research CP/M-86 documents as a prime example of the new excellent documentation DR now produces. I have just spent several hours experimenting with ways of using PIP with user numbers. Although this is vital to hard-disk management, there are precisely three examples of user-number options with PIP, and one of them contains an unexplained * in the command option. There is no example of how to transfer files from one disk to another while changing user numbers when you're logged onto yet a third disk under yet a third user number. It turns out that can be done; but I've wasted hours trying to discover what DR could have told me in 10 lines of text, and after that letter it sent, I'm not in a charitable mood.

Aside, for the record: as I've said more than once, Digital Research's documents have shown remarkable improvement. There's room for more. Some of the improvement is said to be due to my flaying of both its old documents and its rather horrible intermediate "improvements" by a group of technical writers. I'm aware DR has put a lot of effort into document improvement, and the com-

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pany has made great strides. I also realize that documentation is tough, and it's particularly difficult if you're writing for naive users about complex products like operating systems and compilers.

I've also said, repeatedly to the point of nausea, that examples and indexes will cover a myriad of sins. If USR: had been an index entry, I might have had a chance. If there had been more examples of how to use PIP with changing user numbers, I'd have saved time. Please, Digital Research: you're much improved since the CP/M 2.2 manuals, but you have not reached perfection yet.

Back to hard disks and 8/16: I'm hooked. There are too many advantages to having that much data on line.

Alas, I don't yet have one of the advantages. That is, I've been using Ward Christensen's wonderful disk-catalog program to keep track of the myriad floppies I've collected since 1976. It's possible to use that program to locate particular files and particular disks, but the catalog-library file the program must search is very large, and on floppies it was just too slow. I wrote a program that prints out the master catalog on paper. (My printer program, Christensen's public-domain catalog program, and a bunch of other useful stuff are available from Workman and Associates as one utility disk.) Christensen unfortunately wrote his catalog program long enough ago that there was no possibility of disks beyond H:. Consequently, I can't catalog floppy disks with it unless I boot up the system under the old CP/M 2.2 BIOS.

However: I can do that. The hard disk is no longer available when I do that, but so what? I can catalog floppies, and when that's all done, reboot under CP/M-8/16, use PIP to put the master catalog onto the hard disk, and keep it on line. The catalog program will search the master file all right; it's only the disk-map utility that won't run.

The bottom line on hard disks and 8/16 is that there may be aggravations, but the advantages are high. After all, this is a test setup, and I did volunteer to be a guinea pig. By the

*Text continued on page 70*

# ETI's Four Ways To Better Management

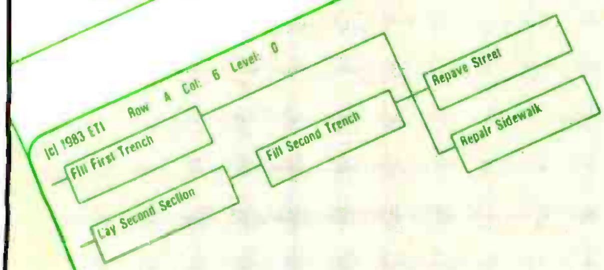
## Project Control System

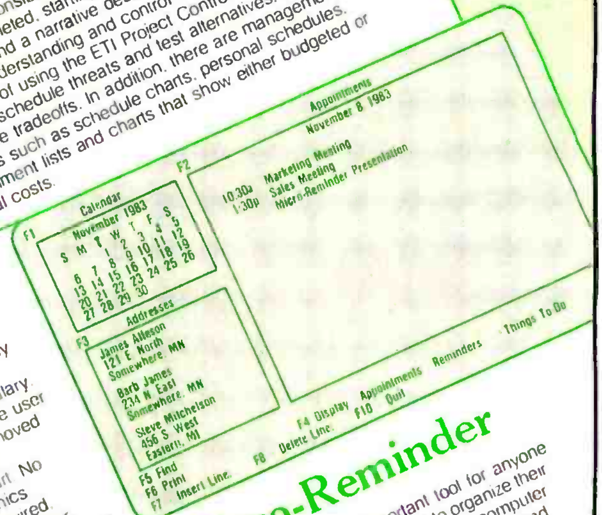
The ETI Project Control System is a visual project management tool. It allows the user to divide large, complex projects into individual tasks and operations.

Based on the proven CPM and PERT methodologies, the ETI Project Control System offers uncluttered "what you see is what you get" displays and extensive user flexibility.

With a few keystrokes, the ETI Project Control System user can draw a task chart to fit nearly any project. Each task may include name, duration, capital cost, labor cost, overhead cost, person(s) responsible, manpower requirements or manpower mix, amount completed, starting and ending dates (including early and late dates) and a narrative description.

Better understanding and control of complex projects is only one result of using the ETI Project Control System. It can also help find schedule threats and test alternatives, or seek the best cost/time tradeoffs. In addition, there are management-aiding displays such as schedule charts, personal schedules, assignment lists and charts that show either budgeted or actual costs.



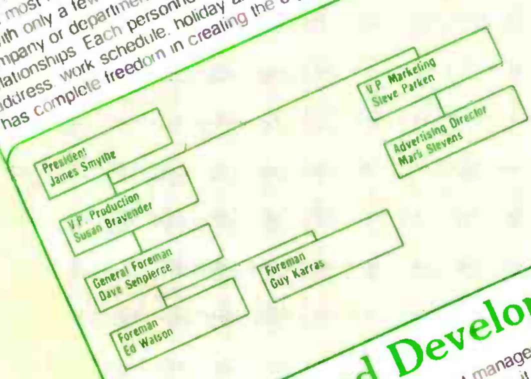




## Personnel System

The ETI Personnel System is a visual personnel management tool. It allows the user to organize a firm's most important resource—its personnel.

With only a few keystrokes, the Personnel System can draw an organization chart to fit nearly any company or department. Persons are displayed in boxes, with lines showing the hierarchical relationships. Each personnel record may include the person's name, department, job title and salary, address, work schedule, holiday and vacation schedule, and a narrative position description. The user has complete freedom in creating the organization chart. People may be added, removed, or moved anywhere on the organization chart. No additional graphics hardware is required.

If you have a printer, "What you see is what you get" reporting of all charts and personnel information transfers your organization to paper. If the organization chart does not fit on a single page it will be printed on multiple pages which may be taped together to form a complete chart.




## Micro-Reminder

Micro-Reminder is an important tool for anyone who wants to use the computer to organize their time. Even if you have never used a computer you will feel at ease with Micro-Reminder and quickly learn to use all of its powerful features.

With Micro-Reminder, you can use the computer's memory to help remember all of the details which make up your day. Micro-Reminder acts as a desk calendar to keep you abreast of your appointments. You can also use Micro-Reminder to write yourself short reminders, and keep track of the tasks facing you by keeping a "Things To-Do" list. Lastly, Micro-Reminder allows you to store names, addresses, and phone numbers for easy reference.

Micro-Reminder separates these functions by dividing the screen into three windows: Calendar, Appointments, Reminders, Things To-Do and Addresses.

By typing just a few keystrokes you can see any of the information, change it, or enter new items.

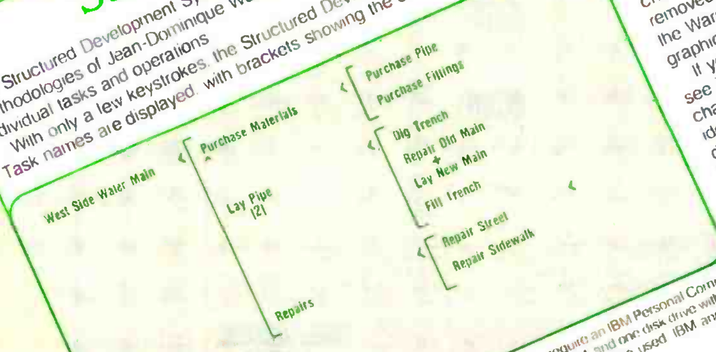
## Structured Development System

The Structured Development System is a visual project management tool. Based on the structured methodologies of Jean-Dominique Warnier and Kenneth Orr, it allows the user to divide large complex projects into individual tasks and operations.

With only a few keystrokes, the Structured Development System can draw a Warnier chart to fit nearly any project. Task names are displayed, with brackets showing the dependencies and sequence.

Each task may include a narrative description in addition to the task name. The user has complete freedom in creating the Warnier chart. Tasks may be added, removed, or moved anywhere on the Warnier chart. No additional graphics hardware is required.

If you have a printer, "What you get" see is what you get" reporting of all charts and narratives transfers your ideas to paper. If the Warnier chart does not fit on a single page it will be printed on multiple pages which may be taped together to form a complete chart.




All programs require an IBM Personal Computer with monochrome display running PC-DOS, a memory of 128K or more bytes of RAM and one disk drive with at least 256K byte capacity. No printer is required, but any printer with at least 80 columns may be used. IBM and PC-DOS are trademarks of International Business Machines.

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| SN7459N | 14 | .25 | SN74153N | 16 | .59 | SN74368N | 16 | .55 |
| SN7460N | 14 | .39 | SN74154N | 24 | 1.25 | SN74390N | 16 | 1.49 |
| SN7470N | 14 | .29 | SN74155N | 16 | .59 | SN74393N | 14 | 1.49 |

## 74LS

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| 74LS04 | 14 | .35 | 74LS107 | 14 | .39 | 74LS197 | 14 | .79 |
| 74LS05 | 14 | .29 | 74LS109 | 16 | .39 | 74LS221 | 16 | .89 |
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| 74LS86 | 14 | .39 | | | | 81LS95 | 20 | 1.49 |
| 74LS90 | 14 | .55 | | | | 81LS97 | 20 | 1.49 |

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| 74S08 | 14 | .39 | 74S138 | 16 | .89 | 74S258 | 16 | 1.19 |
| 74S09 | 14 | .39 | 74S139 | 16 | .89 | 74S260 | 14 | 1.19 |
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| 74S22 | 14 | .35 | 74S158 | 16 | .99 | 74S374 | 20 | 2.49 |
| 74S30 | 14 | .35 | 74S160 | 16 | 2.49 | 74S387* | 16 | 1.95 |
| 74S32 | 14 | .45 | 74S174 | 16 | 1.19 | 74S471* | 20 | 5.95 |
| 74S38 | 14 | .89 | 74S175 | 16 | 1.19 | 74S472* | 20 | 4.95 |
| 74S40 | 14 | .39 | 74S188* | 16 | 1.49 | 74S473* | 20 | 4.95 |
| 74S51 | 14 | .35 | 74S194 | 16 | 1.49 | 74S474* | 24 | 4.95 |
| 74S64 | 14 | .39 | 74S195 | 16 | 1.49 | 74S475* | 24 | 4.95 |
| 74S65 | 14 | .39 | 74S196 | 14 | 1.49 | 74S570* | 16 | 2.95 |
| 74S74 | 14 | .55 | 74S240 | 20 | 2.25 | 74S571* | 16 | 2.95 |
| 74S85 | 16 | 2.49 | 74S241 | 20 | 2.25 | 74S572* | 18 | 4.95 |
| 74S86 | 14 | .55 | 74S242 | 14 | 2.49 | 74S573* | 18 | 4.95 |
| 74S112 | 16 | .55 | | | | 74S940 | 20 | 2.49 |
| 74S113 | 14 | .55 | | | | 74S941 | 20 | 2.49 |

## CA—LINEAR

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CA3010H | | 1.35 | CA3081N | 16 | .99 | CA3130E | 8 | .89 |
| CA3039H | | 1.35 | CA3082N | 16 | 1.19 | CA3140E | 8 | .79 |
| CA3046N | 14 | 1.35 | CA3083N | 16 | 1.49 | CA3160H | | 1.95 |
| CA3059N | 14 | 2.95 | CA3086N | 14 | .69 | CA3161E | 16 | 2.95 |
| CA3060N | 16 | 2.95 | CA3089N | 16 | 1.69 | CA3162E | 16 | 6.95 |
| CA3065E | 14 | 1.49 | CA3096N | 16 | 1.49 | CA3189E | 16 | 1.59 |
| CA3080E | 8 | .89 | | | | CA3401N | 14 | .59 |

## CD—CMOS

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| CD4000 | 14 | .29 | CD4040 | 16 | 1.19 | CD4098 | 16 | 1.95 |
| CD4001 | 14 | .29 | CD4041 | 14 | 1.19 | CD4506 | 16 | 1.19 |
| CD4002 | 14 | .29 | CD4042 | 16 | .89 | CD4507 | 14 | 1.19 |
| CD4006 | 14 | 1.19 | CD4043 | 16 | .79 | CD4508 | 24 | 3.95 |
| CD4007 | 14 | .29 | CD4044 | 16 | .79 | CD4510 | 16 | 1.29 |
| CD4009 | 16 | .59 | CD4046 | 16 | 1.19 | CD4511 | 16 | 1.19 |
| CD4010 | 16 | .59 | CD4047 | 14 | 1.29 | CD4512 | 16 | 1.19 |
| CD4011 | 14 | .29 | CD4048 | 16 | .59 | CD4514 | 24 | 2.49 |
| CD4012 | 14 | .29 | CD4049 | 16 | .39 | CD4515 | 24 | 2.49 |
| CD4013 | 14 | .39 | CD4050 | 16 | .39 | CD4516 | 16 | 1.19 |
| CD4014 | 16 | 1.19 | CD4051 | 16 | .99 | CD4518 | 16 | 1.19 |
| CD4015 | 16 | .39 | CD4052 | 16 | .99 | CD4519 | 16 | .59 |
| CD4016 | 14 | .49 | CD4053 | 16 | .99 | CD4520 | 16 | 1.19 |
| CD4017 | 16 | 1.19 | CD4056 | 16 | 2.95 | CD4526 | 16 | 1.49 |
| CD4018 | 16 | .99 | CD4059 | 24 | 7.95 | CD4528 | 16 | 1.49 |
| CD4019 | 16 | .59 | CD4060 | 16 | 1.49 | CD4529 | 16 | 1.69 |
| CD4020 | 16 | 1.19 | CD4066 | 14 | .59 | CD4543 | 16 | 1.95 |
| CD4021 | 16 | 1.19 | CD4068 | 14 | .39 | CD4562 | 14 | 6.95 |
| CD4022 | 16 | 1.19 | CD4069 | 14 | .29 | CD4566 | 16 | 1.39 |
| CD4023 | 14 | .29 | CD4070 | 14 | .39 | CD4583 | 16 | 2.49 |
| CD4024 | 14 | .69 | CD4071 | 14 | .29 | CD4584 | 14 | .69 |
| CD4025 | 14 | .23 | CD4072 | 14 | .29 | CD4723 | 16 | 1.19 |
| CD4026 | 16 | 7.49 | CD4073 | 14 | .29 | CD4724 | 16 | 1.19 |
| CD4027 | 16 | .45 | CD4075 | 14 | .29 | MC14409 | 16 | 13.95 |
| CD4028 | 16 | .69 | CD4076 | 16 | 1.19 | MC14410 | 16 | 13.95 |
| CD4029 | 16 | 1.29 | CD4078 | 14 | .49 | MC14411 | 24 | 11.95 |
| CD4030 | 14 | .39 | CD4081 | 14 | .29 | MC14412 | 16 | 13.95 |
| CD4034 | 24 | 2.49 | CD4082 | 14 | .29 | MC14419 | 16 | 7.95 |
| CD4035 | 16 | 1.49 | CD4093 | 14 | .49 | MC14433 | 24 | 13.95 |
| | | | | | | MC14538 | 16 | 1.19 |
| | | | | | | MC14541 | 14 | 1.19 |

(More in Catalog)

# MICROPROCESSOR COMPONENTS

## MICROPROCESSOR CHIPS

| Part No. | **Pins | Function | Price |
|---|---|---|---|
| CDP1802 | 40 | CPU | $2.95 |
| 2650 | 40 | MPU (2MHz) | 9.95 |
| MCS6502 | 40 | MPU w/Clock | 5.95 |
| MCS6502B | 40 | MPU w/Clock at 3MHz | 9.95 |
| 6809 | 40 | CPU—8 bit (Internal Clock) 1MHz | 14.95 |
| 6809E | 40 | CPU—8 bit (External Clock) 1MHz | 14.95 |
| INS8035N-6 | 40 | MPU—8 bit (6MHz) | 5.95 |
| INS8039N | 40 | CPU Sgl chip 8 bit (128bts Ram) | 5.95 |
| INS8040N-6 | 40 | CPU (256 bytes RAM) | 9.95 |
| INS8070N | 40 | CPU (64 bytes RAM) | 29.95 |
| INS8073N | 40 | CPU w/Basic Micro Interpreter | 29.95 |
| P8085A | 40 | CPU | 4.95 |
| 8086 | 40 | CPU 16 bit 5MHz | 24.95 |
| 8088 | 40 | CPU 8/16 bit | 29.95 |
| 8155 | 40 | HMOS RAM I/O Port-Timer | 6.95 |
| 8748 | 40 | HMOS EPROM MPU | 24.95 |

## Z80, Z80A, Z80B, Z8000 SERIES

| | | | |
|---|---|---|---|
| Z80 | 40 | CPU (MK3880N)(Z80C) 2MHz | $3.95 |
| Z80-CTC | 28 | Counter Timer Circuit | 3.95 |
| Z80-DART | 40 | Dual Asynchronous Rec./Trans. | 10.95 |
| Z80-DMA | 40 | Direct Memory Access Circuit | 9.95 |
| Z80-PIO | 40 | Parallel I/O Interface Controller | 3.95 |
| Z80-SIO/0 | 40 | Serial I/O (TxCB and RxCB Bonded) | 12.95 |
| Z80-SIO/1 | 40 | Serial I/O (Lacks DTRB) | 12.95 |
| Z80-SIO/2 | 40 | Serial I/O (Lacks SYNCB) | 12.95 |
| Z80-SIO/9 | 40 | Serial I/O | 12.95 |
| Z80A | 40 | CPU (MK3880N-4)(Z80C-1) 4MHz | 4.49 |
| Z80A-CTC | 28 | Counter Timer Circuit | 4.95 |
| Z80A-DART | 40 | Dual Asynchronous Rec./Trans. | 9.95 |
| Z80A-DMA | 40 | Direct Memory Access Circuit | 12.95 |
| Z80A-PIO | 40 | Parallel I/O Interface Controller | 3.95 |
| Z80A-SIO/0 | 40 | Serial I/O (TxCB and RxCB bonded) | 12.95 |
| Z80A-SIO/1 | 40 | Serial I/O (Lacks DTRB) | 12.95 |
| Z80A-SIO/2 | 40 | Serial I/O (Lacks SYNCB) | 12.95 |
| Z80A-SIO/9 | 40 | Serial I/O | 12.95 |
| Z80B | 40 | CPU (MK3880N-6) 6MHz | 9.95 |
| Z80B-CTC | 28 | Counter Timer Circuit | 12.95 |
| Z80B-DART | 40 | Dual Asynch. Receiver/Transmitter | 19.95 |
| Z80B-PIO | 40 | Parallel I/O Interface Controller | 12.95 |
| Z8001 | 48 | CPU Segmented | 44.95 |
| Z8002 | 40 | CPU Non Segmented | 34.95 |
| Z8030 | 40 | Serial Comm. Controller | 44.95 |
| Z8036 | 40 | Counter/Timer & Parallel I/O Unit | 29.95 |

## 6500/6800/68000 SERIES

| | | | |
|---|---|---|---|
| MC6502A | 40 | MPU with clock and RAM (2MHz) | 6.95 |
| MC6520 | 40 | Peripheral Inter. Adapter | 4.95 |
| MC6800 | 40 | MPU | 2.95 |
| MC6802CP | 40 | MPU with clock and RAM | 7.95 |
| MC6809E | 40 | CPU (1MHz) External (Locking) | 14.95 |
| MC6821 | 40 | Peripheral Inter. Adapt (MC6820) | 2.95 |
| MC6828 | 24 | Priority Interrupt Controller | 15.95 |
| MC6830L8 | 24 | 1024x8-bit ROM (MC68A30-8) | 9.95 |
| MC6850 | 24 | Asynchronous Comm. Adapter | 3.95 |
| MC6852 | 24 | Synchronous Serial Data Adapter | 5.75 |
| 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 |
| DP8226 | 16 | Bus Driver | 2.25 |
| 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

| | | | | |
|---|---|---|---|---|
| 1702A | 24 | 256x8 | (1us) | 4.95 |
| 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 |
| MM52040 | 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 |
| 82S190 | 24 | 2048x8 | (80ns) | 14.95 |
| 82S191 | 24 | 2048x8 | (80ns) | 14.95 |
| DM87S180N | 24 | 1024x8 | PROM O.C. (82S180) | 9.95 |
| DM87S181N | 24 | 1024x8 | PROM T.S. (82S181) | 9.95 |
| DM87S184N | 18 | 2048x4 | PROM O.C. (82S184) | 9.95 |
| DM87S185N | 18 | 2048x4 | PROM T.S. (82S185) | 9.95 |
| DM87S190N | 24 | 2048x4 | PROM O.C. (82S190) | 14.95 |
| DM87S191N | 24 | 2048x8 | PROM T.S. (82S191) | 14.95 |

## 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 |
| DAC1000 | 24 | 10-bit D/A Conv. Micro. Comp. (0.05%) | 7.95 |
| 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 |
| DAC1022 | 16 | 10-bit D/A Conv. (0.20% Lin.) | 5.95 |
| DAC1222 | 18 | 12-bit D/A Conv. (0.20% Lin.) | 6.95 |
| LM334Z | | Constant Current Source | 1.19 |
| LM335Z | | Temperature Transducer | 1.40 |
| LM399H | | Temp. Comp. Prec. Ref. (.5ppm/C°) | 5.00 |
| AY-5-1013A | 40 | 30K Baud Uart (TR1602) | 3.95 |

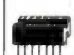
## LOW PROFILE (TIN) SOCKETS

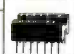
| | 1-9 | 10-99 | 100-up |
|---|---|---|---|
| 8 pin LP | .16 | .14 | .13 |
| 14 pin LP | .17 | .15 | .14 |
| 16 pin LP | .19 | .17 | .16 |
| 18 pin LP | .26 | .24 | .23 |
| 20 pin LP | .30 | .27 | .25 |
| 22 pin LP | .31 | .28 | .26 |
| 24 pin LP | .33 | .30 | .28 |
| 28 pin LP | .40 | .37 | .35 |
| 36 pin LP | .47 | .42 | .39 |
| 40 pin LP | .49 | .46 | .43 |

## SOLDERTAIL (GOLD) STANDARD

| | 1-9 | 10-99 | 100-up |
|---|---|---|---|
| 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 |
|---|---|---|---|
| 14 pin ST | .29 | .27 | .25 |
| 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 |

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74HCU04 is unbuffered. All others are buffered

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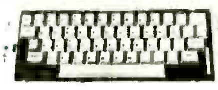

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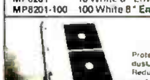

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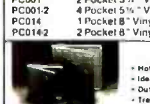

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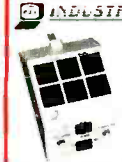

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Circle 214 on inquiry card.

*Text continued from page 66:*

time you see this, much of what annoys me will be taken care of. Even if there were to be no more changes, I'd stay with it. There are enough advantages already.

### Sage Faire

The Sage Computer Faire was held in Reno in early February at the MGM Grand Hotel, where they stage the San Francisco earthquake twice nightly. The MGM dinner show is the most spectacular live stage presentation I've ever seen.

That's not why I went. In the past two years, Sage Computer has taken the same commanding position with development systems based on the Motorola 68000 chip that Compupro holds with respect to the S-100 bus and systems based around the Intel 8086 and follow-ons. Apple will sell a lot more Macintosh 68000 systems, but the Sage is faster, more versatile, and has more software, including advanced languages, *now*. Moreover, I have it on good authority that there's more than one Sage being used to develop Macintosh software.

For those who don't know, we've had a Sage II since the very early days of that machine. It was the Sage and Volition Systems Modula-2 that got me interested in that language. We've never had a glitch with it, and our Sage II is even now being used by Dr. Michael Hyson to develop illustrative programs for the introductory Modula-2 book we are writing.

This year the company brought out the Sage IV, which is faster, has more memory, and has a hard disk. We'll be getting one this month. One reason I went to the Sage Faire was to look at software I might want for the IV.

I saw a lot of it.

Fewer than a thousand people attended the Sage Faire. It reminded me of some of the early micro conventions, the fun ones before they got so large. There was a difference, though: although there were enough hobbyists and hackers to make the conversations interesting, there were also a number of industry heavyweights to make it likely that what was said would have an effect. All told, I don't think I've more enjoyed a convention since the West Coast Faire in Los Angeles where Carl Helmers, my late mad friend Dan MacLean, and I invented this column.

There's now plenty of software for the Sage: decent text editors, FORTH corresponding pretty well to what's described in Leo Brodie's *Starting FORTH*, what looks like an excellent LISP, and an impressive micro APL (you have to buy a special terminal in order to handle APL's screwy squiggles); there's UCSD Pascal; and of course there's Modula-2 from Volition Systems, with the full Modula-2 compiler and operating system to be available from Modula Research Institute very soon.

There's a small but strong market in add-on packages, such as modems for communications and a rumor of an Omninet retrofix for both IIs and IVs.

There are also application packages: business software that works. In as small a show as the Sage Faire, it's possible to look at everything in some detail. I liked most of what I saw. I was also able to talk to a number of publishers and their programmers, pointing out features I'd like to see and things I didn't care for. Some promised to make changes. We'll see.

I've purposely avoided specifics in the above, because I don't like commenting on things we haven't been able to run here at the Manor. Next month we'll have the Sage IV and whatever software I've been able to collect.

What's important is that the Sage looks to be here to stay. The factory in Reno is quite real, large enough for considerable expansion if the company needs it, and not so expensive that it will go bankrupt paying for it. There's an enthusiastic work force and a lot of in-house use of Sage computers.

I've long thought Sage had the best 68000-based computers on the market. Now I'm certain of it.

### Two Views of the Future

Dr. William Godbout of Compupro and Rod Coleman of Sage are, in my judgment, two of a very small num-

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ber of key people in microcomputer development. Both sell topflight development equipment. Both have similar ideas about the future of computers. Godbout and Coleman are both after the business market, because that's where the high-volume sales are; but that's marketing strategy, not love.

Their hearts are with the development of high technology, largely for its own sake. Each foresees dramatic increases in computing power per dollar, and each is obsessed with building machines that access huge amounts of memory and work at the fastest possible speeds. The similarity ends there.

### Bill Godbout

Although Godbout's Compupro company makes a 68000 microprocessor for its S-100 development system, there's little support for the board, and if there are any plans for follow-on developments, such as adding the National Semiconductor 16081 floating-point math chip, it's Compupro's best-kept secret. Dr. Godbout is betting heavily that the future of the micro lies with the Intel iAPX286 and its follow-ons. In addition, he's made some hefty investments in technology based on the National Semiconductor 16032; there's already a Compupro 16032 microprocessor board for the S-100 bus. You might be able to buy one about the time this is in print; about the same time you can probably buy a 286 system, but you'll pay a stiff price for it.

Within a year, though, prices will fall. They always do, and you'll be able to buy working machines with incredible power at reasonable prices. The trend toward more bang for the buck will continue; meanwhile, if you want to develop software for future computers, you can get a machine to develop it on now.

Godbout's development systems are based on the S-100 bus, which he figures will last a few more years before technology irrevocably passes it by. Meanwhile, you can buy a complete development system, with fast memory, disk drives, system support, input/output, etc., and change microprocessor boards as they arrive; and you can have confidence that Godbout will do his best not to leave his customers hung out to dry.

Dr. Godbout likes to talk about future computer technology. So do I, which is a good thing, since when we get together even on thoroughly social occasions the conversation is likely to get technical, to the extreme boredom of the other guests. I have notebooks full of his speculations about the 16032, memory management, math chips, and the future of operating systems. In brief, he thinks supermicros in the future will be built around either the Intel 286 and follow-ons or the National Semiconductor 16032 and its upgrades; and that the operating system of the future will be multiuser multitasking Concurrent CP/M—which will be compatible with, possibly based on, and look an awful lot like Unix.

### Secrets . . .

Like Bill Godbout, Rod Coleman likes to talk technology, and until very recently his Sage Computer was one of the most open companies going. Almost anyone could call him and get him into a conversation on his view of the future.

Lately, though, his marketing and public-relations people have advised him to be a lot more careful, and he's reluctantly taking that advice: for example, everything said about future Sage products at Sage Faire was not only off the record, but preceded by a formal nondisclosure agreement. Unlike Compupro, Sage doesn't have multiple product lines. The Sage is a great 68000-based development system, but it also has to be Sage's business system; and although the Sage has been profitable from the first month it began shipping computers, the company is critically dependent on shipping machines to maintain its cash flow. There's no big wad of venture capital behind Sage; 90 percent is owned by the three original founders.

Thus, Sage is subject to the "Osborne phenomenon": announcements of future machines killing sales of present ones. I think the company worries too much: the present Sage

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II and Sage IV are proven systems, *with* new software coming out every week, which is what business customers want. It's one of Pournelle's rules for users: the best computer to buy is a development system after it has been around a couple of years. You get state of the art with the bugs out.

I didn't really need a confidential briefing to know that Coleman is not standing still, and he was speaking on the record when he said that "the 68000 is a generation ahead of anything Intel is building." Obviously, Sage is going to track new 68000 and follow-on technology, and I must have a dozen letters from readers telling me the virtues of the 68010 and 68020 chips. It's also obvious that any dramatic improvement in 68000 speeds will require some kind of floating-point math chip. In answer to an audience question, Coleman said he expects 256K-bit RAM chips to be available at reasonable prices late in 1984; and everyone knows that really big hard disks are just now coming onto the market.

Put all that together, and lay a french curve through the speed, memory, disk capacity, and price of the Sage II and Sage IV plotted against their date of introduction.

Thus, the only real secrets Sage has are when it will bring out the new stuff and how much it will charge for it: and Coleman gave a clue to *that* when he said, in a nonrestricted speech, that he doesn't consider a new chip a real part until its price has fallen to 50 percent of the introductory price. "By then it's not only cheaper, it's more reliable. The bugs are shaken out, there's probably been a new mask, and usually there's a second source," Coleman said.

It doesn't take a very large computer to predict what Sage is doing. On the other hand, it doesn't take a market survey to know that business customers aren't interested in state of the art: they're interested in software, service, and reliability. Sage's business sales aren't going to depend on the ability of Coleman's marketing people to shut him up about new Sage products: they're going to depend on Sage's ability to *market* what I'm now willing to say is the best 68000 computer available.

**Rod Coleman**

Coleman believes in the 68000 chip as strongly as Bill Godbout believes in the Intel family. Where Godbout says that "unless you know what you're doing, don't fool around with 68000 machines," Coleman believes the 68000s are the real beginning of the supermicro.

Coleman spends more time worrying about software than Godbout does. Unlike Dr. Godbout—and many 68000 enthusiasts—Coleman rejects Unix as too big, too slow, and too incomprehensible. "Just how different is Unix from Adventure?" he asks. "You get to wander around in the Unix command structure and try to find out if you can make it do anything useful. Once in a while you get hints, like 'Volume not on line.' At least UCSD p-System puts seven words across the top of the screen. That's more than Unix—or CP/M for that matter—ever did."

He also points out that CP/M was designed to work with a Teletype (TTY), a device that couldn't transfer information with any speed at all. Now we have hardware that can store a lot of information and tell it to us quickly; why are we stuck with operating systems based on obsolete technology?

He also sees the future belonging to multitasking—and to integrated software, huge software projects that tie together spreadsheets, databases, word processors, accounting systems, calendars and all the other tasks we now ask computers to do one at a time. In Coleman's view, future operating systems will do much of the work for the programmer. That means they'll be big, a full megabyte and more—which in turn means that the micro will have to work *fast* to make use of all that code.

Huge software projects are beyond human capability. Adding more people to the job eventually brings a point of not merely diminishing, but negative return; adding another person to the job requires enough management and training that the expanded team produces *less* than it did before the new people were put on the job. Since we will need huge integrated software packages, the only answer is modular software—which is what both Modula-2 and Ada were designed to accomplish.

Coleman's only comment about Ada was that it was designed by a committee. Modula-2, on the other hand, was guided by a single (and brilliant) mind. It can, perhaps, serve as a software bus, with new software making use of previous modules—but only if there's some kind of standardization of the Modula-2 library.

At the founding meeting held in Zurich last March of the Modula-2 Users Association, all the major U.S. and European Modula-2 publishers agreed to work together in standardizing the Modula-2 library. Niklaus Wirth, Modula-2's inventor, pronounced himself very pleased with the meeting.

One thing Coleman is certain of: the future doesn't belong to obscurantists, but to people who can design systems—hardware and software—accessible to a lot of people. "It has to be simple, like a doorknob," he's fond of saying.

His picture of the future has many of the elements that Larry Niven and I put into the society of *The Mote in God's Eye*. In our novel, everyone carries a pocket computer, which is used by asking questions in ordinary English. (Well, in our novel it's Anglic, since we set this rather far into the future.) The pocket computers are tied into enormous databases; anyone can get the answer to almost any question simply by asking.

In my speech at NCC last year, I said that by the turn of the century, anyone in Western civilization who seriously wants to will be able to get the answer to any question whose answer is either known or calculable. I see no reason to change that prediction. Neither does Rod Coleman.

### So What's Coming?

If you take what Coleman and Godbout say and cancel out their dis-agreements, you still get a comprehensive picture of the new supermicro. It will have a bit-mapped screen and be able to do high-resolution graphics. There will be a good programming language integrated into the operating system, which will be enormous, Unix-sized even if it's not Unix. The machines will be fast. They'll have several megabytes of memory. They'll do coprocessing, which is to say they'll do several things at once. They'll have access to really large data storage, probably hard disks with 100 megabytes. They'll be able to talk to other machines and do it transparently so the user doesn't really have to know the difference between accessing his own hard disk and accessing one on the other side of the continent.

The operating system will be largely menu driven, and comprehensible to ordinary people. Both Godbout and Coleman have plenty of contacts within the software-development community; Bill Godbout often talks with Digital Research's Gary Kildall, while Rod Coleman's people work closely with Softech, Volition, and the Modula Research Institute. Compupro and Sage are in a position to have major influence over software development.

However, their interests differ. Coleman worries about software development a lot more than Bill Godbout does. Although Compupro is a much larger company than Sage, Sage has more software people and works harder at integrating outside software into its bundle. Compupro tends to have software development done through outside consultants.

Both companies work at the frontiers of microcomputer development—and despite their different approaches, both seem to be headed toward the same place, the world of supermicros.

### To Unix or Not to Unix?

On Mondays and Wednesdays I'm sure Unix is the wave of the future. After all, IBM says Unix. AT&T says Unix. Digital Research is moving in the general direction of Unix and also getting closer to IT&T. There are indications that Microsoft is getting

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heavily into the Unix game. Thus, the Intel chip family seems headed toward Unix.

Meanwhile, a good part of the 68000 chip community (with the notable exception of Sage's Rod Coleman) believes in Unix and thinks the 68000 has a better architecture for doing Unix-like things than the 8086 family does. It's even possible that Unix will bring about some convergence of software written for the 8086 and 68000 series; at least the source codes in higher-level languages ought to be transportable. It's vital to the micro community that we have as large a software market base as possible, so Unix may be a real boon to us all by allowing software developed on one kind of system to tap another kind of system's market, thus encouraging investment in really elegant programs. By Wednesday evening I can convince myself that Unix is a friend to all.

On Tuesdays and Thursdays I'm certain Unix is dead. It's enormous; Unix for the IBM PC comes on 15 floppy disks. You *must* have a hard disk before Unix even begins to make sense.

Unix is slow. It's designed for a multiuser situation, which violates the first principle of the micro world: One User, One Computer. I fervently believe in that principle, and thus I'm much more partial to communications and networking than to multiuser concepts.

Unix is incomprehensible. It tells you almost nothing and lets you guess what you did wrong. It can be modified, but I haven't yet seen one of those "easily constructed" user-friendly Unix shells that will be out Real Soon Now. By Thursday night I can convince myself that Unix is an enemy of the micro revolution.

The rest of the week I refuse to think about it.

## USUS

If we ever do develop truly modular software, some of the credit should go to outfits like USUS, the UCSD Pascal Users Society. USUS membership costs $25 a year, and if you've any interest at all in the future of modular languages, you should join if only to support the outfit.

At the Sage Faire, a number of USUS committees met continually. There was some nattering about USUS business, but most of the discussion was about standards. Since representatives of Apple and Softech, the two largest vendors of Pascal p-code, were present throughout the three days of meetings, there was at least a chance of accomplishing something useful.

A typical problem considered at the USUS meetings was version control for separate compilation.

Separate compilation means that you write and compile your program in little chunks that never have to be recompiled. It saves a lot of time and work.

**If we ever develop truly modular software, some of the credit should go to outfits like USUS.**

Pascal was never designed for separate compilation. Indeed, it wasn't originally designed to be compiled at all; it was intended as a teaching language. After Pascal caught on as a production language, some compiler writers added a kind of separate compilation capability to the language.

Alas, that has its drawbacks. In particular, the "modular" capability additions to Pascal have no provision for version control. This means that you can play holy hell with programs if you make certain kinds of changes and someone else comes along and writes procedures that depend on your *not* having made your changes. It happens more often than you think.

There was a lengthy USUS discussion on how to modify UCSD Pascal to give it version control. Modula-2 has rigid version controls, and Pascal needs them. Implementation would be simple. There are at least a dozen ways to do it—which, of course, is the problem. When I left there'd been no resolution, but they're trying, and that can benefit us all.

You can reach USUS at POB 1148, La Jolla, CA 92038, and you ought to.

*Text continued on page 82*

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# 1-2-3 from Lotus. Maybe the best way to look out for number one is to go with number one.

Text continued from page 78:

## Borland Turbo

I have nearly a dozen letters from satisfied users of Borland's Turbo Pascal—and not one complaint. I also know three people who bought Turbo by mail and received it much sooner than they thought they had any right to expect; the evidence is that Borland really does ship on the same day it gets the order.

Our own experiences have also been positive. Borland's Pascal certainly rivals Digital Research's Pascal MT+ in speed, compactness of code, and ease of use—and it sure costs a lot less. It's almost certainly better than IBM's Pascal for the PC.

It's also the only Pascal, including IBM's, that runs on the PCjr—and its built-in editor is nearly as powerful as IBM's Homeword.

Recommended.

## Games . . .

I always look forward to Avalon Hill computer games, largely because I've liked its board games for so many years. I'm also particularly interested in classical war games (I've got several *banda* of super-heavy cataphract miniatures). Thus, I was eager to get Avalon Hill's Legionnaire.

We received it with two other games; one would not work with Rana drives and Avalon Hill's copy-protection system. However, A-H will honor its lifetime disk guarantee, so if you get a game that won't work on your system, write the company. It will make the game work or give you your money back.

Another, Parthian Kings, has been really popular with the boys. It appears to be a form of chess, with "Hammurabi" economics, combat, and magic thrown in. I haven't had time to play it, but I note that the boys have spent a good bit of time playing, both against each other and against the machine. I expect I'll like it; I know they do.

Legionnaire gets mixed reviews. I hated it. It appears to be a game of strategy, but it takes place in real time, which in practice means that it's an arcade game masquerading as a game of strategy. You're supposed to give orders to your various Roman combat units, in much the same way that you might issue written orders to units in a miniatures game. It takes time for the units to get the orders, and meanwhile something may have happened to make the orders obsolete.

A miniatures game has rules concerning just how you might be able to cancel inappropriate orders and send in new ones and how much initiative the units are allowed to take. In Legionnaire, you have to move the cursor to the unit using a *terrible* control system if you have the Apple version; there's an Atari version that's said to use the joystick, which might not be quite so bad. Once you have the cursor over the unit, it no longer carries out orders, but you can cancel old ones and give new ones. About the time you do that, something has happened on the other side of the board, and you must race the cursor over there, at which point another unit is in trouble, and so forth. There's no time for strategy and not much time for tactical decisions.

I suppose this is intended to produce some kind of realistic "fog of war" effect, but it doesn't, because it

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happens too darned fast. In the real world it takes minutes, not seconds, for a legion to turn and march. If you were to try to match *actual* real time, the game would take too long; but speeding it up the way the company has doesn't work either. Alas, there's no provision for changing the time-scale factor.

In addition, for reasons I don't understand, all the action takes place on a very small part of the screen. You see only a portion of the screen and have to scroll the map up and down and sideways in order to see the entire playing area.

The graphics are lousy, too. All the units look alike; the only way you can figure out which ones are which is to put the cursor over one, at which point the unit is "frozen" in movement and combat, but you can read its designation and strength until you take the cursor away.

Legionnaire has neither history nor realism nor playability to recommend it. Oddly enough, though, Phillip, who wants to be a navy jet pilot and has the family record for arcade game scores, likes it, largely because of its defects: it's really difficult to win, because not only must you be a good arcade game player, but also a good strategist. I notice, though, that he's taken to Parthian Kings again, and Legionnaire sits in its box.

## Hide That BYTE

I have written a long piece of advice for minicomputer establishment managers who want to get along with micros. Alas, there's no room this month, but it's at the top of my notes.

However, I can't resist telling this story.

It seems that the manager of the electronic data processing (EDP) shop of a Fortune 500 company decided to buy a bunch of micros. (Smart move; micros can do things that minicomputers can't, not because the micro is more powerful, but because there's better software due to the larger micro customer base.) He made his choice and put in an order for about a hundred machines.

Naturally the supplier asked why he'd chosen its product.

"Read about it. Guy named Pournelle, writes in one of the computer magazines."

"Oh, you read it in BYTE."

There was a stunned silence from the EDP man. Then he said, "Uh, look, uh, no, I didn't see it there—"

It turns out there's considerable prejudice against BYTE in certain circles. This chap was supposed to be reading *Datamation* or some other "professional computer" magazine, not BYTE for corn's sake . . .

I expect there's a moral to that story, but I'll leave it as an exercise for the reader. ■

*Jerry Pournelle is a former aerospace engineer and current science-fiction writer who loves to play with computers.*

*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.*

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**Legionnaire** $35 cassette, $40 disk
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# Bulletin Boards in Space

## *Amateur radio pioneering promises low-cost global communications*

John Markoff
BYTE Senior Technical Editor

The recent explosion of interest in personal computer communications using electronic bulletin-board systems (BBS) has been paralleled by a rise in interest in data communications among radio amateurs. Unlike their earthbound personal computer counterparts, hams are now raising the data communications ante both literally and figuratively.

Amateurs are seeking approval to be on board a space-shuttle mission to be launched from Vandenberg Air Force Base in Southern California sometime in 1986. If all goes well, the shuttle will carry an experimental amateur satellite system called PACSAT (packet radio satellite) into a low-earth polar orbit. Midway through the mission, a shuttle astronaut will push a series of switches ejecting PACSAT through the open shuttle payload bay.

PACSAT will be placed into orbit at the bargain-basement price of $10,000 as part of the National Aeronautics and Space Administration's (NASA) "Get-Away Special." This program was devised by NASA to interest organizations that might not otherwise be able to participate in the space program. PACSAT will be contained in a 5-cubic-foot package weighing no more than 200 pounds.

When it reaches orbit, PACSAT will be the world's first space-based multiuser BBS. With several CMOS (complementary metal-oxide semiconductor) Z80-based (NSC800) microcomputers and 4 megabytes of RAM (random-access read/write memory) disk storage on board, PACSAT will herald the arrival of a new era of global data communications.

PACSAT will allow licensed radio amateurs anywhere to transmit packet-switched digital messages at 9600 bps (bits per second) for delivery within a 12-hour time period. As the satellite circles the globe at an altitude of 250 miles, inexpensive earth-based gateway communications stations will be able to transmit electronic messages on several ham-band uplink communications channels. These messages will be stored for later retransmission by PACSAT to other hams around the world.

The architecture of the PACSAT communications network looks much like baseband LANs (local-area networks) that use a carrier-sensing, multiple-access (CSMA) scheme to share a single wire in an office setting. However, in this case, digital-data packet communications will share a part of the RF (radio frequency) spectrum using a set of packet-switching protocols that are, in effect, an extension of the X.25 protocols used in commercial packet-switching computer networks.

To make the PACSAT network more efficient, the satellite will communicate directly with network nodes rather than with all amateurs.

"The ultimate goal is for you to be able to connect your packet-radio (printed-circuit) board to a local-network node," says Harold Price, NK6K, an amateur-radio operator with a computer-science background who is serving as PACSAT's full-time project manager.

"You could probably build messages off line," he adds. "You could use Wordstar to build your message and then tell your computer which amateur to send it to. What will actually happen is that your computer will connect up to the local network, put that message on there and say 'forward this,' and the network itself will take care of routing the message the best way. If the person the message is intended for happens to be local, it will keep it locally until there is a check-in. Or it will be sent by satellite if the person is located farther away."

Price admits, however, that the amateurs still have several years of development work before such a sophisticated network is in place.

Two aspects of the project will be of great interest to personal computer users interested in data communications. First, the PACSAT project will offer the first truly low cost global-communications network. PACSAT will be visible to every portion of the globe each six hours, meaning that it will function as an electronic-mail carrier in the sky, taking data up on one side of the earth and transmitting it down to another point during a subsequent orbit.

The Radio Amateur Satellite Corporation (AMSAT) is now designing PACSAT earth stations that will cost less than $700. The stations will consist of a simple digital transceiver de-

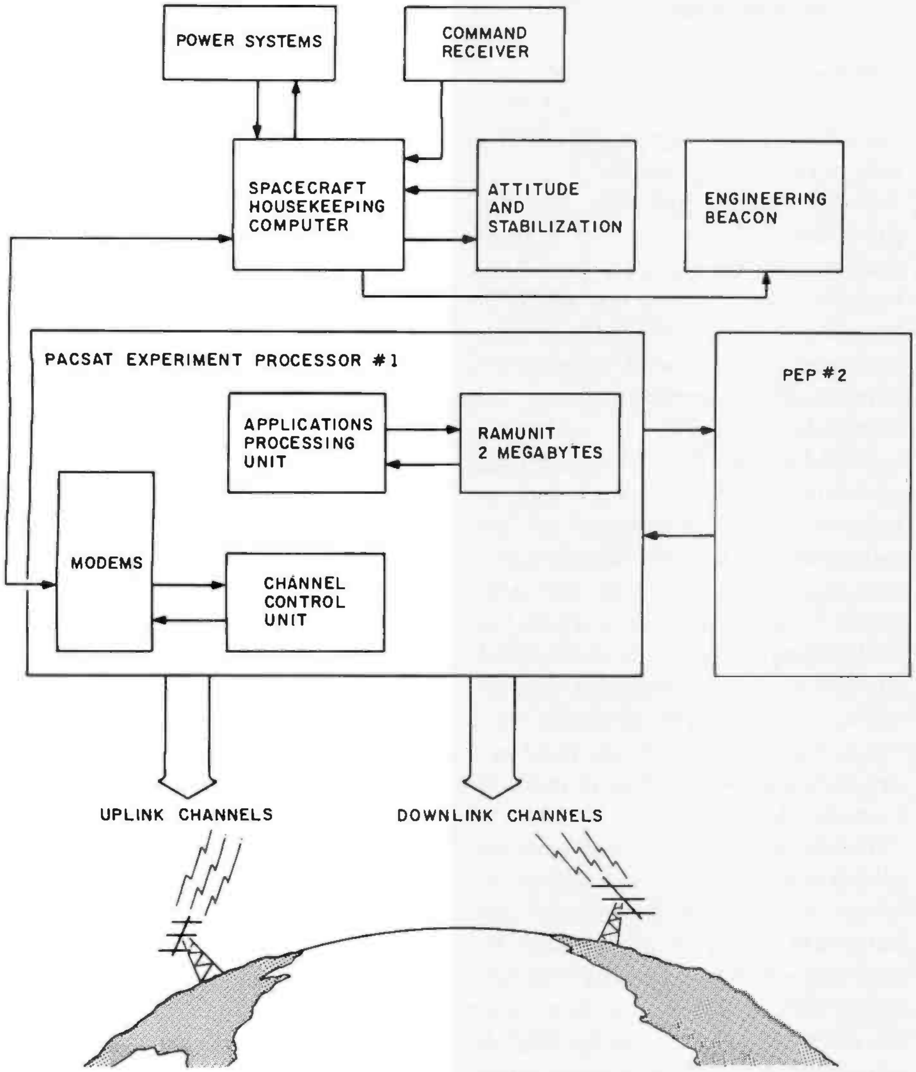


**Figure 1:** *PACSAT system architecture.*

signed to operate at the 70-centimeter (435-MHz) and 2-meter (146-MHz) amateur-radio frequencies, a terminal node controller (TNC) used to convert an asynchronous data-communication stream into synchronous digital packets, and a quarter-wave ground-plane antenna. These stations can be connected to virtually any personal computer.

"The antenna is extremely simple," says Price. "In my case, it is simply two bent coat hangers located in a high place out of the way of trees and other objects."

The second aspect is that the work radio amateurs are doing in satellite and packet-radio communications areas may ultimately find application in earthbound data-communications networks. Hams have begun implementation of several levels of the International Organization for Standardization's (ISO) open system interconnection model designed to standardize communications systems.

PACSAT is a joint project of AMSAT and Volunteers in Technical Assistance (VITA), a nonprofit organization spreading science and technology to poor countries. Inquiries have been received in most scientific areas. VITA will be the second PACSAT user, greatly accelerating the speed of communications between its projects around the world.

PACSAT will, in fact, have two separate BBSes, each with a series of data uplink and downlink channels that will be able to handle communications with multiple earth stations. AMSAT and VITA will each use a separate communication computer, known as a PEP (for PACSAT experiment processor), on board the spacecraft (see figure 1).

Each PEP consists of an applications processing unit (APU), a channel control unit (CCU), and 2 megabytes of system RAM, accessed by a bank-switching scheme, that will function as an electronic mass-storage system. A serial connection exists between the two PEPs to provide redundancy and to permit AMSAT to reconfigure the experiment if one unit fails.

The APU provides microprocessor-based control for the PEP. It is based on an NSC800 (a version of the Z80 microprocessor implemented in low power consumption CMOS) running at 4 MHz. This processor controls the BBS software and handles I/O (input/output) between two CCUs, each containing the modem hardware required to move data between the RF links and APU. Each CCU is also controlled by an NSC800 and supports two uplink and one downlink communications channels. The CCUs function independently and each contains its own programs in 2K bytes of PROM (programmable read-only memory) and 2K bytes of RAM. This is done to keep the communications channels as separate as possible and to avoid having large numbers of data and address lines being strung throughout the satellite.

"What we'll have up there is a multitasking, multiprogrammed operating system," notes Price. "There will be many earth stations connected to PACSAT simultaneously, and PACSAT will have to keep track of multiple users."

To conserve processing power aboard PACSAT, ground stations will be able to request a file directory from the PEP on board the spacecraft and then search the directory for files on earth. Once a file is located, it can be requested and sent to the ground station at the same time new messages are being uploaded.

The spacecraft itself will be controlled by a microcomputer called the integrated housekeeping unit (IHU), which will keep the spacecraft healthy by handling navigation and attitude control, monitoring the solar cells, and collecting telemetry and sending it to the ground control station. On other amateur satellites, this function has been performed by a military-grade RCA 1802 microprocessor using a special Sandia CMOS radiation hardening process that is very rare and expensive.

Price notes that the PACSAT designers will confront special problems outside the earth's atmosphere. Little hard information is available on how the system will fare in a high-radiation environment. Low power consumption semiconductors are relatively susceptible to radiation-induced errors. To work around this problem, instead of using heavy, expensive shielding systems or less vulnerable high-power semiconductors, each PEP will contain software-based error-checking algorithms that will protect the contents of the RAM. Special error-checking hardware circuitry will protect program and operating-system software held in a separate 48K-byte section of memory in each PEP.

Weight and power constraints are also forcing PACSAT's designers to create an extremely low power consumption hardware architecture for the spacecraft. The entire PACSAT spacecraft will run on less than 35 watts of power. On UOSAT B, launched in March, a smaller experimental communications processor that served as a prototype for the PACSAT PEP experiment used 0.75 watt.

"They said they could give us 1 watt," says Price. "They said that if we used a watt they would have to turn us off every once in a while. So we fought to keep the power real small so they would leave us on all the time." For reference, he points out that a standard non-CMOS Z80 microprocessor draws 150 milliamperes at 2 MHz. This is roughly equivalent to the power consumption of an entire PEP on board PACSAT.

The ground-station component of the PACSAT network is built around a simple TNC controller created by a group called Tucson Amateur Packet Radio (TAPR). The group has designed and made available in kit form a TNC that has software and hardware architecture organized in accordance with the ISO layered-network communication model. The TAPR TNC currently implements the first two layers of the ISO model: the physical layer and the data-link layer. The TAPR TNC, which is based on the 6809 microprocessor, can hold a total of 48K bytes of RAM and ROM on the printed-circuit board. It uses the Western Digital 1933 HDLC (high-level data-link control) chip (an LSI [large-scale integration] device that implements much of the ISO level-two standard in hardware) and has both serial and parallel ports. The TAPR TNC is a second-generation design that is an outgrowth of an earlier board built by a group of hams in Vancouver, British Columbia. (For more information on the TNC kit, available for $240, contact Tucson Amateur Packet Radio, POB 22888, Tucson, AZ 85734.)

Amateur packet radio is just beginning to come into its own in the United States. The first digital packet-radio repeater (called digipeaters by the Canadians) was established at the end of 1980 by Dr. Hank Magnuski, KA6M, a data-communications professional and amateur-radio operator in the San Francisco area. Since that time, communities of interest have sprung up around the country as more radio amateurs begin experimenting with radio and personal computers. Currently, several amateurs are experimenting with packet radio in California.

Digital repeaters enable amateurs to send information over a wide geographic region. Several amateurs have set up repeater-based CP/M systems hooked into the network that function as packet-radio bulletin-board systems and permit file transfers as well. In this case, according to Harold Price, no error-checking software (such as the Christensen Protocol) is used at the personal computer level because that function is handled by the TNC.

"When a frame comes in, the TNC board error-checks it; if it doesn't pass, then the frame doesn't get acknowledged," Price says. "The sending station times out and then resends the packet. For file transfer, you do not need a higher-level error-checking protocol like Modem7 be-

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## OSCAR: The Amateur-Radio Satellite Tradition

*PACSAT isn't the first amateur-radio satellite to be launched into space. Since 1961, OSCARs (orbiting satellites carrying amateur radio) have been hitchhiking into space aboard rocket boosters carrying commercial satellites.*

*On December 12, 1961, OSCAR 1 was launched and operated for 18 days. Its communications system was simple. A beacon continually transmitted the message "Hi" in Morse code. The number of "Hi's" transmitted within a 10-second interval was a function of the internal spacecraft temperature.*

*Since then, nine other satellites carrying communications and other scientific experiments have been launched by amateurs based in different countries. One recent OSCAR included a video camera intended to beam television pictures of earth back to amateurs with special television reception equipment.*

*Like their commercial counterparts, radio amateurs also have occasionally been plagued with errant satellites. OSCAR 4, launched on December 21, 1965, was the amateurs' first failure. It was supposed to attain a sun-synchronous orbit, but the third stage failed to ignite, leaving it in a highly elliptical orbit instead.*

*In recent years, OSCARs have been the product of international cooperation among radio amateurs. AMSAT-OSCAR 8, launched as a passenger on a LANDSAT C booster on March 5, 1978, was a joint project of amateurs in the U.S., Japan, and West Germany.*

*In June of 1983, AMSAT-OSCAR 10 was sent into orbit by the European Space Agency. It was a combined effort by volunteers in the U.S., West Germany, Hungary, Argentina, Japan, Canada, and New Zealand. This satellite, which is in an orbit that opens a window of communications between amateurs in North America and Europe, is powered by solar panels that generate 40 watts of power.*

*The next amateur launch, known as UOSAT-B, occurred in March. Designed as a small prototype of PACSAT, it carried scientific experiments on radio propagation and the magnetic and radiation environment in low-earth orbit. The satellite was constructed by scientists at the University of Surrey in England. It carried a "Digital Communications Experiment" that is a precursor of the PACSAT system. It will permit ground stations around the world to gain experience with an orbiting digital store-and-forward device. The UOSAT-B orbiting BBS included 196K bytes of storage and a single 2400-bps path.*

cause the ACK function is taken care of at a lower level. I just spew data out. If my system doesn't get an acknowledgment to the packet, the system determines that either the packet didn't get through or there must have been a collision. One way or another, it retransmits the packet after waiting a random period of time for the channel to clear again."

Amateur operators already have begun experimenting with linking ground-based packet-radio networks via satellite. Recently, a data file was sent from Washington, DC, to Los Angeles via the OSCAR 10 satellite. OSCAR 10 (see the "OSCAR: The Amateur-Radio Satellite Tradition" text box) is a voice and data repeater in high-earth orbit. Shortly, Price and Dr. Tom Clark, W3IWI, an amateur in Washington, DC, and president of AMSAT, plan to see if Clark is able to log onto a CP/M system in California routing via OSCAR 10 and digital-repeater stations. Several stations in North America and a station in New Zealand already have exchanged data files.

To implement level two of the ISO model on board the TNC, amateur packet communications utilize a protocol known as AX.25. This protocol, agreed on at an AMSAT national meeting in 1982, is a variant of the X.25 packet-switching standard. AX.25 differs from X.25 principally in the structure and size of its address field. The AX.25 protocol includes both source and destination addresses while X.25 contains only a single address. This results in optimizing the protocol for "many-to-many" data communications, which is characteristic of amateur-radio digital networks. The selection of the format of the address under AX.25 is simple. Each amateur's packet address is his or her unique ham call sign.

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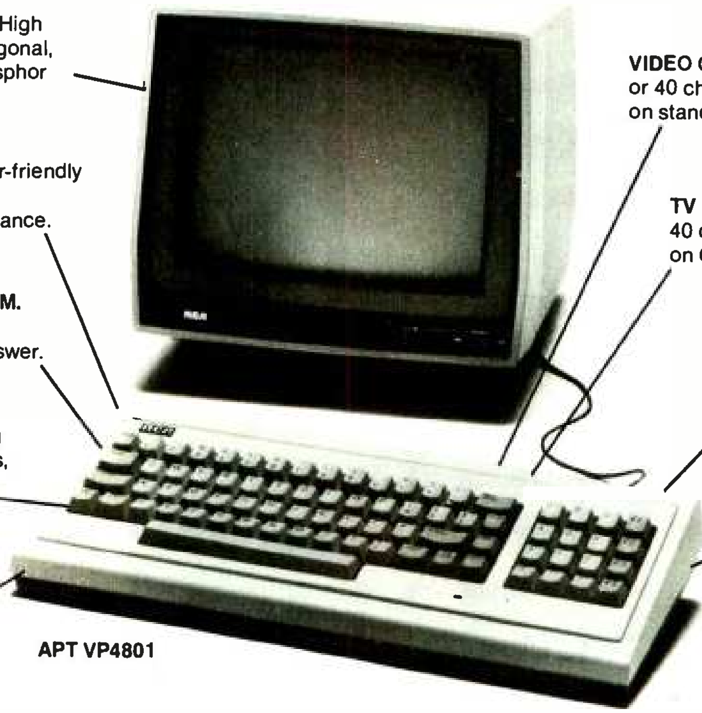


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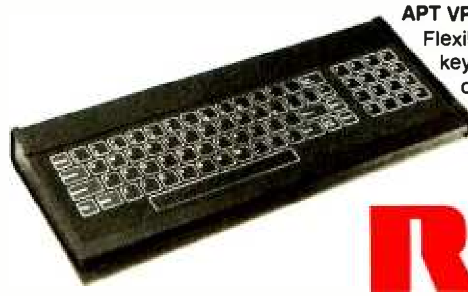

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According to Price, AMSAT members also are working on an inexpensive transceiver that will transmit in the 70-centimeter range and receive on 2 meters as well as contain high-speed modem circuitry capable of exchanging data at 9600 bps. The receiver will be designed to handle only data communications by converting RF frequencies to the intermediate-frequency (IF) stage of 10 MHz.

"We are planning to build a receiver with just the RF and IF stages and no bells and whistles for less than $100," says Price. "We are going to come up with plans for a kit. You'll feed RF into it from an antenna, and you'll get a digital stream out. Data will never get translated to audio frequencies."

VITA is also considering its own low-cost, portable earth stations, currently planning between 6 and 20 of them. These stations will be fully portable and able to operate from solar power.

Today, low-cost satellite-communications technology is still in its infancy, yet the radio amateurs are exploring frontiers that may one day fundamentally change the basis of our communications practices.

"It's very significant," says Dr. Magnuski. "Here are individuals who now have their own satellite-communications ground stations. In the past, these have cost a minimum of $70,000 to $80,000.

"Now for the first time you have the potential for global person-to-person communication not based on commercial offerings. It's a tremendous equalizer. A person who lives in the mountains in the most remote area of the country has, in principle, as much access to information as someone like myself living in the heart of Silicon Valley." ■

**Author's Note:** *For more information on PACSAT, send a stamped, self-addressed envelope to the Radio Amateur Satellite Corporation, POB 27, Washington, DC 20044.*

*John Markoff is a senior technical editor at BYTE's West Coast bureau. He can be reached at McGraw-Hill, 1000 Elwell Court, Palo Alto, CA 94303.*

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# Professional Computing

In a future scenario, you might walk into a doctor's office, explain your medical problems to a computer, and get a diagnosis. The state of the art in microcomputers hasn't reached that level yet. But microcomputers are starting to take on part of the burden of running many types of professional offices.

Yet integrating a microcomputer into a professional work environment can be a particularly frustrating experience. Potential users raise questions concerning the dependability of software and hardware, the usefulness of available software, and how to select the best software to serve their needs. Our theme for this issue, Professional Computing, examines the problems and offers some solutions for introducing a microcomputer into a critical and demanding office setting.

Two articles cover the use of microcomputers in legal and medical practices. Robert P. Wilkins, a practicing attorney, discusses the advantages of using a microcomputer in a legal office and how to select available software to handle an attorney's particular needs. Dr. Jonathan Javitt tackles the herculean task of how to computerize a typical medical office. His article helps the medical practitioner define his or her needs to make selection of the best hardware and software a less risky proposition.

William Hession and Malcolm Rubel describe a benchmarking approach to quantifying the performance of business-modeling software. The authors present an objective method for evaluating software. Peter Callamaras offers his ideas on how a businessperson can develop a decision-support system for assistance in making critical decisions.

William J. Raduchel strips away some of the confusion about the term "user-friendly" and explains what it really means for the purchaser of business software. Milos Konopasek and Sundaresan Jayaraman explain how the TK!Solver program can be used to develop the framework for an expert system for use in business and engineering.

Rounding out the theme is Dr. George Zucconi's description of how he installed a microcomputer in his waiting room. This is his practical response to providing medical information to his patients. *—Stanley J. Wszola, Technical Editor*



Illustration by Robert Tinney

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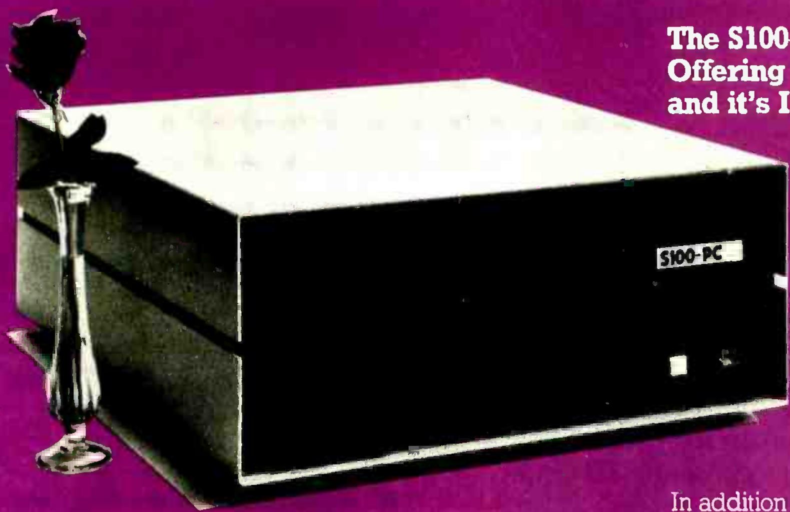


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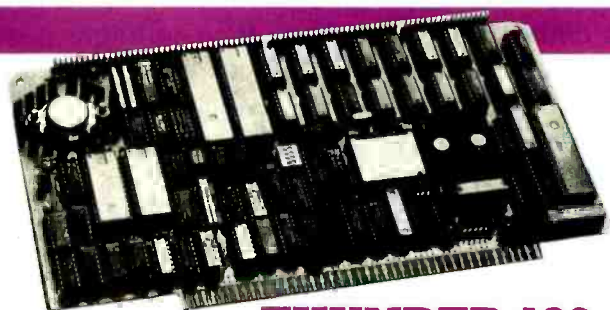

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# A Professional's Perspective on User-Friendliness

*New systems are described as user-friendly—but what does that mean?*

**William J. Raduchel**
**McGraw-Hill Inc.**

Computer software, to be commercially viable, must be user-friendly. And yet nobody can define what user-friendly means, although many claim to know it when they see it. One prominent software developer noted that since every piece of software is presumably friendly to its author, every piece of software can be described as user-friendly. It is primarily a problem of defining the user.

Is "user-friendly," therefore, a tautology? At the other end of the logical spectrum, is it another equally useless "I don't know how to define it but I know it when I see it" phenomenon? I would like to bring more rigor to this problem by offering a tentative definition of user-friendliness and then considering its implications for software development.

## The Problem

Computers have a dramatic impact on the way we work and live. Raising the productivity of service industries and white-collar professionals is the management challenge of the 1980s. Personal computers and office automation are widely seen as the means of achieving this. For productivity to rise, millions of workers must accept computers as an integral part of their daily routine. Computers affect jobs in three primary ways.

First, they perform the often tedious and detailed text and data manipulations vital to modern business. Consider for a moment a world without computers. The airline and financial-services industries as we know them would not exist. Multinational corporations and large organizations would have to survive with primitive information systems covering only the most aggregate of concepts. Many routine transactions would cost significantly more than they do today.

Second, because they work rapidly and accurately, computers permit the use of new algorithms to solve problems. Trend forecasting with statistics has been understood for decades, but until computers became commonplace, these techniques were impractical and generally infeasible. Controlled-capacity airline seating is but one example of computers creating new commodities from old. And now, world weather models await even larger and faster computers.

Third, computers represent a watershed event that has irrevocably altered expectations. Computers can provide precise answers where before there was only vagueness, so precision becomes the norm whether or not each question actually deserves such careful consideration. (I have termed this Gresham's Law of Answers; see "Economic Policy in a Media Age," *Journal of Business and Economics* 13 (1982): 1-14.)

Personal computers are important because their low price permits computerization of tasks that are too small to be done on a mainframe but are tedious and time-consuming nevertheless. Because they can be tailored to individual needs and are priced low, personal computers are justifiable on a presumption of increased productivity.

Microcomputers have made significant changes in three areas. First, they can handle such tedious work as recalculating spreadsheets. Second, they permit broader use of such esoteric tools as graphics. Third, they have permanently altered our ideas on managing information. Timesharing had the same kind of impact when it made computers more accessible in the 1970s.

Mainframe computers have had massive influence despite the fact that only a fraction of workers understand them. But for microcomputers to have the same effect, at least half of all white-collar workers will eventually have to become familiar with them. The personal computer and office-automation industries are staking their futures on making this happen.

The ostensible issue is price: costs have fallen and will continue to fall. Nevertheless, personal computers involve much more than microelectronics, and many of their components are not dropping in cost. The

# Quantifying "User-Friendly"

We can quantify a definition of user-friendly as follows. Define $F(j,k)$ as the probability that a user of group $j$ can solve problem $k$ of $n$ problems in the set $Q(j)$ in one execution of the set of steps $S(j,k) = s_i(j,k)$, $i=1$ to $n(j,k)$. The probability that the user can perform steps $s_i(j,k)$ successfully is $p^i(j,k)$. This probability refers to logical steps rather than keystrokes and includes the user correcting input on the basis of system feedback (error messages). Finally, define $p_0(j,k)$ as the probability that the user can specify $S(j,k)$ accurately. (A more general model would recognize that most problems have multiple solutions, and we should average over these. However, little but complexity seems to be gained by explicitly incorporating this now.) Obviously, as $n(j,k)$ increases, $p_0(j,k)$ decreases. Then, $F(j,k) = P_0(j,k)\ p_1(j,k)\ldots p_{n(j,k)}(j,k)$.

For simplicity and with little loss of generality, let's assume that

$$p_1(j,k)=p_2(j,k)=\ldots=p_n(j,k)=p(j,k)$$

so that

$$F(j,k) = P_0(j,k)(p(j,k))^{n(j,k)}.$$

Furthermore, we generally will not need the $(j,k)$, so we can use $F=P_0p^n$.

Now, define $F_0(j,k)$ as the probability that a user in group $j$ can solve problem $k$ using the best alternative system in terms of elapsed time and cost. Then, the system is user-friendly for group $j$ if and only if

$$F(j,k) > F_0(j,k), \text{ for all } k$$

for some prespecified set of $F_0(j,k)$. The value of each $F_0(j,k)$ depends on the frequency and complexity of the problem. Each $F_0(j,k)$ reflects expectations; for each generation of system, each $F_0(j,k)$ must be at least as large as in the prior

| Standard PC ($P_0 = 0.9$) Task | $p_i$ | Script ($P_0 = 1.0$) Task | $p_i$ | Lisa ($P_0 = 0.95$) Task | $p_i$ |
|---|---|---|---|---|---|
| 1. "term" | 0.995 | 1. Select item | 0.995 | 1. Select Pro File | 0.995 |
| 2. 1 (CR) | 0.995 | 2. Restore form | 0.995 | 2. Open | 0.995 |
| 3. 0 (CR) | 0.995 | | | 3. Select Lisa Term | 0.995 |
| 4. 5 (CR) | 0.995 | | | 4. Tear Off | 0.995 |
| 5. F1 | 0.99 | | | 5. Open | 0.995 |
| 6. 4 | 0.995 | | | 6. "Assumed" | 0.995 |
| 7. 2 | 0.995 | | | 7. Range | 0.995 |
| 8. Stocks. txt (CR) | 0.99 | | | 8. Cut | 0.995 |
| 9. E | 0.99 | | | 9. Set Aside | 0.995 |
| 10. F5 | 0.98 | | | 10. Select Lisa Calc | 0.995 |
| 11. I | 0.98 | | | 11. Tear Off | 0.995 |
| 12. F1 | 0.99 | | | 12. Open | 0.995 |
| 13. 0 | 0.995 | | | 13. Range | 0.995 |
| 14. Y | 0.995 | | | 14. Paste | 0.995 |
| 15. "convert" | 0.995 | | | 15. Calculate | 0.995 |
| 16. ISP (CR) | 0.995 | | | 16. Range | 0.995 |
| 17. Load | 0.98 | | | 17. Cut | 0.995 |
| 18. Retrieve | 0.98 | | | 18. Set Aside | 0.995 |
| 19. Recalculate | 0.995 | | | 19. Select Lisa Graph | 0.995 |
| 20. Graph | 0.995 | | | 20. Tear Off | 0.995 |
| 21. Exit | 0.995 | | | 21. Open | 0.995 |
| | | | | 22. Range | 0.995 |
| | | | | 23. Paste | 0.995 |
| | | | | 24. Set Aside | 0.995 |
| | | | | 25. Select Lisa Term | 0.995 |
| | | | | 26. Erase | 0.995 |
| | | | | 27. Select Lisa Calc | 0.995 |
| | | | | 28. Erase | 0.995 |
| | | | | 29. Select Lisa Graph | 0.995 |
| | | | | 30. Erase | 0.995 |
| $p_i = 0.856$ | | $p_i = 0.990$ | | $p_i = 0.860$ | |
| $F = 0.770$ | | $F = 0.990$ | | $F = 0.817$ | |

**Table 1:** *Once created, the script approach yields the highest probability of a user completing a task successfully. However, script creation is complex and illustrates the difference between systems that are easy to use and those that are easy to learn. (CR), in the Standard PC column, designates a carriage return.*

generation. Finally, each $F_0(j,k)$ reflects the reliability, time, and cost of alternative solutions. Thus, the range of $F_0(j,k)$ is probably between, say, 0.2 and 0.99, but users will surely be interested in replacement systems as long as $F_0(j,k)$ is below 0.9.

We can now assess whether or not a system is user-friendly with the following six steps:

1. Define the target user group $j$.
2. Define the set of $n$ problems $k$ to be solved for that group.
3. For each problem, define the solution $S(j,k)$ to be supplied by the system.
4. For each problem, assess the appropriate $F_0(j,k)$ given its complexity and frequency relative to the alternative solutions.
5. For each $s_i(j,k)$, assess the probability $p_i(j,k)$.
6. Evaluate the set of $F(j,k)$.

In principle, this methodology can be made operational in a controlled experiment. The table on the preceding page is an illustration of a standard personal computer application: connect to a remote database, retrieve stock prices for a fixed portfolio, insert into a spreadsheet to evaluate the portfolio values, and then graph the results in a pie chart. The user is assumed to be inexperienced and the application is assumed to be the product of a skilled programmer. Three cases are presented.

**Standard PC** employs a terminal package with autodial, automatic log-on and macros, and an integrated spreadsheet and graphics package (ISP) with a previously created spreadsheet. One specially created software package (Convert) is assumed to make the necessary format and file conversions.

**Script** employs a fully integrated software package with a macro capability so all the user has to do is specify the task and, from a file, restore the specifications of the portfolio.

**Lisa** employs a variant of the Apple Lisa with three stationary pads for terminal, spreadsheet, and graphics invocation. One extra step is assumed to make the format conversions; in practice, this is not easy.

I have made certain assumptions to simplify the process. An upper bound of 0.995 for any $p_i$ is assumed, and the other values reflect the subjective assessment of difficulty. Two commonly claimed attributes of a Lisa-type environment are accepted in setting $P_0$ to 0.95 and all $p_i$ to 0.995. The results are instructive, in any case.

Once created, nothing can claim to be more user-friendly than a properly completed exhaustive script. Some of the benefits of the Lisa environment are lost because of the multiplicity of steps, but with the numbers assumed, it receives a slightly higher $F$ score. Slightly clearer prompting in the Standard PC approach would eliminate this edge, however.

These examples are intended to help make explicit how sensitive user-friendliness is to the application. For a one-time task to be done by an experienced user, the script approach is unassailable, and the Lisa environment has many strengths. The most important point is that no single approach dominates.

price of power supplies, electric motors, and precision machine parts is partially responsible, but personnel—as represented by software, documentation, training, and support—is the major inflationary cost component.

For the personal computer and office-automation industries to achieve their goals, systems must be not only affordable but also sufficiently user-friendly. This is the real challenge, as is shown by all the press attention to the Apple Lisa, Visicorp Visi On, and Microsoft Windows. These products attempt to introduce the "desktop" metaphor to replace the "spreadsheet" metaphor that has propelled the industry to this point. Both Apple and Visicorp pose an implicit definition of user-friendly: 30 minutes (or less) of training is required for the software to be usefully applied.

## A Paradigm

Pure technology is abstract and sterile. It is of no value until it helps solve problems. Users employ word processors to communicate, not to ogle technology. This suggests the following definition of a user-friendly system: A user-friendly system helps produce accurate solutions in less time and at less expense than alternative systems.

Three important implications of this definition need special emphasis:

- the interface for the nontechnical user is only one factor in user-friendliness
- user-friendliness is relative to both the group of users and to the alternative methods; no software can be user-friendly across the board
- user-friendly relates to solutions, not to tools

Together, these three points imply that no system can be user-friendly *except in the context of specific problems for specific users.*

Another implication is less apparent. A system that is easy to learn may not be easy to use; every user-friendly system faces a trade-off between these two goals. Visicalc is easy to use but not particularly easy to learn. After an application becomes routine, ease of use becomes more important than ease of learning. Thus, user-friendliness in one case may not be user-friendliness in another.

The text box entitled "Quantifying 'User-Friendly' " (beginning on the preceding page) presents an illustrated definition of user-friendliness, but I'll summarize the formal logic here. A system is user-friendly if it solves problems reliably. (This is an admittedly less comprehensive definition than the earlier one.) The probability of the solution, $F$, is above some (high) threshold. $F$ can be the result of three factors:

$P_0$ — the probability that the user will find the set of steps to solve the problem

$p$ — the probability that the user can successfully ex-



ecute each step

$n$ — the minimum possible number of steps in the solution

Formally, $F = P_0 \times p^n$. The requirement of being user-friendly is that $F$ be at or above some threshold probability value $F_0$, determined by the characteristics of the alternative systems.

## The Implications

The preceding definition has implications for software developers. User-friendliness becomes a function of $P_0$, $p$, and $n$. The ideal system has both $P_0$ and $p$ as close to 1.0 as possible, with $n$ as small as possible (at a lower bound of 1.0 step). Unfortunately, software developers cannot freely choose these values.

Why not? Because $P_0$ has to fall as $n$ increases, while $p$ generally increases as each step is made smaller. The classic easy-to-learn system guides the user through hierarchical menus. As long as the user can easily identify where to begin, $F$ will be very high for problems solved by that system. Such a system is inherently limited to the problems selected by the menu builders. Other types of problems may be solved by the system, but if they are not enumerated in the menus, their "$F$ score" is likely to be very low.

The cost of increasing the number of steps is very high, even if $p$ is 0.995 (an error only once in every 200 attempts). For example, $p^n$ would be 0.975 for 5 steps, 0.951 for 10 steps, 0.905 for 20 steps, and 0.818 for 40 steps. This is where ease of use and ease of learning conflict. The user progresses from one level of ability to another through training and experience, and the steps can then be reduced but made more complex with little decrease in $p$. A user eventually will consider a system with fewer, but natively more complex, steps to be more user-friendly.

The problems a user has change from day to day, and a user-friendly system must be able to easily accommodate this change. Therefore, the fundamental tools must be strong.

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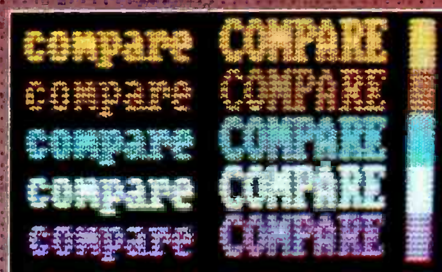


**THEIRS:** .43 mm dot pitch, 80 column text.

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has an upper limit regardless of the computer skills of the user group (probably not far above the 0.995 used in the preceding example). Although their computer skills cannot raise $p$ much beyond a certain level, more training may help a user group to execute substantially more complex steps with the same $p$.

This is a critical point. Any system designed for a mass market can be user-friendly only for relatively simple problems. If the problems to be solved are not simple, it is unlikely that any general, mass-market system can be user-friendly. Resolving this dilemma involves reeducating the user group. With better training and documentation, software vendors can increase the computer sophistication of their users (i.e., raise $p$ and lower $n$). In so doing, they also can increase the scope and complexity of problems for which their systems are user-friendly. Alternatively, by customizing the software to fit specific needs, software vendors can build user-friendly systems for users who have little computer sophistication.

Are integrated systems user-friendly? The answer is clearly "sometimes." Let's consider four major limitations:

1. There are limits to spoon-feeding. Lisa and Visi On succeed exceptionally well in packaging their capabilities in easily recognized, highly robust capsules. The effect of this is to raise both $p$ and $n$ by requiring many steps to do anything. These systems are user-friendly in much the same way as Tinkertoys. They provide easy-to-use building blocks, but you cannot create large, stable applications with them. This is fine because the goal of these systems is to let more people use personal computers and not necessarily to expand the scope of problems that can be solved with personal computers.
2. Current technology does a poor job of telling the user what to do as opposed to how to do it. Lisa and Visi On make spreadsheets, graphics, word processors, and similar tools easier to use. Unfortunately, they also assume that the user knows what data to obtain and from where, what transformations should be made, what other processing is required, and which report format or graphics should be used. In the real world, the user may need more help making these choices than using the software. This is the problem "expert systems" and artificial intelligence seek to address.
3. Much of the day is spent doing routine tasks, but it's not necessarily these tasks that are simplified by using integrated systems. Lisa and Visi On may simplify each step of a task, but the user still has to remember, and then execute, each step individually. The user would much rather select one choice, supply the parameters, and then let the computer step through the various tasks. The popularity of keyboard macro packages, such as Pro Key, derives from the fact that they let users store their most common keystroke sequences.
4. Any integrated computer system is still but a component of a total business system. Merging integrated applications with existing applications likely will prove more difficult than many people expect because the businessperson's tasks are so varied and the tools are so diverse. Meetings, telephone conversations, correspondence, publications, memoranda, calculation and dictation machines, as well as pencil and paper, are used every day; not all work can be done at a workstation. Moreover, professionals travel and go home—and they take their work with them. Integrated workstations can create as many problems as they solve by providing the user with so much power in an isolated environment. Lap-sized computers will help reduce this isolation, however.

To achieve their stated market goals, integrated systems must be perceived as user-friendly and cost-effective. Without question they achieve their integration at double or triple the cost of component-oriented alternatives, so the burden on user-friendliness is extreme. The challenge is great. Training, in-person support, and customization seem essential, yet their price may make these systems no longer cost-effective.■

*William J. Raduchel is vice-president of product development support at McGraw-Hill Inc. (1221 Avenue of the Americas, New York, NY 10020).*

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# A Computer in the Doctor's Waiting Room

*An Atari program that offers some of the capabilities of an "expert system" for one physician's patients*

**George Zucconi, M.D.**
**Private Practice**

For the past year I've kept an inexpensive computer in my office waiting room for my patients to use. The computer, an Atari 400, runs programs that impart medical information to the user. Instructions appear on the screen so that anyone can use the system without any aid from the office staff. The three programs I have developed answer the medical questions most frequently asked by the patients in my obstetrical-gynecological practice.

One program elicits information concerning symptoms of abnormal uterine bleeding. According to the user responses, it will diagnose the seriousness of the condition and will recommend what course of action the patient should take.

The other two programs are somewhat different in nature. One contains information about birth control methods, including the effectiveness, advantages, disadvantages, and risks of each. The remaining program, Drugs in Pregnancy, presented in this article, outlines 15 classifications of commonly available drugs and their effects on the various stages of pregnancy.

Though not meant as a substitute for doctor-patient interaction, the patients' use of these programs saves time for more complicated questions by eliminating basic preliminary queries. My patients take readily to the computer and have found the programs to be helpful. For one thing, using the computer avoids any feelings of embarrassment when inquiring about intimate matters. Furthermore, the computer is tireless and never scoffs at seemingly dumb questions. Even computerphobes overcome their hesitancy after watching someone else use the machine. In fact, it's unusual to see the computer sitting idly when anyone is in the waiting room.

## The Genie in the Lamp

The educational use of computers promises to open up the possibilities for conveying information to others. With the proliferation of small, inexpensive computers, many more people will be able to afford these instruments and experiment with devising new applications for them. No longer the exclusive tool of the few, the power of the computer has been released like the genie from the lamp, waiting to grant us whatever wishes we command. In order to effectively develop the powers of the microcomputer "genie," a concerted effort and sharing of knowledge are necessary.

The beauty of putting so many people in touch with computers is that by merely increasing the number of users, we will attain a "critical mass" wherein a breakthrough in learning is inevitable. Each new kernel of knowledge leads to another, building on the impetus of the previous one, all multiplying exponentially and cascading in a chain reaction.

This concept has long been the tradition in the medical profession. Scientific progress would be nonexistent without the dissemination of discoveries and information. Following in this tradition, I would like to share some efforts I have made toward devising medical applications for this versatile tool. I've provided the BASIC listing of the Drugs in Pregnancy program so that interested readers can use it or learn from its construction (see listing 1).

## When the Doctor's Not In

You may not be anxious to expose a valuable computer to inexperienced hands or to children's sticky fingers. However, even if you do not give

*Text continued on page 116*

**Listing 1:** *The source code for Drugs in Pregnancy, a program written in Atari BASIC that explains the effects of various types of commonly available drugs on pregnancy.*

```
1000 REM INTRODUCTION
1010 CLR :DIM K$(1)
1020 GRAPHICS 2+16:POKE 77,0
1025 SETCOLOR 2,4,0:SETCOLOR 4,7,0
1030 ? #6:? #6;"  please feel free"
1040 ? #6:? #6;"     to come over"
1050 ? #6:? #6;"    and see what"
1060 ? #6:? #6;"   this computer"
1070 ? #6:? #6;"        can do"
1080 FOR J=1 TO 1000:IF PEEK(53279)=6 THEN 3000
1090 NEXT J
1100 GRAPHICS 2
1105 SETCOLOR 4,7,0:SETCOLOR 2,3,2
1110 ? #6;"    YOU CAN ASK"
1120 ? #6:? #6;"   THE COMPUTER"
1130 ? #6:? #6;"      ABOUT THE"
1140 ? #6:? #6;"  EFFECTS OF DRUGS"
1145 ? #6:? #6;"    IN PREGNANCY"
1150 PRINT " PRESS YELLOW <START> PANEL BELOW"
1152 PRINT "RED LIGHT ON RIGHT SIDE OF KEYBOARD"
1154 PRINT " TO ASK ABOUT DRUGS AND PREGNANCY   ";
1160 FOR J=1 TO 2000:IF PEEK(53279)=6 THEN 3000
1170 NEXT J:GOTO 1010
2000 REM SUBROUTINES
2120 PRINT :PRINT
2122 PRINT "         ENTER NUMBER OF TOPIC"
2123 PRINT "              Your Choice is ";
2130 FOR J=1 TO 3000
2140 IF PEEK(764)=31 THEN POKE 764,255:K$="1":PRINT K$:RETURN
2150 IF PEEK(764)=30 THEN POKE 764,255:K$="2":PRINT K$:RETURN
2160 IF PEEK(764)=26 THEN POKE 764,255:K$="3":PRINT K$:RETURN
2170 IF PEEK(764)=24 THEN POKE 764,255:K$="4":PRINT K$:RETURN
2172 IF PEEK(764)=29 THEN POKE 764,255:K$="5":PRINT K$:RETURN
2180 NEXT J:GOTO 1010
2220 IF (ASC(K$)<49) OR (ASC(K$)>50) THEN PRINT " USE NUMBERS 1 TO 2 ":K$="N":PR
INT :RETURN
2230 IF (ASC(K$)<49) OR (ASC(K$)>51) THEN PRINT " USE NUMBERS 1 TO 3 ":K$="N":PR
INT :RETURN
2240 IF (ASC(K$)<49) OR (ASC(K$)>52) THEN PRINT " USE NUMBERS 1 TO 4 ":K$="N":PR
INT :RETURN
2250 IF (ASC(K$)<49) OR (ASC(K$)>53) THEN PRINT " USE NUMBERS 1 TO 5 ":K$="N":PR
INT :RETURN
2280 RETURN
2290 PRINT :PRINT :PRINT "        ENTER C TO MAKE A CHOICE"
2292 PRINT " ENTER R TO RETURN TO THE PREVIOUS"
2294 PRINT "    LIST TO MAKE ANOTHER CHOICE"
2300 PRINT "         ENTER Q TO QUIT ";
2320 FOR J=1 TO 3000
2330 IF PEEK(764)=40 THEN POKE 764,255:K$="R":PRINT K$:PRINT :RETURN
2340 IF PEEK(764)=18 THEN POKE 764,255:K$="C":PRINT K$:RETURN
2345 IF PEEK(764)=37 THEN POKE 764,255:K$="M":PRINT K$:RETURN
2350 IF PEEK(764)=47 THEN POKE 764,255:GOTO 1010
2360 NEXT J
2370 GOTO 1010
3000 REM DRUG LIST "
3010 GRAPHICS 0:SETCOLOR 2,9,4
3020 PRINT :PRINT "   Copyright 1983 G.R.Zucconi M.D.":PRINT
3030 PRINT "          ANY DRUG SHOULD BE AVOIDED"
3032 PRINT " DURING PREGNANCY UNLESS ABSOLUTE-"
3034 PRINT " LY NECESSARY.  YOU  CAN SEE  WHAT"
3036 PRINT " EFFECT EACH DRUG HAS BY CHOOSING"
3038 PRINT " ONE FROM THE LIST.":PRINT
3090 PRINT "  1. ALCOHOL"
3100 PRINT "  2. EPILEPTIC OR SEIZURE DRUGS"
3110 PRINT "  3. BLOOD THINNERS"
3120 PRINT "  4. LITHIUM"
3130 PRINT "  5. HORMONES AND BC PILLS"
3131 PRINT :PRINT " FOR MORE DRUGS, ENTER M"
3132 GOSUB 2290:IF K$="R" THEN 3000
3133 IF K$="M" THEN 3160
3134 GOSUB 2120:GOSUB 2250
```

*Listing 1 continued on page 110*

*Listing 1 continued:*

```
3140 IF K$="N" THEN 3000
3150 ON VAL(K$) GOSUB 3390,3500,3640,3740,3840
3160 PRINT "}":PRINT :SETCOLOR 2,3,2:SETCOLOR 4,11,4
3170 PRINT "        DRUG LIST CONTINUED":PRINT
3180 PRINT "  1. ANTIBIOTICS"
3190 PRINT "  2. ANESTHETICS"
3200 PRINT "  3. DRUGS FOR NAUSEA"
3210 PRINT "  4. TRANQUILIZERS, SEDATIVES"
3220 PRINT "  5. ASPIRIN"
3230 PRINT :PRINT " FOR MORE DRUGS, ENTER M"
3240 GOSUB 2290:IF K$="R" THEN 3000
3250 IF K$="M" THEN 3280
3260 GOSUB 2120:GOSUB 2250
3270 IF K$="N" THEN 3160
3275 ON VAL(K$) GOSUB 3960,4080,4190,4330,4440
3280 PRINT "}":PRINT :SETCOLOR 2,6,2:SETCOLOR 4,15,6
3290 PRINT "        DRUG LIST CONTINUED":PRINT
3300 PRINT "  1. DRUGS TO BE AVOIDED NEAR"
3302 PRINT "     THE END OF PREGNANCY"
3304 PRINT "  2. SMOKING"
3310 PRINT "  3. X-RAYS"
3320 PRINT "  4. FACTORS KNOWN TO CAUSE"
3330 PRINT "     DEFORMITIES IN THE FETUS"
3335 PRINT "  5. STREET DRUGS"
3340 PRINT :PRINT " THIS IS THE END OF THE DRUG LIST"
3350 GOSUB 2290:IF K$="R" THEN 3160
3360 GOSUB 2120:GOSUB 2250
3370 IF K$="N" THEN 3280
3375 ON VAL(K$) GOSUB 4590,4690,4820,4960,5150
3380 REM
3390 PRINT "}":PRINT
3400 PRINT "            ALCOHOL ":PRINT :PRINT
3410 PRINT " RISK  OF  MALFORMATION  INCREASES"
3420 PRINT " WITH THE AVERAGE DAILY INTAKE.":PRINT :PRINT
3430 PRINT " THERE IS ONE  CHANCE  IN TEN OF A"
3440 PRINT " DEFORMITY IF YOU  HABITUALLY HAVE"
3450 PRINT " MORE THAN  ONE OR TWO  DRINKS PER"
3460 PRINT " DAY FOR MOST OF THE PREGNANCY.":PRINT :PRINT
3470 PRINT " HEAVY DRINKERS HAVE ONE CHANCE IN"
3480 PRINT " FOUR OF HAVING A DEFORMED BABY."
3490 GOSUB 2290:IF K$="R" THEN 3000
3500 PRINT "}":PRINT
3510 PRINT "     EPILEPTIC OR SEIZURE DRUGS ":PRINT
3520 PRINT " THERE IS A  2 TO 3 PER CENT  RISK"
3530 PRINT " OF  MALFORMATION  IN WOMEN TAKING"
3540 PRINT " THESE DRUGS.":PRINT
3550 PRINT " PHENOBARBITAL,AND BARBITURATES IN"
3560 PRINT " GENERAL,HAVE BEEN USED FOR A LONG"
3570 PRINT " TIME, AND IT SEEMS UNLIKELY  THAT"
3580 PRINT " THEY HAVE ANY IMPORTANT EFFECT.":PRINT
3590 PRINT " DILANTIN  HAS A LOWER  RISK  THAN"
3600 PRINT " TRIDIONE AND PARADIONE.":PRINT
3610 PRINT " THE RISKS OF THE NEWER DRUGS LIKE"
3620 PRINT " TEGRETOL AND DEPAKENE ARE UNKNOWN."
3630 GOSUB 2290:IF K$="R" THEN 3000
3640 PRINT "}":PRINT
3650 PRINT "        BLOOD THINNERS ":PRINT
3660 PRINT " COUMARIN  SHOULD NOT  BE USED IN"
3670 PRINT " PREGNANCY. IT CAN CAUSE FETAL AB-"
3680 PRINT " NORMALITIES EVEN LATE IN THE PRE-"
3690 PRINT " GNANCY. IT CAN ALSO CAUSE  BLEED-"
3700 PRINT " ING IN THE FETUS AND THE NEWBORN.":PRINT
3710 PRINT " IF AN ANTICOAGULANT IS NEEDED,THE"
3720 PRINT " DRUG OF CHOICE IS HEPARIN."
3730 GOSUB 2290:IF K$="R" THEN 3000
3740 PRINT "}":PRINT
3750 PRINT "            LITHIUM ":PRINT :PRINT
3760 PRINT " THE  EVIDENCE CURRENTLY AVAILABLE"
3770 PRINT " SUGGESTS THAT LITHIUM IS PROBABLY"
3780 PRINT " A CAUSE FOR MALFORMATIONS.":PRINT
3790 PRINT " THE  EVIDENCE  IS  SUFFICIENT  TO"
3800 PRINT " JUSTIFY  AVOIDING  LITHIUM DURING"
```

*Listing 1 continued on page 113*

*Listing 1 continued:*

```
3810 PRINT " THE FIRST  THREE  MONTHS  OF  THE"
3820 PRINT " PREGNANCY."
3830 GOSUB 2290:IF K$="R" THEN 3000
3840 PRINT "}"
3850 PRINT "        HORMONES AND BC PILLS ":PRINT :PRINT
3860 PRINT " THE SMALL AMOUNTS OF  PROGESTOGEN"
3870 PRINT " IN BIRTH CONTROL  PILLS  ARE  NOT"
3880 PRINT " LIKELY TO CAUSE MALFORMATIONS.":PRINT
3890 PRINT " STUDIES  HAVE BEEN  CONTRADICTORY"
3900 PRINT " AND CONFUSING,BUT IF THERE IS ANY"
3910 PRINT " RISK, IT MUST BE SMALL.":PRINT
3920 PRINT " EXPOSURE  TO  DIETHYLSTILBESTEROL"
3930 PRINT " CAN CAUSE CANCER OF THE VAGINA IN"
3940 PRINT " FEMALE OFFSPRING."
3950 GOSUB 2290:IF K$="R" THEN 3000
3960 PRINT "}"
3970 PRINT "             ANTIBIOTICS ":PRINT
3980 PRINT " ALMOST  ALL  DRUGS  USED TO TREAT"
3990 PRINT " INFECTIONS ARE SAFE IN PREGNANCY.":PRINT
4000 PRINT " DRUGS CONTAINING TRIMETHOPRIM AND"
4010 PRINT " PYRIMETHAMINE MAY CAUSE MALFORMA-"
4020 PRINT " TIONS.BRAND NAMES FOR THESE DRUGS"
4030 PRINT " ARE: BACTRIM, SEPTRA,  PROLOPRIM,"
4040 PRINT " TRIMPLEX AND DARAPRIM.":PRINT
4050 PRINT " TETRACYCLINE  CAN CAUSE  STAINING"
4060 PRINT " OF TEETH, AND SHOULD BE AVOIDED."
4070 GOSUB 2290:IF K$="R" THEN 3160
4080 PRINT "}"
4090 PRINT "             ANESTHETICS ":PRINT :PRINT
4100 PRINT " ANESTHETICS FOR SURGERY OR DENTAL"
4110 PRINT " WORK DO NOT INCREASE THE RISK FOR"
4120 PRINT " HAVING A DEFORMED INFANT.":PRINT
4130 PRINT " WOMEN  WHO WORK IN THE  OPERATING"
4140 PRINT " ROOM OR ARE  EXPOSED TO GAS ANES-"
4150 PRINT " THETICS,ESPECIALLY NITROUS OXIDE,"
4160 PRINT " OVER A LONG  PERIOD  OF TIME, ARE"
4170 PRINT " AT INCREASED RISK FOR ABORTION."
4180 GOSUB 2290:IF K$="R" THEN 3160
4190 PRINT "}"
4200 PRINT "          DRUGS FOR NAUSEA ":PRINT
4210 PRINT " MANY STUDIES  INVOLVING MANY HUN-"
4220 PRINT " DREDS  OF WOMEN  HAVE  FAILED  TO"
4230 PRINT " SHOW  AN  INCREASED  INCIDENCE OF"
4240 PRINT " MALFORMATIONS.":PRINT
4250 PRINT " IN SPITE OF OVERWHELMING SCIENTI-"
4260 PRINT " FIC EVIDENCE AND 27 YEARS OF USE,"
4270 PRINT " A RECENT COURT JUDGEMENT HAS CAU-"
4280 PRINT " SED PUBLIC ALARM OVER THE  SAFETY"
4290 PRINT " OF THE MOST  EFFECTIVE  OF  THESE"
4300 PRINT " DRUGS  IN  PREGNANCY,  BENDECTIN,"
4310 PRINT " AND ITS  MANUFACTURE  HAS  BEEN"
4315 PRINT " DISCONTINUED."
4320 GOSUB 2290:IF K$="R" THEN 3160
4330 PRINT "}"
4340 PRINT "      TRANQUILIZERS, SEDATIVES ":PRINT :PRINT
4350 PRINT " TWO  MAIN  STUDIES  HAVE PRODUCED"
4360 PRINT " CONFLICTING RESULTS, BUT RISK, IF"
4370 PRINT " IT EXISTS, IS SMALL.":PRINT
4380 PRINT " THE SAME THING CAN BE SAID  ABOUT"
4390 PRINT " MOOD ELEVATORS OR ANTIDEPRESSANTS,"
4395 PRINT " WITH THE EXCEPTION OF LITHIUM.":PRINT
4400 PRINT " BARBITURATES HAVE BEEN IN USE FOR"
4410 PRINT " A LONG TIME  AND ARE  CONSIDERED"
4420 PRINT " SAFE DURING PREGNANCY."
4430 GOSUB 2290:IF K$="R" THEN 3160
4440 PRINT "}"
4450 PRINT "               ASPIRIN ":PRINT
4460 PRINT " THERE IS NO  ASSOCIATION  BETWEEN"
4470 PRINT " ASPIRIN AND MALFORMATIONS.":PRINT
4480 PRINT " HOWEVER,ASPIRIN SHOULD BE AVOIDED"
4490 PRINT " AFTER THE  FIRST  THREE MONTHS OF"
4500 PRINT " PREGNANCY  BECAUSE  IT CAN  CAUSE"
4510 PRINT " THE PREGNANCY TO BE PROLONGED  IF"
```

*Listing 1 continued on page 114*

*Listing 1 continued:*

```
4520 PRINT " TAKEN IN HIGH DOSES.":PRINT
4530 PRINT " ASPIRIN  MAY ALSO  PROLONG LABOR,"
4540 PRINT " AND  IF TAKEN WITHIN ONE WEEK  OF"
4550 PRINT " DELIVERY, CAN CAUSE BLEEDING PROB-"
4560 PRINT " LEMS IN THE MOTHER AND INFANT."
4570 GOSUB 2290:IF K$="R" THEN 3160
4590 PRINT "}"
4600 PRINT "              DRUGS TO BE AVOIDED     "
4610 PRINT "        NEAR THE END OF PREGNANCY ":PRINT :PRINT
4620 PRINT " SULFA DRUGS AND ASPIRIN  CAN LEAD"
4630 PRINT " TO JAUNDICE IN THE NEWBORN.":PRINT
4640 PRINT " THE  FOLLOWING  DRUGS CAN LEAD TO"
4650 PRINT " RUPTURE OF  THE BABY'S RED  BLOOD"
4660 PRINT " CELLS CAUSING  ANEMIA: DRUGS  FOR"
4670 PRINT " MALARIA,  PHENACETIN (APC), SULFA"
4675 PRINT " AND NITROFURANTOIN."
4680 GOSUB 2290:IF K$="R" THEN 3280
4690 PRINT "}"
4700 PRINT "                  SMOKING   ":PRINT
4710 PRINT " SMOKING IS KNOWN TO BE A POSSIBLE"
4720 PRINT " CAUSE OF  PREMATURITY, AND IT MAY"
4730 PRINT " ALSO INCREASE THE RISK OF SPONTA-"
4740 PRINT " NEOUS ABORTION.":PRINT
4750 PRINT " CHEWING TOBACCO AND NICOTINE CHEW-"
4760 PRINT " ING GUM SHOULD NOT BE USED DURING"
4770 PRINT " PREGNANCY.":PRINT
4780 PRINT " CUTTING BACK ON THE NUMBER OF CI-"
4790 PRINT " GARETTES SMOKED WILL HELP, IF YOU"
4800 PRINT " CANNOT STOP ALTOGETHER."
4810 GOSUB 2290:IF K$="R" THEN 3280
4820 PRINT "}"
4830 PRINT "                 X-RAYS  ":PRINT :PRINT
4840 PRINT " THE AMOUNT OF RADIATION ABSORBED"
4850 PRINT " FROM  CHEST OR  DENTAL  X-RAYS IS"
4860 PRINT " TOO SMALL TO HAVE ANY  EFFECT  ON"
4870 PRINT " FETAL DEVELOPMENT. EVEN X-RAYS TO"
4890 PRINT " THE PELVIS IN EARLY PREGNANCY  DO"
4900 PRINT " NOT PRODUCE  ENOUGH RADIATION  TO"
4910 PRINT " CAUSE ANY MALFORMATION.":PRINT
4920 PRINT " DURING PREGNANCY, HOWEVER, A LEAD"
4930 PRINT " SHIELD OR APRON SHOULD BE USED AS"
4940 PRINT " A PRECAUTION."
4950 GOSUB 2290:IF K$="R" THEN 3280
4960 PRINT "}"
4970 PRINT "        FACTORS KNOWN TO CAUSE   "
4980 PRINT "       DEFORMITIES IN THE FETUS ":PRINT
4990 PRINT " MORE  THAN 65%  OF  MALFORMATIONS"
5000 PRINT " HAVE UNKNOWN CAUSES, BUT PROBABLY"
5010 PRINT " MOST HAVE  MULTIPLE  CAUSES, ONLY"
5020 PRINT " 10% OF WHICH MAY BE ATTRIBUTED TO"
5030 PRINT " DRUGS. THE OTHER 25%  ARE DUE  TO"
5040 PRINT " CHROMOSOME  OR  GENETIC  PROBLEMS.":PRINT
5050 PRINT " EVEN THALIDOMIDE PRODUCES DEFECTS"
5060 PRINT " IN  LESS THAN 25% OF EXPOSED OFF-"
5070 PRINT " SPRING.":PRINT
5080 PRINT " CYTOTOXIC DRUGS  USED  FOR CANCER"
5090 PRINT " TREATMENT ARE  THE OTHER CLASS OF"
5100 PRINT " DRUGS THAT CAUSE MALFORMATIONS."
5140 GOSUB 2290:IF K$="R" THEN 3280
5150 PRINT "}"
5160 PRINT "             STREET DRUGS ":PRINT
5170 PRINT " PREMATURITY  AND LOW BIRTH WEIGHT"
5180 PRINT " ARE COMMON  AND  INFANT MORTALTIY"
5190 PRINT " IS INCREASED  WITH USE OF HEROIN.":PRINT
5200 PRINT " WITHDRAWAL EFFECTS AFTER DELIVERY"
5210 PRINT " OR EVEN WHILE IN UTERO  CAN CAUSE"
5220 PRINT " FETAL DISTRESS AND DEATH.":PRINT
5230 PRINT " NONE OF THE  COMMON STREET DRUGS,"
5240 PRINT " INCLUDING  MARIJUANA, ARE KOWN TO"
5250 PRINT " CAUSE ANY FETAL MALFORMATIONS."
5260 GOSUB 2290:IF K$="R" THEN 3280
5270 PRINT :PRINT "     YOU HAVE REACHED THE END "
5280 PRINT "            OF THE PROGRAM "
5290 GOSUB 2290:IF K$="R" THEN 3280
5300 GOTO 1010
```

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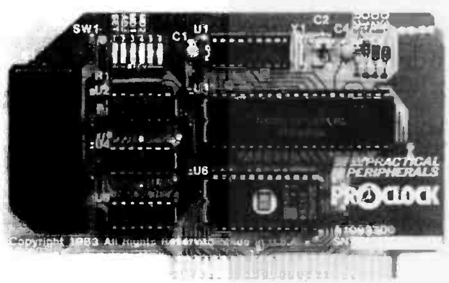


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*Text continued from page 108:*

your patients access to the computer, you may find this type of program useful in another way; it can be used by your staff to answer questions posed by patients.

Letting a nurse or receptionist handle simple medical questions is a common practice, but the aptness and correctness of the response may vary considerably depending on the training and experience of the person answering the questions. A program such as listing 1, used by the office staff to answer patient queries, can, in effect, make use of the expert knowledge and judgment of a physician, even in his or her absence.

In essence, the program and not the staff person supplies the answers. Through the program, the logic and rules of the expert applied to the base of medical knowledge control the response to the questions. The patients receive the answers you would have given, just as if you were speaking to them directly. Full diagnostic programs for large computers are already in operation in some medical centers. These programs, known as "expert" systems, function in much the same way. By interrogating for signs and symptoms and acting on these with rules devised by professionals, the systems arrive at the most likely diagnoses.

## Adaptability to Other Computers

The Drugs in Pregnancy program was written in Atari BASIC and requires less than 13K bytes of memory. I chose the Atari because of its inexpensive price and rugged construction, and because it could be used without difficulty by anyone in the waiting room. The program can be easily rewritten in versions of BASIC for other computers. Instructions helpful for such conversions are given in the next section of this article.

The program structure is not limited to any particular field or topic. By changing the wording of the choices and the responses, you can change the topic to heart disease, exercise physiology, or any other area. By retaining its structure, the program will continue to operate as before, adapted to the new subject.

## Converting an Atari Program

If you are converting this program for use on a computer other than the Atari, you need to change or eliminate some of the Atari-specific statements and commands. These are mostly graphic commands and symbols that differ from those of other computers. In the program listed, they serve to change the colors of the background and the borders of the screen display. You could delete all the graphic statement lines in the pro gram, and it would still convey the information.

**I chose the Atari because of its inexpensive price and rugged construction.**

In designing this program, I devoted particular attention to making it user-proof. Envisioning the user as someone with no previous experience in operating a computer, and considering the environment for the program's intended use, I attempted to make it as difficult as possible to crash the program. The program had to continue operation, or right itself, if the user committed a mistake. This goal was achieved to a point.

Practically all the keys are rendered inoperable except the few that are needed for the user to make choices in the program. Because the office computer does not operate with a disk system, I found no practical way to disable the Break or the System Reset keys other than to cover them with the message, "Do NOT press this key." All responses to the user choices are segregated into timed loops so that if a preset time limit is exceeded, the program will automatically restart at the beginning. This prevents the program from freezing at a particular place if the user abandons it before its conclusion.

Most of the PEEK and POKE statements are used to carry out the foolproofing. Since the PEEKs and POKEs are peculiar to the Atari, if you need this kind of crash prevention, you will have to devise methods for your own computer. The following Atari commands and functions are explained in detail so that you can convert them to the equivalent functions on your computer.

The SETCOLOR statement chooses a particular hue and luminance. The question mark (?) is an abbreviated form of the PRINT statement. PRINT #6 is a graphic statement that produces enlarged characters on the screen. The GRAPHICS command selects one of various graphic modes. Since the Atari GRAPHICS command also clears the screen, wherever you see this command in the program you should substitute your computer's command to clear the screen. Another Atari command also clears the screen: a PRINT statement followed by an arrow between double quotes. However, since most printers cannot print this arrow character, another symbol for the clear-screen command appears in the printout of the program listing. That symbol is "}" (right brace). Wherever you come across PRINT "}" in program listing 1, you should also substitute your computer's clear-screen code.

## Explanation of the Program

Atari BASIC requires dimensioning all string variables for the maximum length of the string. The DIM statement, line 1010 CLR :DIM K$(1), reserves a certain number of memory locations for the string variable K$. Each character in a string requires 1 byte in memory. CLR clears the memory of all previously dimensioned strings, arrays, and matrices.

Ordinarily, luminescence is reduced and the colors are rotated to protect the screen if no one accesses the keyboard after nine minutes. The POKE command, line 1020 POKE 77,0, disables this function since the keyboard frequently goes unused for this period of time. Instead, the program changes screens automatically every 15 to 20 seconds while unattended, so this protection feature is not needed.

Line 1080 sets up a loop to keep the display on the screen for 15 seconds and allows the user to break out of the loop to start the main program by

pressing the Start key. The PEEK command in this line monitors the Atari console switches. When the Start key is pressed, the program branches to line 3000. If the Start key is not activated within 15 seconds, the loop terminates and the program goes on to the next statement.

Line 1160 performs the same function for the second screen display, and line 1170 returns to the first screen if the Start key is not activated.

Lines 2000 to 2370 are subroutines and will be discussed in the sections of the program that call them.

Line 3000 is the beginning of the main program. A brief explanatory message is displayed on the screen followed by a menu of five drugs and an option to go on to a list of additional drugs.

Line 3132 calls subroutine 2290. (This input subroutine ends at 2370 unless an exit is made at one of the earlier lines.) The subroutine displays a menu of choices. A timing loop is set up as before, while the PEEK 764 statements read the value of the last key pressed. This function is similar to that of the INKEY statement in other versions of BASIC. The computer responds when the key is pressed; the user need not hit the Return or Enter key. The POKE statement restores the PEEK location to its normal value of 255, and the character entered is stored in the string variable K$. If the character "C" is entered, indicating that the user wishes to choose one of the drugs listed, the program returns to line 3132 and falls through the next two statements to line 3134, where the program control shifts to the subroutine starting on line 2120.

The subroutine at line 2120 prompts the user to enter a number and sets up another timed loop. The PEEK 764 statements that follow again scan the keyboard for the numbers 1 through 5, store the chosen number in the string variable K$, and then return the program to line 3134. Lines 2140 to 2172 will not respond to any entry except the numbers 1 through 5. This is a further safeguard against the program's being crashed by an incorrect keystroke. Line 2180 restarts the program if keys 1 through 5 are not pressed within 15 seconds.

The second statement on line 3134 calls the subroutine at line 2250. This subroutine checks to see if the keyboard entry was a number from 1 to 5. If not, line 2250 displays an error message and sets an error flag in variable K$; this returns the user to the menu again for another input in line 3140.

If all has gone well up to this point, K$ contains the number associated with the drug of choice. The conversion of this string value to a numerical value with the VAL function in line 3150 causes the program to branch to the appropriate routine with the ON GOSUB statement. If "R" was entered as a choice, the program will return to the previous menu. If "M" was the choice, the program will display the names of more drugs by branching to the next list of drugs.

The many subroutines, nested several layers deep, may make following the logic of the program difficult. However, the memory stack keeps track of all the subroutine calls and returns each one to the proper address. The advantage of such a method is that the user can move from the beginning of the program to the end in sequence, or jump back and forth anywhere in between, without being restricted to a one-way path.

The remainder of the program contains the text for the choices available to the user and further information on the topic chosen. By changing the textual content but retaining the form, structure, and logic of the program, you can rewrite the contents to deal with any topic that lends itself to a list of choices with a response for each one.■

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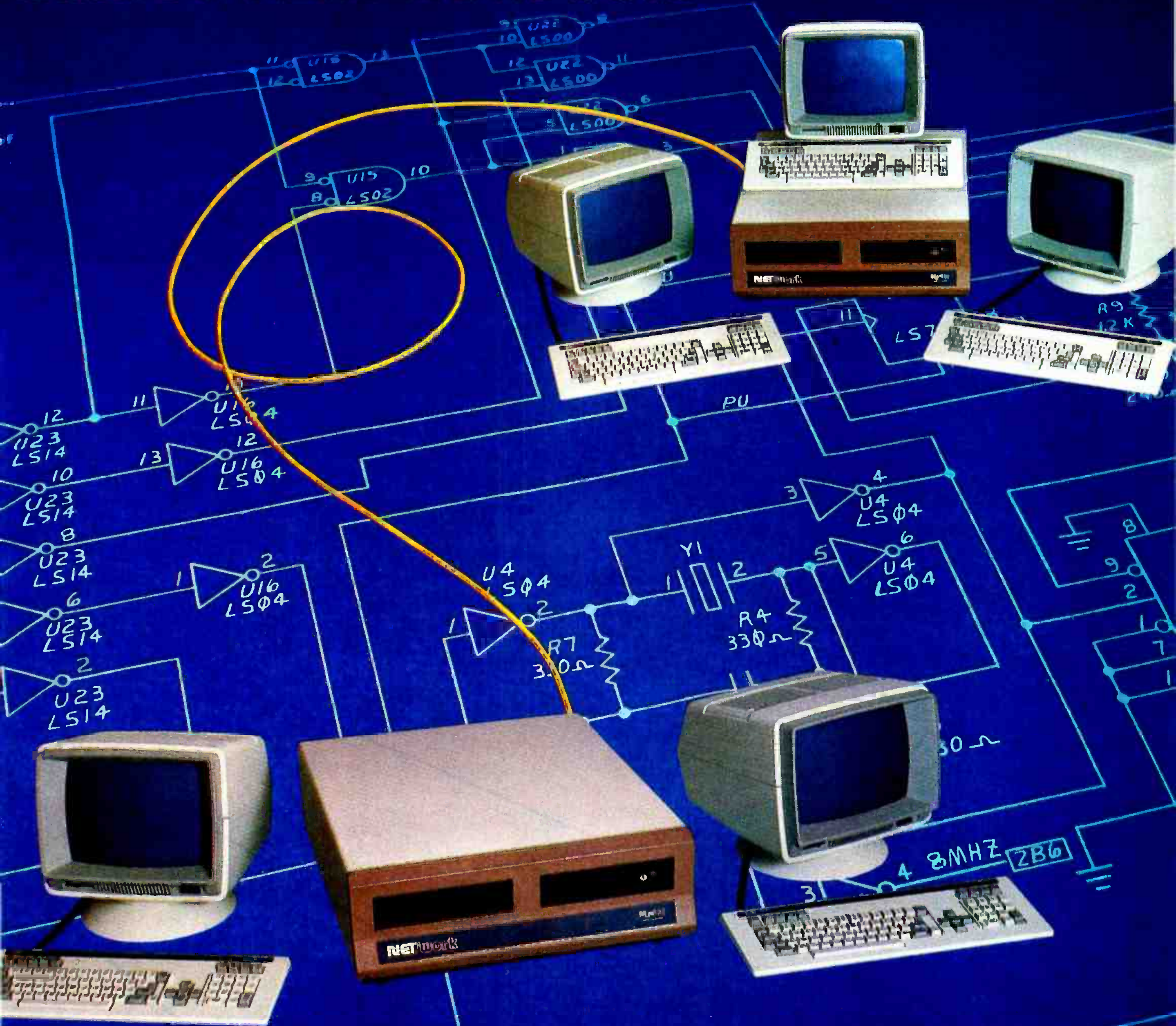

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# The Microcomputer as a Decision-Making Aid

*A computer can help you make decisions at work, but only if you know what to expect*

**Peter Callamaras**
**U.S. Air Force**

The phrase "decisions, decisions, decisions," used either in jest or in response to real frustrations, bears special significance. It has come to be a common, sometimes satiric, way of identifying one source of our problems. In this case, the source of irritation is the fact that the decisions we have to make have a way of piling up, demanding our time and attention, and seemingly never becoming manageable. The average person takes for granted the ability to make complex decisions. From the time we get up (what to wear today?), through the morning (which route to work?), afternoon (what's for lunch?), and evening (more dessert?), we are presented with choices, and we constantly make decisions. Throughout the day we make simple decisions about our personal well-being, even while we are engaged in professional activities. At some point this constant decision making can cause "decision overload." We get tired, our concentration suffers, and we start making mistakes.

## The Problems

The combination of being overburdened with decisions and making a series of bad choices will frustrate most of us. More important, when we're at work this problem can have consequences far beyond its effect on our emotional state. A classic example of decision overload and its possible dangers is a doctor's misdiagnosis.

A second problem related to decision making is the amount of time it takes. Assimilating all the information relevant to a decision can slow the whole process. Add to that the fact that the volume of information keeps growing. In fact, things change too quickly for many of us to keep up, especially in a busy work environment.

With the need to make more and better decisions, and because of the time involved in wading through so much data, we obviously need some way to reduce the burdens of professional decision making. Microcomputers provide a means of satisfying these needs.

Microcomputers can simplify decision making, speed up the process of choosing between alternatives, and help ensure the accuracy of each decision.

## Levels of Decision Making

There are three levels of decision making: operational, managerial, and strategic. Microcomputers can be of great value at all three levels.

Most operational-level decisions involve the specific needs of the decision maker. These decisions make up the majority of our routine choices. They usually are standardized in our daily activities. Operational-level decisions require detailed information, but the data is readily available and its conversion into decision-making information is often subconscious. We have a set of "canned" responses for these decisions and we often can delegate their execution. The typical advice to a cold sufferer, "take aspirin and drink plenty of liquids," is a delegated canned decision.

Managerial-level decisions require a broader base of information. The decision maker must rely on his prior experience, training, and instincts. Managerial-level decisions cannot be delegated, but they can be substantially speeded up. For instance, a lawyer about to accept a new case may have a general idea of what it concerns. However, the lawyer can't give his client any legal advice until all the data concerning the case is in. The client can help the lawyer by giving him detailed and specific information.

Strategic-level decisions require a wide range of information. These decisions usually are made after long periods of thought and planning and they often require the generation of completely new data. For example, the chief space-shuttle program engineer probably had to "imagineer" some of its aspects from technology that was either immature or still speculative when the program began. Thus, the majority of strategic decisions are heuristic (trial and error) and cannot be standardized, canned, or delegated. (For a more detailed discussion of the three levels of decision making, see *Information Processing Systems for Management*, Chapter 20, by D. Hussain and K. Hussain, Homewood, IL: Richard D. Irwin Inc., 1981.)

### Time and the Microcomputer

Work time is one of our most precious resources and also one of the most difficult to conserve. Microcomputers can help us reduce the time we have to spend on the decision-making process by gathering data and converting it into usable information. Once we have all the information we need, we can concentrate on our most prudent course of action.

Computers can bound a problem and ensure that we have the information we need to make a decision at our fingertips. If the decision is routine, computers can provide a canned response and you can get on with more important matters. However, it will take time to integrate a computer into your professional life.

First, you have to decide whether you really want to add a computer to your set of professional tools. Then you have to decide what to buy.

Next, you have to learn how to operate the hardware and interact with the software. Current literature, particularly advertisements, can lead you to believe that you can become proficient at operating a microcomputer in a few hours. This is not so. While you can learn to manipulate the keyboard and turn out some useful products in short order, you will not get the full benefit of the microcomputer until operating it becomes second nature to you. Compare this to oil painting. Until you master the basic techniques of applying the paint to the canvas, shading, mixing, etc., you will not have complete freedom of creativity. The same holds true for a computer system.

It also takes time to enter necessary background information into your computer. Many ads for financial-management programs, for example, only describe the output you can generate and don't dwell on the time it takes to input the information you need to get those impressive printouts. If it took you an entire year to spend the money you are now trying to account for, you can expect that it will take a great deal of time and effort to put your spending history into the computer.

### Some Helpful Solutions

In the past, two data-processing disciplines aimed at satisfying the needs of decision makers have been management information systems (MIS) and decision support systems (DSS). An MIS is a large data-gathering system. You define your data needs and set up a method of gathering it. The DSS is a refinement of the MIS applied to an individual's decision-making needs. An analogy can be found to a microcomputer if you imagine starting with a database management system (MIS) and then designing a set of tailored reports (DSS) based on the MIS data.

**Any professional who has to work with finances and is not using a computer system is wasting valuable time.**

For another example, look at your annual tax return and your checkbook as an MIS and a DSS, respectively. Your tax return should contain all your financial data in one handy form. You can use it to gauge your financial health and make plans for the coming year. You use this MIS to create budget categories for the following year (checkbook/DSS). You then use these budget categories for specific financial decisions. Balancing your checkbook at the end of the month tells you how much you spent in relation to how much you had. You can then break out the totals for each budget category and take a detailed look at your spending for the month. Then, if necessary, you can make adjustments for the next month.

In the past, both MIS and DSS systems had to be implemented on large computers. Today, most professionals can obtain the benefits of an MIS/DSS with a good microcomputer system.

### How the Microcomputer Helps

Any professional who has to work on finances and is not using a computer system is wasting valuable time. This applies particularly to professionals in business for themselves. When reviewing financial activities, the computer makes it easy to compare the money that is coming in with the money that is owed. If there are discrepancies, a computerized financial-management system allows you to go back and locate the source of the problems. If things are going well, you can use a spreadsheet program to speculate on possible future directions. A microcomputer also can make tax planning an easy, ongoing exercise that maximizes income and minimizes payments.

A computerized inventory system can also be of help to the professional. For example, you can establish a set of routine procedures for ordering supplies. If it takes a week to receive a high-consumption item, you can use the computer to determine when to place the order. One way this can be done is through the application of the economic order quantity (EOQ) method. With EOQ you create a model of your consumption patterns and compare them with your ordering/receiving patterns. The result is an indication of the best time to place orders. Accurate and timely order placement ensures that a minimum amount of inventory will be on hand to satisfy operating needs and that you will never run out of something. The stock stays fresh and storage costs decline. This also turns inventory control into a set of operational-level decisions that then can be delegated to a subordinate.

Microcomputers can perform complex statistical analyses. Engineers routinely perform statistical analyses of the failure rates of materials or components they want to use. The results allow them to accept or reject the materials. Once the acceptance/rejection criteria are determined, materials selection can be reduced to a canned routine.

For professionals who travel a great deal, trip planning can be made easier with a transportation model (TM). The TM can also determine the most economical route for product deliveries. For those whose business it is to move people or things around the country, the decision again can be converted into a set of canned control types and delegated.

Another type of software can aid planning and scheduling by providing a pictorial representation of the task at hand. Once the necessary events are determined, the computer generates a graph of the events along a time line. As time passes, the completion of a specific task can be tracked against the graph and corrective action can be taken as needed. One of the better known of these time-line graph programs is the critical-path method (CPM).

Teleprocessing through the phone system opens a whole new world to the microcomputerized decision maker. For those who need a great deal of information, the growing number of on-line data services can be a godsend. An on-line data service can be viewed as a specialized library in a computer. There are several medical libraries, for example, that allow doctors to make more accurate diagnoses or prescribe more effective medication.

On-line data services for lawyers, such as Westlaw, contain a vast body of judicial decisions. These services can reduce the drudgery of wading through all the material that is potentially applicable to a legal question. The search capability allows a lawyer to put in a set of key words and anything relating to those words is returned.

## Conclusion

The more decisions you reduce, standardize, and delegate, the less time decision making will take. The more data you gather, the more information you will have available to make the best possible decisions. The microcomputer's ability to play "what if" gives you trial-and-error results without forcing you to live with the consequences of poor decisions.

The cost of microcomputers now is generally low enough to be affordable to most professionals. Learning to use one properly takes time, but it is worth the investment. The documentation that accompanies most hardware and software is getting better. With clearer instructions, it takes less time to get "up to speed." There is plenty of software available to support decision making, and there are more decision-making packages coming out all the time. The key question is, Can you afford *not* to start using a computer to aid in your decision making?■

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# Benchmarking Business-Modeling Software

*These guidelines will help you compare the functions and speed of business-modeling software*

**William Hession and Malcolm Rubel**
**Performance Dynamics Associates**

When you want to fasten two boards together, you usually use a nail. To drive the nail through the boards you need a tool—preferably a hammer. The heel of a shoe might sometimes work, but it is hardly satisfactory where many nails are involved. You use a hammer because it is the best tool to perform the required tasks.

The process of selecting computer software, specifically business-modeling software (such as spreadsheet programs), can be likened to the hammer and nail problem. The software is your tool, but you need to have the right program to suit your modeling needs. Business-modeling software is a general-purpose tool; the added features of a specific program make it either more or less suited to different modeling tasks. Selecting business-modeling software is therefore complicated and prone to error. Benchmarks, or standard references, can simplify your evaluation of individual programs.

### Alternative Selection Procedures

There are four distinct approaches to selecting software; each has its own strengths and weaknesses.

1. *The "Dealer Demonstration" Approach.* This involves going to a dealer for product demonstrations. While you can view excellent demonstrations at reputable dealers, you will be exposed only to the programs the dealer stocks and sells. These demonstrations will not necessarily be specific to your individual needs. When you go to a demonstration it is essential that you have a clear and concise idea of your needs, so that you can ask the salesperson to show you products that can meet your requirements.

One drawback to this approach is that the salesperson may be unfamiliar with all but one or two products. Thus the salesperson may try to "force fit" your needs to the products he is familiar with. If the salesperson can't tell you about alternative products, you may make a poor purchase decision.

You also should not be afraid to ask the salesperson questions. Although you may think your questions are unimportant, they can be vital. Unasked, they go unanswered.

2. *The "Talk to a Friend" Approach.* Probably the most common way to choose software is on a friend's recommendation. Usually the person making the recommendation has no incentive to sell you something but is well versed in the uses of the product and can recommend it with authority. If you are lucky enough to know someone with the same software needs as you, this approach can be of some value. Problems arise if the person recommending the product did not make an optimal purchase decision or has task requirements that are substantially different from yours.

3. *The "Read the Reviews" Approach.* Many people evaluate business-modeling software by reading reviews on the different programs available. Most reviewers spend a considerable amount of time using the program they are reviewing and are truly knowledgeable about the type of software involved. However, the writer cannot help bringing personal bias into the review.

Each reviewer has preconceived ideas about what a specific type of software should include, and has his own approach to reviewing a product. A reviewer also has a set of problems that he wants the product to solve. Consequently, it is difficult to get an unbiased and comparable set of evaluations by reading a series of reviews by different authors.

One factor that reviewers tend to overemphasize is a product's "user-friendliness." To one person, "friendliness" could mean that the program prompts the operator at every command and asks for confirmation on every move. To another, this *same* "friendliness" could mean hours of tedium and frustration. "User-friendly" is not an absolute term; it is relative to the user's experience, temperament, and environment.

The first three approaches to selecting software draw your attention to the product's capabilities, simplicity of operation, utilities, special features, and the number of tasks it can perform. Unfortunately, they do not take into consideration the tasks you need to perform and whether the product can accomplish them.

The fourth method of product evaluation and selection, benchmarking, enables you to consider your needs first.

### The Benchmark Approach

To use the benchmark approach to choose your business-modeling software, start by defining the jobs you want done and then describe what you need in a product to perform these tasks. Once your needs are defined and you develop a suitable set of benchmarks, you can compare products based on your own specifications.

We use the term "benchmark" when evaluating software with a defined standard against which each software package is compared. Our benchmark is also split into two separate sections: functional comparisons and speed comparisons.

Functional comparisons, by far the most important, deal with the capabilities of a specific program to perform a specific task. Speed comparisons deal only with the individual program's speed and efficiency in performing a defined operational task. Speed comparisons are important only if the tasks defined involve massive data manipulations, substantial internal calculations, and/or many iterations. In general, this criterion becomes inconsequential when compared to the program's functional benchmarks and its simplicity of operation.

It is important to differentiate benchmarking from more traditional product-review techniques. Conventional reviews are characterized by implicit, rather than explicit, standards. You may not know why a reviewer gave a high or low mark to a specific capability of a program, you just know that he did. You are left to rely on the reviewer's judgment.

Conventional reviews traditionally cover only one product and, if any comparisons are made, they are usually ad hoc and do not have a valid foundation. Also, although reviewers' biases do exist, they are not annotated in the review.

Because different reviews are done by different people, it is virtually impossible to make comparisons of the products.

Benchmarking, on the other hand, is characterized by explicit standards. You may or may not be interested in the tasks being benchmarked, but you can at least see what the tasks do and weigh their importance.

Benchmarks make it easy to compare products and evaluate their differences in functionality and speed. Biases in a benchmark (which are certain to exist because the benchmark represents only one perception of what is important) are evident in the required modeling task. If the problem set does not adequately represent your individual needs you are free to ignore the comparisons.

Benchmarks are goal oriented. They are set up to determine whether a product can perform a predefined series of tasks. They are not set up to find out everything a product can do. As such, they are limited, but they are comprehensive within their own problem set.

To benchmark business-modeling software you must develop the benchmark and apply it to a specific product.

### Benchmark Development and Use

You should begin your benchmark development process with a thorough examination of the broad spectrum of business-modeling software. Pay attention not only to what is being modeled but also to how it is being modeled; also note who created the software and for what purpose.

Business modeling can be broken into several different categories. These categories represent the different tools, or capabilities, the software makes available to you. To select software properly you have to be able to define the tasks to be performed.

The software *must* be able to perform those that are required.

A business-modeling tool kit comprises several groups of tools: simple models, advanced simulation models, statistical tools for analysis and forecasting, special mathematical and business functions for modeling and analysis, and a generalized programming capability for user-developed functions and applications.

Elementary applications using ledger-sheet formats for the analysis of business performance require basic spreadsheet-modeling capabilities. The spreadsheet model, with its row/column modeling and basic arithmetic functions, provides the tool for the "quick and dirty" analyses so often required in business. When combined with an ability to link or consolidate sheets, this tool proves useful in report and simple accounting consolidations.

More sophisticated applications, based on large, complex equation systems, require modeling tools explicitly designed for developing and solving these types of problems. Modeling software for these tasks should include the capability to automatically order equations for a solution and the ability to solve both recursive and more complex circular or simultaneous model relationships. In addition, "what-if?" and "goal-seeking" features should be supported to aid model analysis. A sensitivity analysis (what-if?) feature allows you to vary assumptions and provides the means to examine the model's reactions to alternative assumptions. Goal seeking, also called backward solution, lets you determine what actions are necessary to achieve specified model outcomes.

To analyze past business patterns and to forecast future results, a basic statistical ability is required in modeling software. Minimum features should include basic statistics for analysis—mean, variance, standard deviation, simple correlation, forecasting tools such as linear regression, and simple time-series analysis functions such as moving averages or exponential smoothing routines.

Applications in business or financial analysis—for example, investment evaluation, capital budgeting, or profitability studies—are facilitated by special business mathematics functions. The calculation of net present values, internal rates of return, and depreciation and amortization schedules are a few of the more important business and financial functions. These functions may be tested directly in the problem set but must also be covered completely in a benchmark's questionnaire section to ensure that they are properly highlighted.

Developing custom business models and modeling applications sometimes requires the use of special formulas and procedures not always available in business-modeling packages. To meet this need, modeling software often provides a high-level programming capability. The modeling language should provide a full range of conditional functions and the usual programming constructs. Features permitting user-definable functions and subprograms are helpful for the larger tasks.

If it is to be useful, the benchmark problem set must address all different types of modeling applications. Simplify the models you are testing to their bare minimum to ensure that you test only the program's ability to perform a specific function, not its ability to perform a big job. If you keep the program simple you will also be able to apply it to your own needs more easily. The text box, "A Simple Financial Modeling Problem," on page 130, shows an example of one problem from the benchmark problem set designed simply to test a program's abilities.

From the range of business-modeling software that is available you can select those tools that are of primary importance to your work. From this list, you also can determine if there are other modeling tools you would like to have, given their availability. You can then go through the list of products available to you and discard those that do not meet your criteria. This reduces the list of possible purchases to a reasonable length.

At this point, you can examine each program's support of its tools. The benchmark problem set and ques-

## A Simple Financial Modeling Problem

*The Universal Products Corp. wishes to develop a simple financial model of a pro forma income statement. The model will be simulated for five periods.*

*Exercise A*

*Develop and run the model, generating the pro forma income statement shown below. Please attempt to replicate the report format as closely as possible. Save the report to disk and print it. Save the command file to disk and print it. Label the model and printed output EXA.1. Label the command file and output EXA.2.*

UNIVERSAL PRODUCTS INC.
Projected Income Statement

| | 1984 Revenue | 1985 Revenue | 1986 Revenue | 1987 Revenue | 1988 Revenue |
|---|---|---|---|---|---|
| Operating and other revenue | 120,000 | 144,000 | 172,800 | 207,360 | 248,832 |
| Cost of goods sold | 96,000 | 115,200 | 138,240 | 165,888 | 199,066 |
| | ------- | ------- | ------- | ------- | ------- |
| Earnings before interest and taxes | 24,000 | 28,800 | 34,560 | 41,488 | 49,766 |
| Interest expense | 30,000 | 10,000 | 10,000 | 10,000 | 10,000 |
| | ------- | ------- | ------- | ------- | ------- |
| Earnings before taxes | (6,000) | 18,800 | 24,560 | 31,488 | 39,766 |
| Taxes | 0 | 9,400 | 12,280 | 15,744 | 19,883 |
| | ------- | ------- | ------- | ------- | ------- |
| Net income | (6,000) | 9,400 | 12,280 | 15,744 | 19,883 |
| | ==== | ==== | ==== | ==== | ==== |

*The relationships on which the model is based are given below:*

*REV = 1.2 × lagged REV*
*CGS = 0.8 × REV*
*EBIT = REV − CGS*
*INT = $30,000 in period #1, $10,000 thereafter*
*EBT = EBIT − INT*
*TAX = 0.5 × EBT if EBT is > 0, otherwise TAX = 0*
*NET = EBT − TAX*

*Notes: Period 0 is 1983, period 1 is 1984 and so on. All lags are one-period lags. Initial revenue is assumed throughout the exercise to be $100,000. That is, REV for Period 0 = $100,000.*

*Exercise B*

*Assume now that revenue growth is 30 percent in years 1984, 1985, and 1986 and 50 percent in 1987 and 1988. Retrieve the model from disk, run it, and generate a new income statement in the same report format. Save the new report to disk and print it. Label this EXB.1. Save the command file to disk and then print it. Label these EXB.2.*

*Exercise C*

*Assume now that interest expenses are $20,000 per year for 1984–1988. Alter the model to reflect this new assumption (while maintaining the assumptions of exercise B). Run the model and generate an income statement similar to the one above. Save the report to disk and output it to the printer. Label these files EXC.1. Save the command file to disk and print it. Label these files EXC.2.*

*Exercise D*

*This question tests your product's ability to perform goal seeking, or the backward solution of the model. Use the model saved in exercise A. Find out what revenue would have to have been in 1984 if the net income will be $25,000 in 1985. Run the report, save it to disk, and print it. Label these files EXD.1. Save the command file to disk and print it. Label these files EXD.2.*

tionnaire should address a series of questions on how well each program works to support its problem-solving abilities.

You should design the benchmark's questionnaire to answer these important questions: who is doing the modeling, and for what purpose? You must ask questions about the documentation and output presentation. If you want the product to be a personal productivity tool, you will not ask the same benchmark questions as you would if the product is to be used by several people of differing skill levels. Your questionnaire should consider the following:

- Documentation—Is it complete, easy to read, and indexed? Does it give operator instructions for novices? Is there a tutorial or a reference card? Does it offer on-screen help?
- Data Input—Can data input into a model be simplified so that it can be done by a third party? Can forms be designed for input on screen? What is data editing like?
- Data Management—Can specific information be changed, modified, or copied? How? Is information easily retrieved? Can models easily access data?
- Functions and Utilities—What tools, both arithmetic and statistical, are available to assist you in developing and running your models? Some programs provide many specific functions such as net present value or variance. Others may require the operator to define the functions with many lines of code.
- Report Writing—What capabilities does the program have to output the finished report?
- Graphics—Does the program have the ability to present your information graphically? If so, in how many ways? What output devices are supported? Can you do color work?

An example of part of a function questionnaire is given in table 1. The set of questions that you ask should be comprehensive. The more points of differentiation between the varying programs, the easier it will be to reduce the set of possible choices to a final few.

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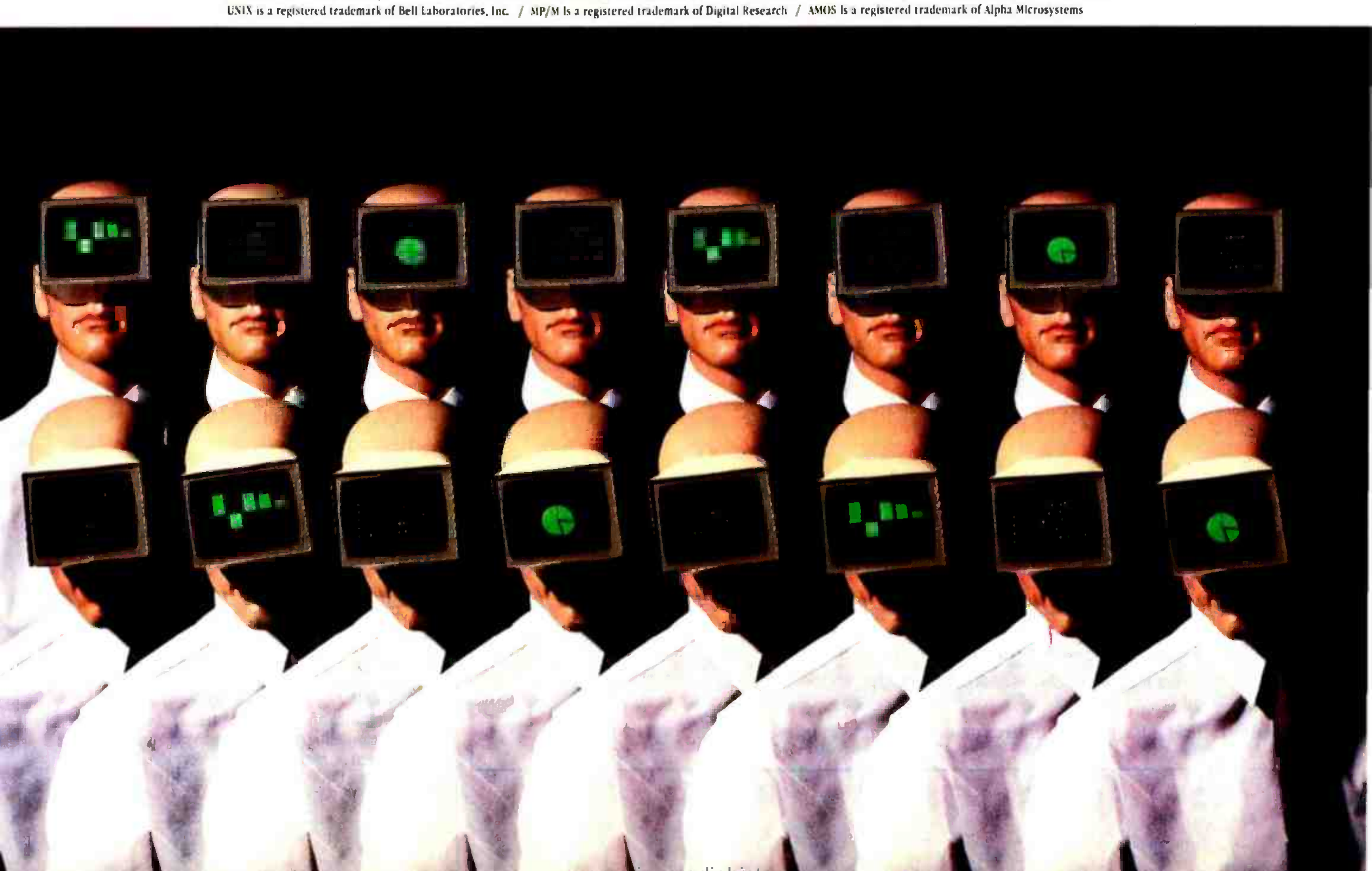

## Narrowing the Field

Once you have discarded programs that do not meet basic tool and function criteria, you must subject the remaining programs to "test drives." At this point, you can profitably consult a dealer or friend who has the program.

When consulting a dealer about a targeted product, it is important that you ask specific questions about it and that you set up and solve specific problems. If the salesperson is reluctant to do this, ask if you can conduct your own demonstration. At this point, you should determine how well the programs you have selected work for you. Get as much hands-on experience as you can before making a purchase.

It may seem like we have made the process of selecting a business-modeling program overly complicated, but when you consider your investment in a program, not only in actual but also in implied dollars (learning the program, setting up data files and models, and getting used to working with the program), your time and effort spent researching and selecting it is insignificant. The benchmark process can help you compare programs objectively and arrive at the proper purchase decision.■

*Malcolm Rubel is president and William Hession is executive vice-president of Performance Dynamics Associates (305 Madison Ave., New York, NY 10165), a marketing-consulting firm specializing in software marketing. They are also the authors of* The Performance Guides to Business Software, *a series of books benchmarking word-processing, business-modeling, and database-management software. The books will be published by McGraw-Hill in 1984.*

Sample Product Function Questions

Does the product have any of these Boolean and control functions:

| | |
|---|---|
| EQUALS (=)? | -------- |
| GREATER THAN (>)? | -------- |
| LESS THAN (<)? | -------- |
| GREATER THAN OR EQUAL TO (≥)? | -------- |
| LESS THAN OR EQUAL TO (≤)? | -------- |
| NOT EQUAL TO (≠)? | -------- |
| AND? | -------- |
| OR? | -------- |
| NOT? | -------- |
| IF . . . THEN . . . ELSE? | -------- |
| NESTED IF . . . THEN? | -------- |
| TRUE? | -------- |
| FALSE? | -------- |

Does the product have any of the following business functions:

| | |
|---|---|
| NET PRESENT VALUE? | -------- |
| FUTURE VALUE? | -------- |
| INTERNAL RATE OF RETURN? | -------- |
| PAYBACK PERIOD? | -------- |
| AMORTIZATION? | -------- |
| DEPRECIATION: | |
| STRAIGHT LINE? | -------- |
| DOUBLE DECLINING BALANCE? | -------- |
| SUM OF THE YEARS DIGITS? | -------- |

Does the product have any of the following statistical functions:

| | |
|---|---|
| MAXIMUM? | -------- |
| MINIMUM? | -------- |
| MEAN? | -------- |
| MODE? | -------- |
| MEDIAN? | -------- |
| VARIANCE? | -------- |
| STANDARD DEVIATION? | -------- |
| CORRELATION COEFFICIENTS? | -------- |
| SIMPLE LINEAR REGRESSION? | -------- |
| MULTIPLE LINEAR REGRESSION? | -------- |
| MOVING AVERAGE? | -------- |
| EXPONENTIAL SMOOTHING? | -------- |
| RANDOM-NUMBER GENERATOR? | -------- |

Indicate any additional functions that are included in the product.

**Table 1:** *Part of a questionnaire for evaluating business-modeling software.*

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- Access a department store catalog and pick out a wine rack, tools, toys... any thing!
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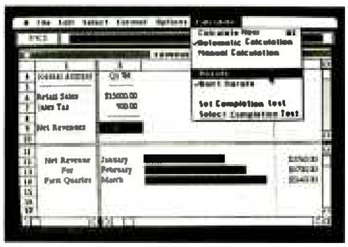

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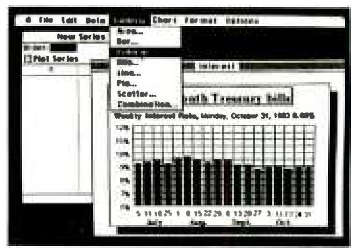

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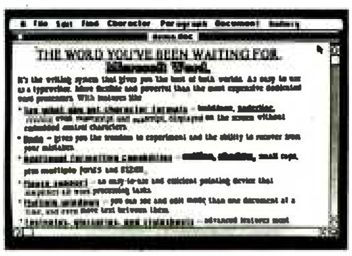
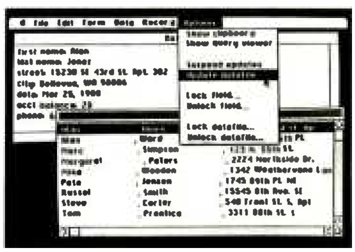

Microsoft Word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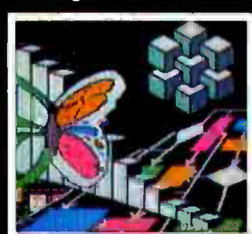

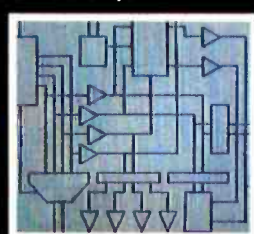


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# The Gibson Light Pen System

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# Expert Systems for Personal Computers

## *The TK!Solver Approach*

**Milos Konopasek and Sundaresan Jayaraman**
**Software Arts Products Corp.**

Although some question the possibility of implementing expert systems on today's personal computers, the authors of this article wish to present a counterexample. This article will show that many characteristics of expert systems are present in TK!Solver and will describe a framework for building a variety of expert systems with *quantifiable* knowledge bases.

### Historical Note

Early research in artificial intelligence (AI) was aimed at producing domain-independent reasoning techniques. General Problem Solver (GPS), a classic example, could prove theorems and solve a variety of problems and puzzles; however, it was inadequate for larger real-world problems. By the mid-1960s research efforts had shifted to the building of expert systems with large stores of domain-specific knowledge, such as Dendral at Stanford University and Macsyma at the Massachusetts Institute of Technology. This marked the beginning of increased research in the development of applied AI systems and into the philosophy behind them (the bibliography on page 154 refers you to publications concerning artificial intelligence and its history).

The fundamental issue of problem representation became more important in the context of these expert systems. Efforts were directed at determining the proper structures to efficiently represent the knowledge applicable to the problem domain, with the difficulty increasing as the domain broadened. These efforts represented a paradigm shift in AI during the 1970s.

The knowledge bases for the expert systems were hand-assembled—requiring many man-years of effort and mediation of a knowledge specialist. Some observers felt that this was the principal bottleneck in the development of expert systems (see reference 4), and that Tieresias was the first step toward the elimination of this bottleneck (see reference 2). Although it was limited to helping debug and fill out the knowledge base of Mycin, Tieresias separated the two basic components of an expert system—the knowledge base and the problem-solving or inference part. This also was a step toward domain independence, i.e., realization of the idea of removing the current knowledge base and "plugging in" a different one.

More recently, with expert systems development and experimentation costs increasing, a trend toward developing design tools to build expert systems is emerging. These tools also are designed to facilitate easy modifications of and experimentation with expert systems. Emycin, Ops, Age, Expert, and Hearsay III are some examples of this trend. TK!Solver is another.

TK!Solver is aimed at realizing many concepts expounded in AI research, human-computer interface design, and human problem solving. It has no built-in knowledge of any particular discipline, but it provides a framework to make it easier for the user with such knowledge to construct expert systems. The knowledge engineer—the bottleneck we mentioned earlier—is eliminated.

There are strong links between the prehistory of TK!Solver and developments in AI. Before detailing these links we have to mention the efforts outside the mainstream of AI aimed at creating special-purpose languages/frameworks for computer-assisted problem solving in specific areas. Ices, for civil engineering, SPSS, a statistical package, and GPSS, a simulation package, are typical examples. These programs lacked "knowledge" in the AI sense but they simplified the noncomputer professional's use of computers. They reflected the then state of the art in commercial hardware and software. Yet a large amount of domain-specific and mathematical knowledge went into the design of constituent subprograms and command structures. Running these programs was equivalent to accessing the embedded knowledge and using it for solving a variety of problems.

The development of these and scores of similar packages (for computer-aided design (CAD), operations research, forecasting, etc.) was facilitated by the application programmer's grasp of particular fields of expertise coupled with the expert's grasp of programming in high-level languages. The utility of these packages, their complexity, and their relative efficiency still present a challenge to mainstream AI tech-

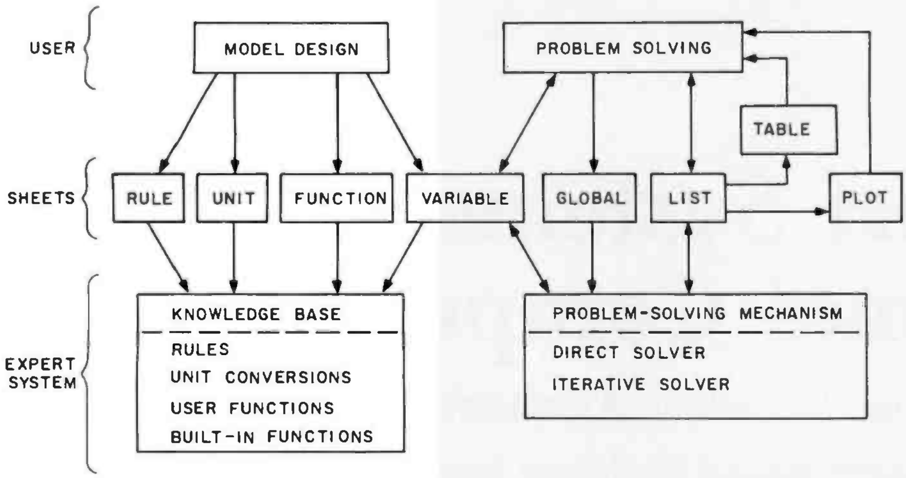


**Figure 1:** *A functional diagram of the TK!Solver user interface. The arrows indicate the predominant flow of information but all links are bidirectional.*

```
=================== RULE SHEET =====
S Rule
- ----
  I = V / R              " Ohm's Law
  I^2 = P / R            " Joule's Law
  P = V * I
  U = P * t
  rho = fun(MC)
  R / rho = L / A
  A = pi()/4 * D^2
```

**Figure 2:** *The "laws of electricity" knowledge base: rule sheet.*

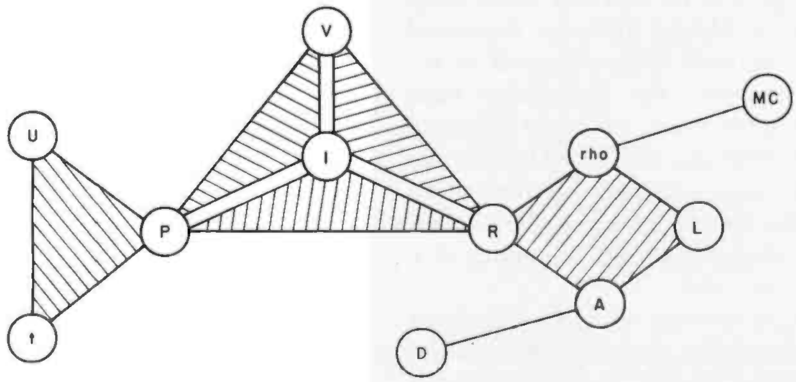


**Figure 3:** *The R-graph for the equations in figure 2.*

niques and to the methodology of expert-system design.

In the late 1960s, one of the authors of this article (Milos Konopasek, then at the University of Manchester Institute of Science and Technology) was assigned the task of developing what in present terminology would be equivalent to an expert system for textile engineers. The knowledge base for this system included (but was not limited to) components from mechanical, industrial, and chemical engineering. He faced a dilemma: on one hand, the nature of the knowledge base did not justify or require the Ices/GPSS/SPSS approach; on the other hand, the AI approach looked promising but was unlikely to yield quick results because of the lack of practical tools at that time.

Most of the knowledge under consideration dealt with relationships that could be described in terms of algebraic equations and empiric functions. This fact, and the desire to quantitatively and qualitatively increase the computer's share in the problem-solving process, led to the idea of making the user communicate with the computer at the level of relationships (represented by equations), rather than at the level of sequential programs and assignment statements. In 1972 a GPS, limited in scope but suitable for solving a large variety of real-world problems inexpensively, was developed. It was called "Question Answering System on mathematical models and related databases," or QAS. It was implemented first on PDP-10 and some other mainframe time-sharing systems and much later on microcomputers.

In QAS the expert sets up (types in or loads) the domain-specific knowledge as a "model" consisting of a set of relationships in the form of equalities

<expression> = <expression>

and empiric functions defined by lists of pairs

(<argument value>,
<function value>)

The expert then assigns the values of any combination of variables as input and lets the computer find a way to solve for the unknowns using either the consecutive-substitution procedure or iteration.

Interestingly enough, the intended role of QAS as an expert system brought about the separation of the knowledge base and control strategy—a key factor in the design of expert systems.

QAS's strong points were its fast response to any question, high power/resources ratio, and knowledge-carrying potential. Its weak point, especially in light of recent developments in human-computer interface, was the line-oriented dialogue.

TK!Solver is essentially an enhanced implementation of the QAS system. Its development was made

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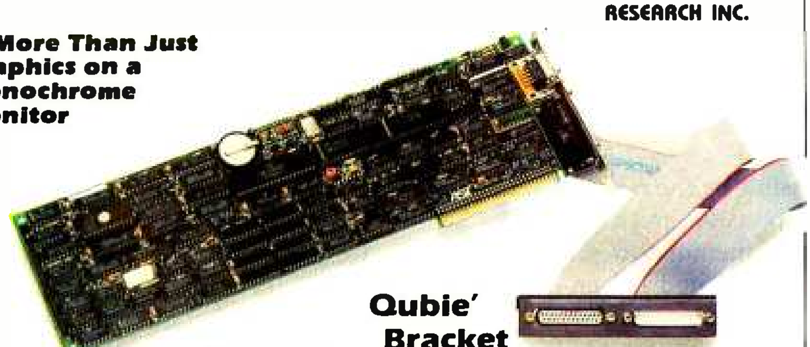

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```
==================== UNIT SHEET ==============
From        To          Multiply By  Add Offset
----        --          -----------  ----------
hour        min         60
min         sec         60
kW          W           1000
J           cal         .239
W           cal/sec     .239
kWh         J           3600000
hp          W           746
m           cm          100
m^2         cm^2        10000
```

**Figure 4:** *The "laws of electricity" knowledge base: unit sheet.*

```
=================== USER FUNCTION: fun ========
Comment:             Electrical Properties of Matter
Domain List:         material
Mapping:             Table
Range List:          resistivity
Element Domain          Range
------- ------          -----
1       'aluminum       .0000000263
2       'copper         .0000000162
3       'gold           .0000000222
4       'iron           .00000011
5       'platinum       .000000111
6       'silver         .000000016
```

**Figure 5:** *The "laws of electricity" knowledge base: user function subsheet.*

possible by the rapid proliferation of inexpensive microcomputers with direct memory to screen mapping that facilitated screen-oriented dialogues and resulted in an improved human-computer interface. We view TK!Solver as an attempt to create expert systems to fit the mass-produced professional-class personal computers.

## Overview

Figure 1 shows the architecture of TK!Solver. The domain-specific knowledge responsible for system performance is contained in the knowledge base. The problem-solving tools that contain the control strategy—the Direct and Iterative Solvers—use the knowledge base when solving particular problems. For interaction (or I/O (input/output)) TK!Solver provides "sheets" displayed through one or two windows on the screen.

The explicit division between the knowledge base and the control strategy is this architecture's main feature. Consequently, the expert/user deals only with issues of domain-specific knowledge and is insulated from the details of control-strategy implementation.

In the following paragraphs we will describe the four components of the knowledge base, the characteristics of a mode, and the problem-solving mechanism. We will try to illustrate these concepts with examples from a knowledge base of basic information about Ohm's law, Joule's law, and resistivities of materials. Obviously, the kind of interaction shown here is not restricted to this particular knowledge base.

## Rules

Rules are the basic component of domain-specific knowledge. They express mathematical relationships in terms of the equality between left-hand and right-hand expressions. Equations, constraints, or definitions can all be represented as rules. Figure 2 shows the rule sheet for our sample knowledge base. The set of rules can be represented as a network of relationships called the R-graph (for relationships graph) as shown in figure 3. A variable is represented as a node and each polygon-shaped subgraph represents a rule.

## Unit Conversions

Units of measurement are associated with most measurable quantities. Conversions between them are frequently encountered in problem solving and have to be defined in the knowledge base. Figure 4 shows the unit sheet with the unit conversions in our example's knowledge base.

## Function Definitions

Empiric relationships between sets of values are expressed as (user-defined) functions and make up the third component of the knowledge base. Figure 5 shows the user function subsheet, with materials and their resistivities, in our sample knowledge base.

## Built-in Knowledge

Irrespective of the domain-specific knowledge, TK!Solver is designed to solve problems involving basic arithmetic operations and built-in mathematical functions. Standard varieties of those are supplemented by special ones such as "element" (for retrieving list components) and "apply" (for associating empiric functions with arguments). TK!Solver may, for example, associate the function defin-

*Text continued on page 144*

```
=================== VARIABLE SHEET ===========================
St Input     Name    Output     Unit      Comment
-- -----     ----    ------     ----      -------
   4         I                  amp       current
   110       V                  volt      voltage
             R       27.5       ohm       resistance
             P       440        W         power
             U       3168000    J         energy
   2         t                  hour      time
             MC                           material of conductor
             rho                ohm-m     resistivity of material
             L                  m         length of conductor
             D                  m         diameter of conductor
             A                  m^2       cross-sectional area
```

**Figure 6:** *A variable sheet with a list of variables used in the rules in figure 2. It shows the solution of a problem concerning the energy supplied to a motor drawing 4 A (ampere) from a 110-V (volt) line over two hours.*

When You Turn this Page You'll be Leaving the World of Ordinary Microcomputers

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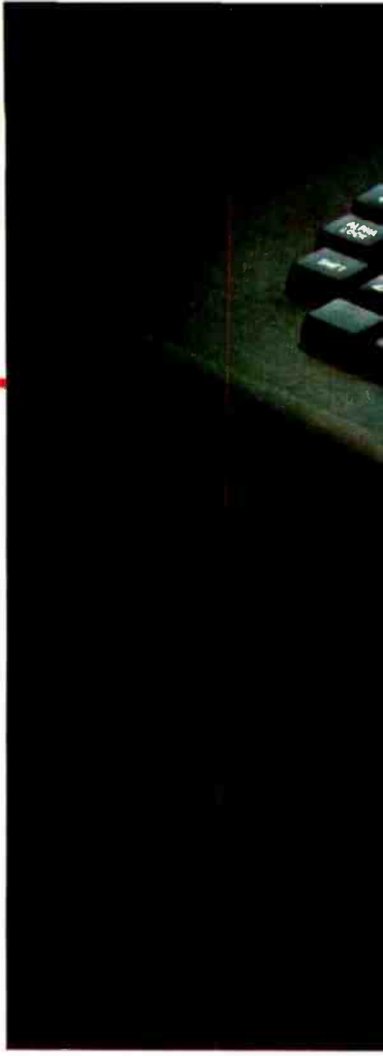

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And the solid feel of people-sized keys set up in a field that gives you room to work and space in which to think.

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Take a close look at the MTX512.

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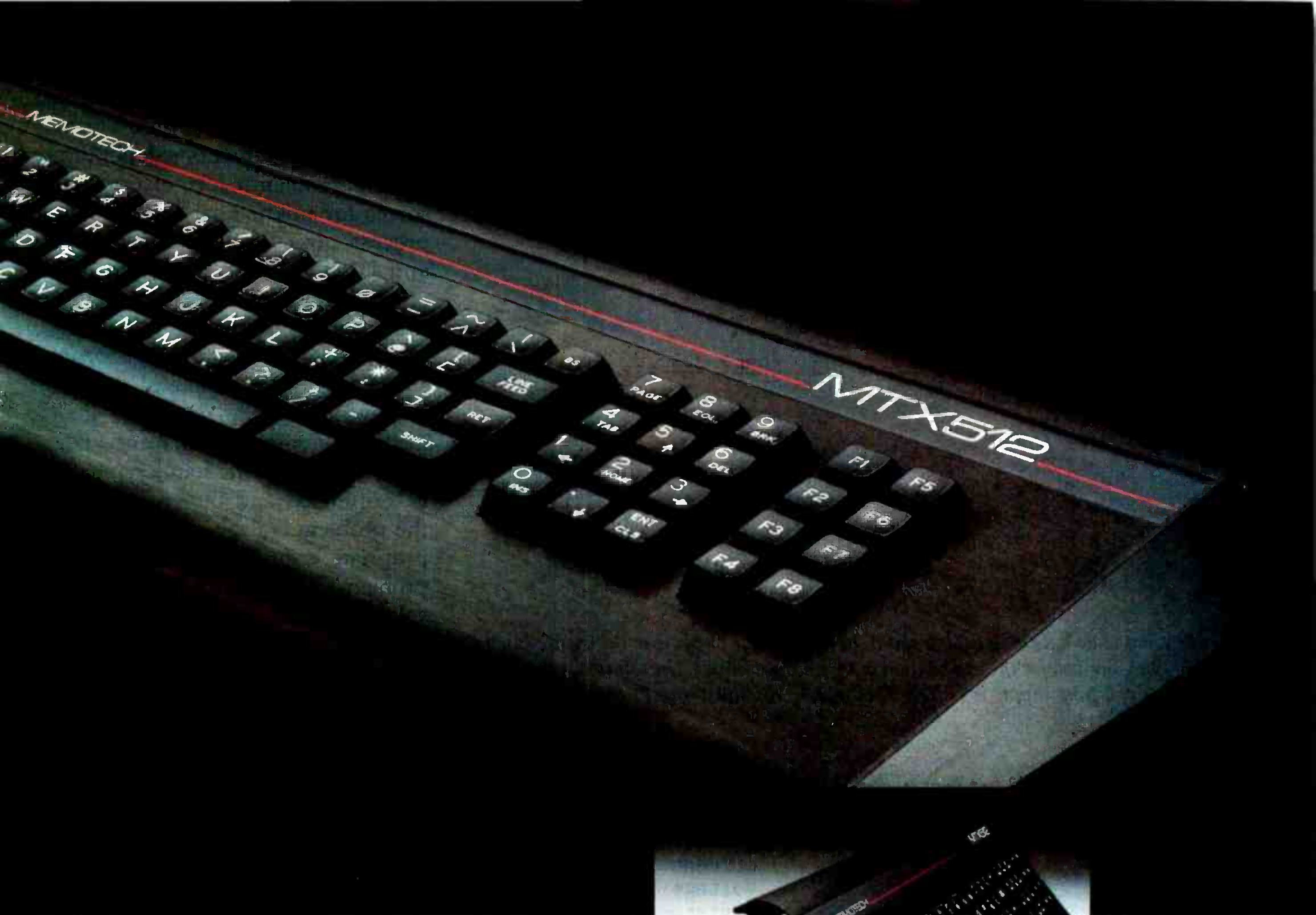

MEMOTECH
MTX512




MEMOTECH

```
(3s) Status: > Inconsistent

==================== VARIABLE SHEET ===
St Input      Name    Output    Unit
-- -----      ----    ------    ----
    4         I                 amp
    110       V                 volt
              R       27.5      ohm
 >            P       440       W
 > 1.25       U                 kWh
 > 2          t                 hour

==================== RULE SHEET =======
S Rule
- ----
  I = V / R
  I^2 = P / R
  P = V * I
> U = P * t
* rho = fun(MC)
* R / rho = L / A
* A = pi()/4 * D^2
```

**Figure 7:** *What must have been the current if, in the example in figure 6, the energy supplied was 1.25 kWh? (See text for the explanation of the inconsistency.) The solution, after removing the value of I from input, is I=5.68 A, R=19.36 Ω (ohms) and P=625 W (watts).*

```
==================== VARIABLE SHEET ===========================
St Input     Name    Output      Unit      Comment
-- -----     ----    ------      ----      -------
             I       10          amp       current
             V       1.5         volt      voltage
   .15       R                   ohm       resistance
   15        P                   W         power
             U       .0075       kWh       energy
   30        t                   min       time
   'copper   MC                            material of conductor
             rho     1.62E-8     ohm-m     resistivity of material
             L       7.2722052   m         length of conductor
   .1        D                   cm        diameter of conductor
             A       .00785398   cm^2      cross-sectional area
```

**Figure 8:** *The variable sheet with the solution of the following problem: What would be the current and the voltage across a 0.15 Ω copper resistor producing 15 W of heat? What is the energy supplied in 30 minutes if the wire diameter is 0.1 cm (centimeter)?*

*Text continued from page 140:*

ing the stored load-deformation characteristics with a given type of material.

## Model

The model encompasses the first three components of the knowledge base in figure 1 (rules, unit conversions, user functions) as contained in the rule, variable, unit, and user function sheets. It can be viewed as a compact, high-level representation of domain-knowledge structure, organization, and content. The model's content and structure allow for a control strategy that we feel is both simple and powerful. The model is also intended to serve as a user-friendly guide during problem solving.

The model usually reflects a specific part of a particular discipline's knowledge base. Different models may be merged later by loading some or all of their components into TK!Solver, thereby creating larger models capable of addressing more complicated problems. There are commercial versions of model sets, called TK!SolverPacks, for such disciplines as mechanical engineering, financial analysis, and building design.

## Problem-Solving Mechanism

The Direct Solver is the workhorse of the problem-solving mechanism. It manipulates equations depending on the problem's formulation and solves for unknowns. The solution process goes through the R-graph and "fires" all polygons with only one unknown node. It continues until as many unknowns as possible are evaluated. This "propagation of solution" strategy simulates the consecutive-substitution procedure. If an inconsistency error or an illegal operation is detected, the solution process is terminated and the rule causing the problem is flagged with the appropriate error message. Because a problem's formulation dictates the solution path, the control strategy may be regarded as forward chaining or data-driven.

Whenever the Direct Solver cannot match the nature and complexity of a given problem, the Iterative Solver can be used. The heart of the Iterative Solver is a modified Newton-Raphson procedure that handles sets of simultaneous linear and nonlinear equations. It either can be invoked explicitly or automatically called when the Direct Solver fails to produce a solution.

## Examples

Figures 6 through 8 show variable sheets with formulations and solutions for a few problems concerning our sample knowledge base. The "calculation units" (i.e., units implied in figure 2's rules) are specified and used in figure 6 for all variables except t. In the next two figures the units for U, D, and A were changed respectively to kWh, cm, and $cm^2$, and the values were changed accordingly.

In figure 7 the user overconstrained the model by assigning U = 1.25 without releasing I from the set of input variables. The partial view of the variable and rule sheets shows the offending rule and related variables marked by >. Bringing the cursor over the > mark in the rule sheet causes the error message "Inconsistent" to be displayed in the status line.

The asterisk (*) in front of the last three rules in figure 7 indicates that

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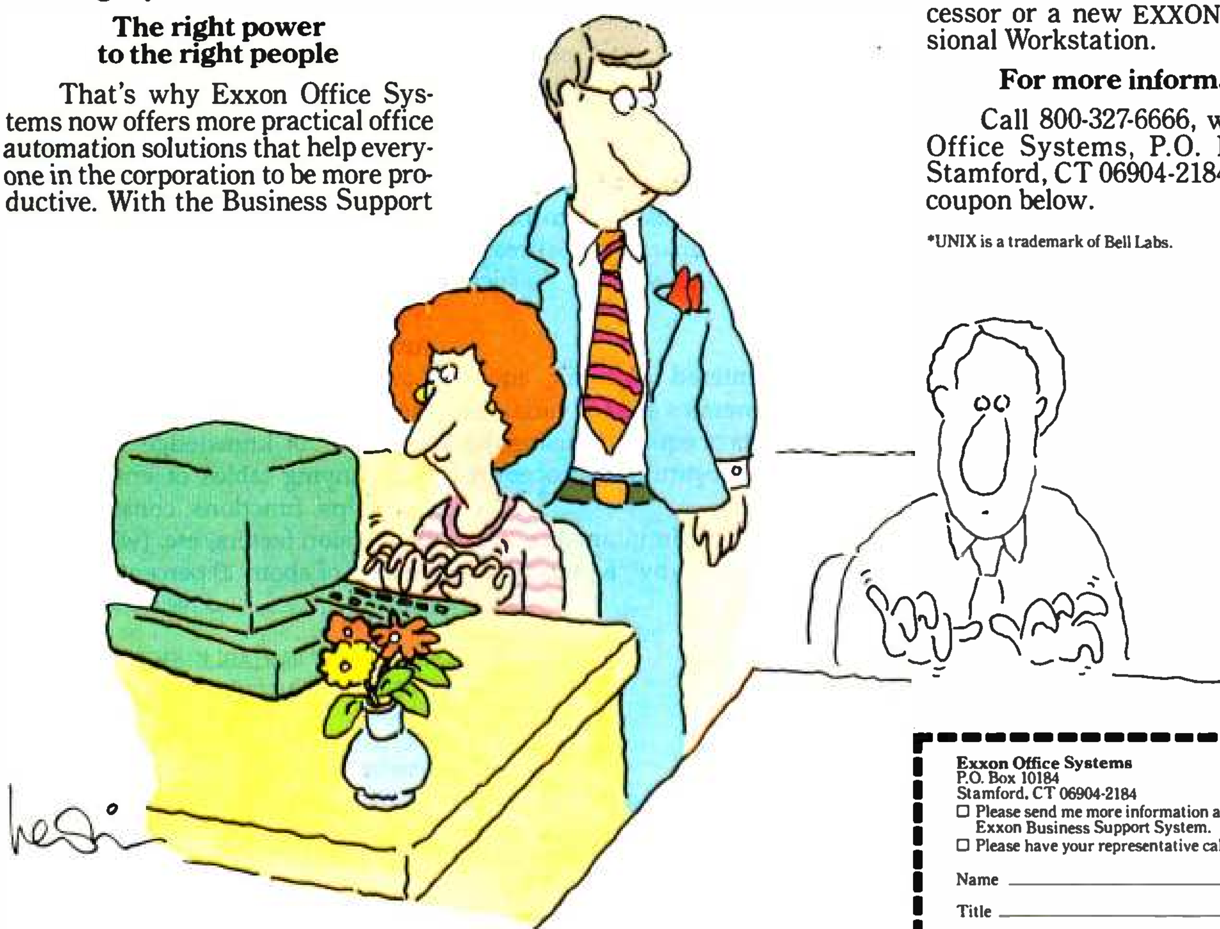

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```
==================== VARIABLE SHEET ============================
St Input        Name    Output     Unit        Comment
-- -----        ----    ------     ----        -------
                alpha   36.869898  deg         angle opposite to side a
                beta    53.130102  deg         angle opposite to side b
                gamma   90         deg         angle opposite to side c
   3            a                              side a
   4            b                              side b
   5            c                              side c
                P       12                     perimeter
                A       6                      area
=================== RULE SHEET ==================================
S Rule
- ----
* alpha + beta + gamma = pi()                 " sum of angles equals pi
* a^2 = b^2 + c^2 - 2*b*c*cos(alpha)          " cosine theorem
* a / sin(alpha) = b / sin(beta)              " sine theorem
* P = a + b + c                               " perimeter
* A = a * b * sin(gamma)/2                    " area
```

**Figure 9:** *The variable and rule sheets for the triangle model showing the solution of a right-angle triangle with sides 3, 4, and 5.*

those rules were not used in the attempted solution. The solution to the problem in figure 8 involved all the rules, the function relating the type of material and resistivity, and the unit conversions.

The procedure for changing the knowledge base is demonstrated in figure 9. To solve problems concerning the elements of a triangle (after finishing with electrical properties of matter), the user types /RA (for Reset All) and loads the "Triangle" model.

Somewhat more complicated situations are exemplified in figures 10 through 13. The results (in figures 11 and 13) had to be arrived at using the Iterative Solver. Figure 12 shows an impromptu modification of the knowledge base: the desire to solve for an isosceles triangle is expressed simply by adding the rule a = b to the rule sheet.

In figure 14 the knowledge base is changed again to deal with simple projectile problems.

In short, we feel that TK!Solver's power comes from the ease with which a particular knowledge base may be set up or selected, problems formulated, assumptions varied, and results generated.

## TK!Solver and Expert Systems

TK!Solver was designed to be an expert system primarily in the area of numerical problem solving. As such it

(1) parses entered algebraic equations and generates a list of variables
(2) solves sets of equations using the consecutive-substitution procedure (Direct Solver)
(3) solves sets of simultaneous algebraic equations by a modified Newton-Raphson iterative procedure when the consecutive-substitution procedure fails (Iterative Solver)
(4) searches through tables of data and evaluates either unknown function values or arguments when required in the process of (2) or (3)
(5) performs unit conversions
(6) detects inconsistencies in problem formulation and domain errors
(7) generates a series of solutions for lists of input data and outputs results in tabular and graphic forms

However, we also consider TK!Solver to be a general framework for setting up expert systems in a whole class of disciplines. A class is defined by the heavy dependence of human experts on the use of mathematical and logical skills. See the text box "Attributes of Expert Systems" on page 152 for a comparison of TK!Solver and the typical characteristics of an expert system.

We experimented with TK!Solver by using it to build expert systems in a variety of disciplines. For example, we were able to set up models and use them for solving whole sets of problems in Schaum's Outline Series books on physics, chemistry, finance, etc.

We also feel that the TK!Solver concept is useful in covering well-structured knowledge as embodied, for example, in *The Engineer's Manual* (see reference 5) consisting of 1029 "chunks" of knowledge and 30 accompanying tables of empiric relationships, functions, constants, unit conversion factors, etc. (with the exclusion of about 10 percent of the text

*Text continued on page 152*

```
==================== VARIABLE SHEET ===
St Input      Name    Output    Unit
-- -----      ----    ------    ----
              alpha             deg
   55         beta              deg
              gamma             deg
G  3          a
G  4          b
   5          c
              P
   7          A
```

**Figure 10:** *What would be the elements of a triangle given angle beta = 55 degrees, side c = 5, and area A = 7? Direct Solver failed. This partial variable sheet shows a and b set as guesses for Iterative Solver.*

```
==================== VARIABLE SHEET ===
St Input      Name    Output      Unit
-- -----      ----    ------      ----
              alpha   42.652161   deg
   55         beta                deg
              gamma   82.347839   deg
              a       3.4181688
              b       4.1325618
   5          c
              P       12.550731
   7          A
```

**Figure 11:** *The solution to the problem in figure 10.*

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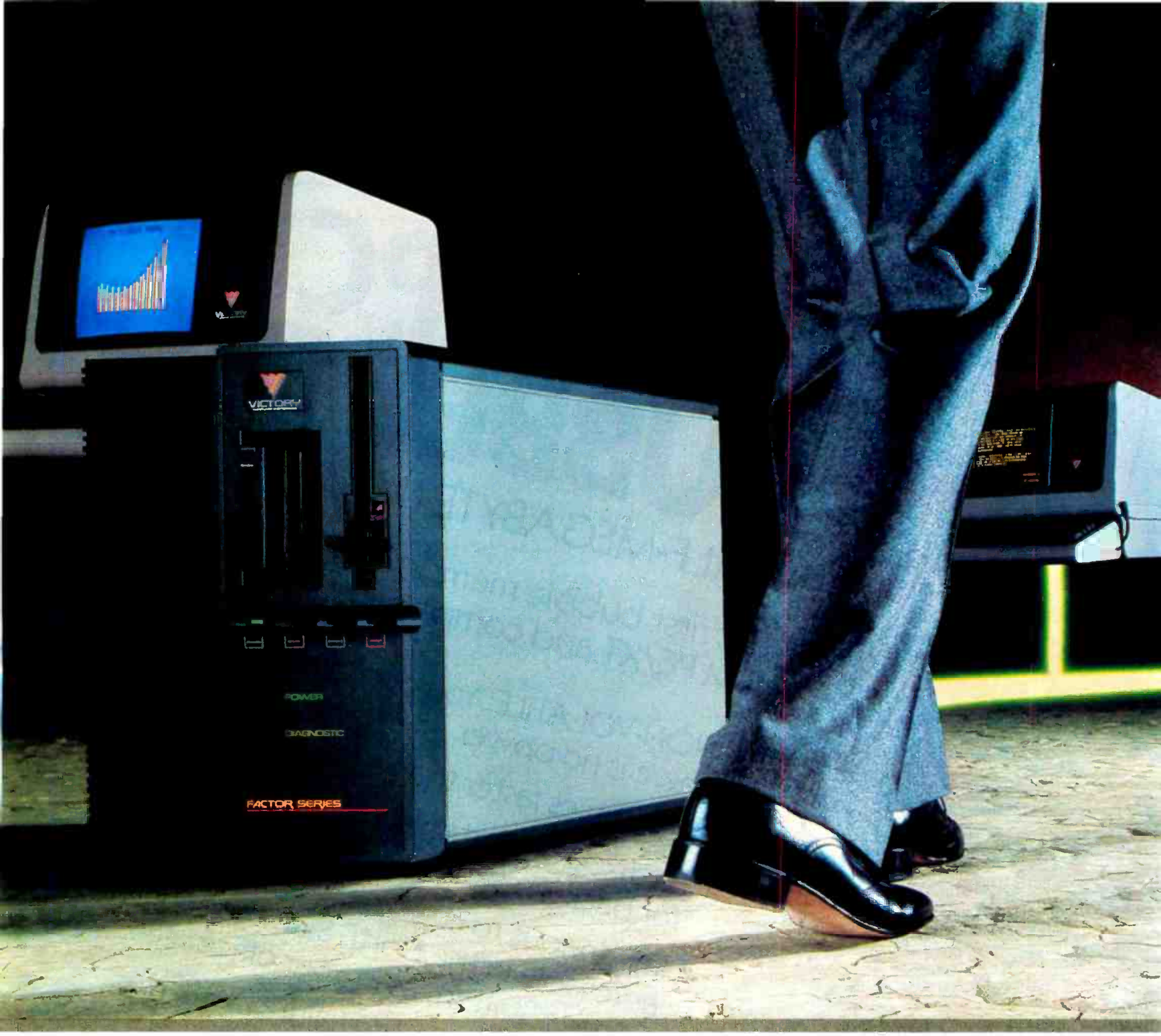


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```
=================== VARIABLE SHEET ===
St Input      Name     Output     Unit
-- -----      ----     ------     ----
              alpha    42.652161  deg
              beta                deg
              gamma    82.347839  deg
 G 3.7753653  a
              b        4.1325618
   5          c
              P        12.550731
   7          A
=================== RULE SHEET =======
S Rule
- ----
* alpha + beta + gamma = pi()
* a^2 = b^2 + c^2 - 2*b*c*cos(alpha)
* a / sin(alpha) = b / sin(beta)
* P = a + b + c
* A = a * b * sin(gamma)/2

* a = b
```

**Figure 12:** *What are the elements of an isosceles triangle if side c and area A are the same as in figure 11 and no angle is given? Constraint a = b is added to the rule sheet. Guess the value for a arrived at by typing in (a + b)/2 (rationale: the expected value must lie between previous values of a and b). Values in output field left from previous solutions don't count.*

```
=================== VARIABLE SHEET ===
St Input      Name     Output     Unit
-- -----      ----     ------     ----
              alpha    48.239700  deg
              beta     48.239700  deg
              gamma    83.520599  deg
              a        3.7536649
              b        3.7536649
   5          c
              P        12.507330
   7          A
```

**Figure 13:** *The solution to the problem in figure 12.*

```
=================== VARIABLE SHEET ============================
St Input      Name     Output     Unit       Comment
-- -----      ----     ------     ----       -------
   100        V0                  m/sec      initial velocity
   30         alpha               deg        angle of departure
   32         a                   ft/sec^2   accln. due to gravity
              time     10.252625  sec        time taken
              maxht    128.15781  m          maximum height reached
              range    887.90334  m          horiz. dist. travelled
=================== RULE SHEET ================================
S Rule
- ----
  maxht = V0^2 * sin(alpha)^2 / (2 * a)
  range = V0^2 * sin(2*alpha) / a
  time = sqrt(8 * maxht / a)
  (range/time)^2 = V0^2 - 2*maxht*a
```

**Figure 14:** *The variable and rule sheets for the projectile model with the solution of the following problem: A baseball is thrown with an initial velocity of 100 m/s (meters per second) at an angle of 30 degrees. How far does it travel and how long does it take before it hits the ground?*

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*Text continued from page 146:*

dealing with concepts beyond the scope of the control strategy of the current version of TK!Solver). This experience compares favorably with the domain limitations of systems like Mecho or Newton; the latter also faced difficulties in interfacing the quantitative knowledge with the mathematical expertise provided by Macsyma.

## Further Developments

TK!Solver in its present form provides a general framework for building expert systems in scientific, engineering, and other disciplines. In this sense it falls in the category of knowledge-representation languages like KRL, NETL, Klone, or Prolog.

It may be argued, however, that TK!Solver falls short of learning capabilities, analogical reasoning, reasoning under conditions of uncertainty, and some other features stipulated by the theoreticians of expert systems or proclaimed for the Japanese fifth-generation computers. There are also other AI "standards" for the design of expert systems that TK!Solver seems to ignore: natural-language interface, restriction to problems that are "not algorithmic or totally understood" (see reference 3), and "representation of symbolic knowledge for use in machine inference" (see reference 4). Finally, there is the implicit notion of the need to use a list-processing language for AI work (incidentally, TK!Solver is implemented in a LISP-like language).

Although in fact all these advanced attributes are present in TK!Solver to

### Attributes of Expert Systems

*Readers are invited to test TK!Solver against each of the expert system characteristics listed here.*

- *The expert system has separate domain-specific knowledge and problem-solving methodology and includes the concepts of the Knowledge Base and the Inference Engine.*
- *The expert system should think the way the human expert does.*
- *An expert system tells the computer "what" the problem is rather than "how" to solve it.*
- *Its dynamic knowledge base should be expandable, modifiable, and facilitate "plugging in" different knowledge modules.*
- *The interactive knowledge transfer should minimize the time needed to transfer the expert's knowledge to the knowledge base.*
- *Addition of a new rule should result in a new competency for the system, and conversely, the absence of the rule should mark the absence of the related ability.*
- *The expert system should interact in the language "natural" to the domain expert; it should allow the user to think in problem-oriented terms. The system should adapt to the user and not the other way around. The user should be insulated from the details of the implementation.*
- *The principal bottleneck in the transfer of expertise—the knowledge engineer—should be eliminated.*
- *The control strategy should be simple and user-transparent, the user should be able to understand and predict the effect of adding new items to the knowledge base. At the same time it should be powerful enough to solve complex problems.*
- *Expert systems should be computationally fast and not demanding of resources, avoiding situations where interactive intelligent systems suffer from a basic conflict between their computationally intensive nature and the need for responsiveness to a user.*
- *There should be an inexpensive framework for building and experimenting with expert systems.*
- *Human engineering aspects are important for making the system understandable and for keeping experts interested and making users feel comfortable.*
- *The expert system should have provision for help and English-language dialogue.*
- *The system should have a display-oriented interface.*
- *It should be able to reason under conditions of uncertainty and insufficient information, and should be capable of probabilistic reasoning.*
- *An expert system should be able to explain "why" a fact is needed to complete the line of reasoning and "how" a conclusion was arrived at.*
- *Pragmatic systems are needed; they should be robust, general, and efficient for routine use.*
- *The expert system should be available to users in properly sized, properly packaged combinations of hardware and software; chronic absence of cumulation of AI techniques in the form of software packages that can achieve wide use; proliferation should lead to expert systems at everyone's disposal.*
- *The system should be useful, i.e., responsive to the practical needs of professional communities; real-world systems.*
- *Expert systems should be capable of learning from experience.*

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a small or embryonic extent, it would serve no purpose to argue to what extent they have to be present in order to classify the system one way or another. We would rather point to what TK!Solver can do in its present form and stress the fact that it provides a basis for implementing additional features and capabilities as the hardware permits and as the mass user requires.

In its future development TK!Solver should look two ways: first, at concepts and tools emerging from research in AI, and second, at the time-proven "non-AI" program packages that have become a part of human experts' lives. ■


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# How Lawyers Can Use Microcomputers

*Cutting costs while upgrading legal service with the aid of microcomputers*

**Robert P. Wilkins, J.D.**
**R.P.W. Publishing Company**

Microcomputers are a mystery to many lawyers because, too often, they try to learn about them in terms of BASIC programming, RAM (random-access, read/write memory), ROM (read-only memory), bps (bits per second), and other foreign, often unnecessary technical terms. All lawyers need to know is how computers can improve the efficiency of a legal practice.

Reviewing the firm's needs is the first step in this analysis. Work in law offices is generally divided between administrative and substantive tasks—those relating to the actual practice of law.

Administrative tasks in the law office are similar to those in any other small buiness: bookkeeping, bank account reconciliation, payroll, calendar control, file management, information retrieval. One legal administrative task uncommon to most small businesses is timekeeping and billing. Most lawyers keep time records and either submit bills based on them or use them in determining what they will bill. This may be the most important administrative reason to acquire a computer.

Generally, legal services can be divided into broad categories. Lawyers prepare letters, opinion letters, memoranda of law, briefs, deeds, wills, agreements, and other documents. When everything else fails, they may go to court on the client's behalf. Before going to court, pleadings must be prepared, witnesses interviewed, depositions taken, and the paper associated with the lawsuit managed. In addition, there are some critical court-proceedings deadlines that must be followed and observed. In complex litigation many exhibits must be tracked.

Although some lawyers spend the majority of their time in court, most usually spend it in the office. Lawyers research and analyze problems, give advice, prepare documents, make mathematical projections, prepare tax returns, gather data, and analyze the information gathered. The practice of law involves much paperwork and includes a substantial amount of document preparation. Because of this, many lawyers have become interested in the use of computers. For the most part, however, lawyers have been slow to take advantage of new technology. Most lawyers in America practice in small firms; 70 percent practice in firms of five or fewer lawyers. Until recently, word processing was relatively expensive, and many small-firm lawyers did not feel they could afford it. The cost of a single, dedicated word-processing system dropped from the $12,000 to $20,000 range. Today, the cost can be as low as $2100. A very powerful microcomputer with letter-quality word-processing capability can be purchased for between $2100 and $7000. As a result, many lawyers are now using microcomputers, not for computing, but for low-cost word processing. Once they acquire the computer for word processing, they realize the tremendous potential of the computer to help in other ways.

It is interesting to note that the smaller firms have seemed to lead the way in the microcomputer explosion. Initially, many large firms with minicomputers and mainframes turned up their noses at microcomputers. Now, large firms are waking up to the potential of microcomputers, and many are now buying them for their individual lawyers. The computers are usually used both as freestanding units and as terminals into the mainframe.

For the lawyer who has a microcomputer for word processing or one who is considering a first purchase, it is important to understand what a computer does. Generally speaking, a computer can be used for: word processing; number crunching (including bookkeeping, payroll, tax projections); information or data management; communications; electronic spreadsheets; and specialized tasks to help in specific areas of the law. Let's look at each category and explore it as it relates to the practice of law.

## Word Processing

The practice of law is ideally suited for word-processing equipment, and without a doubt, word processing is the legal profession's most common use of the microcomputer. The use of the word processor in the law office can be broken down into three major categories:

- routine daily correspondence
- long documents that require extensive editing
- repetitive documents

It is important to understand that most lawyers are under pressure to cut costs and to price services reasonably. Because labor can be the highest single cost in a law office, efficiency is important. In the first two categories listed above the benefit of word processing is largely that it improves staff efficiency. The long documents may include agreements, briefs, and memoranda of law. In almost every case a draft of the document is prepared and input is received from other lawyers and the client. In some cases, such as a negotiated contract, input will also be received from the opposing lawyer and that lawyer's client. By using a word processor you will benefit by quick document turnaround after editing or preparation.

In the third category, where repetitive documents can be recalled from magnetic media and modified to meet a particular client's needs, a major benefit is the time saved. Examples of these documents are: wills and trust agreements; property settlements; pleadings in court cases; pension and profit-sharing plans; and leases. These do not have to be prepared from scratch and since the new draft of the document requires a minimum of keyboarding, another major benefit is increased productivity.

Merging variables and assembling separate paragraphs into one document are capabilities that make word processors especially useful in the legal profession. The footnote capability is especially helpful to lawyers who file a large number of briefs.

## Number Crunching

I first began using word-processing equipment in 1964 when I bought a paper-tape Royal Typer, which used folded paper tape punched much like the scrolls of music for a player piano. Since that time, I have used word processors employing cassettes and disks, and I presently use a CPT 8000.

**Next to word processing, timekeeping and billing software probably represents the most common reason a lawyer might want a computer.**

Having thus taken a personal interest in electronics technology, when I acquired my first full-capability computer I intended to learn all I could about it.

The first software I used was a general ledger package. All of my bookkeeping had previously been done by hand, and the final numbers often were not put together until well after the end of the year. I almost never had the luxury of a monthly financial statement.

With my general ledger package, which was relatively inexpensive ($199), I was able to set up account numbers for my income and expense items and key in my checks and deposits once a month. The computer automatically produced: a list of all posted documents; a ledger of these entries sorted by account number; a trial balance; an income statement for the month showing percentages and year-to-date balances; and a balance sheet for the month showing percentages and year-to-date balances. When the December entries were posted, I immediately had a printout of my year-end financial information and could complete my tax return on time.

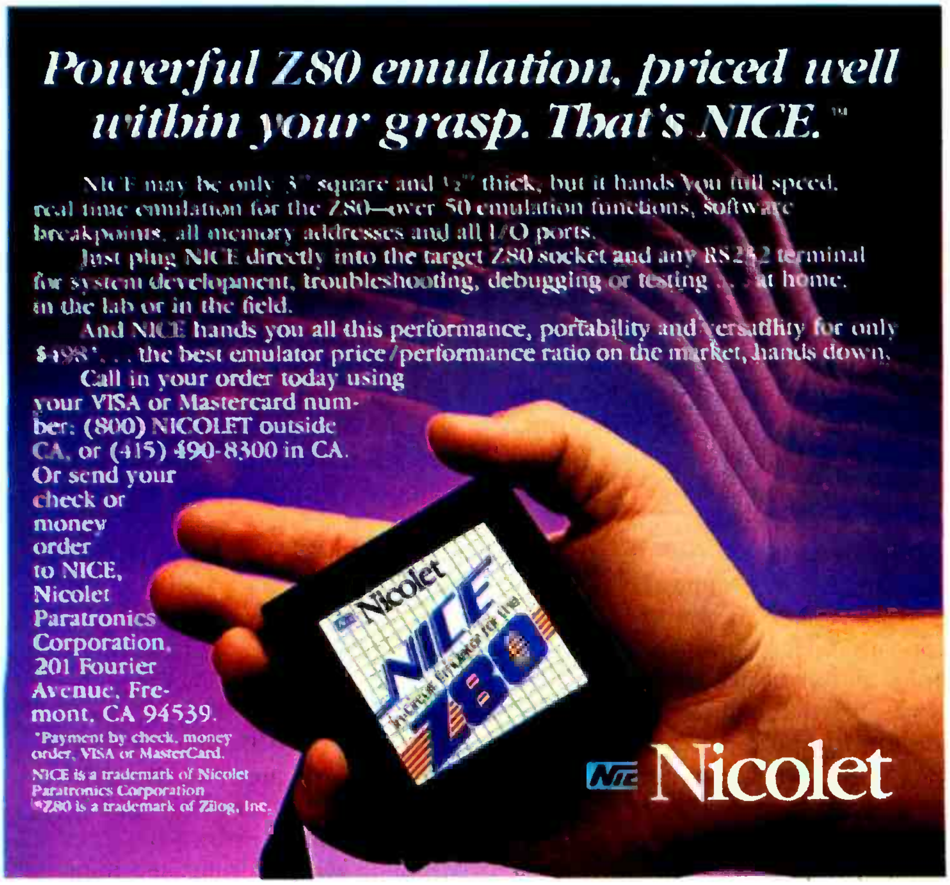
The second software program I added was payroll. Year-end W-2 preparation had generally been completed amid turmoil on or near January 31. With the payroll package, which cost about $499, I only had to input the employee information once. Thereafter, checks for salaried employees and quarterly returns could be produced. The process for hourly employees only required keyboarding of each employee's hours for a particular pay period.

Next to word processing, the need for timekeeping and billing software is probably the most common reason a lawyer might want a computer. There are more than 120 companies offering software for timekeeping and billing, and this large number creates more of a problem than it solves. (For a list of them, see the March 1, 1984 issue of *The Lawyer's PC*, or contact POB 1108, Lexington, SC 29072, (803) 359-9941.)

Lawyers do not all keep time the same way, nor do we render statements the same way. There are many variations of timekeeping and billing techniques, as well as many differences between software packages and what they accomplish. Trying to match the two is a problem of some magnitude.

Before acquiring a timekeeping and billing package, it is extremely important to see the program up and running. It can be helpful to talk with a peer at a comparably sized firm who bills in a similar fashion and is using the program. Timekeeping and billing programs range in price from about $500 to $5000. The difference in quality is not necessarily represented by the difference in price. The size of the firm in many cases will be the determining factor. Packages designed for use by five or fewer lawyers probably will not work effectively for larger firms, and those designed for 15 lawyers may not be what the smaller firm needs.

Although we are discussing time-




keeping and billing systems as they apply to number crunching, a lawyer familiar with database managers can design a very simple timekeeping and billing system for a small firm.

In the number-crunching category, a system is also needed for keeping track of other people's money held in a trust. Under the Code of Professional Responsibility, a client's funds cannot be commingled with the law firm's, and the firm must be able to account for any client's funds held in a trust account. Software packages to handle trust accounts can be purchased or designed to include such features as: the ability to enter checks and deposits at random with an item description and an account number for the client; the ability to receive a printout at least monthly of the transactions in the entire bank account, with a total balance, together with an individual printout of each client's transactions and a balance of the client's account; and the ability to confirm that all clients' accounts equal the total amount in the bank account. This seems to be a relatively simple accounting procedure, but it is amazing how little software is available to accomplish it.

### Information Management

Another category of computer use that is tremendously beneficial to people in the legal profession is information management. Database management programs fall into this category, as do a number of specialized information programs.

Information management, as I use the term, means the ability to keyboard certain information once and then sort, select, and use it effectively without having to rekeyboard. The most common uses of this technique are: maintaining client records, keeping a calendar and docket control system, file management, and litigation support.

There are many other information-management needs specific to a law firm's practice. Any of these can be handled with a database manager. For lawyers who use the IBM Personal Computer (PC) or compatibles, dBASE II is popular. For lawyers who use Radio Shack computers, Profile

Plus is probably the most commonly used.

With a program of this type, you can visualize how it works by imagining a page organized in vertical columns of information with horizontal lines representing a particular file. The vertical columns are called fields. Each field contains the same kind of information for every client. For example, last names would be in the same field for every client.

The horizontal lines that represent one client's information are called records. Once the information has been keyboarded, it can be massaged in many different ways without having to be keyed again. For example, if the client record consists of a name, address, telephone number, court in which the action is pending, and lawyer responsible, then by using the sort and select technique of the database manager the lawyer can print an alphabetical list of all clients by last name. It is also possible to sort, select, and print a sublist that, instead of including all clients, will only include those for a particular lawyer in a particular court.

The information in the database can be merged with form letters so that, for example, you can use the will-retrieval database to select the names and addresses, salutation, and date of the last will executed by the client. This information can be merged into a letter to the client indicating that the will needs review. These letters can then be printed automatically on continuous-run paper.

In larger firms, database managers can be used to manage records that only need to be keyboarded once and then accessed by using sort and select techniques. For example, the client database can be searched as each new client is accepted to make certain there is no conflict if a suit is begun against some other person. Firms with many clients and several lawyers must take this precaution to avoid suing one of their own clients.

"Where is it? Why can't we find it?" is a familiar cry in the law office. Lawyers manage a lot of paper and, therefore, filing is frequently a problem. The filing problem relates not only to where a particular document might be but, more importantly, where to find research information. We almost always can find material in a client's file. The question is, in which case did we last handle a matter involving a similar dispute, e.g., the eviction of a tenant for damage to the premises?

Softshell (POB 18522, Baltimore, MD 21237, (301) 686-1213) offers a program called Mindex and Search that costs $25 and will solve most information-retrieval problems. Under the Mindex and Search program, entries of 255 characters are possible (about three typewritten lines). Each of these entries is considered a separate record. The 255 characters, of course, must contain the location of the basic information and the keywords to let you find it. In the previous matter, we would enter "eviction of tenant for damage or destruction of the premises" and the name or number of the file in which the research data and pleadings for that particular matter are located. We might (since we have not used the entire three lines) want to include the kind of research material to be found in that file. We can make thousands of entries of this type at random and then, using the Search program, search for any three characters in a row. In most cases, we use the actual keyword; we might choose "eviction" or we might choose "tenant". If we have a large number of eviction and tenant cases, we might want to search a combination of words connected by "and," e.g., "eviction and destruction." We can also search by using "or" as the connector, which will result in the program finding all records containing either word.

### Communications

A lawyer can use the computer for electronic mail, bulletin-board reading, and access to on-line databases.

When lawyers think about on-line databases, the first that come to mind are Westlaw and Lexis. These two legal-research databases have been available for many years. Only recently, however, could we access them via microcomputers. Westlaw

can be accessed by almost any microcomputer. At this writing, Lexis can only be accessed by the IBM PC. These database services are relatively expensive, but accessing them through your own microcomputer gives you greater control over the costs.

There are a number of other on-line databases of possible interest to lawyers. The American Bar Association recently announced ABA/net. Using this service, electronic mail and bulletin boards can be accessed, in addition to the UPI news wire, the Official Airline Guide, and financial news from Unistox, for as little as $12 per hour. The American Bar Association publication and information database, Ambar, will go on line with ABA/net in the near future and will cost $32 per hour in prime time and $22 per hour in nonprime time. (For details on ABA/net write: ITT Dialcom, 1109 Spring St., Silver Spring, MD 20910 or call (800) 323-1717 and ask for operator 129. In Illinois, call operator 129 at (800) 942-8211.)

Dialog is probably the largest nonlegal database of interest to lawyers. It actually consists of more than 200 databases. The most common is the Legal Resources Index, which contains more than 660 legal periodicals, newspapers, and magazines published since January 1980. Other databases on Dialog include the Federal Register and a number of technical databases involved with medicine and other technical subjects. (For information write: Dialog Information Services, 3460 Hillview Ave., Palo Alto, CA, or call (800) 227-1927. In California, call (800) 982-5838.)

The General Electric database contains tax projection and other business accounting projection programs. Some of these programs were prepared by Arthur Andersen & Company, some by J. H. Cohn & Company, and some by Coopers & Lybrand. (For details write: General Electric Information Services Company, 401 N. Washington St., Rockville, MD 20850, or call (800) 638-8730. In Maryland, call (800) 492-8470.)

In time, the most frequent use of the microcomputer's communications feature may be electronic mail. By using electronic mail, you can transmit a document to another lawyer's computer for almost instant review and input. The document can then be retransmitted to you with changes. If acceptable, it can be printed out in final form at both locations. A third lawyer can review the document, since either office can send it anywhere over the telephone network. All the traveling lawyer needs is a portable computer (such as the Radio Shack Model 100) with a modem. This lawyer can make changes and send the document back to either office.

Communications make it possible for a branch office to function with limited support staff. Much of the heavy document preparation can take place at the home office and then be transmitted to and printed out at the branch.

Bulletin boards are available for almost any subject. ABA/net is expected to provide bulletin boards of specific interest. With a bulletin board, you can call the number and, by keyboarding instructions, select a substantive area to review. For example, you can call a bulletin board and review the particular substantive area on medical malpractice. If you see any information or inquiries of interest, you can write a response on the bulletin board or communicate directly to the other lawyer if a telephone number or address has been left.

Messages can also be left for others who read the bulletin board. For example, a lawyer can ask for information from other lawyers with experience in specific fields.

The introduction of ABA/net may have more influence on the use of databases by lawyers than any other event of recent years. The American Bar Association plans to actively solicit lawyers to join ABA/net. Since this database is relatively inexpensive, it gives lawyers a chance to overcome fears or hesitations at a low cost and for a useful purpose.

Many law book publishers are exploring the possible use of on-line databases to furnish their services. Looking far into the future, it is quite

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possible that most legal-research needs will be met by on-line databases. Competitive pricing may speed this occurrence.

### Electronic Spreadsheets

Use of electronic spreadsheets will depend on the kind of law practiced by the firm. Electronic spreadsheets allow mathematical projections to be made and manipulated. They can be useful in preparing budgets and cash-flow projections. They can be used to project earnings in damage cases, to perform a blood alcohol analysis in drunk driving cases, and many other tasks requiring mathematical projections and "what if" calculations. (For a template of the blood alcohol analysis program, see *The Lawyer's PC*, November 1, 1983, page 4, or write POB 1108, Lexington, SC 29072.)

Many publishers are producing inexpensive electronic spreadsheet templates that take much of the drudgery out of using these powerful programs. Quite a number of these templates can be useful to lawyers, since they deal with business calculations.

### Specialized Software Packages

There are several specialized software packages that lawyers should know about. These software packages can be purchased and run immediately to accomplish specific tasks. For example: a long-distance analyzer is designed to allow the development of a directory of calls, date called, and amount of call, so this out-of-pocket expense can be charged to clients (Long Distance Analyzer, $195, Golden Braid Software, 1450 Ranchero Dr., Sarasota, FL 33582, (813) 371-0388).

Estate tax projections are designed to allow lawyers to enter details about the client and get projections of different estate plans. Two common ones are: Estate Tax Plan, $750, Aardvark/McGraw-Hill, 1020 N. Broadway, Milwaukee, WI 53202, (414) 225-7500; and ESTAX, $295, Professional Data Corp., 6449 Goldbranch Rd., Columbia, SC 29202.

Real estate closing packages are designed to allow for the input of the basic information. The program then produces all the documents necessary for a HUD real estate closing (RESPA Resolver, $250, Electronic Law Publishing Company, POB 1027, Buies Creek, NC 27506).

Programs for the preparation of immigration and naturalization forms are designed to allow keyboarding of the basic information and have the program prepare the necessary forms (Immigration Program, $350, Hudson Computer Bureau Inc., 6135 Bergenline Ave., West New York, NJ 07093, (201) 868-6134).

Income tax projections allow for the input of information about the client's tax circumstances to make "what if" calculations. An example of this type program is Cal-Q-Tax (Cal-Q-Tax, $595, Tax Management, a subsidiary of Bureau of National Affairs Inc., 1231 25th St. NW, Washington, DC 20037).

There are numerous other income tax preparation packages. A list and analysis of them appeared in *The Journal of Taxation*, A Guide to the Practitioner's Selection of Tax Software for the Microcomputer, December 1983. The November 1983 issue contained a comparison of software vendors. For information, write *The Journal of Taxation*, 1633 Broadway, New York, NY 10019. The list is growing every day as new programs for lawyers are developed.

The computer is going to make the most significant change in the way law is practiced since the invention of the telephone and the typewriter. There is resistance, but strange as it may seem, there was also resistance to the telephone and typewriter.

In the long run, economic issues will prevail. There is no question that those of us who use the computer efficiently can practice law more effectively and, therefore, can provide legal services to the client at reasonable cost. That is the name of the game.■

*Robert P. Wilkins (POB 729, Lexington, SC 29072) is a lawyer and the editor of* The Lawyer's PC *and* The Lawyer's Microcomputer *newsletters for lawyers using the IBM PC and compatibles and Radio Shack computers, respectively.*


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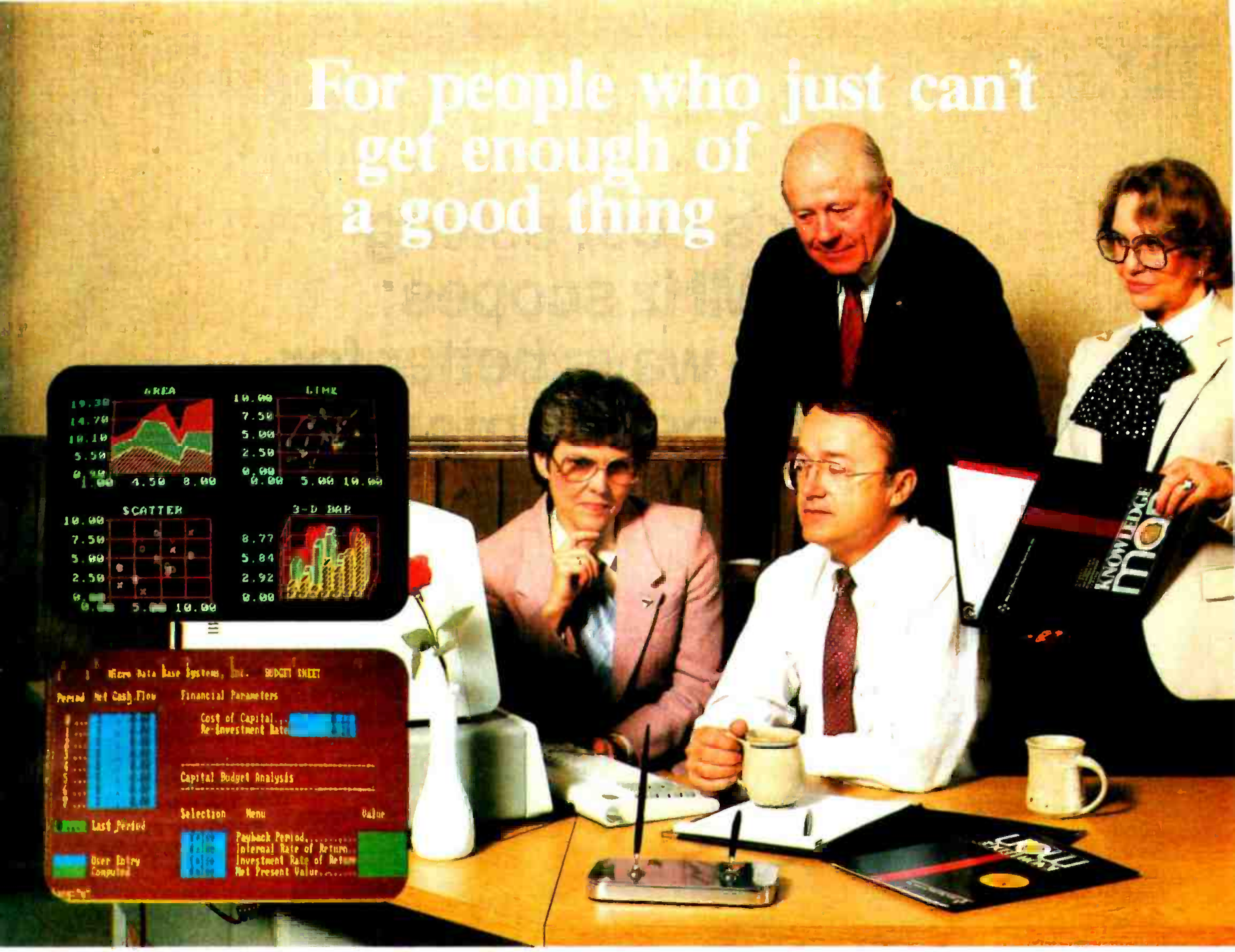


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# Computerizing a Medical Office

*A physician's advice can be handy for other professionals needing tailored applications*

**Jonathan Javitt, M.D.**
**Computer Consultant for Medical Applications**

As of July 1983, only 5 percent of the physicians in the United States owned microcomputers. Nevertheless, I believe physicians will no longer be able to maintain an uncomputerized office. Perhaps by the end of the decade all medical practices will have a computer. [**Editor's Note:** *The trend may extend to other professional offices with an extensive but specific clientele. The following advice for physicians may well apply to any professional needing a tailored computer system.*]

### Why Computerize?

As medical practice costs rise and the supply of physicians increases, practices will need to pay increasing attention to economics and marketing. Most good office-management programs can generate productivity reports by practitioner, by procedure, or even by piece of equipment. Determining whether the practice is running a piece of diagnostic equipment at a profit or a loss then becomes a simple matter.

One of the most difficult aspects of practice management is patient follow-up and recall. With a computerized record-keeping system, however, mailing one or more reminder letters to patients and tracking those who don't respond can be done with ease. Such a system might also allow you to generate patient newsletters and health alerts. This contact can make a significant difference in a patient's satisfaction with your service.

A computer in a medical office can also be an instant link to a world of information, from the hospital records of one's patients to the extensive database of the National Library of Medicine. Up-to-the-second conferences on a variety of topics are available to anyone with a computer and a telephone. Within the next few years, electronic mail will be the most efficient way for physicians to share information about patients. Ordinary mail will then be as useful as bloodletting.

### How to Computerize Successfully

The selection of a computer system for a medical office need not be painful, protracted, or even inordinately expensive. When done logically and systematically, it may even be enjoyable and informative. If at all possible, find a consultant who is experienced in medical office systems. I believe that the cost of mistakes in system selection is far more expensive than any consultant's fee.

By a consultant I mean someone who is familiar with the medical-management programs on the market and with the computer systems needed to run those programs, rather than a programmer who offers to write a program for running your office. Custom software is not an ideal solution to medical-management needs because if you have a problem with the software, you have only the original programmer to rely on. If he or she is no longer available, then you're stuck, with no one else able to help you. With commercial software, however, you will have the support of a large company and access to successive revisions.

Seven steps for selecting a computer system for a medical office are listed below:

1. needs assessment
2. system specification
3. software survey and selection
4. hardware survey and selection
5. vendor selection
6. office task assignment
7. software support

While these stages may seem obvious

at first, each one is crucial, and by-*passing* any of them is an invitation to disaster. If at all possible, do not change their order. Especially try to avoid allowing the vendor to be the determining force in system selection; the vendor's priorities are clearly different from yours.

## Needs Assessment

Involving all office staff in needs assessment from the outset is imperative. A computer system is only as capable as those who use it. If the staff is unenthusiastic about the system, the chances of a successful transition are minimal. All too frequently, the office staff first encounters a computer system when it shows up in boxes. The other side of this caveat is equally important. Often the office staff knows far more about work flow than the physicians in the practice and will be able to spot inadequacies in a system while they can still be corrected with an eraser and notepaper. "If only I'd known . . ." is an expensive utterance when it comes to computerizing a medical office.

## System Specification

What jobs do you expect the computer to do? Your answer should state exactly what information the system will be expected to store on any given patient, which report functions the software must be able to write, and so on. With this information, you will be able to choose software that will do the job that you want done.

How expandable should the system be? If the system cannot grow, then you will have to stunt your practice or get a new computer system—a costly way to do business.

How will the flow of information in and out of the computer be managed, and how many users will be on the system at once? These factors will determine the hardware that you'll need.

How much can you afford? The only intelligent approach to budgeting for this project is to sit down with the practice's financial advisers and determine the monthly cost of the system versus the projected return. In all likelihood, the calculations will justify a system large enough to handle the office's needs. Once all the above questions are answered, you can start choosing the software.

## Software Survey and Selection

Currently, there are no microcomputer-based office-management programs that can store detailed clinical information for each patient. While the concept of a paperless office with all patient data stored electronically is highly attractive, it is not yet practical on microcomputer-based systems. At present, that level of data management is available only on minicomputers.

The reason for this situation is twofold. First, software development is driven by market demand. At this time, relatively few medical offices have state-of-the-art microcomputers, so why would programmers bother writing a complex clinical information-management system for such a small market? Second, the nature and structure of clinical information vary greatly from one medical specialty to the next. It is simply not possible to design a clinical database

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that is generic enough to be useful to a large segment of the market and yet specific enough to be perfect for the specialist.

However, packages have been created that accommodate specific items of clinical information. These programs allow a practice to designate 10 or 20 items that must be recorded for each patient and to configure data fields to store those items. Similarly, the programs enable a practice to store lists of diagnoses, medications, and allergies for each patient. Some packages allow visit notes to be entered as free text in addition to the structured data. In the long run, what is needed is a relational database that is able to track clinical parameters over time and correlate them with other parameters. This level of sophistication has not been developed under current microcomputer operating systems and is currently available only under Unix. As the base of computer users within the medical world enlarges and more powerful operating systems become available on microcomputers, undoubtedly specialty-specific clinical databases will be designed to run on microcomputers.

Even today, a microcomputer can do a vast amount of work in a medical practice. For instance, any good management program can maintain a general ledger for each patient. (But be sure that the program you select lets you perform a complete audit trail for each account.) By storing the insurance carriers for each patient, one or more carriers can be automatically billed for each account payable. Another major way the computer will rapidly earn its keep is by its ability to track and age accounts receivable. Further, by billing on a staggered basis rather than monthly, a practice can maintain a smoother cash flow. The availability of this ledger information makes it simple to develop management reports to determine the economics of the practice's fee structure, particular pieces of equipment, or procedures. Look for a software package that not only offers these reports, but will allow you to devise your own reports as you go along.

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Well-designed software can be an enormous asset in enhancing communication with patients. By combining scheduling functions with automatic patient recall, systematically sending reminder notices to patients before an appointed visit, test, or procedure is possible. This application makes it much easier to periodically recall patients with chronic conditions, such as hypertension or diabetes, for the appropriate clinical tests. This type of follow-up is nearly impossible using manual methods. The mail-merge functions of these packages also make it simple to generate a patient newsletter to report new services offered, important medical news, or other information of interest.

The program you consider should contain a good word processor or interface with one. If it doesn't, changing a form letter or recall notice will be difficult.

A major consideration in choosing software packages is that they be easy to use. Unfortunately, many packages on the market are adaptations of hospital mainframe computer packages. The mainframe programs usually run in batch mode, which means they are designed to run one function at a time on a large group of data, such as generating bills for all of your patients. This system doesn't work well if you want to run several functions on just a handful of data, such as entering a patient's account, posting a single charge, and generating one bill. Select a package that is primarily record oriented so that you are not constantly switching from one batch program to another.

On the other hand, batch mode is excellent for certain tasks. To be able to post the hospital charges for an entire hospitalization in one step or the charges for one day's rounds with a single command can be extremely useful. Similarly, printing all outstanding insurance forms at once is important. Therefore, look for a software package that can also operate in batch mode.

In evaluating software, pay little or no attention to the advertising for the product—the only valid data is provided by current users. Many software packages have attractive demonstration programs that dealers are only too happy to show. These demo programs accommodate a small number of patients, run fast, and never lose data. The story may be quite different when the software is loaded with information on 2000 to 5000 patients. Any reputable company should be willing to provide you with the names of colleagues who are successfully using its software. If it is not willing to do this, look elsewhere.

Installation of medical-management packages is time-consuming, and the length of time can vary greatly from one package to another. In the initial phase, the personal data on each physician in the practice must be entered as well as the particulars of each insurance carrier with which the practice deals. A complete list of diagnoses and procedures used in the practice must then be entered along with the appropriate procedure charges and standard diagnostic codes. The most painless way to do this part of the installation is to maintain a list of all diagnoses and procedures encountered during the month prior to installation. Try to find a program that can learn new diagnostic codes and procedures as it comes across them.

**When buying a microcomputer, do not be concerned about whether it will ever break. I promise that sooner or later it will.**

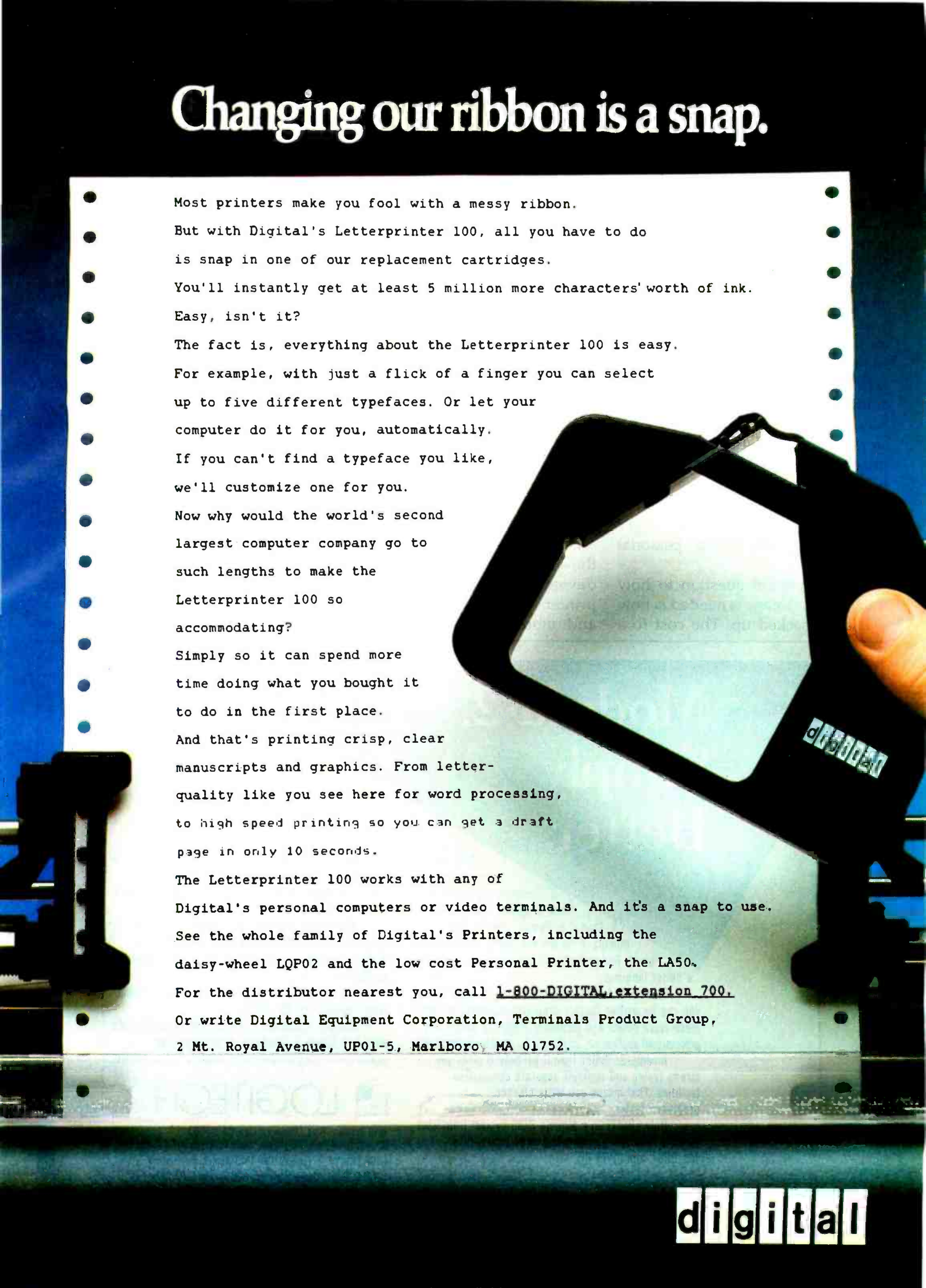
Instead of spending a lot of time designing billing forms and insurance forms, look for a program that has predesigned forms. Even better, choose a program that comes with the paper on which those forms must be printed. Predesigned forms can save 20 hours of installation time in a busy practice.

One misleading feature of several packages is that of electronic claims submission, that is, submission of claims via modem. Since insurance carriers have no standard electronic communications system, it isn't likely that your package will be able to communicate with all of the different carriers. As electronic claims submission becomes a reality, the big software publishers will update their packages to include this feature. In other words, when shopping for software, do not be influenced by bells and whistles that you cannot use today. If the product is stable, these features will be added as they become practical.

### Hardware Survey and Selection

Only after the software has been chosen is it reasonable to consider hardware. In a single-station, single-user system running under CP/M or MS-DOS, hardware selection is straightforward. More likely, however, a system will have several workstations—the issue then becomes complicated. The problem centers around the lack of standardization in multiuser or network operating systems. Software designers are struggling to keep their products compatible with these continually evolving operating systems.

Although I prefer not to make strong hardware recommendations in a topical essay, I have observed that medical-management software is currently easier to marry to network systems than to true multiuser systems. The distinction I am drawing is between a system in which each user is connected to a separate, dedicated microprocessor, sharing only mass storage, versus a system in which all users share time on one microprocessor. Examples of the first approach range from freestanding microcomputers linked together in a network to a micro/mini arrangement in which all microprocessors are housed in one box and each is connected to a dedicated remote terminal. Standard CP/M software tends to run exceptionally well in the micro/mini type of system but none as yet run MS-DOS. If you are committed to MS-DOS software and want to support several users, the only alternative is networked MS-DOS-based personal computers with a common file server. Be sure that the software publisher will support this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network system before you make the commitment. A little bit of checking will tell you that the micro/mini approach is far cheaper than linking freestanding personal computers.

Before you buy a computer, you should determine the quantity of information to be stored on it. You can do this by multiplying the number of patients by the amount of information you need to store on each one. A practice that fills up its mass storage in two years and is then faced with a major financial expenditure for more disk space has clearly made some mistakes at an early stage of the selection process. The only intelligent solution is to determine the actual number of bytes needed per record stored and to multiply that by the projected number of patients over the next five years. One of the advantages of micro/mini computers is that they tend to support much larger hard disks than linked personal computers.

The companion question to how much mass storage is needed is how will it be backed up. The cost to a medical office of an unprotected hard-disk crash is incalculable. Discipline is required on the part of the office staff. Murphy's law guarantees that when backup is not performed the disk will crash. The only safety lies in iron-clad rules about daily backup, preferably with a tape streamer. Similarly, invest in a backup power supply in case the failure is on the part of the local electric company. In this environment the investment in security is well worth it.

In evaluating hardware, be somewhat conservative. The tested product is generally a safer bet than the newer release with that added feature. No shortage exists of maturing products that will provide all the power any office needs. Only through a year or two of experience in field situations can a manufacturer work out the final bugs that develop under the pressure of daily use.

Don't fall short when you choose the simplest and cheapest hardware device—the printer. Dot-matrix printers are getting less expensive and more reliable by the day. A medical practice needs to print on several types of paper, including insurance forms, demand statements, and letterhead or bond paper. A sensible approach is to purchase enough printers so that the office staff is not continually installing and aligning different types of forms in one overworked printer. The equipment cost is rapidly offset by the savings in staff time.

## Vendor Selection

Although most vendors are honest and have good intentions, vast discrepancies appear in their abilities to follow through on promises regarding installation, training, and support. Because of the high cost of inventory in computer dealerships, cash-flow problems can be fatal, as is demonstrated by the rate of dealership failures. Carefully evaluate the business record of the dealer with whom you plan to undertake the project. Ask for bank references and for the names of satisfied customers. By all means, call the manufacturer's sales division and say that you are

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considering buying the company's product through a specific dealer. Often, you will get a between-the-lines impression of the dealer's reputation and stability.

Any promises regarding installation, staff training, and support must be included as part of the initial sales contract. Installation work and staff training to be provided must be specified in terms of both hours and personnel. If service is furnished by the dealership, find out if the technicians are employed full-time or if service is being subcontracted.

When buying a microcomputer, do not be concerned about whether it will ever break. I promise that sooner or later it will. The essential question is how fast will it be fixed and by whom. Repair turnaround must be promised to you in terms of working hours, not days. An obvious point is not to consider operating without a service contract with a firm willing to make this commitment.

All your hardware should be serviced under the same contract. You do not want to find yourself in the position of having the computer serviced by one party and the printer by another. They will quickly start to argue about whose equipment is causing any problem, leaving you in the middle.

### Office Task Assignment

All too often, office personnel come in one morning to be confronted with a stack of ominous-looking boxes filled with equipment that they are told to learn how to use. Effectively integrating a computer system will take some time, and provisions should be made for staff overtime and a temporarily reduced workload.

One person in the office must take overall responsibility for system installation, training, and maintenance, ideally, someone who is enthusiastic about the project in the first place and is likely to remain on the staff for some time. Installation planned for in advance will be a smooth process.

### Software Support

Determine ahead of time who, if not the dealer, is going to support the software and to what extent. It is

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unrealistic to expect a dealer to know as much about a package as the company that developed it. Similarly, if the dealer does not sell more than a few copies of a product, he or she cannot afford the time to learn it inside and out, and your problems can further be compounded by the tendency of dealers to reorganize, restructure, and go out of business. Therefore, unless the product is directly and completely supported by the publisher, that software is a risky investment. Regardless, the dealer should know the software well enough to install it competently and train your staff to use it. Ask him or her to supply you with the names of people to whom this particular product has been sold and make sure to call those people.

To expect full software support for free would be unreasonable; no company can afford to provide it. A company that guarantees to keep your software running, even if it has to put a support person on an airplane to do it, is entitled to charge a monthly fee. Any company that provides this level of service without charge is trying to finance the support out of future sales and is likely to be headed for serious financial trouble. More often, however, the company simply does not provide the support staffing that is promised. Full software support and revision is worth the price. Too many users have learned that lesson the hard way.

## Conclusion

Although some warnings are expressed in this article, the process of office computerization is ultimately worthwhile and likely to be highly successful. If the above guidelines are followed, the chance of untoward surprises will be minimized and the most probable question to arise will be "Why did we wait so long to do this?" ■

*Jonathan Javitt, M.D., M.P.H., is a Kellogg Fellow in Health Management at the Harvard School of Public Health. He has been a consultant in medical microcomputer and information systems for the past two years. He can be reached at 207 Park Drive, Boston, MA 02215. In July, Dr. Javitt will be joining the staff of Wills Eye Hospital, in Philadelphia, Pennsylvania.*

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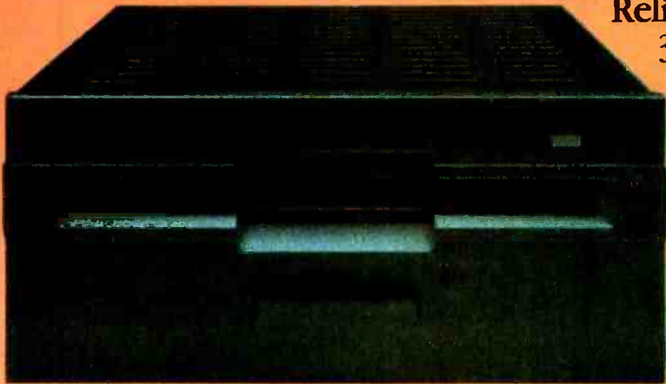

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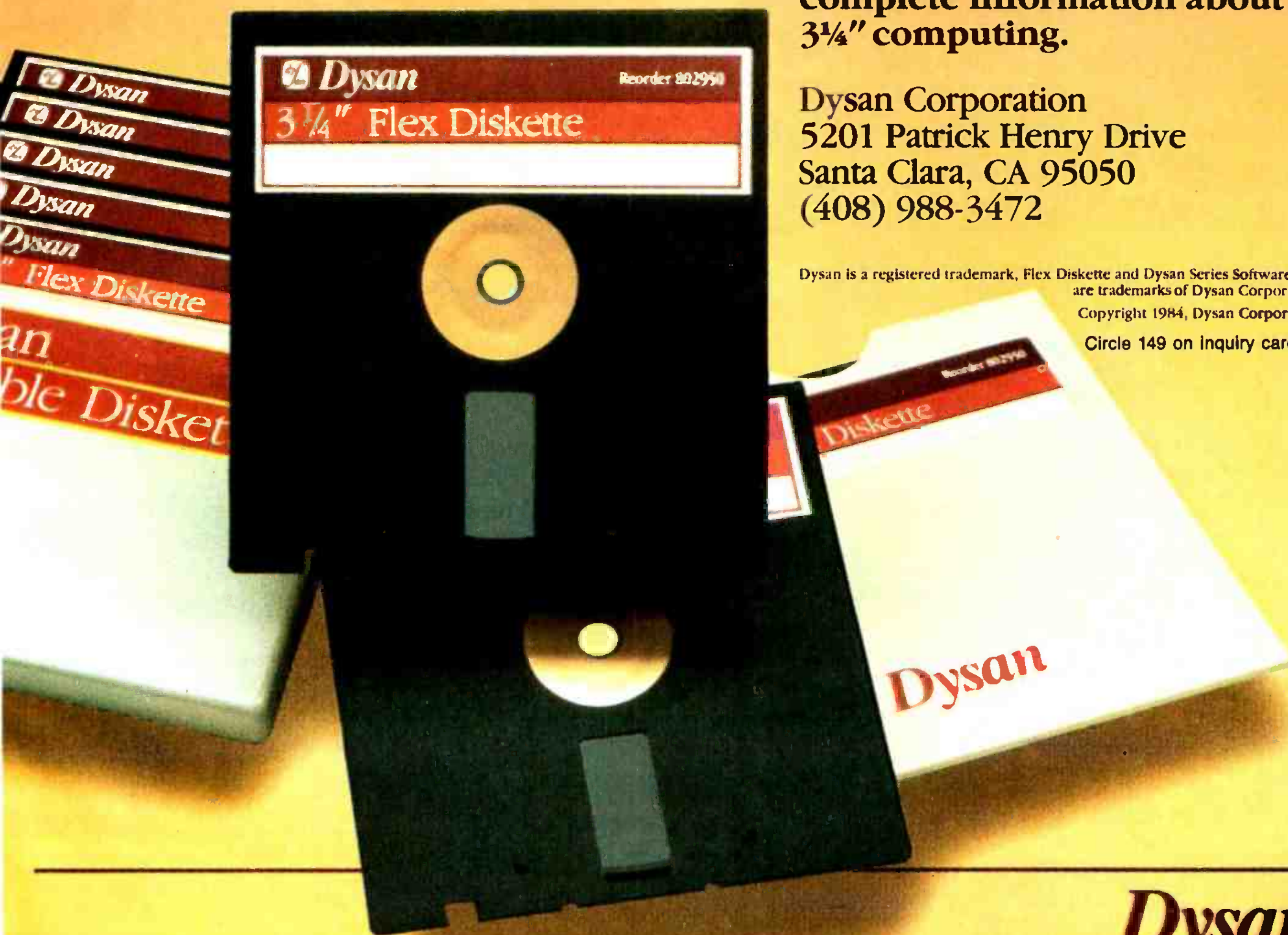


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# Reviewer's Notebook

Rich Malloy
BYTE Senior Technical Editor

Last month I mentioned the Panasonic Sr. Partner, a good, new IBM PC compatible. Since then, however, the prices I quoted have been changed. The two-drive version with 128K bytes of memory, a printer, and a good software bundle (Wordstar, Visicalc, PFS:File, Graph, and Report) now costs $2945. This is still a fairly good price, but it's not as great as the original one.

### Multiplan and PFS:Write

There are a number of good products out there that somehow take a long time to get reviewed in this magazine. Two of the best in this category are Multiplan, a spreadsheet program from Microsoft, and PFS:Write, a word processor from Software Publishing Corp.

Multiplan is very easy to use, fairly powerful, available for many systems, and reasonably priced ($195). It will probably replace Visicalc as the standard to which other spreadsheets are compared.

PFS:Write is also very easy to use and fairly dependable. It lacks some fancy features, but it has all of the essentials. And although the program is copy protected, it costs only $150. PFS:Write is currently at the top of my list of recommended word processors.

### The Leading Edge Word Processor

One of the programs just behind PFS:Write on my list is the one by Leading Edge. It's very easy to use and loaded with features. One of the nicest of these is the ability to "undelete" material, a feature that comes in very handy when, thanks to the IBM's keyboard buffer, you delete more than you intended to. The program is a bit expensive ($295), but it's a lot cheaper than Wordstar, and it's not copy protected.

Unfortunately, the Leading Edge word processor has a peculiar way of storing files on disk. Every file, no matter how small, uses up at least 6K bytes of disk space (12K if you don't turn off the backup provision). You can eat up a lot of disk space very fast. Also, files are stored in a very unusual format. An "end of text" character appears in the beginning of the files, which makes it impossible to get the operating system to TYPE out a file. And the filenames look like this: "F01D0002." If you accidentally alter one of this program's directory files, vast quantities of text may become relatively inaccessible. There is a way to access these lost files, but you'll have to call Leading Edge to find out.

### Infoscope

The folks at Microstuf, who brought us the Crosstalk communications program, have recently come out with an impressive database manager for the IBM PC called Infoscope. For $225, this program has a lot of very novel features. First, it has the fastest sort capability I have seen. Second, it's one of the few programs that make full use of the IBM PC's memory. Third, it has its own windows. Fourth, it has a powerful "focus" command to focus in on data records that fit particular conditions. And Infoscope has a spelling checker that tries to guess what command you would have typed if you hadn't made a typing mistake.

Infoscope is not going to replace dBASE II or Microrim, but it is going to fill a big niche in the software market. A review of the program should appear in these pages very soon.

### PC-Talk

The best communication programs are also usually the cheapest. For example, the series of MODEM programs originated by Ward Christensen for CP/M systems has set the standard for data transfer. Best of all, MODEM7 and XMODEM are available for free from several bulletin boards around the country.

For the IBM PC, a BASIC program called PC-Talk is available from a company called Freeware. Users are encouraged to copy the program and pass it on to their friends. There is no charge, but Freeware encourages customers to contribute $35 to the company.

PC-Talk version 3 is one of the best programs I have seen for any price. Some very good communication programs for the IBM PC cost much more and have more features. But for general-purpose communication, PC-Talk is hard to beat.

### This Month

This month we're reviewing two Z80 machines. The first is the Kaypro 10, the economical Z80 machine with a 10-megabyte hard disk. Another Z80 machine with a hard disk, the QDP 300, is a high-priced, high-performance machine with a 192K-byte disk cache.

Last August we reviewed a group of compilers for the C programming language. This month we take a look at two more C compilers for Z80 systems.

We also review a computer-aided design system called CAD-1 from Robographics.

For TRS-80 Model III enthusiasts, we take a look at three CP/M boards and the LNW-80 microcomputer system. And for the IBM we have a review of Thinktank, a program that's supposed to help people write more clearly and coherently.■

*Rich Malloy is BYTE's product-review editor. He can be reached at POB 372, Hancock, NH 03449.*

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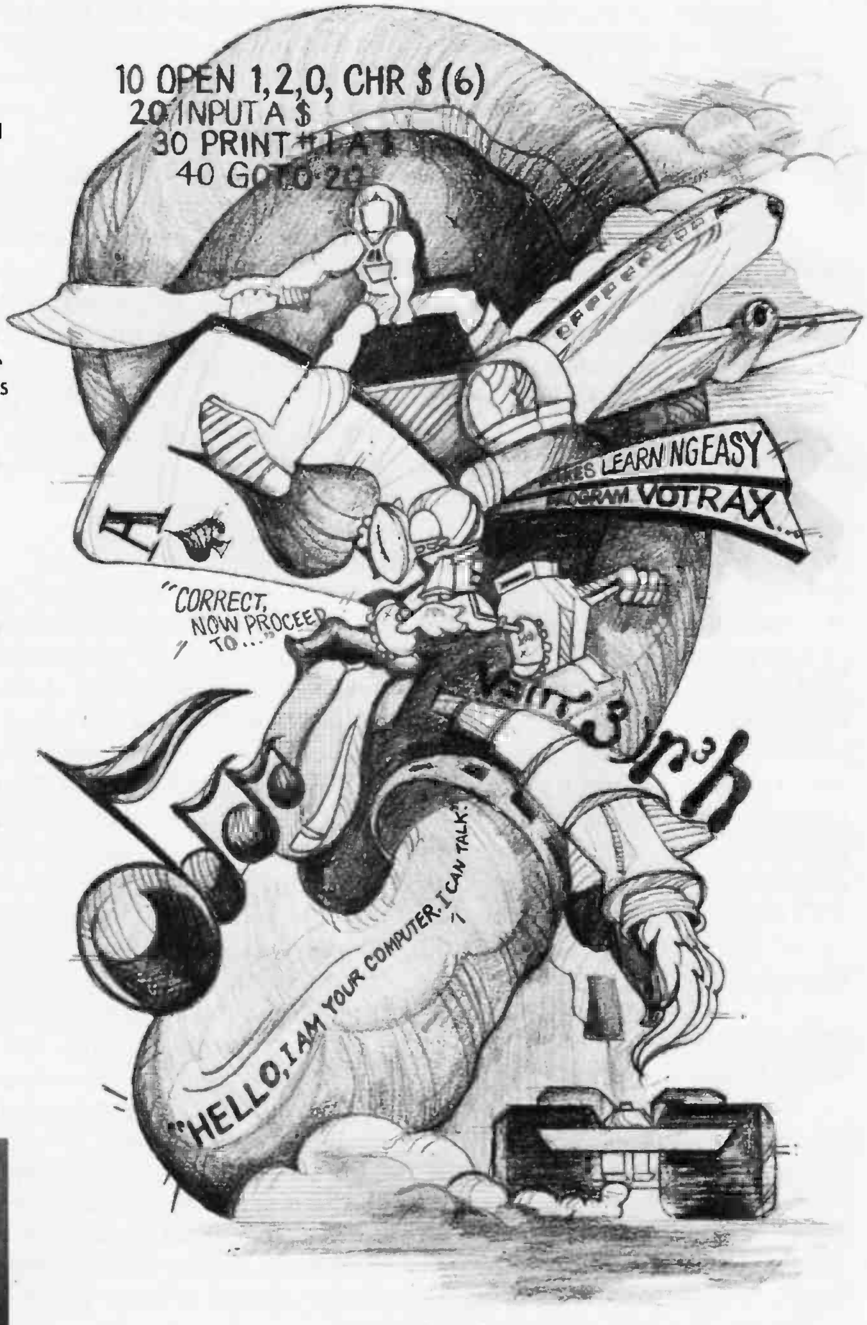



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# Thinktank

## An outlining and organizing tool

William R. Hershey
MITRE Corporation

In the same way that Pascal and other structured programming languages encourage a top-down approach to programming, outlining encourages a top-down approach to writing. The benefits are the same. The investment of a little time planning and organizing saves time in the long run and results in a more efficient final product. It's not surprising, therefore, that a couple of Pascal programmers, David Winer and Jonathan Llewellyn, have come up with a clever program for outlining: Thinktank, billed as the first "idea processor."

In the first part of this review, I'll discuss Thinktank's capabilities, its similarity to word processors, and some of its unique features. Many of Thinktank's commands are, after all, word-processing commands: INSERT, DELETE, COPY, MOVE, XCHANGE, etc. In the second part, I'll describe what it's like to use Thinktank. Learning and using the program is generally very easy. The documentation is top-quality but the program has some shortcomings. Thinktank also has several potential applications beyond organizing and writing text.

### What Is an Idea Processor?

My first big question about Thinktank was, "What does this program do that a good word processor doesn't?" Thinktank's advantage is in its ability to display an outline at different levels of detail without modifying the contents. You can display the level of detail you need with two commands, COLLAPSE and EXPAND. These commands help you visualize how your writing fits together. You can see relationships you might have missed if you tried to absorb all the headings in a long outline.

Thinktank also lets you alphabetize the subheadings beneath a given heading at any level, which is very handy for certain file-management tasks. And it offers the options of generating section numbers and tables of contents with page numbers.

### The Thinktank Environment

Thinktank reserves the bottom four lines of the screen for menus, prompts, and error messages. The top 20 lines constitute a text area that serves as a window into your outline. Headlines appear in the text area with pluses or minuses preceding them. A plus means additional subordinate headlines exist at deeper levels, and a minus means the headline has no subheadings. Thinktank automatically generates the pluses and minuses and indents the headlines appropriately on the screen. A headline can also have an optional block of text, called a paragraph, of up to 2048 characters in any format. The paragraph follows the headline in the outline; any subheadings follow the paragraph.

A bar cursor highlights an entire headline at a time. Move it up and down through your outline with the arrow keys; the location of the cursor determines where a command is to take effect.

The manipulation of headlines and paragraphs is similar to the manipulation of text with a word-processing program. Because headlines follow a structure, however, the commands are probably slightly more complex than the ones in a word processor. When you want to create or edit material, you have to specify whether you want to edit a headline or a paragraph. When creating a new headline, you need to indicate if it's to be positioned directly above the one highlighted, directly beneath it, beneath it at a higher level (to the left), or beneath it at a lower level (to the right). Similarly, moving a headline from one place to another in an outline can be an involved process, sometimes requiring multiple steps with several level changes. The DELETE command also operates in several different ways. You can delete a single character, an entire headline or paragraph, or a selected portion of a paragraph. You can also restore a previously deleted block of text.

In Edit mode, the bar cursor disappears, and a blinking character cursor indicates where the action is. To edit headlines, which is more limited than editing paragraphs, you enter Insert mode; the left arrow functions as a destructive backspace, and Ctrl-D deletes the character under the cursor. Paragraph editing includes automatic word wraparound, a Typeover mode, the capability to exchange one pattern for another, a FIND com-

## At a Glance

**Name**
Thinktank

**Type**
Idea processor

**Manufacturer**
Living Videotext Inc.
1000 Elwell Court
Palo Alto, CA 94303
(415) 964-6300

**Price**
$150

**Computer**
64K-byte Apple II, II Plus, or IIe; 96K-byte Apple III, IBM Personal Computer; Apple Macintosh version slated for the second quarter of 1984

**Language**
Pascal and Assembly

**Format**
Apple II, II Plus, and IIe: two 5¼-inch floppy disks (p-System); Apple III: three 5¼-inch floppy disks (p-System); Apple Macintosh: one 3½-inch disk; IBM Personal Computer: one 5¼-inch floppy disk (PC-DOS)

**Documentation**
Users manual (228 pages, spiral-bound) with tutorial and reference guide; reference card; data disk to accompany tutorial; technical notes available separately for $5 each

**Audience**
Writers and others who need to organize their thoughts

mand, and SELECT, which highlights a section of text that you may then copy or delete.

Depending on the capacity of your disk (hard or floppy), you can create up to 10,000 levels of headlines with Thinktank. This permits a fairly robust outline. Each level is indented to the right of the next higher level, and the display automatically scrolls left and right to let you see all 80 characters in a headline.

If you don't want to see all the deeper levels in an outline, you can make them disappear by issuing the COLLAPSE command. EXPAND brings them back to any level you wish. The < and > keys represent EXPAND and COLLAPSE, respectively; the shapes of these symbols suggest the operations invoked. In their simplest form of usage, these two commands apply to both the paragraph and the subheadings beneath the highlighted headline; however, you can COLLAPSE or EXPAND just the paragraph or just the subheadings.

These two commands make Thinktank unique and give it capabilities not available in word-processing programs. You can experiment with how your ideas relate and test how each detail contributes to the whole. I like to COLLAPSE an outline so that just the highest-level headings show, then step down the subheadings and EXPAND each one to see how it relates to the whole piece. I can determine if a subheading really belongs where I put it and then COLLAPSE it again before proceeding to the next one.

The COLLAPSE and EXPAND commands may seem insignificant at first, but I recently found them invaluable in writing about a mazy systems-engineering problem. I ended up rearranging that outline many times.

### Other Handy Features

Alphabetizing a list can be a tedious chore even with a word processor, but if your program has sorting capability, it's a snap. Fortunately, Thinktank can sort. When you issue the ALPHA command, the program arranges all the subheadings beneath the bar cursor in alphabetical order. You can also sort a list of numbers or numbered headlines or alphabetize the subheadings at any level. You can manage a simple database, like an address file, with the ALPHA command.

The PORT command directs Thinktank's output to a printer or to text files. Sixteen format settings offer lots of flexibility for printed listings. In addition to the usual capabilities for specifying line spacing, margins, page length, headers, footers, number of copies, and printer control codes, you can have Thinktank assign section numbers to your headlines (see figure 1).

You can also control indentation and the level to which headlines and paragraphs are printed, which enables you to generate one listing of just your outline (with the paragraphs suppressed) and another that shows only the major headings with all paragraphs. (Figures 2 and 3 illustrate these alternatives.)

Thinktank can be used to generate a final written product. If you need a table of contents, Thinktank will generate it, automatically inserting the proper page number for each headline. However, if you would rather use a word-processing program to polish up your final version, you can PORT the document to a Pascal text file and read it from there into your word processor. It is preferable if your word processor reads Pascal text files, but the utilities to translate them to text files for other operating systems are available from Living Videotext.

### Learning Thinktank

Thinktank is easy to learn and use. A slash (/) produces a main command menu at the bottom of the screen, which is very helpful while learning the program. But after you learn the commands, you can optionally evoke each one with a single keystroke (M moves a headline, for example) without pressing / first. A hierarchy of menus leads you through all the choices, and the Escape key consistently operates as an exit from all menus. (If you are distracted by the clicking and squirting sounds, simply turn them off with Ctrl-Q.)

The 228-page manual, by John Unger Zussman, is well written and well constructed. The book starts with an introduction that describes Thinktank's philosophy and then covers the differences between the versions available for various Apple computers—the 64K-byte Apple II, II Plus, or IIe, or 96K-byte Apple III. (Your system must have two disk drives because Thinktank accesses program segments periodically from one disk while updating the outline file on a different drive.) Other chapters in part I deal with how to start using the

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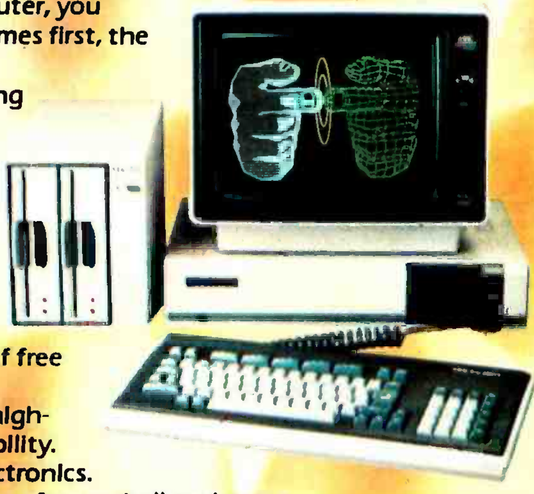

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**NEC Home Electronics (U.S.A), Inc.**
**Personal Computer Division**
1401 Estes Avenue
Elk Grove Village, IL 60007

NEC Corporation, Tokyo, Japan

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```
1:        the screen
1.1:             command area
1.2:             text area
1.2.1:                headlines
1.2.2:                paragraphs
2:        bar cursor
3:        manipulating headlines and paragraphs
3.1:             creating and editing
3.1.1:                apply to headline or paragraph?
3.1.2:                where?
3.2:             moving
3.2.1:                involved process
3.3:             deleting
3.3.1:                several forms
4:        edit mode
4.1:             blinking character cursor
4.2:             headline and paragraph editing different
4.3:             some commands
4.3.1:                insert
4.3.2:                delete character
4.3.3:                typeover
4.3.4:                find
4.3.5:                exchange
4.3.6:                select
4.3.7:                copy
4.3.8:                delete select
```

**Figure 1:** *A Thinktank outline with automatically generated section numbers. You can specify the number of levels to print and the amount of indentation.*

```
the screen
        command area
        text area
                headlines
                paragraphs
bar cursor
manipulating headlines and paragraphs
        creating and editing
                apply to headline or paragraph?
                where?
        moving
                involved process
        deleting
                several forms
edit mode
        blinking character cursor
        headline and paragraph editing different
        some commands
                insert
                delete character
                typeover
                find
                exchange
                select
                copy
                delete select
```

**Figure 2:** *A Thinktank outline with the headlines only. This is helpful in organizing your thoughts when you're just getting started.*

```
the screen
Thinktank reserves the bottom four lines of the screen for menus,
prompts, and error messages.  The other 20 lines form a text area that
is a window into your outline.  Headlines appear . . .

bar cursor
A bar cursor highlights an entire headline at a time.  Move it up and
down through your outline with the arrow keys.  The position of the
bar cursor determines where commands will take effect.

manipulating headlines and paragraphs
The manipulation of headlines and paragraphs is similar to the
manipulation of text with a word-processing program.  Because
headlines follow a structure, however, the commands are probably
slightly more complex than the ones in a word processor.  When you
want to . . .

edit mode
In edit mode the bar cursor disappears, and a blinking character
cursor determines where the action is.  Editing headlines is more
limited than editing paragraphs.  With headlines . . .
```

**Figure 3:** *A Thinktank outline with major headlines and paragraphs. In this mode, the final product starts to emerge. You can insert a paragraph beneath a headline at any level.*

program. A tutorial uses a sample outline supplied on a separate disk. A chapter entitled "Notes and Suggestions" offers shortcuts; a glossary defines all the terms used in the manual; and appendixes cover an introduction to the Pascal operating system, disk management, and other technical information.

Part II contains a reference guide with all the commands listed in alphabetical order. A section on error messages describes where an error may occur, the possible causes, and some suggested solutions. There's an extensive index at the end of the manual.

Technical notes describing how to link Pascal programs to Thinktank are available from Living Videotext for $5 each. Telephone support is excellent. When I called with questions, I received very helpful advice from one of the program's authors. Also, Thinktank's lack of copy protection makes it easy to create backups.

## Annoyances

Some of my complaints relate to command logic and are unique to the type of program Thinktank is. The MOVE command needs improvement. You can't move groups of headlines without moving the higher-level headline and all the subheadings under it. If, for example, you want to move 5 out of 10 subheadings to a different headline, you must move them one at a time. If you want to move a subheading so it falls under a different headline, you can't simply move it up or down: you have to move it left, then up or down, then right to get it back to the proper level. It is also difficult to move a piece of a paragraph so it falls under a different headline.

The COPY command is similarly limited. You can copy only one headline at a time, and the copy goes directly beneath the original. You then have to move the copy to where you want it.

Certain keystrokes should work at different menu levels, not just at the main menu. These keystrokes that are restricted include the up and down arrows for moving the bar cursor (Ctrl-O and Ctrl-K on the Apple II and the Apple II Plus) and the < and > keys when used for the EXPAND and COLLAPSE commands. It would be very helpful to have these operations available in the New, Edit, and Move modes. Such improvements would save many keystrokes and unnecessary menu changes.

Differences in the sequence of commands for creating and editing paragraphs is bothersome. Within the same paragraph, the New mode, for example, requires a different set of cursor moves than the Edit mode (which you can use after entering the text for the new paragraph). And why does SAVE require an extra step? Elsewhere, the program saves headlines automatically. After a save, you must answer the question, "Are you finished editing this paragraph?" Since the limit on paragraphs is only 2048 characters, repeated paragraph saves are a waste of time.

I originally intended to write this review entirely with Thinktank. But the editing routine for Thinktank paragraphs is so cumbersome that I decided to use the Word

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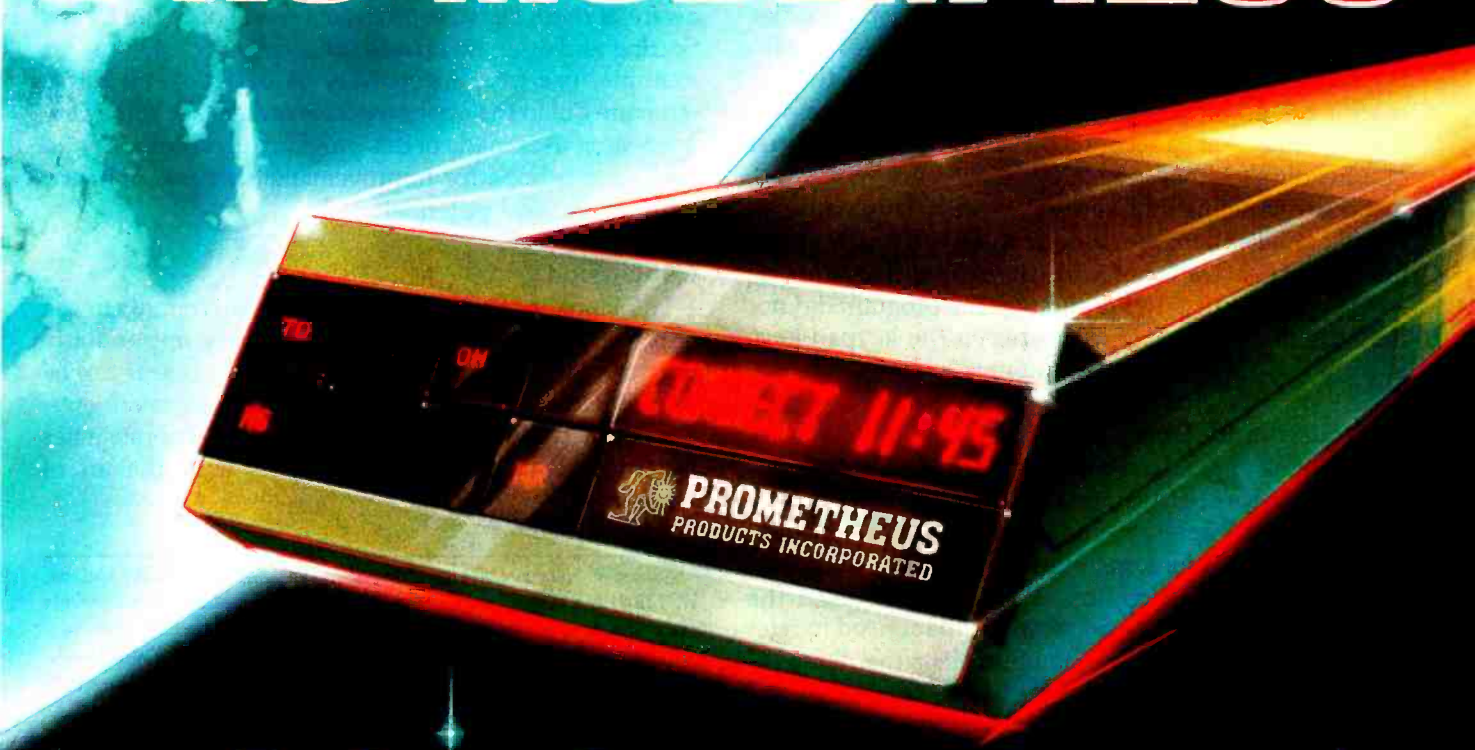


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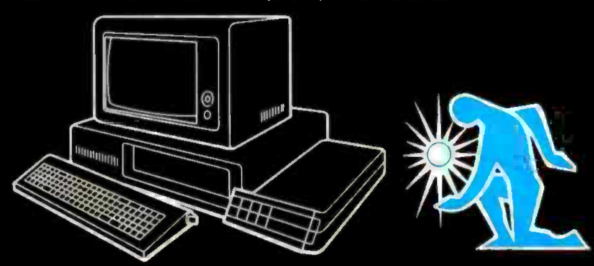

**PROMETHEUS**

Juggler program from Quark (2525 West Evans, Suite 220, Denver, CO 80219, (303) 934-2211), which now has me spoiled. I still believe, however, in the value of Thinktank for organizing information and writing outlines.

My remaining complaints have to do with Thinktank's implementation on the Apple III. Despite the 256K bytes of memory available, you must wait interminably for disk accesses—both for program segments and for data—because the program is really designed for a 64K-byte machine. It takes 5 to 10 seconds for most disk accesses, but I timed one at 25 seconds—25 seconds to delete just one headline.

You can redefine edit keystrokes with Thinktank, so I tried to make them the same as the Word Juggler commands, which are input with the Apple III's numeric keypad. Unfortunately, I found that the program did not have the logic to distinguish between the keypad keys and their main-keyboard counterparts.

### Databases and Trees

Thinktank has database-management capabilities, thanks to the ALPHA command, and the ability to hide what you don't need to see. The manual has an extensive list of applications, including "to do" lists, telephone directories, and catalogs of collections. I've used the program to keep a list of publications that I need to refer to in my work. The table of contents lists the names of the publications (sorted alphabetically, of course) and their page numbers. The actual listing page contains a brief description of the publication, the author, and the date.

A topologist will tell you that Thinktank's data structure is called a *tree,* a convenient device for lots of mathematical endeavors. Computers use trees all the time in their internal workings. Users, however, are seldom aware of them because programs reveal only the forest. Sorting and other database-management operations, for example, use trees extensively. With Thinktank's tree structure out in the open, we can expect to see some very interesting uses made of this program (genealogy is one), and we can hope for improvements that will enhance its mathematical potential.

### Conclusion

Thinktank is a refreshing new program, friendly to use and well documented. Because it is very important to organize ideas before writing, an idea processor can be as useful as a word processor. With a few improvements, Thinktank could be a *total* word processor that integrates the process of organizing thoughts with the art of writing. ■

*William R. Hershey (MITRE Corp., 1820 Dolley Madison Blvd., McLean, VA 22102) is a systems engineer with a B.S. in engineering from Princeton and an M.A. in computer and communication sciences from the University of Michigan. He is chairman of an Apple III users group in the Washington, DC, area and an instructor in computer literacy at the University of Maryland's University College.*

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# The QDP-300 Computer

## *A speedy Z80 at a premium price*

**Edward Joyce**
**Free-lance Writer**

Line end to end all the Z80 systems on the market and you could almost circle the earth. From this conglomeration, eliminate the ones that run at less than 6 MHz and you narrow the field considerably. Of this group, isolate the systems costing more than $6000 and you'll probably end up with one machine—the QDP-300 from Quasar Data Products (QDP).

The speed and price of the QDP-300 distinguish it from most Z80 systems. The microprocessor hums at 6 MHz, compared with to 2 to 4 MHz for most Z80s. The price


**Photo 1:** *The QDP-300 with a 10-megabyte hard-disk drive and one 8-inch floppy-disk drive.*


**Photo 2:** *The back of the QDP-300. Two RS-232C serial ports and two Centronics-compatible parallel ports come standard with the system.*

of $6395 buys 192K bytes of memory, including cache. Take away 64K bytes and replace the hard disk with a floppy disk and you're looking at QDP's least expensive system—$3995. The QDP is intended for business users who can afford to pay a premium for more horsepower to crank through packages like Wordstar, Multiplan, dBASE II, and other software heavyweights of the CP/M-80 environment.

Photo 1 shows the $6395 hardware package. The top cover of the cabinet is attached to the body at the two strips of real wood that run the length of the chassis. Besides adding an aesthetic touch to the package, the wood slats provide a convenient handhold.

The single floppy-disk drive accepts 1.2-megabyte, double-sided, double-density, 8-inch disks. The drive also reads and writes single-sided, single-density disks.

Photo 2 shows the back panel. Serial ports A and B, which are driven by a Z80 SIO (serial input/output) device, connect to the system terminal and printer. A Z80 PIO (parallel input/output) device handles the bit-banging on the two Centronics-compatible parallel ports. The other seven ports are inactive stubs. Serial ports C, D, E, and F are for attaching terminals in an MP/M multi-user environment. (This article reviews the single-user version only.) The auxiliary ports, labeled "Aux. A and B," are available for user devices that may be plugged into the two open slots on the S-100 bus. Finally, the port labeled "Aux. Disk" seems to be designed to enable daisy-chaining of disk drives; however, QDP offers no hardware configurations other than the one-cabinet unit.

On the left side of the back panel is the fan. There must be an axiom in the computer-design cookbook that says "cool a powerful computer with a powerful fan." The QDP rivals the Digital Equipment Corporation (DEC) Rainbow as a candidate for generating jet streams in the wind tunnels of General Motors research laboratories. Any hard-working machine needs protection from overheating, but a system that generates the exhaust sound and thrust of a small turbine engine won't find widespread acceptance as a desktop computer. A smaller fan should be able to handle the cooling load at a fraction of the noise.

While I'm offering free advice to the designers on the physical aspects of the computer, I'll put in my two cents regarding the power switch. As seen in photo 1, the switch protrudes prominently from the left side of the front panel, a little too prominently for my liking. Every time I saunter past the machine, I worry about accidentally bumping the switch and possibly flushing a 180-cell spreadsheet down the tubes. To avoid electronic disaster, I've unconsciously developed the habit of executing a quick side step when I pass the computer. My choreography would make Michael Jackson jealous. The designers wisely recessed the reset switch; why they left the power switch sticking out like a sore thumb is anyone's guess.

The inside of the cabinet is shown in photo 3. Most of the system logic fits neatly on one board. For instance, a Z80 DMA (direct memory access) chip, which manages disk-data transfers and memory-to-memory block moves, is on this board. Additional circuits and memory

| Benchmark | Execution Time | Compilation and Link Time | Compilation and Link Time with List Option on |
|---|---|---|---|
| Pascal Sieve (with cache) | 16 | 25 | 27 |
| Pascal Sieve (without cache) | 16 | 36 | 38 |
| MBASIC Sieve | 1197 | — | — |

**Table 1:** *Sieve of Eratosthenes benchmarks were executed on the QDP-300 using Pascal/MT+ version 5.5 and Microsoft BASIC version 5.2. All times are in seconds. The Pascal compilations were executed with and without the 128K-byte cache buffer to demonstrate its effect on system throughput. Both compilations were performed on the 10-megabyte hard disk.*

## At a Glance

**Name**
QDP-300 Model 300F1H10

**Manufacturer**
Quasar Data Products
10330 Brecksville Rd.
Cleveland, OH 44141
(216) 526-0838

**Dimensions**
19.5 by 18 by 8.25 inches; 50 pounds

**Computer**
Zilog Z80B microprocessor, 6-MHz clock; 192K bytes of RAM; three-slot S-100 bus (two expansion slots); two RS-232C serial ports; two Centronics-compatible parallel ports; real-time CMOS clock with battery backup

**Disk storage**
One 10-megabyte fixed hard disk; one 1.2-megabyte, double-sided, double-density, 8-inch floppy-disk drive

**Software included**
CP/M-80 version 2.2 (uses 128K bytes for disk buffering), Perfect Writer, Perfect Speller, Perfect Filer, Perfect Calc

**Hardware options**
256K-byte RAM disk ($995), 512K-byte RAM disk ($1395)

**Documentation**
200-page Users Manual and Osborne CP/M User Guide by Thom Hogan

**Prices**

| | |
|---|---|
| Dual floppy, 128K-byte RAM system | $3995 |
| Single floppy, 10-megabyte hard disk, 192K-byte RAM system | $6395 |
| Single floppy, 15-megabyte hard disk, 192K-byte RAM system | $6895 |
| Dual floppy, 10-megabyte hard disk, 192K-byte RAM system | $7145 |
| Dual floppy, 15-megabyte hard disk, 192K-byte RAM system | $7645 |

can be placed in the two empty slots of the three-slot S-100-bus motherboard, which is shown toward the back in photo 3.

At the very bottom of photo 3, barely visible, is the top of a 10-megabyte hard-disk drive manufactured by Miniscribe Corporation. The drive interfaces to the computer through a Western Digital WD1000 controller. The floppy-disk drive is just above the hard-disk drive; a NEC D765AC chip controls the floppy-disk drive.

A battery keeps the CMOS (complementary metal-oxide semiconductor) MM58167 real-time clock ticking when the power is turned off. It was a nice feeling to have the QDP-300 greet me with the correct time and date when I unpacked it and typed in the CLOCK command. A voltage selector lets you choose between a 115-volt or 220-volt power source.

QDP provides a 12-month, on-site warranty, managed by General Electric Apparatus and Engineering Services, which has 50 service locations in the U.S.

### Software

The QDP-300 first awakes under the control of an 8K-byte ROM (read-only memory) monitor. The monitor provides the lowest level of housekeeping, including booting, system routines, and debugging support. The boot logic loads CP/M-80 version 2.2 from either the hard or the floppy disk.

Although the CP/M implemented is version 2.2, QDP's programmers have incorporated several features of CP/M Plus (or CP/M 3.0). The most outstanding feature, a cache BIOS (basic input/output system), divides the 192K bytes of total memory into a 128K-byte cache region and a 64K-byte CP/M region. The cache region contains much of the BIOS, a fresh copy of the CCP (console command processor) and the BDOS (basic disk operating system) for quick warm booting, and a cache or LRU (least recently used) buffer for disk sectors. The cache buffer stores disk sectors in memory as they are read. When an applications program requests a sector, the BIOS checks the cache first. If the sector is in memory, that is, in the cache, it is transferred to the applications program without performing a disk read. Transferring a sector from memory versus reading it from disk is like delivering a transcontinental message over the telephone versus sending it by horse. Programs running in a cache environment can increase throughput significantly.

With much of the BIOS residing in the cache region, CP/M's transient program area (TPA) weighs in at a healthy 55K bytes without overlaying the CCP, a generous allotment that few CP/M 2.2 systems can match. Another CP/M Plus feature inherent in QDP's enhanced CP/M is the ability to search for command files on other than the current drive. If a command file is not found on the current drive, the operating system automatically searches drive A for the command. This obviates the need to place copies of commonly used utility programs on each drive.

QDP supplements CP/M's standard repertoire with several utility programs, the most notable of which are HELP, MENU, HCONFIG, FORMAT, SECURE, HARDBACK, and RESTORE. HELP adds a little hand-holding to CP/M's terse command structure. It supplies on-line assistance for the utilities. HCONFIG provides the tool for fine-tuning the system. It configures logical drive assignments, protocol for the I/O (input/output) ports, and the cold-boot auto-load command.


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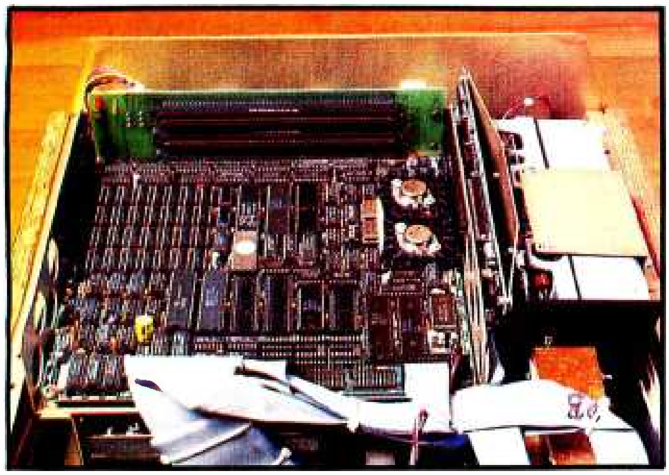


**Photo 3:** *The inside of the QDP-300. The hard-disk drive is on the right. Two S-100 bus connectors are in the left rear.*

At first glance, FORMAT appears to be a typical program that writes track and sector-header information to a floppy disk in single- or double-density mode. You can select 128-, 256-, 512-, or 1024-byte sectors. QDP apparently believes that the variety of options enables customization of disk formats for optimal performance. I think that providing anything more than the usual single and double density (128- and 256-byte sectors) is overkill, but the flexibility might suit some discerning users.

SECURE wins the Strange Program of the Month award. According to the documentation, SECURE directs the Winchester hard-disk read/write heads to a safe "landing zone" and "should always be run before powering down the computer." As sure as the sun rises in the east, there will be times when either operator forgetfulness or an act of nature will cause the voltage to drop to zero before SECURE is executed. QDP claims that failing to run SECURE at power-down will probably result in loss of data on the hard disk. This is the first I've heard of such a limitation with a Winchester. Certainly there's a risk of data destruction if power is lost during a read or write operation; however, while the disk is idle, the heads shouldn't go diddling-bopping on the platter when the current is turned off. It sounds fishy; SECURE makes me feel insecure.

The HARDBACK and RESTORE utilities enable the hard disk to be conveniently backed up on eight double-sided, double-density disks.

QDP has added several systems features that make its CP/M more than just another plain implementation. All serial I/O ports are buffered up to 128 bytes. With a buffer that size, exceeding the type-ahead capacity of the keyboard is virtually impossible. System software automatically logs hard and soft disk errors. A utility program called SYSTAT can be used to display error counts. This feature is invaluable for earmarking marginal media or drives. Worn or deteriorating disks, for example, would post an inordinate number of errors.

## Benchmarks

Now that I've whetted your appetite with an overview of the QDP's innards, I'd like to discuss its most impressive feature—speed. Table 1 lists the results of the traditional Sieve benchmark (see "Eratosthenes Revisited: Once More through the Sieve," by Jim Gilbreath and Gary Gilbreath, January 1983 BYTE, page 283). The QDP clocks in at 16 seconds in Pascal/MT+, about 16 percent faster than the fastest Z80 Pascal listed in the aforementioned article. In Microsoft BASIC, the QDP-300 runs the benchmark about 19 percent faster than a Z80 machine running at 4 MHz.

Table 1 also shows the increased throughput attributable to the system's cache buffer. With the cache buffer enabled, the Pascal compilation and link run about 30 percent faster than without the cache.

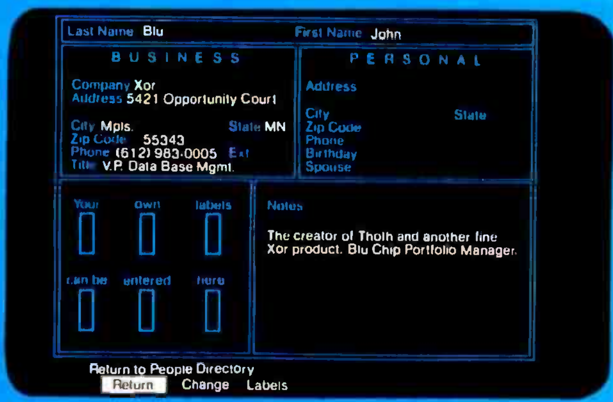
To determine how the QDP-300 fares in word processing, I fed a 3600-word document into the Oasis Systems Word Plus spelling checker. Then, for a gross comparison, I ran the same document through Word Plus on a 2.5-MHz Z80 system with 64K bytes and dual, single-sided, single-density, 8-inch disk drives. The QDP knocked the socks off the disk-based system, processing the document in 30 seconds, one-tenth the time of the slower, albeit older and less expensive, computer.

Although benchmarks provide salient statistics, true appreciation of the QDP's speed comes only when you sit down at the terminal with your favorite software. Programs execute swiftly. On my old computer, I typically fill up the keyboard type-ahead buffer, then daydream while the processor catches up. But on the QDP-300, there's nary a moment between pressing the Return key and seeing the cursor flashing on the screen, awaiting your next command. Adjusting to the speed of the QDP-300 is a pleasurable experience. It's like flying to a distant city instead of taking the bus. You get to read fewer magazines, but you arrive at your destination faster.

## Documentation

The QDP-300's greatest weakness surfaces in its documentation. The 200-page users manual describes the hardware and software poorly. It chalks up demerits for its lack of organization, clarity, and comprehensiveness. The critical procedure of running the SECURE program before powering down mysteriously pops up on page 38 in a subsection describing the MENU utility. The text of the manual betrays its Wordstar origins in sentences like this: "Taking good care of your disks is essential, and you will be rewarded with minimum problems..PA." A word such as "optionnumber8willnotappear" indicates that several pages were treated with something bigger than a fine-tooth comb.

The most annoying attribute of the users manual is its self-congratulatory, backslapping tone. For example, the section entitled "Computer Error Messages" starts out saying, "One of the most important features of the QDP-300 is its unique error handling, both human and computer types. QDP was the first microcomputer com-

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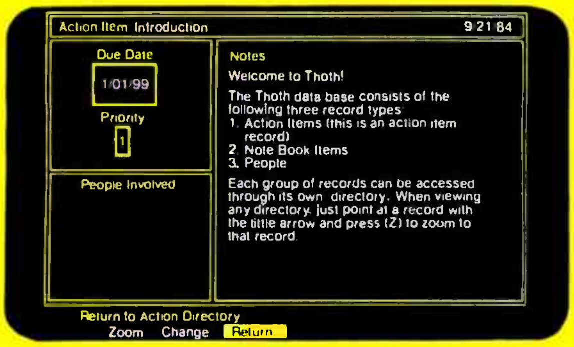


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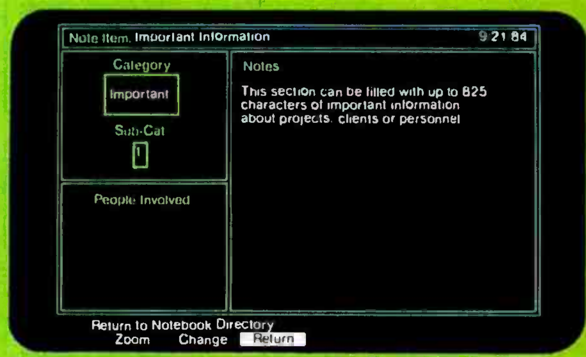


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5421 Opportunity Court Minnetonka MN 55343 (612) 938-0005 pany to introduce this feature." The manual goes on to describe how the BIOS traps disk errors and enables the operator to retry, ignore, or reboot instead of just returning to BDOS. "In our nasty scenario above things were looking pretty bleak," the text continues, "but now comes QDP to the rescue!!!" Yuk.

The description of the configuration program, HCONFIG, begins in a similar vein. "QDP has instituted a revolutionary utility program that changes the way our microcomputer operating system can be modified by end users." Come on, QDP. Any decent implementation of CP/M offers disk error trapping in the BIOS and a configuration program for modification of system parameters. Does the company really believe that its system, which was first sold in 1983, inaugurated these "revolutionary" features? Statements such as these remind me of Detroit's annual claims of revolutionary new automobiles.

To its credit, QDP supplements the documentation with a copy of *Osborne CP/M User Guide* by Thom Hogan. Jerry Pournelle recommends Hogan's guide as a "good introduction" to CP/M. It's definitely better than the standard documents distributed by Digital Research.

## Conclusions

If asked to summarize the QDP-300 in one sentence, I would paraphrase a statement from Peter McWilliams's *The Personal Computer Book*: "All things considered, I'd rather have a good computer with poor documentation than good documentation with a poor computer." In my experience, this hardware breaks all speed records for CP/M-80 programs. And the extra utilities and better-than-average BIOS earn the software a gold star.

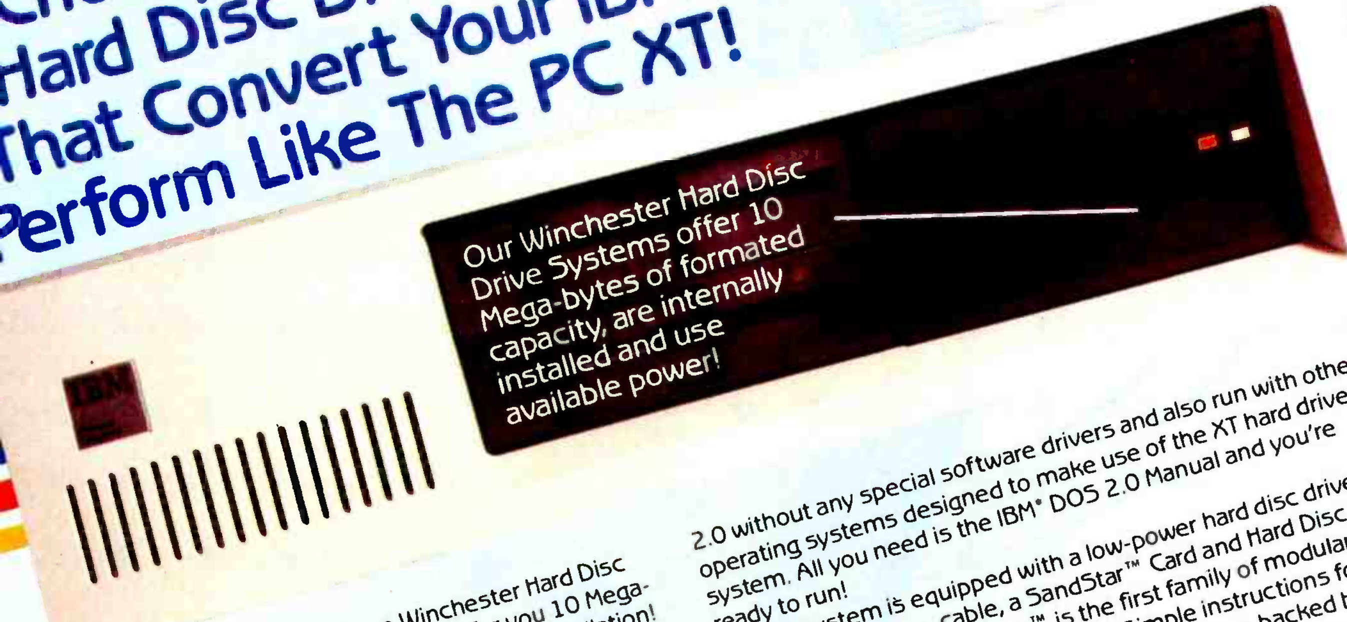
The documentation falls short by any measure, but QDP's customer representative patiently guided me through the gray areas. The information he supplied over the phone, coupled with addendums sent a week later, filled many gaps in the original users manual.

Some people may be concerned about investing their computing future in a five-year-old company that, quite frankly, holds less than the lion's share of the market. This risk applies to many technological ventures, but on the brighter side, QDP has not retired its development staff after one system. The company recently announced the QDP-400, a six-slot, S-100 bus, Z80B system that includes the TurboDOS operating system from System 2000. A 16-bit coprocessor, which will open a path to the world of MS-DOS software, is in the works.

The complexity of the QDP-300 extends far beyond the needs of casual and first-time users. The computer's largest audience will be shops that employ professional programmers and systems houses that specialize in packaging hardware and software for small businesses. These sophisticated users should have no difficulty justifying the top-dollar price tag of this Z80 screamer. ■

*CP/M user Edward Joyce (Rt. 9, Box 149, Charlottesville, VA 22901) received his baptism in microcomputers at the Department of Computing and Information Sciences at Trinity University in San Antonio, Texas.*

# 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.

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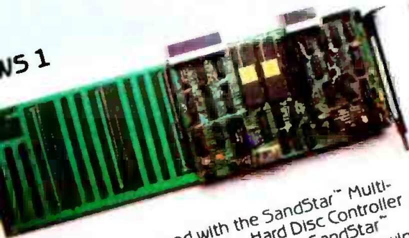

This System is equipped with the SandStar™ Multi-function card. In addition to the Hard Disc Controller Module, you can add up to three other SandStar™ Modules while using only **one** card slot. The following modules are available: Serial Port, Parallel Port, Clock Calendar, Game Adaptor, and Prototyping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

WS 2

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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.

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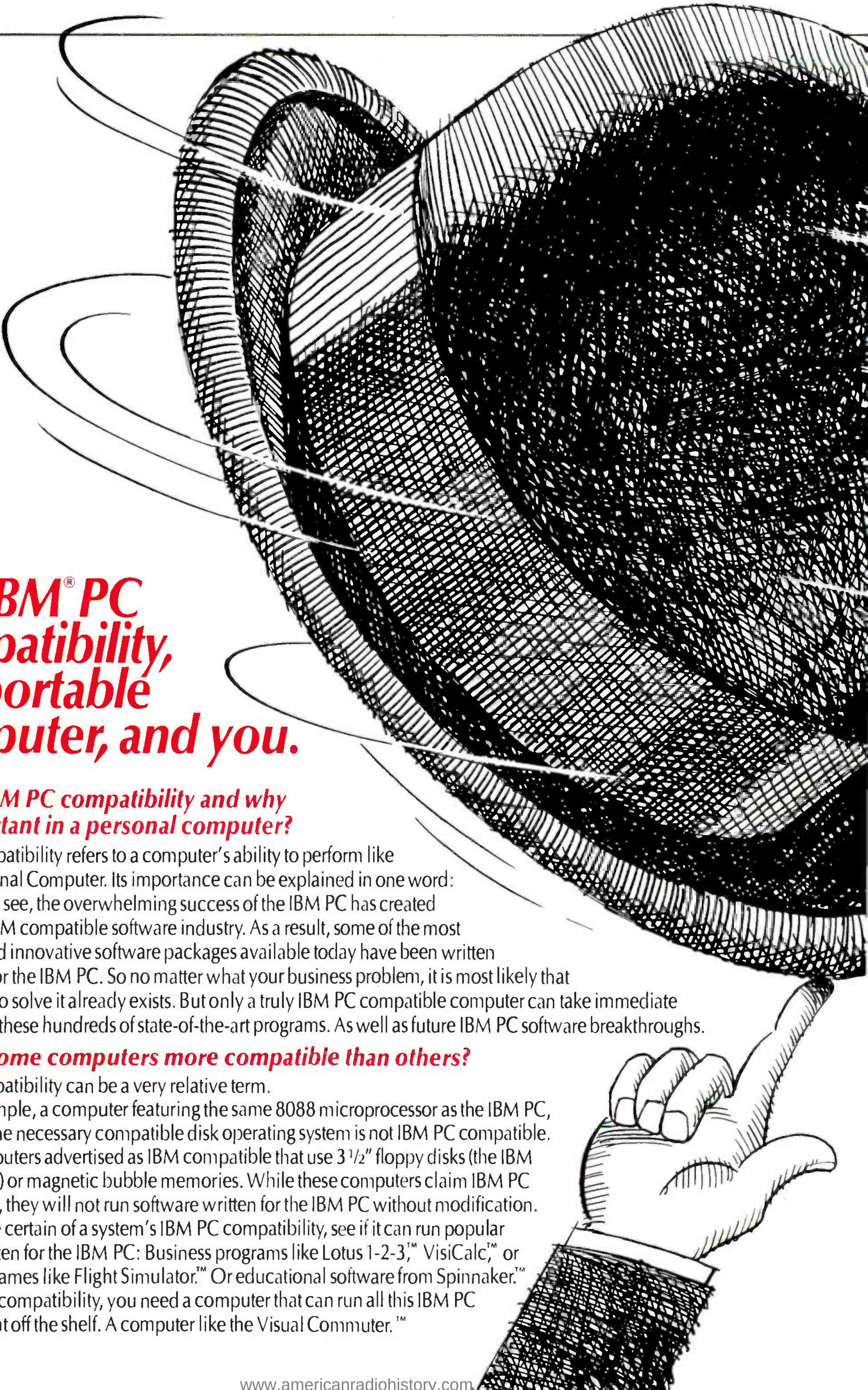

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IBM PC compatibility can be a very relative term.

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# The Kaypro 10

## *A hard-disk CP/M portable with a large software bundle and a small price*

**Steve McMahon**
**Independent Software Developer**

Kaypro's hard-disk portable computer, the Kaypro 10, like its siblings, the Kaypro II and 4, is not a technologically innovative machine. Kaypro has taken existing single-board computer and Winchester hard-disk technology, combined with a monitor, keyboard, and floppy-disk drive and wrapped it all up in a simple bent-metal case.

On another score, though, the Kaypro 10 is very innovative. The equipment and power delivered for the price are outstanding. At $2795 the Kaypro 10 costs less than many stand-alone hard-disk drives. And along with its 10-megabyte hard-disk drive comes a sturdy and serviceable CP/M microcomputer, a high-quality, built-in terminal, and an astonishingly large software bundle (see photo 1).

So, while the Kaypro 10 may have little to teach us about electrical engineering or systems programming, and nothing to teach about aesthetics or ergonomics, it offers many lessons about what kind of value is available for a limited budget.

### Hard Disk or 16 Bits?

The appearance of this hard-disk computer with software for under $3000 will present many computer buyers with a dilemma: will they get better performance from an 8-bit machine with a hard-disk drive or a comparably priced 16-bit machine with floppy disks?

The answer, of course, will depend on the principal purposes for which the computer will be used. Large spreadsheet applications, graphics work, high-precision computation, and heavy statistical analysis will likely be served better by the expandable RAM (random-access read/write memory) resources of a 16-bit machine.

But if you're doing a lot of word processing or database management, you'll probably find that the 8-bit machine with the hard disk is faster and more convenient than the 16-bit machine with only floppy disks.

A reliable hard-disk computer system like the Kaypro 10 is a joy to work on if you're used to floppy-disk-only systems. The advantages are speed and capacity. The Kaypro 10 reads and writes material to and from the hard disk at a rate two to four times faster than the floppy disk. Programs run faster and records are found more quickly (see table 1).

The difference in capacity adds up principally to great advantages in convenience. Working with the 10, I found I could keep all my current projects on the hard disk along with all the tools I needed to do the work, such as word processors, spelling checkers, compilers, and database programs. I could switch easily and quickly among projects and tools. Floppy-disk handling, and the subsequent likelihood of damaging disks, was cut to a small fraction of what it was on a floppy-disk-only system. I got a lot more done in the same time because I spent less time with the logistics of getting the right files onto the right floppy disks at the right moment.

For people doing a lot of database-management work, the added capacity of the hard disk may be not only con-

**Photo 1:** *The Kaypro 10 and its documentation. Even glancing through all the documentation for the extensive software bundle is a major chore.*

venient but necessary. It enables rapid access by more than one index to records that previously had to be stored on separate disks.

## The Winchester

A Winchester-type fixed hard disk is what makes all of this possible in an inexpensive portable. The two-platter, 10-megabyte drive manufactured by Tandon is sealed in its own container and double shock-mounted inside the 10. The sealing of the drive protects it from a possibly dusty or moist environment. Because there is only one drive, which cannot practically be removed, the drive must be backed up by copying its contents to floppy disks. The floppy disks can then be removed and protected.

## Safety

Included with the Kaypro 10 is a safety program that is an important part of the portability of the machine. The safety program must be run before the 10 is turned off. The program causes the hard-disk read/write heads to be withdrawn to a data-free "landing zone" where the heads can do no damage if they accidentally strike the disk surface during movement of the computer.

The 10 also automatically deselects the hard disk whenever it is not in use for more than a few seconds. While this probably slows the 10 down some on hard-disk access, it cuts the chances of damage to the disk if power is interrupted.

| BASIC Benchmarks | Time (Seconds) Kaypro 10 | IBM PC XT |
|---|---|---|
| Disk Write (64K bytes) | | |
| Floppy Disk | 65 | 29 |
| Winchester | 15 | 8 |
| Disk Read (64K bytes) | | |
| Floppy Disk | 17 | 23 |
| Winchester | 9 | 8 |

**Table 1:** *Disk read and write speed comparisons of the Kaypro 10 and the much more expensive IBM PC XT. The comparison mainly serves to highlight the slow speed of the Kaypro's floppy- and hard-disk write routines. The Kaypro test was made with Microsoft's BASIC-80, which is included with the 10. BYTE's benchmarks are listed in the January 1982 BYTE, page 54.*

## Transporting the 10

Calling the 10 a portable is pushing the definition of portable. At 30 pounds, it's a hefty burden to carry for more than a block or so. Anyone doing that will also discover that the carrying handle is quite uncomfortable.

Nonetheless, the 10 folds up into a neat package that can be carried easily to a car parked nearby, or it can be moved from room to room. The 10 fits under most major-airliner seats—a popular benchmark for portability—as long as you avoid the window seats. You won't have any leg room left over, but it's much preferable to

**Photo 2:** *The complete character set of the Kaypro 10. The 10 includes a good collection of graphics characters.*

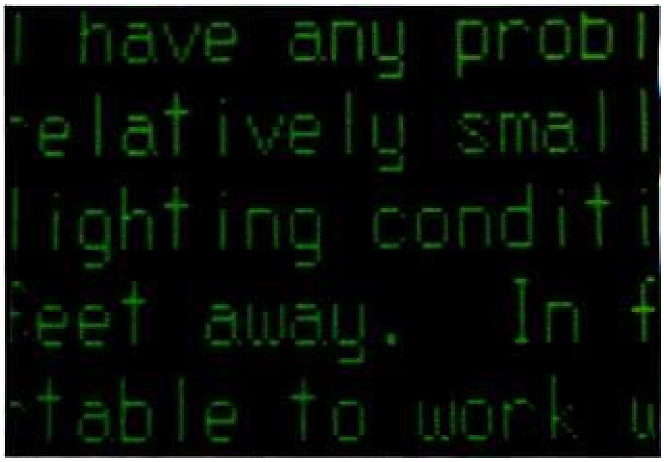


**Photo 3:** *A close up of the Kaypro 10's display. Note the very high resolution and the fact that character spacing is a bit uneven.*

checking the computer as luggage (a Kaypro technical-support hotline employee told me this would constitute abuse of the computer).

If you carry the Kaypro around much you should definitely get a cover of some sort for it. Even folded up for transport, all the Kaypro 10's ventilation slots are completely open to dust and moisture.

The 10 I tested survived my carrying it around from day to day with no difficulty at all. While I didn't deliberately drop it, I did bump it around some, and nothing went wrong. The machine also survived being shipped across the country twice without accumulating any bad spots on the hard disk in the process.

By this measure, Kaypro's shock-mounting system for the Winchester seems to be a success. Despite this, I have one complaint: the *Kaypro 10 User's Guide* offers no guidelines at all on how to transport the machine safely or what kind of shocks it can be expected to survive. Presuming that the hard disk is vulnerable, I found this to be a distressing omission.

## The Display

The folks at Kaypro have certainly packed a beautiful monitor into this metal box. The 9-inch non-glare screen holds a full 25 rows (only 24 easily available to the user) and 80 columns of very clear green-phosphor characters. The characters are composed of 14 dots vertically by 7 horizontally, with 3 of the 14 vertical dots used as true descenders (see photo 2). The screen's resolution is much better than the Kaypro II's and the characters are a lot

## At a Glance

**Name**
Kaypro 10

**Manufacturer**
Kaypro Inc. (formerly Non-Linear Systems)
533 Stevens Ave.
Solana Beach, CA 92075
(619) 755-1134

**Dimensions**
19 by 17 by 9 inches (when closed for transport); 30 pounds

**Components**
Processor: 4-MHz Z80; Memory: 64K bytes RAM; Display: built-in, high-resolution 9-inch green-phosphor; 80 by 25 display with underline, reverse-video, half-intensity, blinking, or in combination. Graphics Format: 160- by 100-pixel graphics-plus-character graphics. Keyboard: 75 full-ASCII keys in Selectric-style layout; 14-key numeric keypad and 4-key cursor vector pad double as user-definable function keys

**Mass storage**
1 shock-mounted 10-megabyte (8944K bytes available) fixed hard-disk drive subdivided into two logical drives; 1 half-height double-sided, double-density 390K-byte floppy-disk drive

**Interfaces**
1 Centronics-type parallel printer port; 2 RS-232C serial ports; 1 light-pen port

**Software**
CP/M version 2.2 with enhancements for easier employment of user areas. Word Processors: Wordstar version 3.3, Perfect Writer version 1.20. Spreadsheets: Perfect Calc version 1.10, Chang Lab's Microplan. Spelling Checkers: The Word Plus, Perfect Speller. Database: Perfect Filer. Programming Languages: Microsoft BASIC, CBASIC, and Topaz Programming's S-BASIC. Communications: Superterm, a smart-terminal program with XMODEM protocol option. MUFBAR disk-backup system. Assorted games

**Options**
Kaylink mainframe-to-microcomputer synchronous communications package. Kaynet networking system. Contact Kaypro for prices and availability

**Documentation**
*Kaypro 10 User's Guide*, approximately 150 pages, from Kaypro. Manuals for all software items (except games). Reference cards for Wordstar and all the Perfect Software. A current copy of Kaypro's magazine *Profiles*

**Price**
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The 3014/3024 models print 132 columns, while the 3304/3404 models give you a full 136 column width. The 3304 and 3404 models even offer color printing.

Each printer is easy to use, lightweight, functionally styled and attractive. And you can choose options from pedestals and paper racks to document inserters, sheet feeders and 8K character buffer expansion, plus more.

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more readable than the II's (see photo 3).

I don't think most people will have any problems reading this display, despite its relatively small size. It was quite readable under a variety of lighting conditions and at distances from very close to 5 feet away. In fact, I found this screen to be a lot more comfortable to work with for extended periods than many 12-inch monitors on nonportable computers.

The only advantage these larger, separate monitors have over the Kaypro's is that some may be easily adjusted for height and angle. Adjusting the Kaypro's monitor position or angle involves moving the whole machine laterally and propping things under it. It would have been nice if Kaypro had provided an adjustable stand to compensate for users' preferences and working conditions.

The 10's monitor is versatile as well as readable. It offers reverse video, half-intensity, underlining, blinking, and any combination of these video effects. Most of the 10's users won't see much of this versatility, though; only a small number of the programs included with the 10 make use of even the reverse video.

The reverse-video effect was very irritating to my eyes when it occupied more than a tiny portion of the screen. Unfortunately, Kaypro chose to make Wordstar's menus and status line appear in reverse video. The result is a glaring screen that makes it hard to concentrate on the text at hand. I was able to solve this problem by patching Wordstar to use half-intensity type rather than reverse video for its menus. Users who don't know how to patch Wordstar and don't have a sympathetic dealer won't be so lucky.

There shouldn't be any trouble getting applications software that will operate acceptably on the 10's screen because Kaypro imitated the popular Lear-Siegler ADM-3A methods for clearing the screen and addressing the cursor. Getting commercial software to use the previously mentioned video effects, though, will require some extra work on either the user's or the software vendor's part, because Kaypro went its own way in determining the codes to invoke these features.

## Graphics

Ultrahigh resolution for text does not mean high resolution for graphics. The 10 offers bit-mapped pixel (picture element) graphics, but the resolution is only 160 by 100 pixels. These plump pixels can be used for bar charts if there aren't too many bars and there certainly will be a few games written to make use of them. But my guess is that there won't be a whole lot of use made of the 10's pixel graphics by applications programmers. If you're thinking of purchasing the 10 rather than another computer because of the 10's graphics, you should think again unless you're only after a taste of graphics programming.

The 10 also offers a good set of graphics characters that should prove marvelous for drawing up sharp menus or such. The graphics characters aren't documented in the manual, but Kaypro includes the source code for the

10's menus, all of which make use of the special characters. (You'll have to hunt for these, though, as the *User's Guide* doesn't tell you where to look.)

### The Keyboard

The 10's detached keyboard covers the monitor and floppy-disk-drive opening when the machine is packaged for travel. In use, the keyboard is connected to the back of the computer by a curly cord similar to the one that connects most telephones with their handsets (in fact, the modular jacks and connectors are exactly the same). The cord allows you about 3 feet of play without stretching it too far, so I had no trouble finding a comfortable place to put it for typing.

The touch of the keyboard is smooth and consistent, but extremely light. Even though I am accustomed to light keyboards (I use a Kaypro II), I still make a lot more errors than usual when working with the 10. Presumably, if you type only on this keyboard you'll get used to the light feel, but it might be difficult to switch back and forth between the 10 and other keyboards.

The keys themselves are well designed and conveniently arranged; for instance, the Return and Shift keys are large and placed where most touch-typists expect them. The keyboard makes a noise that sounds like a cross between a squeak and a click when keys are pressed or when they repeat. The sound is not adjustable, but the manual does tell you how to turn it off.

All the keys repeat when held down for more than a fraction of a second—unless you are holding down the Control key at the same time. Control characters don't repeat. I found that to be quite a problem, particularly when using Wordstar and Perfect Writer, until I learned how to use the function-key facility to put frequently used control characters on the numeric keypad, where they can repeat. This worked well, but it would have been better if the control characters repeated when used normally.

The function-key facility is one of the nicest but also most poorly documented of the 10's facilities. Each of the 14 keys on the numeric keypad and the four additional cursor-control keys can be redefined to produce the equivalent of up to four keystrokes when pressed. A program, Config.com, included to accomplish this redefinition is well designed and also lets you change the default printer port and the data-transmission rates of both serial ports. The problem is that there is only a brief and very incomplete mention of this important program in the *User's Guide*. Many users will never discover that they have function keys.

### The Operating System

When using nearly 10 megabytes of storage, it's critically important to be able to subdivide the directory so that the whole multiscreen mess doesn't appear every time you ask for a directory. CP/M versions 2.0 and later (the Kaypro's is 2.2) solve this problem by allowing each drive to be logically broken into as many as 16 user areas. Each of these user areas is invisible to each other area, even


**Photo 4:** *The Kaypro 10's main menu.*

though they take up space on the same disk. Size of user areas is flexible; each could potentially contain nothing or utilize the entire disk.

Kaypro made a couple of modifications to the CP/M's CCP (console command processor) that make a world of difference in the usefulness of the user-area feature. The modified CCP displays the current user area along with the current drive letter whenever it prompts the user for a command line. So the usual CP/M A> prompt is replaced with A0>, A1>, . . ., A15>, depending on which user area you're logged to. Also, whenever a command file is asked for that can't be found in the current user area, the CCP searches user area zero for the program. This means you can place most of your utilities in user area zero and they'll be available no matter what area you're logged to. (Unfortunately, programs like Wordstar can't find their overlays in different user areas, so there are still problems.) These little changes save a lot of time and trouble in day-to-day work.

## Hard-disk Backup

Hard-disk backup should be easy and reliable. Winchester drives may be more reliable than floppy disks, but they still make errors. With the capacity of a hard disk, a directory error or a hard-disk failure can make a real mess.

Fortunately, Kaypro has included a quite workable hard-disk backup system with the 10. The MUFBAR (multi-floppy backup and recovery) system will back up anything, from an entire user area to individual files, from the hard disk onto floppy disks.

MUFBAR will automatically break up very large files onto multiple floppy disks if necessary. This capacity is an important one if you're thinking of keeping a large database on the 10. This backup program also gives you the ability to "stamp" backup disks with a note about the time and contents of the backup.

What the program won't do is tell you which files need backing up. As provided by Kaypro, CP/M offers no facility for marking files that have been changed so that just the changed files may be backed up. This means that either you'll have to keep a list of what files have been altered since the last backup or you'll have to back up all the files every time. Because the hard disk contains the equivalent of about 23 floppy disks, the latter would be a burdensome task.

In an environment where several people use the machine and each can't be disciplined to keep records of files changed, a floppy-disk backup system could mean courting disaster, no matter how convenient the backup program is. Such users would be well advised to look for a hard-disk computer with a better backup system, even though it is likely to be a far more expensive system than the 10.

## Menus

The Kaypro 10 includes a set of menus extensive enough that many users may be able to completely avoid learning CP/M if they wish.

The master menu (see photo 4), which automatically runs when the 10 is turned on (this auto-load feature may be turned off easily by running a program called Nomenu.com), enables you to run any of the major programs provided with the Kaypro. All you have to do is move the cursor to the program desired and press the Return key. Brief explanations of what each program can do are provided in an information area on the right side of the menu. The explanations change depending on where you have positioned the cursor.

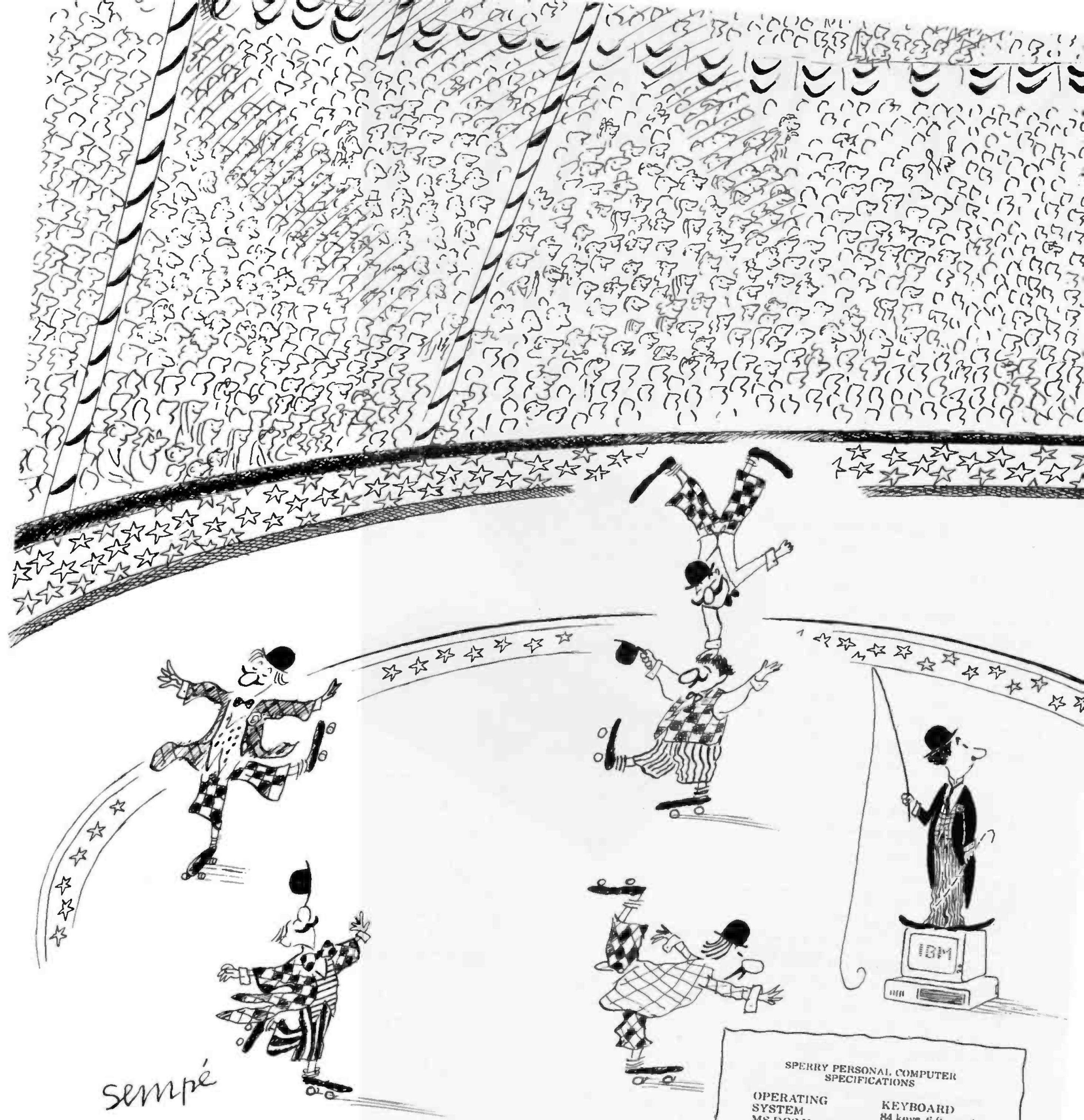
The main menu chains into a set of subsidiary menus in cases where there are more decisions to be made. These special-purpose menus follow exactly the format of the main menu. All are quick to use and intelligible.

I liked these menus a lot better than any of the other menu systems I've seen on inexpensive microcomputers. The reason the Kaypro menus worked, though, didn't have as much to do with the menu design as with the hard disk. Most microcomputer menu systems break down because all the applications you might want to run are not available on the same disk. Thus, the menus lead you through disk changes in a way that necessarily leaves room for errors the menu system can't deal with well. This problem goes away when the menu can immediately run the desired application.

The hard disk also eases up the space constraints that hinder the designers of a menu system. The 100 or so kilobytes an adequate menu system might require is a big sacrifice on smaller-capacity, floppy-disk-only computers.

The 10's menus, though generally very useful, do have some annoying flaws: chief among these is that there are some important omissions from the menus. For example, the hard-disk backup system is completely menu-driven, except for the fact that you can't format a floppy disk from the menu. So backing up disks requires you to leave the menu system. Anything that makes the backing-up process harder or more confusing is a real problem.

Also, there is no easy way for you to customize the

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menus. Kaypro provides the S-BASIC source code for the menus, but this isn't enough. Customization should be possible without having to program. It certainly shouldn't require having to program in an unusual hybrid language available only with the Kaypro 10.

## Documentation

It's helpful that the menu programs that Kaypro provides to move you around the hard disk are so good, because the *Kaypro 10 User's Guide* provided with the machine is a positive hindrance.

This manual must be rated unacceptable for several reasons. Its description of the organization of the 10's software bundle is not only incomplete, but very often incorrect. Vital information on system software utilities is missing or also incomplete. Very important documentation, such as the description of the hard-disk backup utility, is stuck in the back, without so much as a note at the beginning of the manual to indicate it's there. There is no index.

The information presented in the manual also fluctuates between user-friendly and cryptic. The first few pages of the manual constitute a very gentle "shake hands with your Kaypro 10" introduction, complete with simple illustrations. They are followed by explanations of a few important CP/M utilities rendered in such a way that only someone already familiar with CP/M stands much chance of understanding them. This sudden change in tone is characteristic of the manual as a whole. The *Kaypro 10 User's Guide* will satisfy neither new nor accomplished users.

The *User's Guide* is only one of a small shelf's worth of manuals that come with the 10. Most of the other manuals are for one or more of the many programs bundled with the machine. All of these manuals (even Digital Research's improved CP/M manuals) are much better than the Kaypro manual.

One very welcome piece of documentation included with the 10 I reviewed was the second issue of *Profiles*, a slick magazine published by Kaypro for Kaypro owners (*Profiles*, POB N, Del Mar, CA 92014). Many outfits offering software and hardware add-ons specifically designed for the Kaypro have ads in *Profiles* that are enlightening.

## Software

One of the advantages occasionally touted for the practice of bundling software with a computer is that it eliminates the problem of choice for the buyer new to the computer world. The manufacturer makes the software choices for the average user by making appropriate software part of the bundle purchased. Because the computer manufacturer usually has great buying and bargaining power, bundling also often provides a software package that would add up to more than the price of the computer system if each software item were purchased separately.

Kaypro apparently has tremendous buying and bargaining power. But while the company may have used


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this power to provide great value, it hasn't exactly eased the novice's burden of choice.

Indeed, the Kaypro 10 comes bundled with an astounding quantity of software. Unfortunately, many a novice user will prefer to substitute the adjective "stupefying" for "astounding." There is far more software included with the 10 than anyone is likely to find useful.

Experienced computer users will likely be happy to make the appropriate choices between two word processors, two spelling checkers, two spreadsheets, two communication programs, and three versions of BASIC. But without guidance from a friend or dealer, people new to word processing will likely flounder trying to choose whether first to learn Wordstar or Perfect Writer. It would be very difficult to learn both at the same time. The same will hold for spreadsheet-users-to-be faced with both Perfect Calc and Chang Lab's Microplan or novice programmers confronted with M, C, and S BASIC.

To the well-guided user, though, the only problem with this over-bundling will be the embarrassment of riches. There are several first-rate, tremendously useful programs in the Kaypro's bundle.

While I can't possibly describe all the software in this review (most of it has been extensively reviewed on its own previously), a few items deserve particular note.

## Word Processing

Micropro's Wordstar version 3.3 is a fine enhancement of an already excellent product. While users of version 3.0 will not notice any particular changes in Wordstar itself, the manual and installation program have been markedly improved. Wordstar's manual is no longer scandalously difficult to read and there is even a good tutorial booklet included. I wish that Wordstar had accomplished this without inserting so many self-congratulatory cartoons and text passages in the process, but the new manual still makes me feel much better about recommending Wordstar to new users.

The installation program can now be used to easily change such variables as the justification method and the degree of help displayed when the editor is first entered. Previously, only persons able to use the difficult patching facility were able to customize these features. (Yes, the patching facility still exists and is also much improved.)

If you've given up on Wordstar as slow and awkward, you may be in for a pleasant surprise when you try it on the 10. First, the inherent speed of the hard disk allows it to run a lot more smoothly and quickly. There are no more agonizing pauses while program overlays or the next page of text loads from disk into memory. Second, Kaypro has implemented a function-key system that makes use of the redefinable numeric keypad keys to trim down several multikeystroke Wordstar commands to single keystrokes.

Perfect Writer provides an interesting and useful contrast to Wordstar. This Perfect Software product is not nearly the text-formatting tool that Wordstar is, but it is a far better writing tool. Anyone who does (or wishes to do) a lot of actual writing at the keyboard should take a careful look at Perfect Writer.

Perfect Writer's principal advantage for writing is its ability to split the screen into two text windows. This feature allows me to work on one portion of text while having another portion in view (that portion may even be in another file). It often saves me from having to print out a draft just to be able to look at a piece of text while writing a reference to it. All this is great for writing and nearly indispensable for programming. Imagine being able to look at a function declaration while writing the function call.

Add to the split screen a very fast block-move feature, a deletion "undo" command, the capacity to have up to seven files open for editing (and passing text back and forth among them), and a good search-and-replace facility, and you have a very good editor.

What you don't have, though, is a very workable text formatter. Perfect Writer is not a "what you see is what you get" editor. This is not necessarily bad. When working on a long manuscript, I'd rather not do my formatting while I do my writing. Instead, I'd like to pass it through a formatting program, one that would do the hard work for me, when I finish. This is what Perfect Writer attempts to provide, but the program fails to allow even adequate formatting control. Only through a very awkward process of multiple formattings is it possible to avoid such formatting disasters as section headings alone at the bottom of pages. Getting a good format of a long (75 double-spaced pages) academic manuscript took me a good part of a day.

## Spelling Checkers

Kaypro has provided what is, in my opinion, the crème de la crème of 8-bit spelling checkers: Oasis Software's The Word Plus. The Word Plus not only checks spelling against a 50,000 word dictionary, but shows suspected errors in context and suggests alternative spellings. The dictionary can be easily updated, and special-purpose supplementary dictionaries can be assembled. Best of all, though, The Word Plus consistently identifies fewer correctly spelled words as potentially misspelled than other checkers I've tried. This may, of course, just mean that the folks at Oasis Software and I share about the same vocabulary.

Perfect Speller runs a good bit faster than The Word Plus, but I found that it frequently missed my typographical errors. This spelling program is one of those that tries to make a small dictionary file seem big by using prefix/suffix rules to expand on it. If you don't mind having words like "whyed" and "whileor" in your correspondence, this might not bother you as much as it did me.

## Spreadsheet Programs

One strong point in favor of the Perfect Software is that once you've learned one of the programs, the others are a lot easier to learn. This is because each member program of the Perfect series shares a similar command

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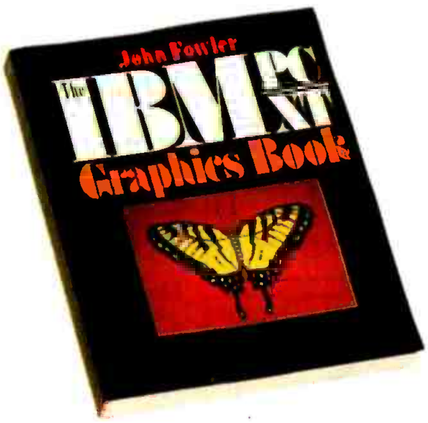


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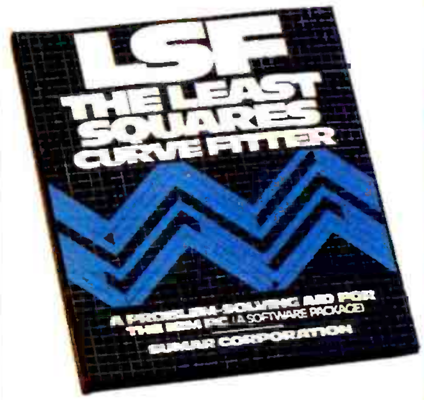


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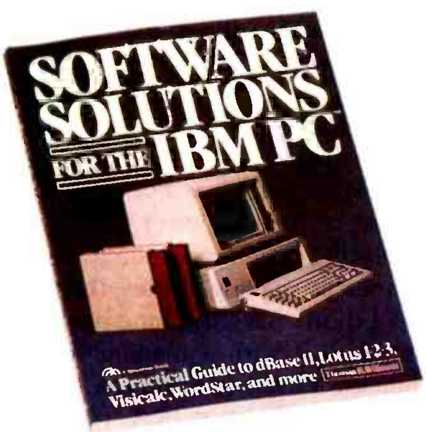


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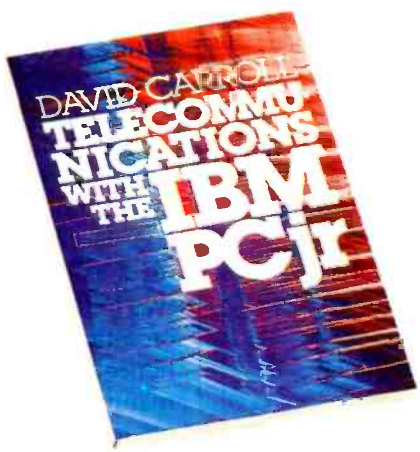


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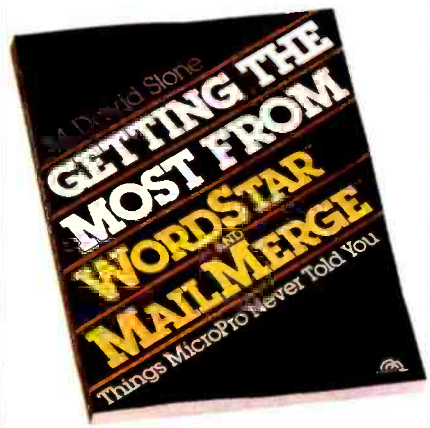


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structure. Typing Control-X 2 splits the screen in Perfect Calc as well as Perfect Writer. Such small advantages are not to be scoffed at when trying to find your way through a software bundle as extensive as the Kaypro 10's.

Perfect Calc was a lot easier to learn after learning Perfect Writer. It is a complicated spreadsheet program with a thick manual and a nearly useless Help function. It is also a very powerful spreadsheet, and the thick manual is a good one with lots of tutorial lessons.

Like Perfect Writer, Perfect Calc enables you to edit multiple files with free interchange of information between them (two of these spreadsheet files may even be on the screen at the same time). Perfect Calc also enables you to construct some very large spreadsheets because it uses the disk as a buffer to expand available memory. This works only poorly on a floppy-disk system: large spreadsheets become horribly slow spreadsheets. It works better on the 10, so much better that it seems to take spreadsheets right to the limit of what's possible on an 8-bit 64K-byte computer. Perhaps it takes them past the limit: Perfect Calc lost information more than once on large spreadsheets I built.

Microplan, also included with the 10, is Perfect Calc's opposite: it is simple to use, but not particularly sophisticated. Unfortunately, Microplan's manual is also the opposite of Perfect Calc's: instead of making a difficult program simpler, the Microplan manual makes a simple program more difficult.

## Database

Anyone interested in keeping databases with the 10 should know that Perfect Filer may not meet your needs. While the program's preconfigured mailing-list databases worked very well and were easy to use, Perfect Filer proved aggravating when I tried to do much more.

The Perfect Filer manual provided with the 10 was noticeably the weakest of the Perfect series. After warmly greeting me with easy tutorials when I wanted to do easy things, it coldly abandoned me the moment I wanted to do something other than create a sample database of current members of Congress. The problem was that I tended to make mistakes. Apparently the authors of the tutorials were not so error-prone, because an explanation of how to make corrections was not included.

Perfect Filer was just as poor on error handling. Its response to that likely database error, filling the disk, was to let me go on merrily making entries. (I tried this on a floppy disk, as I didn't have the time nor the patience to fill the hard disk with a mailing list.) The manual didn't explain error messages and the program's on-screen messages were cryptic at best, particularly when it didn't like my attempts at form-letter generation.

## Floppy-disk Translation

While reviewing the 10, I had the opportunity to try out a wonderful $49.95 disk-format translation program from Micro Solutions.

Uniform, which is available in different forms for the Kaypro II, 4, and 10, enables you to read, write, and for-

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mat 5¼-inch disks for a variety of different microcomputers. The version of Uniform for the Kaypro II can, of course, only translate single-sided disk formats; the versions for the 4 and the 10 can handle most of the major double-sided formats as well. Televideo, NEC, Osborne, Xerox, Epson, Otrona, Cromemco, Hewlett-Packard, Zenith, Morrow, and Radio Shack CP/M microcomputers are just a few of the many different machines listed on Uniform's easy to use menus.

Most impressive of all, Uniform on the 4 and 10 also provides a facility for translating CP/M and PC-DOS directory formats. This enables you to transfer data files between PC DOS 1.0 (160K bytes) and 1.1 (320K bytes) disk formats. I was able to use this feature to move a friend's Wordstar-format text files from NEC 8001 format disks to disks for use on an IBM PC in only a few quick steps.

Having Uniform on the 10 gives you a hard-disk computer that is data-compatible with the IBM for under half the price of the IBM PC XT. As PC format disks become the de facto standard for disk information exchange between microcomputers, this data compatibility will be very important. Some writers already are offered incentives by their publishers to furnish their prose on a PC-readable disk.

## Revisions

The Kaypro 10 had been on the market about five months when I wrote this review. The machine I reviewed (a late November 1983 model) was very different in both the software bundle and implementation of the operating system from what Kaypro was shipping in July of 1983. The software bundle had gone through several major changes, the BIOS (basic input/output system) was in revision "F," and the monitor EPROM (erasable programmable read-only memory) and the hard-disk interface board had each been changed. Several system utilities for use with the hard disk had been revised to work with the new EPROM and interface.

The BIOS, EPROM, interface board, and utility changes were necessitated, a Kaypro spokesperson said, to rectify a problem that only a few machines might have: incorrectly reporting hard-disk errors. In addition to preventing inaccurate reports of read faults, the changes also appeared designed to prevent a possible hard-disk reset error, an independent comparison of the old and new interface card suggested.

Kaypro is shipping kits to all its dealers that are necessary to fix any 10s already sold that might have the hard-disk difficulties, and no charge will be made for the repairs whether in or out of warranty, the Kaypro spokesperson said.

## Conclusion

The drawbacks of the Kaypro 10 are definitely overshadowed by its many advantages; for instance, the 9-inch, high-resolution, non-glare screen has the problem of inflexibility, yet is much more readable than the 12-inch (and larger) screens of many desktop computers. In addition, the software varies in quality—but there is a lot of it bundled with the system. And while the *User's Manual* is poorly organized and incomplete, the menu system and enhancements to CP/M will aid both novice and experienced CP/M users in mastering the tremendous storage capacity of the hard-disk drive. Furthermore, the floppy-disk backup may not meet the needs of all users, but on the other hand, the system's hard-disk drive has advantages in speed and convenience over comparably-priced, floppy-disk-only computers. Overall, the machine reviewed was reliable and fairly easy to transport. Despite a few rough spots, the Kaypro 10's many advantages make it an exceptional value for the money. It should be considered by anyone interested in hard-disk capacity or performance at an excellent price. ■

**Author's note:**

*I would like to thank the staff of Technika Computer Center in Berkeley, California, for their assistance in preparing this article.*

*Steve McMahon (2208 Martin Luther King Jr. Way, #6, Berkeley, CA 94704) is an independent software developer working particularly on small newspaper business systems. He is also a graduate student in sociology at the University of California at Berkeley.*

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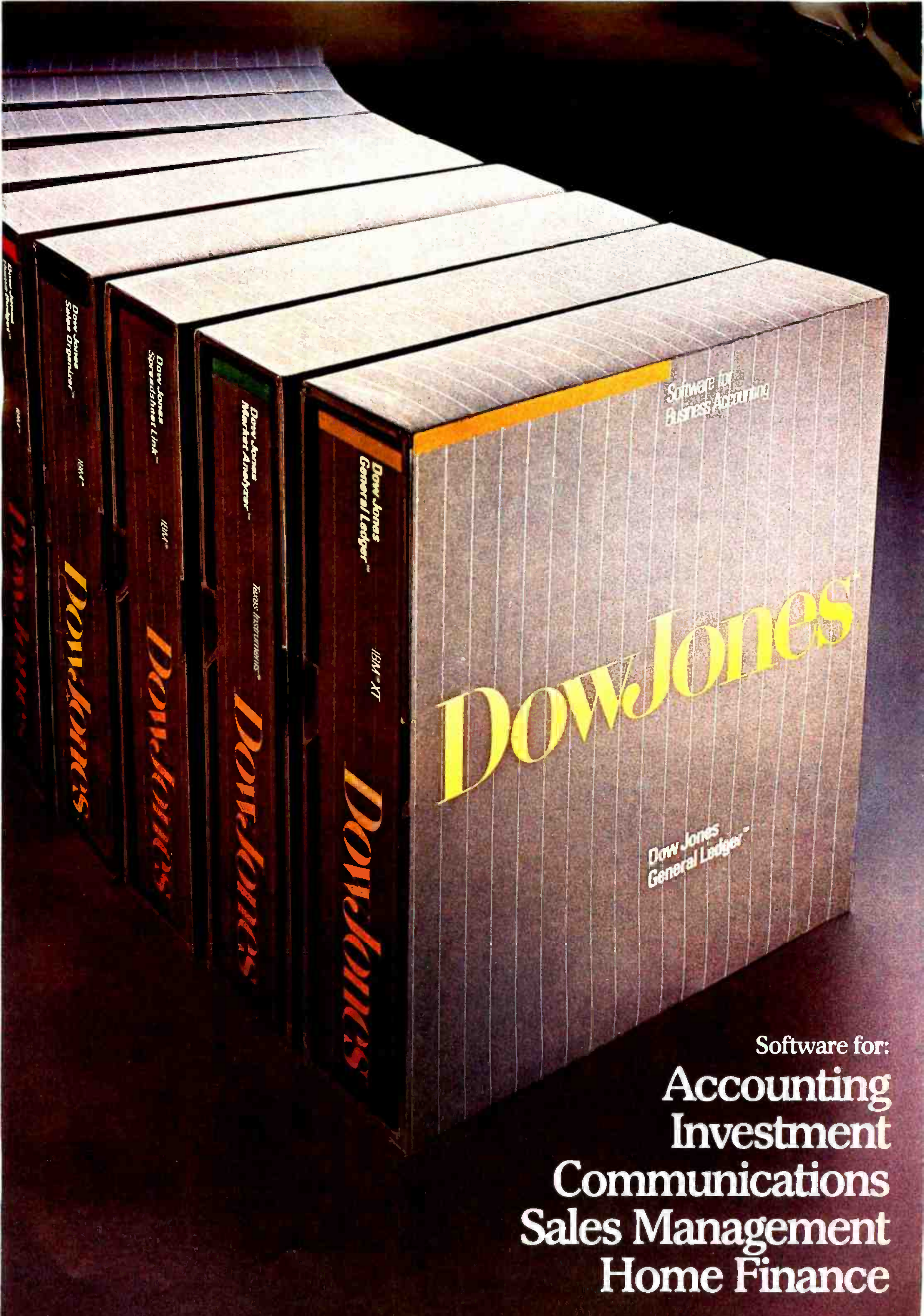

Dow Jones Sales Organizer™
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**Dow Jones Sales Director™** automatically consolidates information from the other two programs in the sales system, performs analysis and produces management reports that can then be distributed throughout the organization. Scheduling, word processing, graphics and spreadsheet capabilities are also included.

*(Available summer/fall 1984) By P/E Software, Inc. and Dow Jones & Company, Inc. Available for the IBM PC and IBM XT.*

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*By Decision Support Software, Inc. and Dow Jones & Company, Inc. Available for the IBM PC, and Apple II computers.*

*List of Accounts, Dow Jones Home Budget*

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*By Dow Jones & Company, Inc. Available for the IBM PC and TI Professional.*

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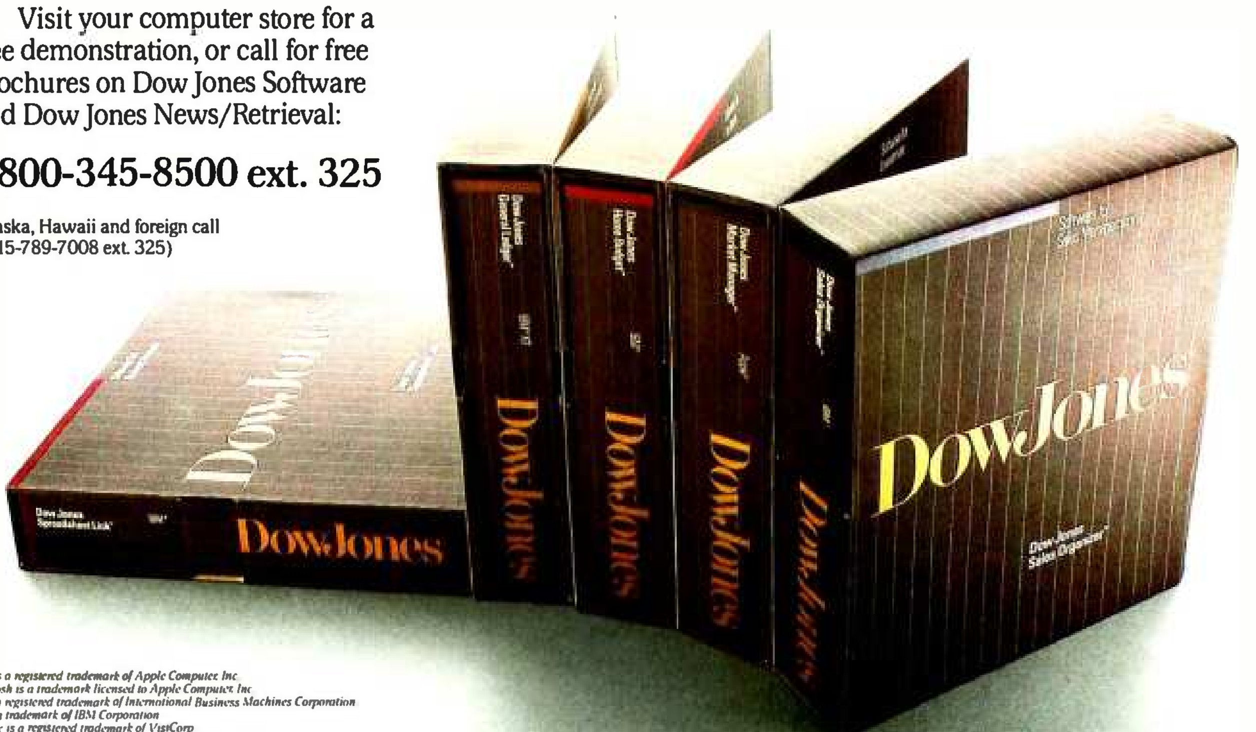

The Market Manager automatically values your existing position in the stock market. Its tax lot accounting system records all your securities transactions and matches your sell transactions to existing positions in the market, to minimize tax liability. You can also generate reports for individual accounts and an overall securities holdings report.

*By TELEWARE, Inc. and Dow Jones & Company, Inc. Available for the IBM PC and Apple II and Apple III computers.*

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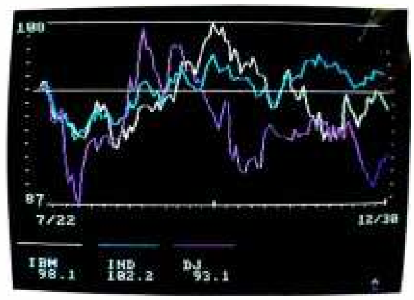
*By National Softworks and Dow Jones & Company, Inc. Available for the IBM PC, TI Professional and Apple II computers.*




*Comparison Chart, Dow Jones Market Analyzer*

# Communications

Dow Jones communications software is designed to meet the business analysis needs of executives and investors. These programs allow you to collect, store, and organize timely information from Dow Jones News/Retrieval. You have access to financial information on companies and industries, current and historical quotes, and exclusive news from The Wall Street Journal, Barron's and the Dow Jones News Service.


*Main Menu, Dow Jones Spreadsheet Link*

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*By Solutions, Inc. and Dow Jones & Company, Inc. Available for the IBM PC, IBM XT, IBM® PCjr.™ IBM® PC 3270, Apple II systems and Apple® Macintosh.™*

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*(Available fall 1984) By Gaia Communications and Dow Jones & Company, Inc. Available for the IBM PC, IBM XT and IBM PCjr.*

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Dow Jones sales management software enables sales professionals and their organizations to sell more effectively. These powerful new programs can be used as an integrated system. They produce reports that give you information about all phases of your sales cycle. All three programs feature in-depth tutorials and easy-to-follow menus.

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*Call Reporting, Dow Jones Sales Organizer*

# Dow Jones News/Retrieval means information.

Included in any Dow Jones Software program, your Dow Jones News/Retrieval password brings you a world of electronic information on your personal computer (via telephone and modem). There is only one Dow Jones, and Dow Jones News/Retrieval provides you with exclusive news and information from The Wall Street Journal and Barron's, stock quotes direct from the floor of the exchange, and a wide range of information and services for you, your business and your family. Dow Jones Investment and Communications software is specifically designed for easy access and management of information from News/Retrieval. Here are some of News/Retrieval's data bases:

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- Text search of Dow Jones News
- Weekly economic update
- Full text of The Wall Street Journal

## Dow Jones Quotes™

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- Historical quotes covering a full year
- Historical Dow Jones Averages™

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- Detailed corporate financial information from Media General Financial Services
- Economic and foreign exchange survey
- Forbes rankings of U.S. corporations and industries
- Airline schedules and fares
- Merrill Lynch Research Service

## General News and Information

- Academic American Encyclopedia
- Foreign and national news
- Sports
- Movie reviews
- Wall $treet Week Online™ transcripts
- Comp-U-Store™ electronic shopping service

## MCI Mail Service and Free Customer Newsletter

# Converting the TRS-80 Model III for CP/M

## *Comparing Mapper III, Shuffleboard III, and Vid-80*

**Mark E. Renne**
**Free-lance Writer**

When Radio Shack announced CP/M compatibility for the Model 4, it became another of the many manufacturers to make the CP/M operating system available for its computers. But should Model III owners rush down to their Radio Shack stores and shell out $799 for a Model 4 upgrade kit, or should they look into the many CP/M conversions available for the Model III? This article will briefly explain some of the basics of CP/M and then examine three different conversions that are available.

The so-called control program for microcomputers (CP/M) designed by Digital Research of Pacific Grove, California, has become the standard operating system for 8-bit microcomputers. It is used by more manufacturers than any other system. Some people would like to have you believe that CP/M is the answer to all your problems, but it has a few bugs of its own.

### Myths about CP/M

Either on purpose or by ignorance, many salespeople insist that CP/M allows programs to be used on any other computer as long as it uses CP/M. Although there is some truth to this, CP/M is not as transportable as many people think. In fact, for a program to be transported from one brand of computer to another, several things have to be true depending on the program. For example, if it's a machine-language program, the computers must have the same central processing unit. CP/M Apple Visicalc will *not* work on a TRS-80 under CP/M. For other programs, the same language—including version—must be available on both computers. Also, the same version of CP/M usually will be required on both computers. TRS-80 users are familiar with this from Radio Shack's upgrade of TRSDOS from 1.1 to 1.3. In this article we will talk primarily about CP/M version 2.2. Note, however, that some new programs for CP/M version 3.0 may not run on CP/M 2.2.

Another problem is screen compatibility. Most people write CP/M programs with an 80-character by 24-line screen in mind; the Model III has a 64 by 16 screen. Some CP/M conversions for the Model III also change the format of the III's screen, but that increases cost. Because most microcomputers at one time had 64 by 16 screens, many programs work well in this mode. Other programs work on different brands and have an Install program that allows the user to adjust screen size.

Also, each computer formats the disks used in its system differently. The 8-inch, single-density format is standard, but 5¼-inch disk formats are chaotic. Don't be misled into believing you can simply take a disk from your neighbor's North Star and insert it in your TRS-80 because they both use CP/M. (Actually, you could insert it—it just wouldn't work!) Some CP/M systems, however, do allow this type of interchangeability, and I'll discuss that later.

For a program to be totally transportable, then, even under CP/M, it must be written for the same processor,

## At a Glance

**Name**
Mapper III

**Use**
To convert the Radio Shack TRS-80 Model III to operate under the CP/M operating system as well as TRSDOS

**Manufacturer**
Omikron
1127 Hearst St.
Berkeley, CA 94702
(415) 845-8013

**Size**
6 by 3½ by ½ inches

**Weight**
4 ounces

**Features**
16K bytes of RAM; Omikron utilities and enhancements available

**Hardware required**
Radio Shack TRS-80 Model III, 48K bytes of RAM, disk

**Software supplied**
CP/M 2.2, MBASIC

**Documentation**
8½- by 11-inch, three-hole punched, 6-page installation manual, 15-page users manual, 150-page MBASIC manual, and 249-page CP/M manual

**Price**
$199

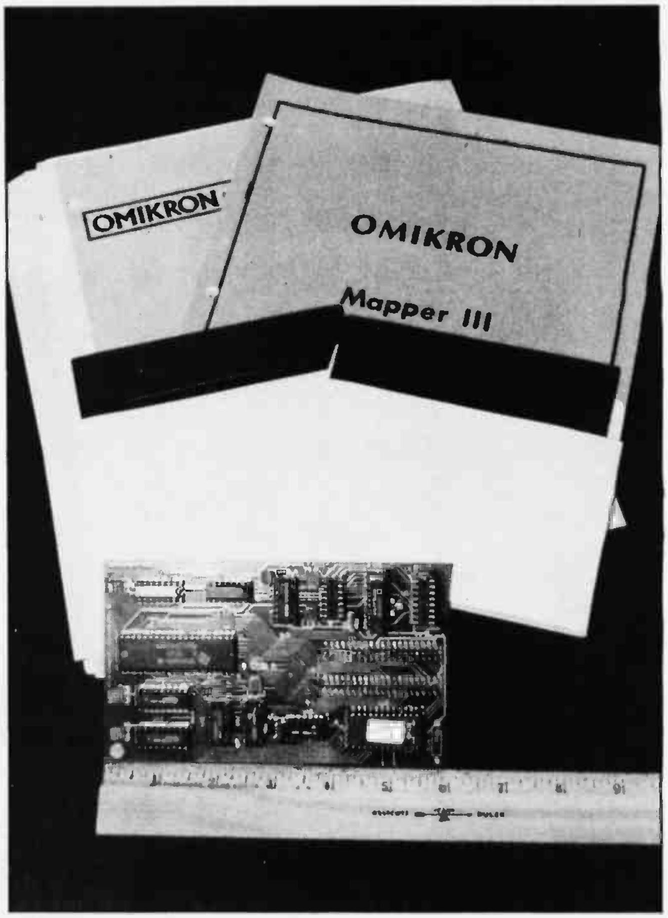


**Photo 1:** *Mapper III from Omikron.*

use the same language (including version), be set up for the same screen size, and be formatted in a way that can be read by the conversion.

### The Advantages of CP/M

Why then, would you convert to CP/M? The principal advantage for users is the great number of programs available that run under CP/M. There are also a great number of users groups that support CP/M, providing public-domain software and also assistance for modifying CP/M for different machines.

The greatest advantage of CP/M for manufacturers is that it is hardware independent. In other words, only a small part of CP/M—specifically, the BIOS (basic input/output system)—has to be changed to work on different computers. This flexibility enables manufacturers to include an operating system for their computers with relatively little effort. It also makes it possible for programs written on one computer to be used on other computers because they have an operating system in common.

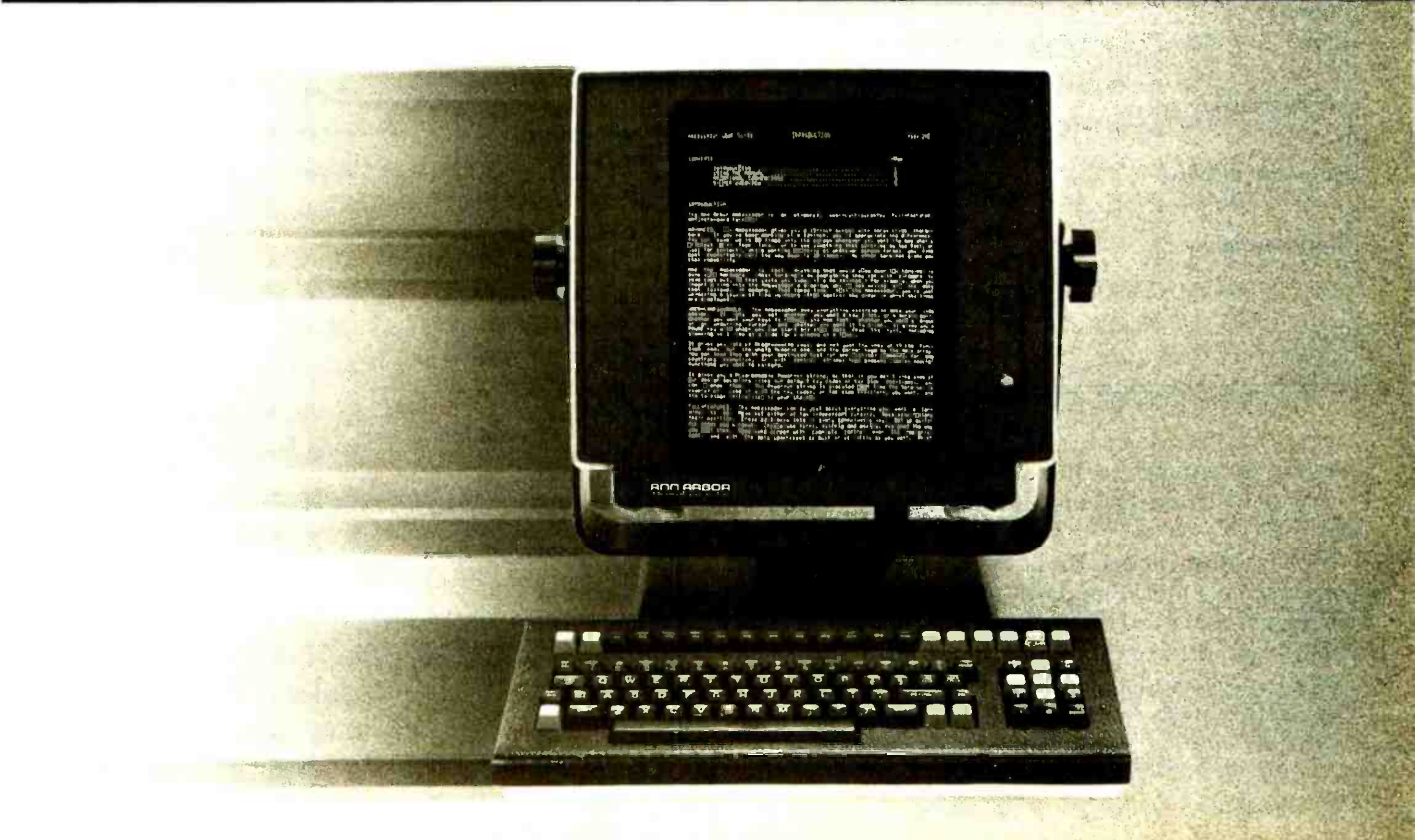
### The Disadvantages of CP/M

Because of its flexibility, CP/M doesn't take advantage of any of the special features of a particular machine. For example, there's no way to access the graphics capabilities of the TRS-80. Also, CP/M works with only one drive at a time. If you want to execute a program, you must be "logged on" the correct drive; it does not search all drives for the program as TRSDOS does. There is no password protection on any files, but because any password eventually can be broken, maybe that isn't a drawback. Also, to copy a disk you must use three separate programs. The last problem with CP/M is the quality of error messages—there are only a few, and all are nondescriptive. It's hard to believe, but this operating system reports more cryptic messages than TRSDOS.

### Converting the TRS-80 to CP/M

Let's look at some CP/M conversions available for the TRS-80 Model III. First, this machine requires a hardware conversion rather than just software because the Model III uses the first 14K bytes of memory for ROM (read-only memory) BASIC, while CP/M expects that memory to be empty and available for operating system use. This conflict can be resolved only by a hardware modification. Of course, all modifications still allow you to use TRSDOS for your existing software.

The conversion procedure is similar in all cases. Remove the cover of the TRS-80 as well as the heat shield covering the central processing board. Remove the Z80 chip and replace it with a circuit board that plugs into the Z80 socket. Then plug the Z80 chip into the circuit board. Some modifications also require a RAM (random-access read/write memory) chip to be removed and replaced by a plug connected to the CP/M board. The en-


ANN ARBOR

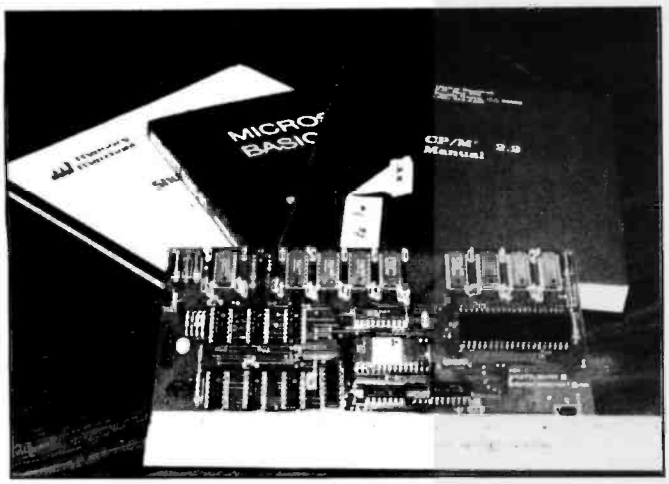



**Photo 2:** *Shuffleboard III from Memory Merchant.*

## At a Glance

**Name**
Shuffleboard III

**Use**
To convert the Radio Shack Model III to operate under the CP/M operating system as well as TRSDOS

**Manufacturer**
Memory Merchant
14666 Doolittle Dr.
San Leandro, CA 94577
(415) 483-1008

**Size**
8 by 3¾ by ½ inches

**Weight**
4½ ounces

**Features**
High-density disk format, 16K bytes of RAM, direct cursor addressing, virtual-drive concept, 15-day free trial

**Hardware required**
Radio Shack TRS-80 Model III, 48K bytes of RAM, disk

**Software supplied**
CP/M 2.2, MBASIC

**Documentation**
7- by 9-inch perfect-bound 77-page users and installation manual, 184-page MBASIC manual, and 214-page Digital Research manual

**Price**
$299

tire procedure takes about a half-hour and is easy even for those who have had only a casual acquaintance with electronics.

Because the Model III lacks a number of ASCII (American National Standard Code for Information Interchange) characters on the keyboard (braces, brackets, control key, etc.), CP/M modifications must also reconfigure the keyboard to generate all the ASCII characters. Usually this involves a combination of keys, such as the Up-Arrow and another key. I'll discuss each modifica-

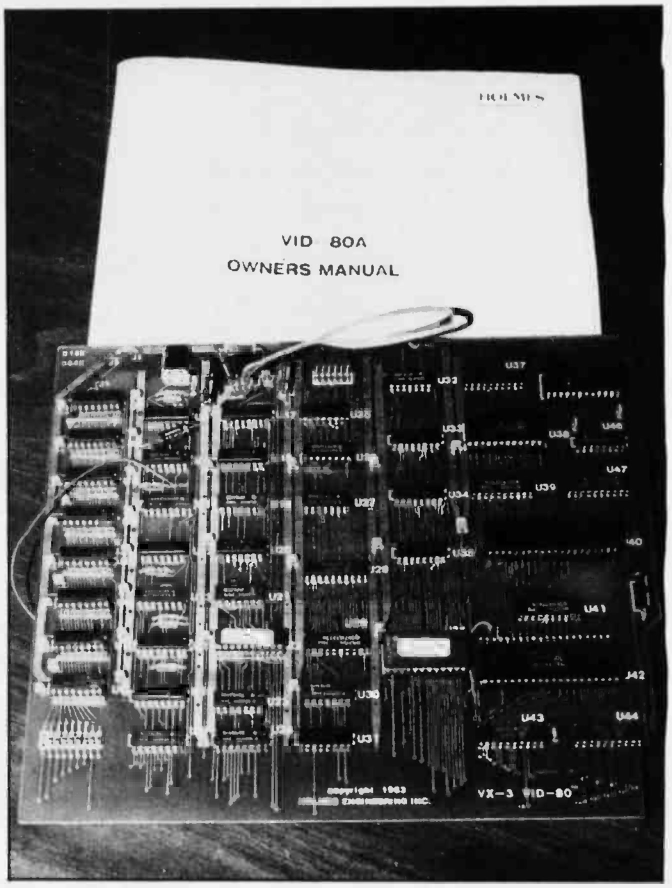



**Photo 3:** *Vid-80 from Holmes Engineering.*

## At a Glance

**Name**
Vid-80

**Use**
To convert the Radio Shack TRS-80 Model III to operate under the CP/M operating system as well as TRSDOS. Also, converts screen to 80 by 24 under both operating systems.

**Manufacturer**
Holmes Engineering Inc.
5175 Green Pine Dr.
Salt Lake City, UT 84107
(801) 261-5652

**Size**
9½ by 9 by ½ inches

**Weight**
14 ounces

**Features**
16K bytes of RAM, 80-character by 24-line board included

**Hardware required**
Radio Shack TRS-80 Model III, 48K bytes of RAM, disk

**Software supplied**
CP/M 2.2, utilities

**Documentation**
8½- by 11-inch 30-page users and installation manual; 320-page CP/M Handbook (with MP/M) by Rodnay Zaks

**Price**
$399

| Name | Control Key | Software Included | Disk Formats | Price | Able to use CP/M 3.0 | Auto Repeat |
|---|---|---|---|---|---|---|
| **Mapper III** | Down-Arrow | CP/M 2.2 MBASIC | See text | $199 | no | yes |
| **Shuffleboard III** | Up-Arrow | CP/M 2.2 MBASIC | Osborne, Xerox, IBM | $299 | no | no |
| **Vid-80** | Clear | CP/M 2.2 | Kaypro, Xerox | $399 | yes* | yes |

**optional at extra cost*

**Table 1:** *A comparison of the CP/M conversion boards.*

tion separately, but I've also summarized conversion features in table 1.

## Mapper III

The least expensive board evaluated was the Mapper III from Omikron. Although the board lists for $199, it functions well and most of its limitations should be eliminated by the time you read this.

The board I evaluated was an early prototype board that Omikron was shipping to its customers. This board is single-density, uppercase only. The manufacturer indicated that double-density should be available very soon, which would be a must for any serious user of CP/M. Omikron indicated that this will be a free upgrade for its customers and will contain a number of enhancements I'll cover later.

The Mapper III uses the Down-Arrow key for the Control key and Shift-Break for escape. It emulates the SOROC IQ120 terminal for video addressing and screen display. Installation is easy and requires the removal of only one chip, the Z80. The board contains all chips in sockets for easy repair and upgrade. It's also the smallest board that was tested.

The Mapper III that I tested could read only disks formatted for the Mapper III. Omikron indicated that the production board will read a number of formats with the previously mentioned software upgrade.

Omikron also expects to release a number of very useful utilities that will be standard with the production of the Mapper III, or free to owners of earlier Mapper IIIs, in the near future. These include programs to check memory, check disk condition, emulate a dumb terminal, and transfer programs from TRSDOS to CP/M. The last program will be most useful for long BASIC programs that you don't want to retype. Programs written under TRSDOS probably won't run under CP/M without modification.

For another $199, Omikron offers an additional software package to go with the Mapper III. The package, which includes CBASIC-II, Wordstar, and Microproof, represents a substantial savings over retail prices of these packages and gives you a good start on CP/M software. Omikron also has a special user's purchase group, Cougar, that enables owners to buy additional software at greatly reduced prices.

The installation instructions are well written and I encountered no problems with the board. Also, Omikron offers a lifetime warranty on the Mapper III. Although the software for the version I tested was not as sophisticated as the other boards, even in its preliminary form, the Mapper III offers a good value for those interested in CP/M. You should check with Omikron, however, to verify current capabilities for a particular application.

## Shuffleboard III

The Shuffleboard III from Memory Merchant is a moderately priced ($299) yet excellent conversion that contains an additional 16K bytes of memory, for a total of 64K under CP/M with a 48K-byte Model III. It includes both CP/M 2.2 and MBASIC, Microsoft's BASIC interpreter for CP/M, similar to the TRS-80 standard BASIC. A 77-page users manual and 398 pages of Digital Research documentation for MBASIC and CP/M 2.2 provide necessary documentation.

This conversion features an "auto-sense" boot that automatically determines what type of operating system is contained on the disk in drive zero. In other words, once installed, the conversion boots in the proper mode automatically; you can disable this feature if desired. The system normally boots from drive zero, but this also can be disabled, allowing you to boot from any drive for CP/M. (TRSDOS, of course, always boots from drive zero.)

The Up-Arrow key functions as a control key, and all other ASCII characters may be generated from the keyboard. The cursor may be set for either blinking or nonblinking, and linefeeds for the printer may be disabled or enabled easily to accommodate different printers.

A special function allows a remote terminal to be hooked up to the RS-232C port to allow for graphics, an 80 by 24 display, or any other special function. A SETCOM command, similar to that found in TRSDOS, is used to set the data rate, parity, character length, and stop bits. Direct cursor addressing is implemented, and console control characters are equivalent to a Lear-Siegler ADM-3A control set.

Perhaps one of the most unique features of the Shuffleboard III is its *virtual drive function*. Although difficult to explain in this limited space, virtual drive means that it may appear to the system that you have more drives than you actually do. For example, the operating system may believe that you have two double-density and two single-density drives even though you have only two double-density configurations. This makes some difficult operations easy. A high-density format routine also increases disk capacity by about 11K bytes.

I strongly believe that any good conversion should include the ability to read many disk formats because very little CP/M software comes in the TRS-80 format. The Shuffleboard III will read *and format* Osborne, IBM, and Xerox disks. Superbrain, Kaypro, and Televideo should be ready soon. Of course, IBM programs won't run on the TRS-80 because IBM uses different central processors, but this conversion does make data transfer possible. Please note that I said Shuffleboard III would also *format* these disks. This enables you to prepare a disk directly on your computer for a friend who owns a different computer, a very nice feature that is well implemented on the Shuffleboard III.

The warranty is good for one year, and Memory Merchant offers a 15-day trial period. Installation instructions are well written and clear. I installed the board quickly and without board or documentation problems. The Shuffleboard III offers a conversion with the features most users require for a reasonable price.

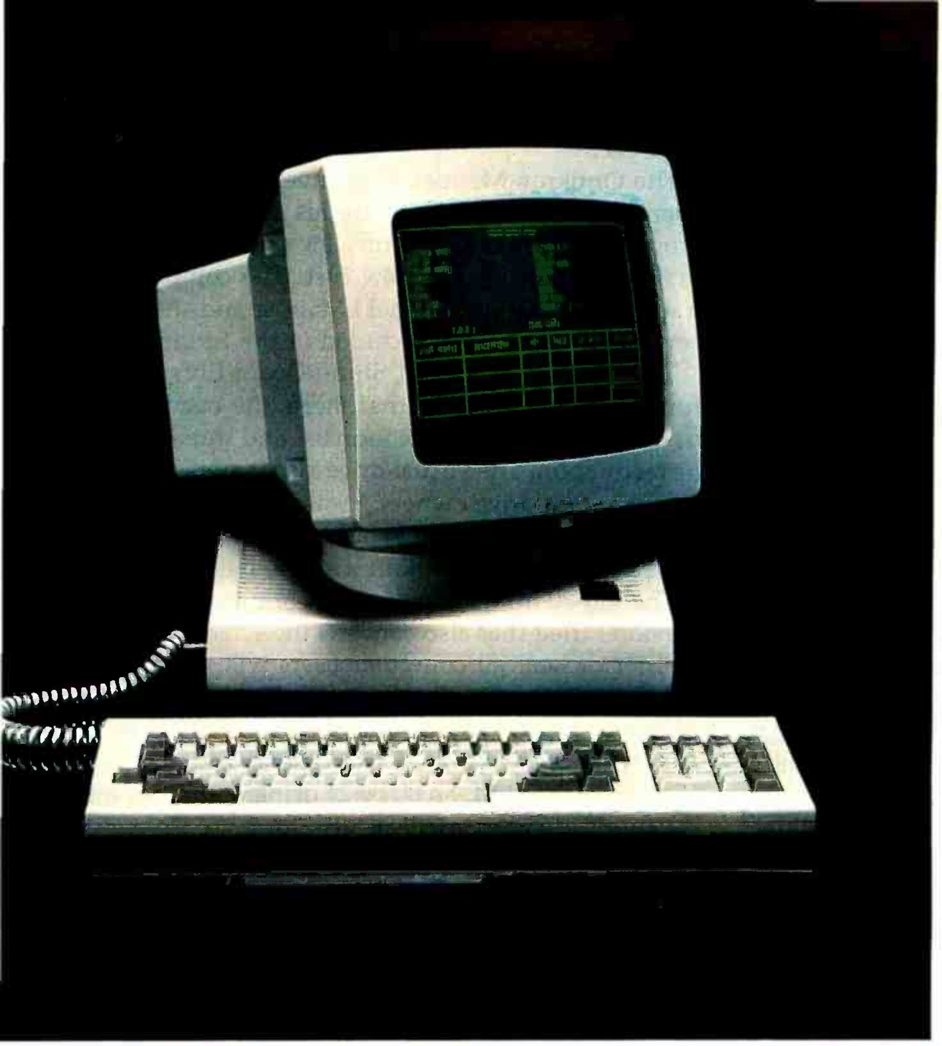
### Vid-80

The $399 Vid-80 by Holmes Engineering is the one board that not only converts the TRS-80 to CP/M but also converts the screen to 80 by 24. As mentioned earlier, most software is formatted for an 80 by 24 screen, and this conversion makes the Model III compatible with almost all CP/M software. For video and screen formatting, the Vid-80 emulates the Lear-Siegler ADM-3A terminal.

The conversion for 80 by 24 also works in TRSDOS with some limitations. Software, especially machine language, will not work without conversion in the 80 by 24 mode. The board also redefines graphics from 127 by 47 to 159 by 71, slightly improving resolution. Locations for the PRINT@ command are also redefined from 0 through 1024 and 0 through 1919. It would take a separate review to evaluate the board for its use in TRSDOS, but it does function under both operating systems.

The latest version of the board has the ability to read and write several 5¼-inch disk formats, including those of the IBM PC, Kaypro II, Xerox 820 (single- and double-density), Osborne-I, Zenith Z-100, Freedom Tech, and Morrow Micro Decision. Maximum storage using the Kaypro standard is 191K bytes. Considering that CP/M uses quite a bit of disk overhead, this is amazing. You end up with more storage capability than TRSDOS.

After the board is installed, the Model III automatically recognizes which operating system is on the disk and boots up in the 80-character mode. If you want a 64-character mode, you hold down a "6" during booting. Installation requires the removal of two integrated circuits and their replacement on the Vid-80 board. Two solderless jumper cords and two power cords must be at-



# The all new Freedom™ 110 VDT has just two things going for it.

**The price, $595.** The new Freedom 110 Video Display Terminal is without question the price leader of all low-end smart terminals. And it doesn't stop there. In fact, the price is only the beginning.

**The performance.** It starts with distinctive styling, including a tilt and swivel screen, and a sculptured, detached European DIN-standard keyboard. We paid a little extra for the green phosphor (amber optional) non-glare high resolution screen so you get the best in crisp, easy to read characters. We've packed the ergonomic Freedom 110 with a long list of user-relevant features, too.

- ☐ 24 x 80 display with user-accessible 25th status line.
- ☐ 10 programmable non-volatile function keys (20 with shift) and 20 pre-programmed codes.
- ☐ Flexible non-volatile set-up modes (full page or status line).
- ☐ 15 thin-line graphic characters.
- ☐ Non-embedded character attributes.
- ☐ 9 cursor control and 8 editing keys.
- ☐ Screen time-out.
- ☐ Block, conversation, monitor and local communication modes.
- ☐ Bidirectional buffered auxiliary port.
- ☐ 8 standard foreign character sets.
- ☐ Self-test mode.
- ☐ TeleVideo 910, ADDS Regent 25, Lear Siegler ADM 3A/5 and Hazeltine 1420 emulation.
- ☐ Chassis-mounted PC board for the same easy serviceability and add-on board capability as the advanced Freedom™ 200 VDT.

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tached. All this is done without any soldering or permanent change to your TRS-80.

In addition to the CP/M operating system and its utilities, two other programs are included. A Sap utility sorts and packs the directory to conserve space and alphabetize. An Unerase utility lets you restore files that may have been accidentally erased. Auto-repeat capabilities for each key are also standard with the Vid-80.

The Vid-80 RAM can be increased through expansion modules to nearly 1 megabyte. A CP/M 3.0 version should be available by now for Holmes's 64K-byte memory option (112K bytes total), which sells for $524.

For technical assistance and updates, Holmes maintains both a phone number and a computer bulletin board. This bulletin board, Connection-80, enables Holmes to pass on patches and other technical information and allows the user to leave questions about Vid-80 for Holmes. When I contacted Holmes with technical questions, both as a reviewer and customer, the company was courteous, quick, and correct each time.

Both Omikron and Memory Merchant indicated that they will be marketing an 80 by 24 conversion for their CP/M boards in the future. The Vid-80 already has this feature, which makes the Model III very competitive with the Model 4. The Vid-80 is a complete CP/M conversion and enables you to enter the world of CP/M without reservation.

### What about the Model 4?

What advantages does the Model 4 have over the Model III? Well, the most significant are a higher speed processor, an 80 by 24 screen, ASCII character generation, a new (TRSDOS 6.0) operating system, and CP/M compatibility. If you're only interested in CP/M, you should consider one of these boards for your Model III. Holmes also sells a speed-up kit for the Model III for about $100. Converting this way allows you to add one piece at a time, instead of all in one big costly chunk.

### Conclusions

Each of the conversions is targeted at different users. You should decide which you need for your individual use. All the conversions worked without major problems and are easy to install following the instructions included with each.

The Omikron Mapper III is aimed at the low-budget user who intends to purchase his software from Omikron. Omikron's Cougar club allows owners to purchase major programs at very low cost. The company has a track record with the Model I Mapper and should have several enhancements included in the future.

The Memory Merchant Shuffleboard III is a full-featured CP/M conversion that meets the needs of most users. It reads three disk formats, and three more will be ready soon. The virtual-drive idea is exciting and very useful to two-drive owners. I was most impressed with this board and its implementation. I have used this board for several months without a single bug.

The Vid-80 from Holmes Engineering is the only conversion I tried that also converts the screen to 80 by 24. Sooner or later all computer users will want this size screen for some application, and Holmes solved that problem. I give Holmes four stars for this conversion. I know that $400 is quite a bit to spend, but that's a very low price for CP/M, an 80 by 24 display, and accommodation of a wide variety of disk formats. Holmes has been in the TRS-80 business for many years and has a good record with the dealers with whom I spoke. If you can afford to do the conversion all at once, the Holmes board is a good choice.

All in all, the TRS-80 user has a number of conversions from which to choose. With Radio Shack turning to CP/M, it may not be many years before TRSDOS is gone forever. I think all serious users should start looking into CP/M and what it has to offer. ■

**Author's Note:**
*I'd like to thank all the manufacturers for their cooperation and answers to my questions. I'd also like to thank Bob Byars at Mountain Data in Havre, Montana, for the use of his equipment and time.*

*Mark E. Renne (53 Glacier Ct., Bozeman, MT 59715) is a free-lance writer and full-time student at Montana State University in Bozeman.*

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# Robographics CAD-1

*Convert an off-the-shelf Apple into a drafting system*

**Rik Jadrnicek**
**Micro Flow Company**

There are more and more CAD (computer-aided design) packages coming out all the time. In fact, trying to keep up with them becomes a job in itself. Out of necessity, I find myself picking one or two outstanding characteristics from each to separate it from the rest. Robographics CAD-1 stands out for its use of libraries—the way it enables you to assemble large drawings with complete disregard for the amount of available RAM (random-access read/write memory)—and for its zooming abilities—the way it allows you to draw in much greater detail than the graphics monitor can show.

CAD-1 is a computer-aided design software package for the Apple II and Apple IIe computers. Using CAD-1, you can draw a wide variety of pictures with great accuracy and plot the image precisely on various output devices. For example, you may draw simple block diagrams, flowcharts, or a more complex schematic; you may design a personal computer circuit board or do some mechanical drawing on a valve; or you may do some space planning or architectural design.

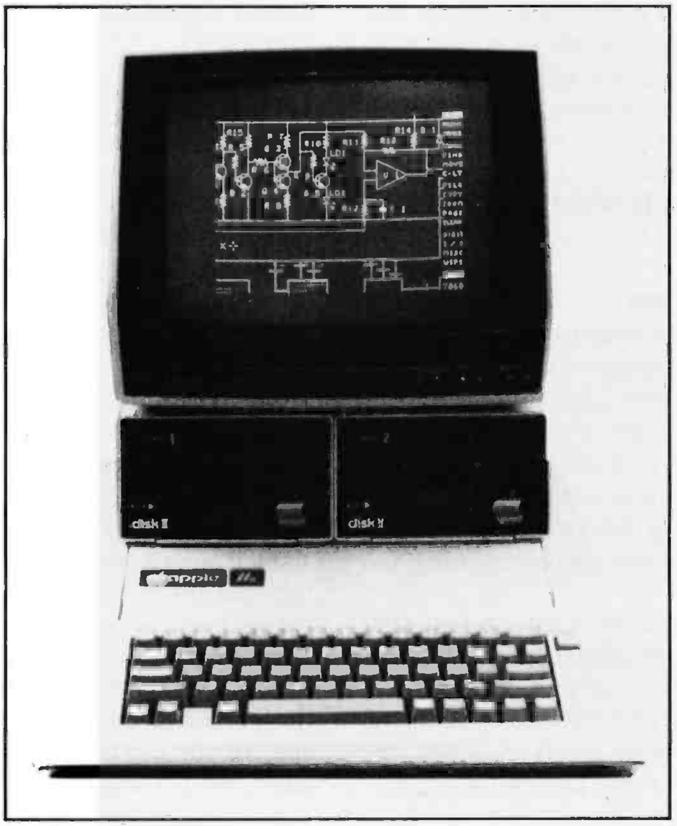

**Photo 1:** *An Apple IIe displaying a typical CAD-1-created drawing.*

How well a CAD system performs these tasks depends on software quality, the central processor, the graphics processor and monitor, and the hard-copy output device. Within the limitations of Apple's 6502 processor and graphics resolution, CAD-1 performs very nicely. Written in assembly language with high-precision floating-point math, the program is lightning fast and seems to implement fully the processing power available.

### Hardware

With this software, you can convert an off-the-shelf Apple computer into a drafting system. You need the CAD-1 software, the joystick supplied with the software, an Apple II or IIe with 64K bytes of RAM, a suitable video display, and two Apple II DOS 3.3 disk drives with controller cards.

CAD-1, with its special input device (a hardware box with three buttons, a rotating dial, and a joystick) retails for $1095. With it you can make the most of the entries necessary to run the program. You can draw accurately with the joystick and rotate and scale objects with the dial. More on this device later.

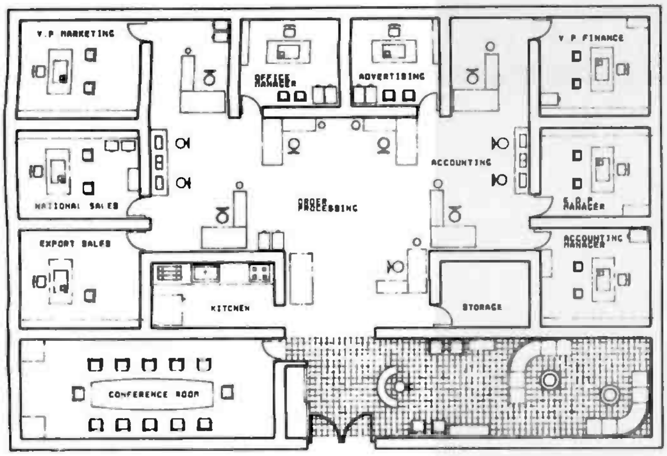


**Figure 1:** *A sample floor plan prepared with CAD-1. This drawing is made easy by manipulating different user-defined library drawings of standard office furnishings.*

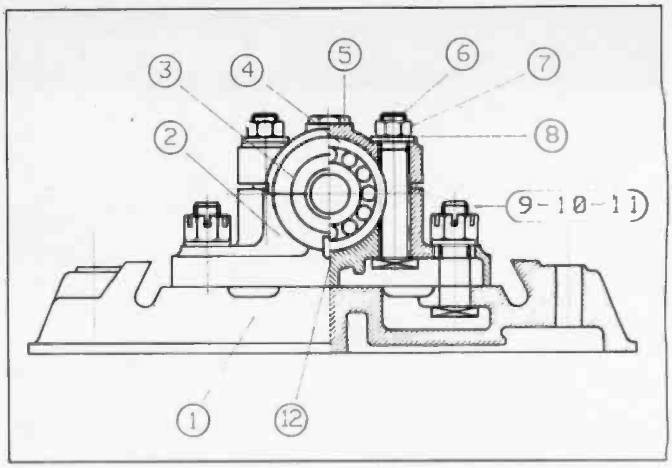


**Figure 2:** *A mechanical drawing created with CAD-1 showing the potential accuracy of the software and the use of line types, arc, circles, and crosshatching.*

Optionally, CAD-1 also supports the Robographics and Apple Graphics 11 by 11 digitizing tablets to make drawing easier. These devices simulate a drafting table and come in all sizes. You can trace existing drawings or simply draw from scratch on the digitizer surface. A stylus or cursor (sometimes called a puck) serves as an electronic pencil for entering data points at the press of a button.

To produce low-resolution, hard-copy plots of your drawings, you can use a dot-matrix printer. The software supports a variety of interface cards and you can configure the software yourself if a particular card is not directly supported. You can use a variety of quality plotters capable of producing A to D size plots (USA) or A1 to A4 size plots (Europe). These currently include Bausch & Lomb (Houston Instrument DMP 40 through 42), Calcomp (models 81, 84), Gould Bryans Colorwriter, Hewlett-Packard (7470A, 7580A/B, 7585A) and Watanabe Digiplot (all B or A3 sizes).

## Monitor Drawing Resolution

A variety of graphics monitor options are available in addition to the standard Apple graphics capability. Herein lies the major limitation of most CAD systems including CAD-1. The software is capable of producing a large drawing (e.g., 24 by 36 inches) in detail, and a large format plotter is fully capable of plotting the same detail. However, the graphics display device can't accurately represent the image you see while you are creating and editing your drawing.

The resolution of the graphics processor and monitor determines the accuracy with which a display can represent an image. These devices have only a certain number of pixels (picture elements) with which to describe an image. The lower the number of pixels available, the lower the resolution and the more jagged the image.

For example, the resolution of the Apple is 280 horizontal pixels by 192 vertical pixels. The Robographics CAD-1 system uses the rightmost 24 columns of pixels for on-screen menus (see photo 1), leaving a workspace of 256 by 192 pixels. This area is used to represent your image no matter how large it is. It stands to reason that a 24- by 36-inch drawing appears very crude.

On the other hand, the actual drawing database is very accurate. The output device resolution provides the only limitation on the quality and resolution of the hard-copy output. For example, a dot-matrix graphics printer produces a low-resolution image while a high-resolution plotter reproduces the drawing accurately. These differences in actual, display, database, and output resolution are important to understand when configuring CAD systems.

## Let's Draw

To begin drawing with CAD-1, you hook up the input device to your Apple, insert the program disk in the drive, and load the program. Then you insert a library disk in drive A and a buffer disk in drive B. There is a lot of disk swapping with CAD-1. When you use a plotter, an additional disk must be swapped. The system really needs a hard-disk version developed for serious applications.

Once the proper disks are in place and the system is loaded, the system presents you with a clear screen to draw on—clear except for a menu area down the right-hand side of the screen and a function area at the bottom. Using the joystick on the input device, you move a small cursor (an "x" on the screen) around the drawing area and place it on menu choices. Pressing a combination of the device's three buttons, you choose commands and functions from the menu and create drawings on the monitor screen. For example, if you move the cursor to the function area at the bottom of the screen, you can choose a primitive type (e.g., line, arc, circle, etc.), a color, and a line type (e.g., dotted). Then if you choose DRAW on the monitor menu, you can draw images on the screen with the joystick (or digitizer) and the buttons. You can freehand sketch, trace lines of

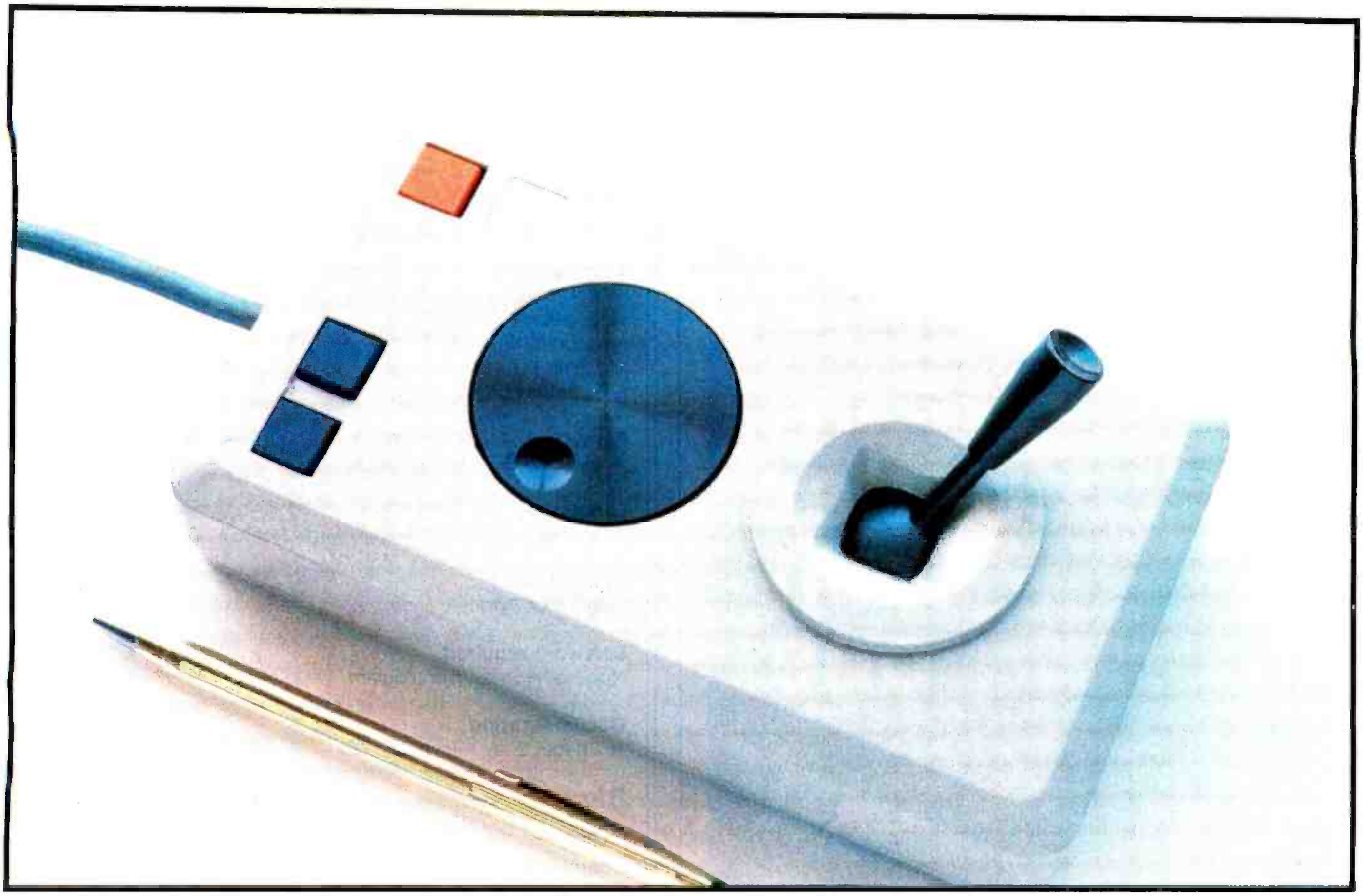

**Photo 2:** *The Robographics CAD-1 specially designed input device, consisting of a hardware box with three buttons for selecting and deselecting points and menu options, a joystick for positioning the cursor on the display screen, and a rotating dial for controlling such things as the radius length of a circle, or an arc, or the rotation of objects on the screen.*

different widths, fill areas temporarily or permanently, insert text, erase objects, zoom, and pan (scroll from one area to another). See figures 1 and 2.

Since the program is written in assembly language, the cursor movements and placement of lines and shapes are instantaneous. You can freely manipulate lines, arcs, and circles while you watch them stretch and shrink on the screen before you. You can turn on a grid system and lock your drawing to the grid points (your drawing points snap to the nearest grid point—standard or user-defined) to produce precision drawing. You can have different $x$- and $y$-axis values and you can rotate the grid if you want to work on isometric images.

## Commands

Several cursor lock modes are available for drawing precision. You can lock the cursor to move in only two fixed directions from its current position. The axes of these two directions can be set at different angles providing tremendous help in constructing isometric images. A NORMAL-TANGENT lock mode automatically senses the slope of the last line drawn then sets an orthogonal axis (at right angles) lock at the end of the line. I find this helps to create a smooth continuation of a previous line with an arc—a good way to construct a fillet (the concave transition surface between two otherwise intersecting surfaces).

You can determine the location of a specific point with the FIND command, snap the current grid to that point with SHIFT-GRID, and rotate the grid using NORMAL-TANGENT. You can even skew the grid for more variety. These are very powerful features for precision work. You can draw isometric projections in true scale or, if this is too confusing, call up two preset standard grids to restore your sanity.

The scale of the CAD-1 system is metric but the database units could just as well be feet or inches with decimal fractions. By the time you read this, CAD-1 expects to have automatic dimensioning with feet and inches (requiring a Saturn RAM expansion board to boost the Apple to 192K bytes of RAM), but currently dimensioning must be done manually.

With the NIB command you can determine the spacing between, and the direction of, the fill elements. This allows you to shade objects, giving dimension to your drawings.

There are some software limitations in CAD-1. I did not see a provision for entering data-point coordinates manually from the keyboard, either relative to the origin (0,0), relative to the current point, or using polar coordinates (angle and distance from a point). The ability to draw on layers, turning them on and off to display dif-

### At a Glance

**Name**
Robographics CAD-1

**Type**
Computer-aided design (CAD) software

**Manufacturer**
Chessell-Robocom Corporation
111 Pheasant Run, Suite 2B
Newtown, PA 18940
Mr. Peter Kendall
(215) 968-4422

**Format**
Apple DOS 3.3 5¼-inch floppy disks

**Language**
Assembler

**Computer**
Apple II or Apple IIe

**Software required**
None other than the program

**Documentation**
167-page, 6- by 9-inch manual

**Price**
$1095 including hardware input device

**Comments**
CAD-1 provides fast, powerful, and easy-to-use computer-aided design capability on an Apple II or Apple IIe

ferent elements of your drawing, is also missing. In addition, only one text font is provided and it is only adequately attractive.

## Zooming

CAD-1's ability to zoom into an area of the drawing helps to overcome the display monitor's limitations. For example, when you zoom into (or window) a particular room of a floor plan you are drawing, that room will fill the entire monitor screen. You can see more detail and you can draw with greater precision. The width of the screen could represent, for example, 1 inch, 1 foot, or 1 mile.

The concept of zooming is important to understand. CAD-1 provides a window into your drawing. Consider a 24- by 36-inch drawing. With CAD-1, you can see as much of that area as you want at a time. You can draw a border on the drawing and then zoom in to a 9- by 12-inch area to do some detailed work. You can zoom in further to a 1-inch square and draw at 0.001-inch precision. In effect, you are scrolling a window (often called a viewport) over the surface of a larger drawing. Zooming back to the full-size drawing condenses all that detail into a relatively small area on the screen. This doesn't have any effect on the final plot, however; the full 24- by 36-inch image is plotted to scale depending on output device capability.

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## Drawing Size

Each drawing holds up to 3000 bytes of information. For example, a line takes 10 bytes, an arc 15, a circle 8, a nib fill pattern 18, text 10 (plus 1 byte per letter). When the workspace fills up, the system notifies you with a beep. This is where CAD-1 gets creative. It is obvious that 3000 bytes is not much room for a detailed drawing. CAD-1 lets you store the work you have done in a library on disk. Within one library file you are allowed three pages of drawings. The number of drawings you can keep on each page varies from 4 to 64. Put simple images like letters on the 64-division page and more complex drawings on the 4-division page where you can save more detail.

Once you store your drawing in a library slot, you can return to the drawing editor, clear the screen, and draw another 3000-byte image. You can also store this drawing in a library and return to do another and so on until the memory is used up. Then you can copy back the stored library images to your current drawing. As the images come in, you can freely scale them by $x$ and $y$ and rotate them in increments of 5 degrees (by turning the rotating dial on the input device). Once copied, they are treated as one entity and occupy only 20 bytes in your current drawing. You can assemble about 150 of these drawings within the new drawing and then save that drawing as a library image. When copied into another drawing, this image also takes only 20 bytes of memory. This procedure can go on until the disk space is used up.

Developing large drawings with CAD-1 is a process of assembling smaller drawings that have been stored in the library. A certain amount of preorganization is, therefore, required to do complex drawings. You can even copy library items from different library disks into your current drawing. When the current screen is full, simply save the increasingly complex image to an available library slot and continue, incorporating it in another drawing. Animation effects can be developed by creatively interacting with the library images and the drawing-regeneration process.

There are some limitations associated with using library images that ought to be mentioned. When you copy a complex drawing in from the library, you can't edit it in detail. However, you can edit the original library image after which all references to it reflect the revisions. You can also print/plot your library pages for reference in assembling your drawings. Needless to say, this is a clever way of overcoming the RAM limitations of the Apple. The real drawing size limitation becomes the available disk space.

Since the regeneration of your drawing slows down in proportion to the drawing size, it makes more sense to assemble large drawings by overlaying a series of smaller drawings onto your plotter rather than by trying to fit everything into one drawing. Nevertheless, significant capability is available and one Apple disk will store several 24- by 36-inch plots with an average amount of detail.

## Packaging

CAD-1 documentation consists of one 6- by 9-inch manual with typeset pages printed on one side. The manual contains three sections, Getting Started, Basic Drawing, and Precision Drawing, and eight appendixes covering subjects like library archives, constructing lines with a given angle and length, creating symmetrical drawings with the mirroring function, discussion of the plotting utility and the options available, and others. The manual is well illustrated with a good tutorial. It needs double-sided pages and a good section on CAD basics, though.

The package includes an intelligent plot utility on a separate disk with a variety of options. You can search the library pages for the image you want to plot and window the appropriate area. You can change line types or colors, choose predefined zoom and plot scales, and plot with dimensions in metric or English units (in decimals). The program automatically selects different pens on multipen plotters, and you can stop or pause the plot at any time—very handy if you need to change a pen.

The software is copy protected with one backup of the program disk supplied. There is a 90-day warranty against defects in material and workmanship after which disk replacement costs $10. Enhanced versions seem to be on the horizon, so check the company's update policy.

## Conclusions

CAD-1 makes good use of the Apple computer. I am amazed at how much is possible with the processing power of the 8-bit 6502 chip. The accompanying hardware input device provides a very friendly interface; however, it is nice to see that a selection of digitizer devices and plotters is also supported.

CAD-1 is written in fast assembly language and uses floating-point math for very high precision capability. The drawing library is a very strong feature. The ability to copy library drawings into the current drawing with minimal RAM overhead makes large drawings possible within the limitations of addressable RAM. Automatic dimensioning in feet and inches will be a welcome addition.

Like all CAD systems, this package needs a graphics processor/monitor combination with higher resolution to take full advantage of its capabilities. Running the program requires too much disk-shuffling, especially for more complex drawings. A hard-disk version is needed along with more addressable RAM and an MS-DOS version. Currently the program runs on the IBM PC with a Quadlink card installed. A true MS-DOS version is planned for release in 1984.

This software appears as somewhat of a sleeper, like a Ferrari engine in a Volkswagen. It is worth checking out, especially if you plan some serious drawing with an Apple computer.■

*Rik Jadrnicek is president of Micro Flow (POB 1147, Mill Valley, CA 94942), a microcomputer consulting firm. When he isn't writing or playing with microcomputers, Rik likes sailing and traveling.*

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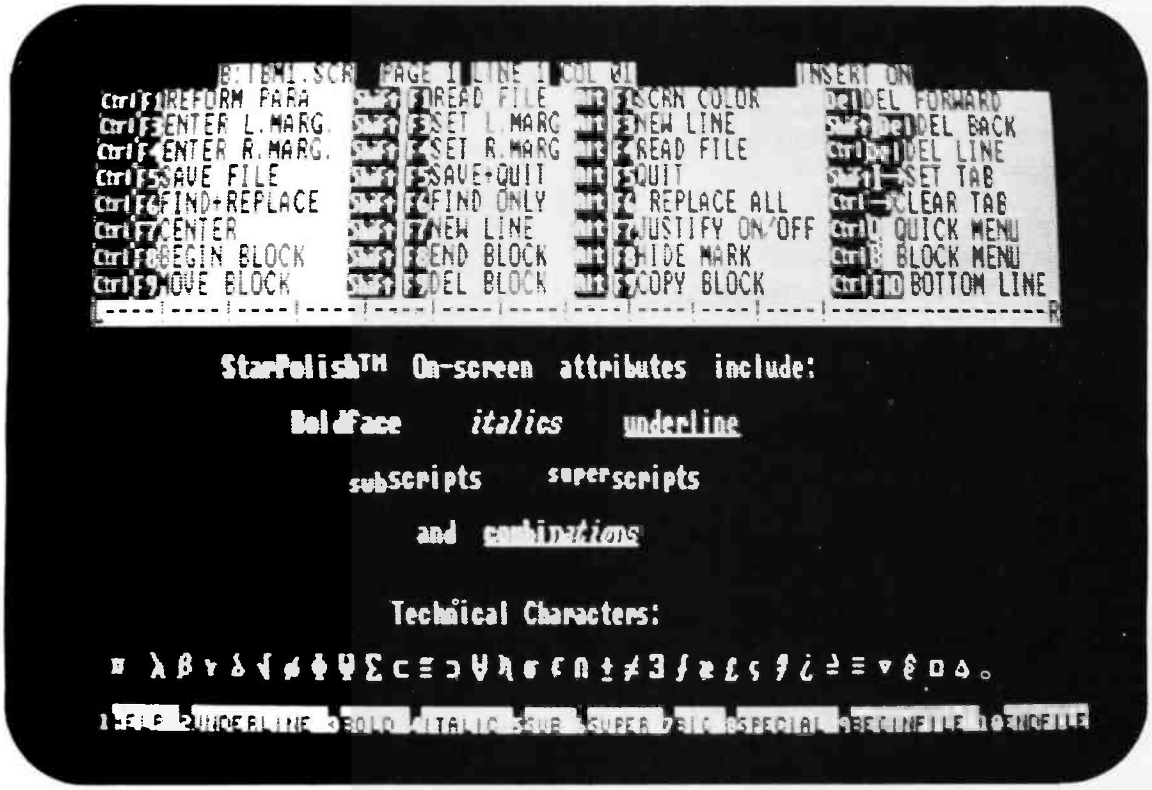


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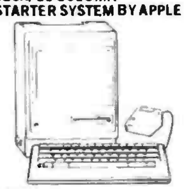

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| ★ Titan/Saturn, Accelerator II | $ 599 | $ 449 |
| Transend/SSM, AIOII, Serial/Para I/F | $ 225 | $ 169 |
| TG Products, Game Paddles (II+) | $ 40 | $ 29 |
| Joystick (II+) | $ 60 | $ 45 |
| Videx, PSIO I/F Card | $ 229 | $ 169 |
| WICO, Mouse, Complete | $ 179 | $ 119 |

## SOFTWARE for APPLE II+IIe

### BUSINESS

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| ★ Applied Soft Tech., VersaForm | $ 389 | $ 259 |
| Artsci, Magic Window II | $ 150 | $ 99 |
| Magic Combo (Wind.Mail&Words) | $ 225 | $ 149 |
| ★ Ashton-Tate, dBase II (Req CP/M 80) | $ 700 | $ 385 |
| Friday (Requires CP/M 80) | $ 295 | $ 199 |
| BPI Systems, GL,AR,AP,PR or INV,each | $ 395 | $ 269 |
| ★ Broderbund, Bank St. Writer or Spell,ea. | $ 70 | $ 45 |
| Continental, GL,AR,AP or PR each | $ 250 | $ 165 |
| ★ Home Accountant | $ 75 | $ 49 |
| Tax Advantage | $ 70 | $ 47 |
| Dow Jones, Market Analyzer | $ 350 | $ 275 |
| Market Manager | $ 300 | $ 235 |
| Market Microscope | $ 700 | $ 525 |
| Fox & Geller, Quickcode or dGraph, ea. | $ 295 | $ 185 |
| dUtility (for dBase II) | $ 99 | $ 66 |
| Hayden, Pie Writer (Specify 80 col. bd) | $ 150 | $ 99 |
| ★ Howard Soft, Tax Preparer, 1984 | $ 250 | $ 185 |
| LJK, Letter Perfect w/Mail Merge | $ 150 | $ 99 |
| Micro Pro, (all require Z80-CP/M Card) | | |
| ★ WordStar w/applicard &CP/M SPECIAL | $ 495 | $ 295 |
| InfoStar w/applicard &CP/M SPECIAL | $ 495 | $ 295 |
| WordStar™ + Training Manual SPECIAL | $ 495 | $ 239 |
| SpellStar™ or MailMerge™, ea. SPECIAL | $ 250 | $ 129 |
| ★ WordStar Professional, 4 Pak SPECIAL | $ 895 | $ 395 |
| Options Pak, SS/MM/SI | $ 295 | $ 175 |
| Microsoft, Multi-Plan (CP/M or Apple DOS) | $ 250 | $ 169 |
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| Some Common Basic Programs (75 ea.) | $ 100 | $ 49 |
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| Peachtree, Requires CP/M & MBasic. 64K | | |
| Series 40 GL & AR & AP, all 3 | $ 395 | $ 239 |
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| Advanced DB Master | $ 595 | $ 495 |
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| Visicalc Enhanced (IIe) | $ 250 | $ 179 |
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| Visifile or VisiDex, each | $ 250 | $ 179 |

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| Typefaces (Req. Ap. Mechanic) | $ 20 | $ 15 |
| DOSS Boss or Utility City, each | $ 30 | $ 22 |
| Tip Disk #1 | $ 20 | $ 15 |
| Pronto DOSS | $ 30 | $ 20 |
| Alpha Plot | $ 40 | $ 27 |
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| Einstein, Compiler —Applesoft BASIC | $ 129 | $ 85 |
| Epson, Graphics Dump | $ 15 | $ 9 |
| Hayes, Terminal Prog. (SM or MM.ea.) | $ 100 | $ 65 |
| ★ Insoft, GraFORTH by Paul Lutus | $ 75 | $ 59 |
| Microsoft, A.L.D.S. | $ 125 | $ 85 |
| Fortran 80 | $ 195 | $ 135 |

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| Penguin, Complete Graphics System II | $ 70 | $ 53 |
| Graphics Magician | $ 60 | $ 41 |
| Phoenix, Zoom Grafix | $ 40 | $ 34 |
| Quality, Bag of Tricks | $ 40 | $ 29 |
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| Utilico, Essential Data Duplicator III | $ 80 | $ 49 |

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| Bluechip, Millionaire | $ 60 | $ 40 |
| Broderbund, Choplifter or Lode Runner,ea. | $ 35 | $ 25 |
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| IBM-PC Smartcom II Software | $ 149 | $ 109 |
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| Transmodem 1200 | $ 695 | $ 559 |

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| 12" Color, Composite, 1215A(Apple) | $ 399 | $ 299 |
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| ★ Amber, MAX-12(Mono Brd.) | $ 249 | Call |
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| Quadscreen 17" 968x512 | $1995 | $1495 |
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| 92, 80 col., 160 cps, para. | $ 599 | Call |
| 93, 136 col., 160 cps, para. | $ 999 | Call |
| 2350P, Pacemark, 350cps, para | $2695 | Call |
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| ORANGE MICRO, Grappler+, for Apple | $ 165 | $ 119 |
| PRACTICAL, Microbuff In-Line 64K,Para. | $ 349 | $ 259 |
| Microbuff In-Line 64K,Ser. | $ 349 | $ 259 |
| QUADRAM, Quadjet, Jet Color Printer | | Call |
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| NEC, 15LQ, 14cps, Para,w/TF, 101col | $ 695 | $ 525 |
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| ★ TTX, 1014, 13cps, Para.&Ser., Pin&Fric. | $ 649 | $ 459 |

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| IBM-PC to Epson or Star Micro. Cable | $ 60 | $ 35 |
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| Microfazer, w/copy, PP, 8K, #MP8 w/PS | $ 189 | $ 129 |
| Microfazer, w/copy, PP, 64K, #MP64 w/PS | $ 319 | $ 219 |
| Microfazer, w/copy, PP, 128K, w/PS | $ 465 | $ 295 |
| Microfazer, Snap-on, 8K, PP, Epson w/PS | $ 179 | $ 145 |
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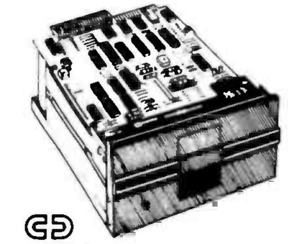

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| Wave, 256K (short brd.) | $ 499 | $ 369 |
| Bosun, S/P/C (short brd.) | $195 | $145 |
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| **Titan** Accelerator PC (8086 + 128K) | $ 995 | $ 750 |
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# Two More Versions of C for CP/M

## *A benchmark comparison of Q/C and Eco-C*

**David D. Clark**
**Pennsylvania State University**

In recent years the C programming language has generated a great deal of interest. Small, concise, fast, powerful, and offering many operators, it provides both systems-implementation and applications-programming capabilities. C compilers for microcomputers have virtually exploded onto the marketplace in the past two years. I reviewed two of the newer releases: Q/C, written by Jim Colvin and distributed by The Code Works, and Eco-C from Ecosoft.

### Q/C Version 3.0

Q/C is a fairly complete implementation of the C compiler unless you require floating-point capabilities. It comes in two basic forms: 8080, which requires either Digital Research's RMAC assembly language or Microsoft's M80 assembly language, and Z80, which works only with the M80 assembly language. It is a single-pass, recursive-descent compiler that takes its input from a file, passes it through a "window," and produces an assembly-language file.

Originally derived from Ron Cain's small-c compiler (see reference 1) and tremendously increased in power through several major revisions, Q/C 3.0 is now a subset of the Unix Version 7 C compiler from Bell Laboratories. It lacks:

- variable types—long, float, and double
- bit fields
- casts
- sizeof
- typedef
- local declarations in compound statements
- parameterized #define statements
- type specifiers on function declarators (all functions return integers)

The Z80 package includes an excellent paperback user's manual and a disk containing an executable version of the compiler, a program to change the defaults, a relocatable version of the function library, and *the source text for the compiler and the library*. You must buy the M80 (or the RMAC) assembly language separately.

The manual first explains how to compile, assemble, and link a small program. Then it goes into more detail, explaining the command-line options (see table 1), redirection, assembly-language interfacing, the standard library, and the internal workings of the compiler itself. The manual is readable and complete.

### Eco-C Version 1.52

Eco-C from Ecosoft has a three-pass compiler. First, the preprocessor accepts a C program as input and writes an intermediate token file to disk; then the C parser program writes an intermediate code file; finally, the code-generation pass reads the intermediate code file and generates an assembly-language output file. If the parser pass detects a bug, it calls an error-handling program to print a message telling where the error occurred and to abort the compilation.

The Eco-C compiler attempts to adhere strictly to standard C's syntactic and semantic rules. It is a very complete implementation lacking only:

## At a Glance

**Name**
Q/C C compiler

**Version**
3.0

**Manufacturer**
The Code Works
POB 6905
Santa Barbara, CA 93160
(805) 683-1585

**Price**
$95

**Computer needed**
8080- or Z80-based CP/M with at least 56K bytes of memory and at least one disk with a capacity of 240K bytes (two are recommended)

**Documentation**
136-page paperback manual

**Audience**
Systems and application-software developers, hobbyists

## At a Glance

**Name**
Eco-C C compiler (including M80 assembly language)

**Version**
1.52

**Manufacturer**
Ecosoft Inc.
POB 68602
Indianapolis, IN 46268-0602
(317) 255-6476

**Price**
$350

**Computer needed**
Z80-based CP/M or MP/M 2.0 or later versions, with at least 56K bytes of memory and at least one disk with a capacity of 240K bytes (two are recommended)

**Documentation**
61-page loose-leaf manual; a 186-page loose-leaf manual also is included describing Microsoft's Utility Software Package, included with the compiler

**Audience**
Systems and application-software developers

- bit fields
- initializers
- parameterized #define statements
- the #line preprocessor directive
- macro expansion in a compound expression following an #if preprocessor directive
- redirection of standard I/O (input/output) (This is the responsibility of the operating system, not the compiler. However, many versions of C for CP/M provide the function in a library routine.)

| | |
|---|---|
| -a | Generate an assembly-language file for Digital Research's RMAC assembly language. This option is not available with the Z80 version. |
| -c | Generate a commented assembly-language file. |
| -d | Send output to the console rather than a disk file. This is useful for debugging. |
| -i | Toggle initialization of large arrays. When turned off, arrays larger than 128 bytes will not be initialized to zeros. |
| -l | Do a library generation. Each function encountered will be written to a separate file. |
| -m | Generate an assembly-language file for Microsoft's M80 assembly language. This option is not available with the Z80 version. |
| -o | Specify a name for the output file. |
| -r | Toggle the inclusion of redirection capability into the compiled program. When turned on, a larger version of the run-time initialization routine is included that allows redirection of standard I/O from the command line. |
| -s | Generate ROMable code with an optional specification of the stack starting address. |
| -t | Generate trace messages in the compiled program. When turned on, code is generated to print a message of the form ">function-name" on entry to each function and "<function-name" on exit. |
| -v | Toggle the compiler between verbose and terse mode. In verbose mode, the compiler displays progress messages as it proceeds. |

**Table 1:** *The Q/C compiler command-line options.*

The Ecosoft package consists of a loose-leaf user's manual and a disk containing the software. Microsoft's Utility Software Package, a standard software component, is included. It contains the M80 relocating macro assembly language, L80 linking loader, LIB80 library-management program and CREF80 cross-reference utility. Because the M80 assembly language comes with the compiler, you don't need any additional software to use the system.

The manual for Eco-C contains instructions on how to get started, command-line options (see table 2), some programming hints, a description of the standard library, and various details on how to work with the system. Some packages also come with a copy of the C *Programming Guide*, an easy-to-understand introduction to C by Jack Purdum, Ecosoft's president.

### Benchmarks

To compare the relative performances of various implementations of the C programming language, I ran benchmarks on a "generic" CP/M-based system consisting of a Teletek Systemaster with a 4-MHz Z80A, a Heath H19A terminal, and two 8-inch, double-density, double-sided Mitsubishi disk drives. The CP/M 2.2 operating

| | |
|---|---|
| -b | Turns off most of the progress messages normally displayed by the compiler during its operation. |
| -c | Uses the library in which getchar() and putchar() do direct BDOS calls to CP/M for console I/O rather than passing through getc() and putc(). The code generated is slightly smaller. |
| -i | Tells the compiler to use the version of printf() for integers. If the program does not need to print floating-point numbers, this option should be used. |
| -o | Specify a name for the output file. |
| -snnn | Select the system libraries nnn at link time. There are 10 reserved system libraries. The only one implemented at the time of this writing is SLIB0, which contains the transcendental library. |
| -unnn | Select the user libraries nnn at link time. This option is similar to the -s option. User libraries may contain whatever the user wishes. |
| -ns or -nu | Variations of the last two options. These options allow selection of a range of libraries. For example, -5u would search from ULIB5 down to ULIB0. |

**Table 2:** *The Eco-C compiler command-line options.*

system had a 56K-byte TPA (transient program area) and the BIOS (basic input/output system) used 256-byte disk buffers.

I am including the BDS C compiler in some of the benchmark results to allow you to indirectly compare Q/C and Eco-C with other C compilers previously benchmarked against the BDS compiler. (The BDS compiler is one of the most popular and intensively examined versions of C for microcomputers.) (See reference 2.)

To measure the speed of compilation, assembly, and linkage, timing started when the Carriage Return was tapped at the end of the command line and stopped when the CP/M prompt line reappeared on the screen. Because of this, the times listed include the time required to load the compiler, assembly language, or linker and the time required to warm-boot CP/M (a total of 4 to 12 seconds depending on the program). To measure execution speeds, timing started when the first program message line appeared on the screen and stopped with the display of the program termination message. All timing, reported to the nearest half-second, was done on a handheld stopwatch.

The Q/C programs were compiled with the -i option, which directs the compiler not to initialize large arrays to zero. This results in a tremendous reduction in the size of some assembly-language files and the time required to assemble them. When you invoke this option, the system uses a DS (define space) assembly-language directive to allocate array space rather than a series of DB 0 (define byte 0) directives. If you don't require zero initialization, this option makes a great deal of sense.

With the exception of the floating-point benchmark, the Eco-C programs were compiled with the -i and -c options. The -i option says to use a version of the printf() function that doesn't format real numbers, resulting in smaller code size and slightly greater speed. The floating-point benchmark needs to perform output of real numbers so the -i option is inappropriate. The -c option tells the compiler to use the direct console I/O procedure in the CP/M BDOS (basic disk operating system) instead of passing console I/O characters through the file handlers. Because Ecosoft doesn't supply the source of the printf() function, it is impossible to know how it handles character I/O.

The BDS versions were compiled with the -o and -e options. The -o option optimizes speed for some processes while it sacrifices space. The -e option gives the compiler the address where "external" variables should start. This allows direct reference to the variables (rather than indirect through a table), saving time and space. The BDS versions used the L2 linker from Mark of the Unicorn (222 Third St., Cambridge, MA 02142), which offers some advantages over the standard linker, CLINK (such as linking very large files by swapping part of the linkage tables to disk and replacing indirect table references with direct references, eliminating the tables, reducing code size, and moderately increasing speed). The L2 linker is included with the BDS compiler.

## The Sieve of Eratosthenes

One of the most difficult parts of benchmarking is selecting the programs to use in the tests. Jim and Gary Gilbreath proposed what has since become a standard for comparing microcomputer compilers and interpreters—the "sieve" program (see reference 3). Listing 1 shows the standard version of the sieve program.

The benchmark used a variety of different compiler options to check how small variations in the code would affect program performance. Figures 1 and 2 and table 3 present the results of the sieve program.

The BDS C compiler doesn't support register or static allocation; therefore, those results are missing from the table. In the setmem examples, in addition to making the variables external, a call to the library routines to fill the array with the value TRUE replaces the following statement:

```
for (i = 0; i = SIZE; i++)
  flags[i] = TRUE;
```

This saves a substantial amount of time. So does the *improved algorithm* program supplied with Eco-C—proof that an intelligent programmer can usually create a quicker program than an intelligent compiler can.

The Eco-C and Q/C compilers require larger file sizes to hold their code because they include data space in the code files (see figure 3). The BDS C compiler places a pointer to the external variables' location in the code file and calls a runtime routine to initialize the external variables to zero when the program executes. Thus, the code file doesn't store the sieve program's flags array so the code size is about 8K bytes smaller for the BDS C compiler, which, therefore, doesn't support initializers.

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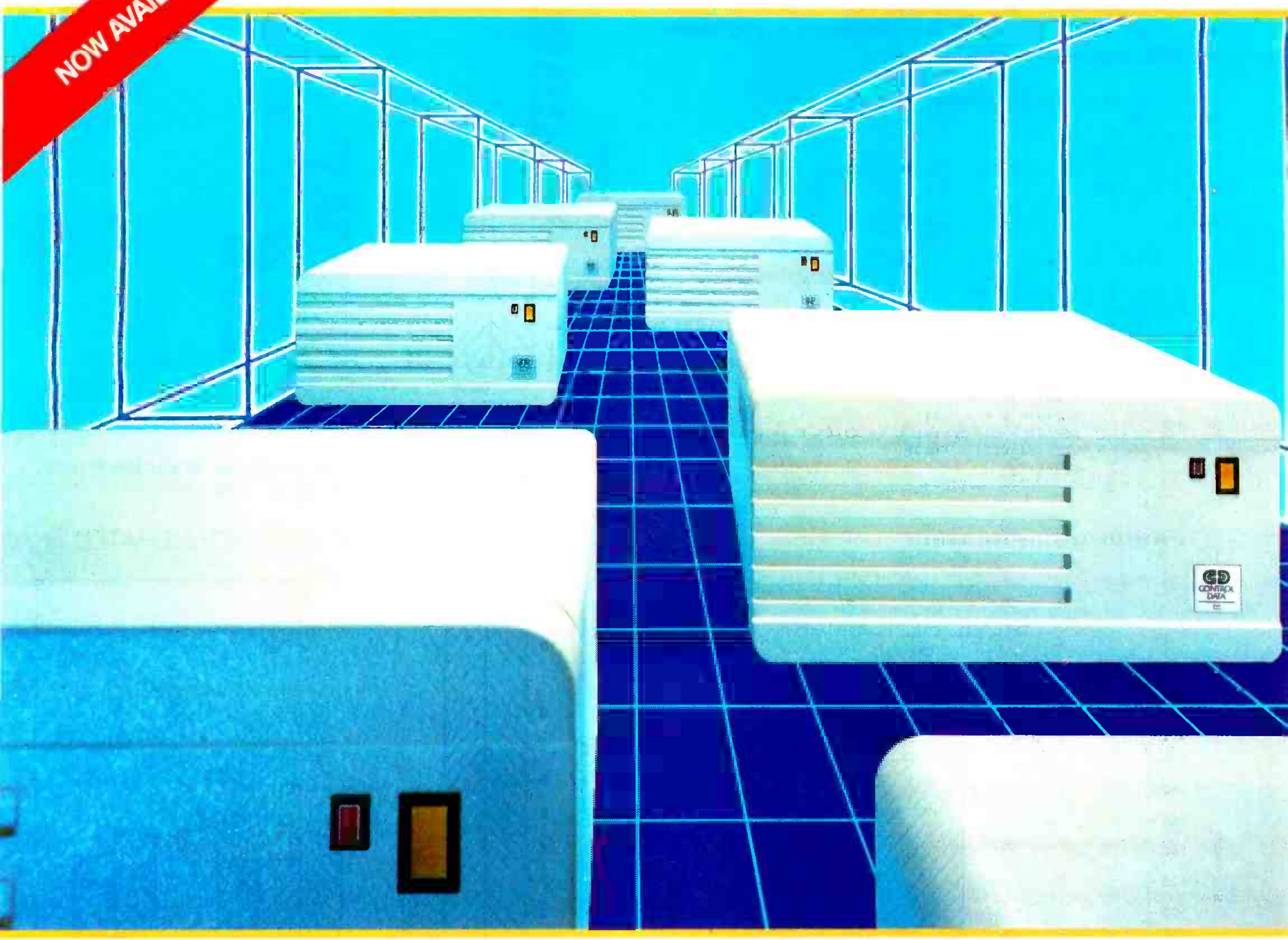

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**Listing 1:** *The sieve prime-number generator benchmark program. This is the same program as originally presented in "Eratosthenes Revisited" (see reference 3). This version is slightly different from the version presented in Christopher Kern's comparison of five versions of C for CP/M (see reference 2) in that there is no preprocessor directive to include the header file "stdio.h."*

```
/* Eratosthenes Sieve Prime Number Program in C */
#define TRUE    1
#define FALSE   0
#define SIZE 8190

char flags[SIZE+1];

main()
{
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;
                for (k = i + prime; k <= SIZE; k += prime)
                    flags[k] = FALSE;
                count++;
            }
        }
    }
    printf("%d %d\n", prime, count);
}
```

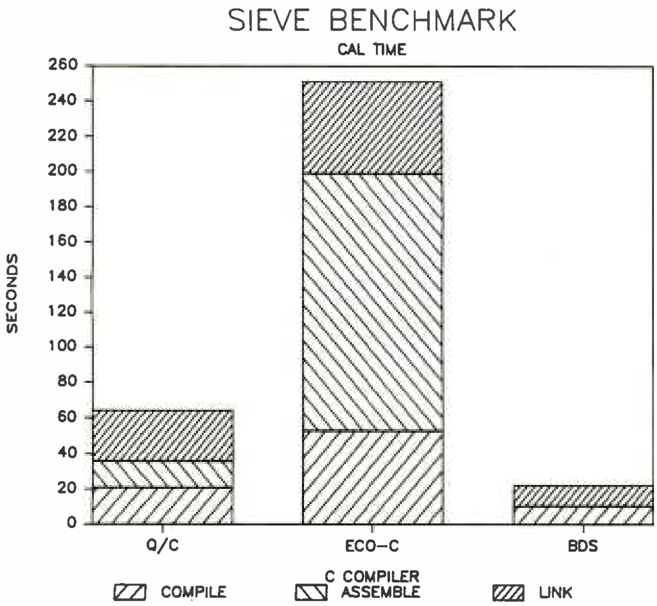


**Figure 1:** *A comparison of the cumulative program CAL (compile, assemble, and link) times for the sieve benchmark. (All figures were drawn with a Hewlett-Packard 7475A plotter.)*

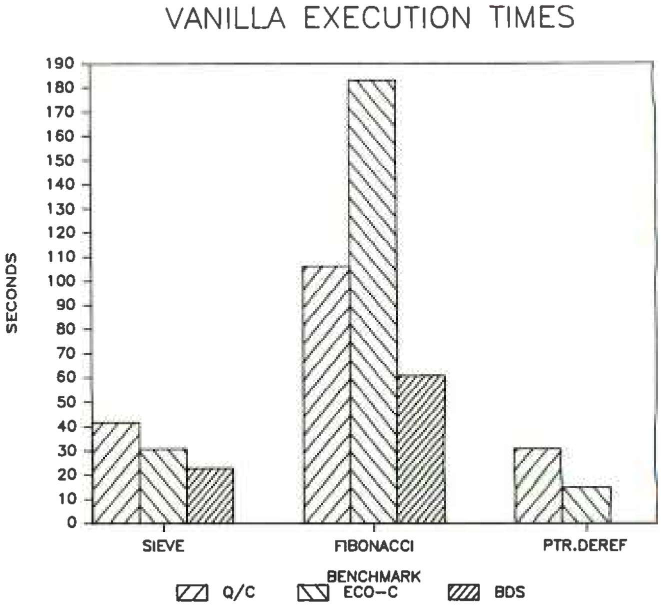


**Figure 2:** *Comparative execution times for the various benchmarks.*

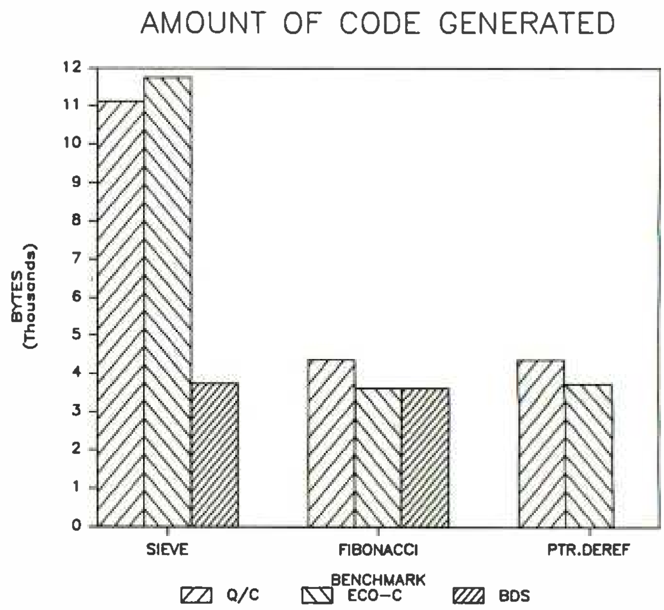


**Figure 3:** *Comparative code sizes for the various benchmarks.*

The long assembly and link times for Eco-C are the result of its method of initializing external arrays. The definition of C says that all external variables not initialized explicitly will be set to zero (see reference 4); therefore, the sieve program must initialize the external array flags to zeros before the program starts. In Eco-C the assembly language expands a macro containing the statement "DB 0" the required number of times, resulting in fairly small assembly-language files but very slow assembly.

## Fibonacci Numbers

Another important measure of performance of any block-structured language is the speed at which it performs function calls. The calculation of Fibonacci numbers (1, 1, 2, 3, 5, 8, 13 . . .) is naturally recursive (obtainable by a finite number of computations), and thus provides an excellent way to examine the speed of function calls. Christopher Kern presented a benchmark program (see reference 2), shown in listing 2, that calculates Fibonacci numbers recursively. Because Q/C doesn't allow type declarators on functions, I modified the program slightly to do that compilation.

Figures 2 and 4 present the results from the Fibonacci number benchmark program. There is a wide variation in execution speed for this program—a factor of three.

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| | vanilla | register | static | external | setmem | Improved algorithm |
|---|---|---|---|---|---|---|
| Q/C | 42 | 26 | 26 | 26 | | |
| Eco-C | 31 | 31 | 22 | 22 | 17 | 11 |
| BDS | 23 | | | 15 | 13 | |

Compiler Execution Times (in seconds)

vanilla — the program compiled exactly as shown in the article "Eratosthenes Revisited"
register — the auto variables declared as register integers
static — the auto variables declared as static integers
external — the auto variables moved outside the main() function
setmem — the library routines used to fill large blocks of memory with a specified value
improved algorithm — the improved version of the published algorithm used

**Table 3:** *The results of running the sieve benchmark program with various options and definitions of those options.*

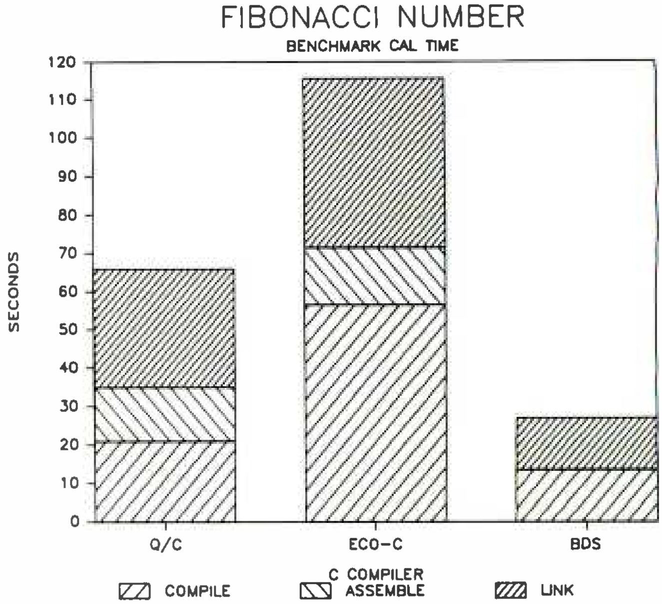


**Figure 4:** *A comparison of the cumulative program CAL times for the Fibonacci benchmark.*

**Listing 2:** *The Fibonacci number-generator benchmark. This is the same program that originally appeared in Christopher Kern's article (see reference 2).*

```
#include <stdio.h>

#define NTIMES 10 /* number of times to compute Fibonacci value */
#define NUMBER 24 /* biggest one we can compute with 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);
}
```

Eco-C has a tortuous function-calling protocol. My opinion on this is based on the assembly-language interface description and the file produced. The compiler puts all sorts of stuff in the code file and on the stack and then calls a library routine to perform the function call. When control returns from the function, Eco-C calls another library routine to put the returned values in the right places—not an efficient way to do things. Eco-C is the most costly of the three in execution time while Q/C is intermediate between BDS C and Eco-C.

The similarity of the code-file sizes in this benchmark is interesting. The Fibonacci program doesn't contain a large array like the sieve program does; therefore, the program sizes for Q/C and Eco-C are comparable to BDS C's (see figure 3).

## Pointer Dereferencing

Because most sizable C programs make extensive use of pointers, a good compiler should generate efficient code for dereferencing them. The program in listing 3 attempts to test the capabilities of Q/C and Eco-C in this area. It declares a "structure" containing a single member with 20 levels of indirection (indirect addressing). The main program then declares a pointer to the structure through an additional 20 levels and repeatedly references the character located through these 40 levels of indirection. To compile this program with Q/C, you must increase the size of the compiler's "type table" from 35 to 50 entries using the included QRESET program.

Figures 2 and 5 show the results of the pointer-dereferencing program. BDS C can't parse the structure declaration and, therefore, is omitted from the results. Here Eco-C shines, producing a smaller, faster program (see figure 3).

It was more difficult than expected to create this benchmark. My first attempts produced programs that executed too quickly to be accurately measured. The program shown in the listing executes two million dereferencing operations and both compilers are fairly good at it.

## Floating-Point Calculations

One nice feature of Eco-C is that it includes floating-point variables. The matrix-multiplication program presented by Jerry Pournelle (see reference 5) was rewritten in C to test floating-point speed. Listing 4 shows the resulting program. Because all arrays in C start with an index of 0, some changes occur in the for loops, the final answer changes to 383740.00000, and the implicit data type conversions in Dr. Pournelle's program become explicit with the use of casts. Because C does all its floating-point calculations in double-precision, the matrices are

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**Listing 3:** *The pointer-dereferencing program. This program declares a fairly simple structure with 20 levels of indirection then a variable that is a pointer to that structure through 20 additional levels of indirection. The program repeatedly references the character pointed to through the 40 levels of indirection.*

```
/*
**      deref.c -- benchmark program to examine the efficiency
**  of pointer dereferencing
*/

#define LOOPS   50000   /* how many loops */
#define BELL    7       /* ASCII bell character */

struct cptr1 (
        char ********************ptr1;
        );

main()
(
unsigned i;
char yekdorb;
struct cptr1 ********************pointer;

        printf("%u loops\n", LOOPS);

        for (i = 0; i <= LOOPS; i++)
                yekdorb = ********************
                        (********************pointer).ptr1;

        printf("%cfinished\n", BELL);
        exit(0);
}
```

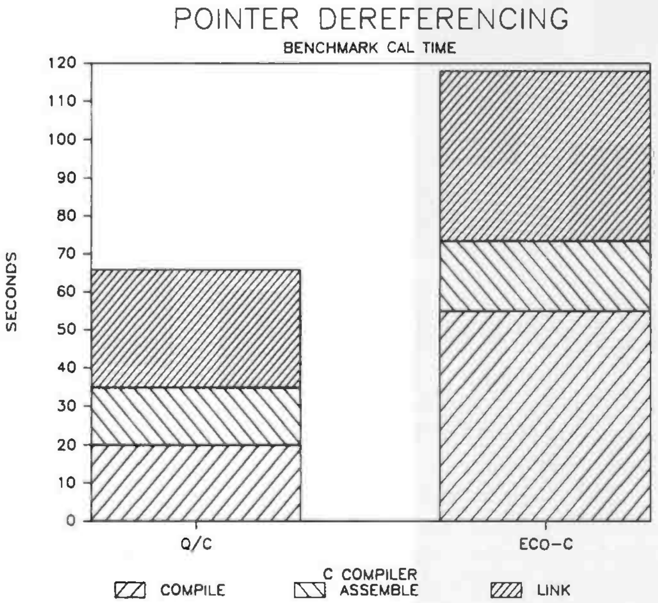


**Figure 5:** *A comparison of the cumulative program CAL times for the pointer dereferencing benchmark.*

declared double, rather than float, which incurs the time necessary for repeated conversions. When the 22K-byte compiled program ran, it required 48 seconds to execute using 8-byte floating-point numbers.

## Pros . . .

Both Q/C and Eco-C have some nice attributes.

QC is a large subset of Unix Version 7 C for nonnumerical applications. It has an excellent manual and it includes the compiler's source code as well as the library's. Q/C is a modular compiler that doesn't seem difficult to modify if you want to produce code for a different processor. The Code Works provides good support—I have received two updates at low cost. Overall, it is a reasonably quick compiler that produces fairly good code.

Eco-C also provides fairly good support with free updates for one year. When the first copy of my compiler had a problem, I found that Ecosoft already knew about the error and had shipped the corrected version. Eco-C also features strict adherence to standard syntax and semantics, making it easier to write portable programs. It has good numerical capabilities including an excellent transcendental-function library, and the LL(1) parsing strategy finds errors at the earliest possible point of detection (some other types of parsers scan past the error before detecting it and their error messages are confusing).

## . . . and Cons

Q/C and Eco-C have one problem in common. The Microsoft M80 assembly language (as well as Digital Research's RMAC) only allows six significant letters in identifiers. The L80 linker and format for relocatable files allows up to seven, but this too is inadequate. This limitation often requires more foresight and care in naming variables than it really should. It would be nice to have a relocating macro assembly language that allowed at least eight significant characters in identifiers. (The relocating macro assembly languages supplied with the UCSD p-System do. Unfortunately, they are not available for CP/M.)

Q/C has no real problems. It runs well, produces acceptable code, is cheap, and is an incredible learning tool. However, sizeof and type specifiers on function declarators would be helpful. It looks like typedefs would be easy to add.

The Eco-C compiler is a disappointment after reading Ecosoft's glowing advertisements and paying its high price. When I bought this compiler, the ads proclaimed Eco-C as a full C compiler with no mention of any restrictions. A typical compile and link supposedly took only a minute or two. Since then, these claims have disappeared from the ads. Now the ads say that the package includes most of the library source code. My copy came with only one small runtime-initialization program in assembly language. Questions to the company about these problems received no response. (See the text box "Xtra, Xtra . . ." on page 256 for an update on these problems.)

One of the most annoying things about the Eco-C compiler is that it aborts compilation after detecting an error. It is impossible to continue scanning for additional syntax errors after finding one. If there are several trivial errors like missing semicolons, it takes a long time to compile a large program even though the LL(1) parsing scheme used by Eco-C is good at error recovery.

Eco-C generates lots of slow code for some applications. When BDS C or Q/C compiles a test program that involves filling the CRT (cathode-ray tube)screen with characters one at a time using cursor addressing, the

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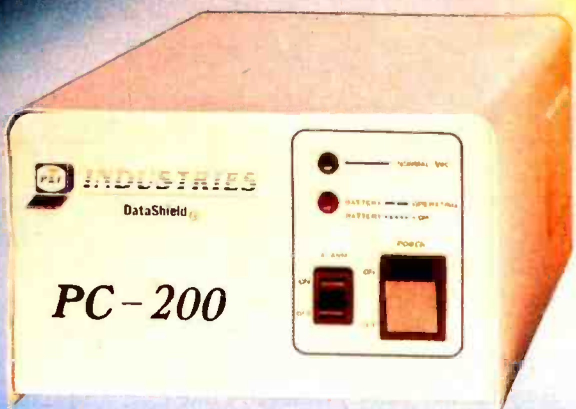


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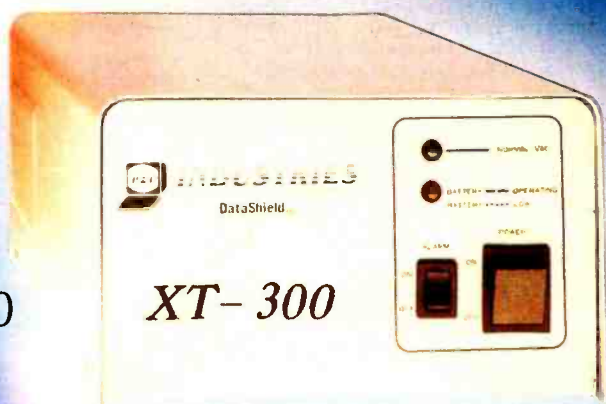


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**Listing 4:** *A C-language version of the matrix-multiplication benchmark originally proposed by Jerry Pournelle (see reference 5).*

```
/*
** matmult.c -- a benchmark based upon the matrix multiplication
** program given by Jerry Pournelle in Byte October 1982 p. 254.
**
** Type conversions have been made explicit with casts. Array
** and loop indices now start at 0.
*/

#define M       20
#define N       20
#define BELL    7

char gup;
double summ, a[M][N], b[N][M], c[M][M];

main()
{

    summ = 0.0;
    printf("Hit any character to start\n");
    gup = getchar();

    filla();
    printf("\nA filled\n");
    fillb();
    printf("\nB filled\n");
    fillc();
    printf("\nC filled\n");

    matmult();
    printf("\nMultiplied\n");
    summit();

    printf("The sum is: %20f\n", summ);
    putchar(BELL);
}


filla()
{
int i, j;

    for (i = 0; i < M; i++)
        for (j = 0; j < N; j++)
            a[i][j] = (double) i + j;
}


fillb()


{
int i, j;

    for (i = 0; i < N; i++)
        for (j = 0; j < M; j++)
            b[i][j] = (double) (int) ((i + j)/j);
}


fillc()
{
int i, j;

    for (i = 0; i < M; i++)
        for (j = 0; j < M; j++)
            c[i][j] = (double) 0;
}


matmult()
{
int i, j, k;

    for (i = 0; i < M; i++)
        for (j = 0; j < N; j++)
            for (k = 0; k < M; k++)
                c[i][j] = c[i][j] + a[i][k]*b[k][j];
}


summit()
{
int i, j;

    for (i = 0; i < M; i++)
        for (j = 0; j < M; j++)
            summ = summ + c[i][j];
}
```

**Xtra, Xtra ...**

*Since this article was written, some changes have been made to Q/C and Eco-C. I have not, however, received review copies of the revisions.*

*Eco-C has a new version that supports initializers and parameterized macros that allow it to handle most programs written for Unix Version 7. Ecosoft also answered some of my questions concerning the source code for library functions. It seems that the source was distributed for a while but some bugs that were eventually traced to modified versions of the library were reported. Because of this, Ecosoft stopped distributing the source with the system. Advertising copy has presumably been changed but publishing lead times dictate that some of the old copy is still appearing in some magazines. Those who bought the compiler expecting the source code can get it by requesting it from Ecosoft. They must, however, state in their request letter that they understand no support for the library, therefore, will be offered by Ecosoft.*

*A new version of Q/C has also been announced by The Code Works. The new version (3.1) includes typedef, sizeof, type casts, function typing, and library functions to support large file buffers. These features should make Q/C one of the most complete C compilers available for nonnumerical applications.*

screen fills as fast as the terminal can accept characters. Eco-C takes twice as long and generates twice as much code as Q/C. This is apparently the result of the slow procedure-calling process.

## Summary

As you may have guessed, I like Q/C and have mixed feelings about Eco-C.

Q/C, a large subset of the standard language and a good introduction to it, has a portable library and produces good code quickly. If you want to learn compiler construction techniques or modify the standard language, Q/C is the obvious choice.

Eco-C does everything claimed in its manual. It has the long, float, and double variable types required for many calculation-intensive programs—possibly the purpose behind its development. Eco-C also includes Microsoft's M80 assembly language—a nice extra for use with other packages. ■

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1. Cain, R. "A Small-C Compiler for the 8080s." *Dr. Dobb's Journal*, May 1980, page 5.
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5. Pournelle, J. "A BASIC and Pascal Benchmark, Elegance, Apologies, and FORTH." BYTE, October 1982, page 254.



*Dr. David D. Clark (246 South Fraser St., #2, State College, PA 16801) is a post-doctoral research scholar in the department of chemistry at Pennsylvania State University. He has a B.A. in chemistry from Indiana Central University and a Ph.D. in biological chemistry from the University of Nebraska.*

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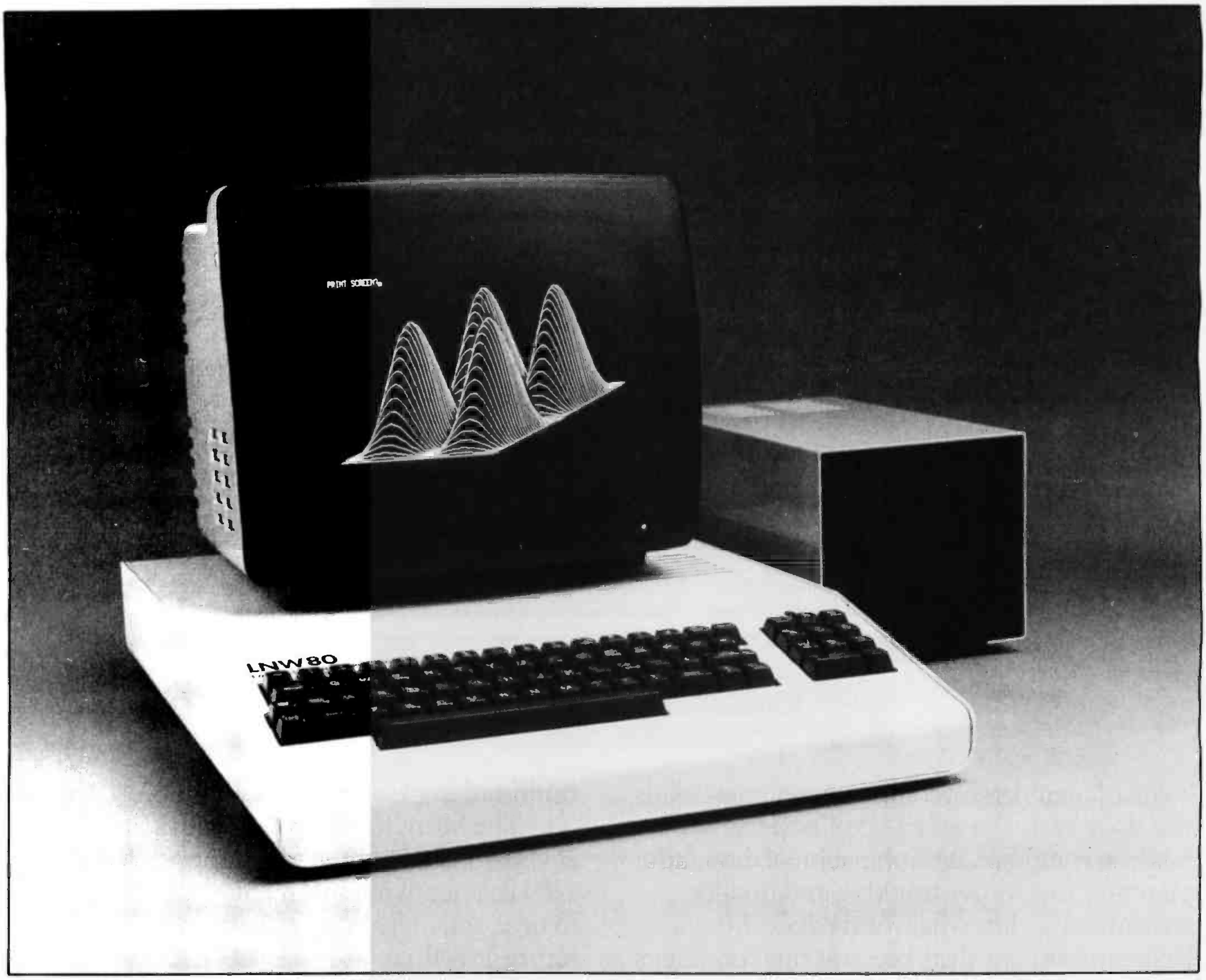


**Photo 1:** *The LNW-80 Model II microcomputer.*

# LNW-80

## *One user's glowing report*

**Mahlon G. Kelly**
**University of Virginia**

The LNW-80 Model II is a Z80-based, 8-bit microcomputer that evolved gradually from the old TRS-80 Model I. It is capable of running virtually all software and operating systems for the TRS-80 Models I, III, and 4 better than the TRS-80s do and of supporting a full-featured CP/M with 96K bytes of RAM (random-access read/write memory). Please note that this is not an objective review. I happen to believe that the LNW is the best 8-bit microcomputer you can buy. I'll try to tell you why.

While I'm an avid admirer of the TRS-80 Model I's basic design, the machine itself had a lot of faults. The Model III solved many of the severe problems but it didn't go far enough—no high resolution or color and only a 16 by 64 screen, for example. The Model 4 is better but it still doesn't provide color, Model I and III programs won't run in Model 4 mode, there's little flexibility in the types of disk drives supported, and CP/M and high-resolution graphics cost extra.

The LNW-80 Model II (see photo 1) lacks the limitations of the TRS-80 Model 4. It has the excellent basic design of the TRS-80 Model I, none of its hardware problems, all the important features of the Model 4, and more. Like the Model 4, it has an 80 by 24 screen, high-speed operation (4 megahertz), and compatibility with CP/M.

But unlike the Model 4, it has high-resolution graphics, excellent color capabilities, and good compatibility with Model I, III, and 4 software, including all of the popular operating systems. It can also use almost any disk-drive configuration (including 8-inch and hard disks); its CP/M can read the most popular disk formats including IBM PC (Personal Computer), Osborne, Kaypro, Xerox, and industry standard 8-inch; and it's built better than any microcomputer I have seen.

In addition, the LNW comes with an incredible array of software, including several integrated small-business programs, a spreadsheet program, a word processor, a smart-terminal program, a TRS-80-compatible operating system, and a well-tailored version of CP/M. The software also includes an enhanced BASIC that supports the color and high-resolution features. The software alone, if purchased separately, would cost nearly the price of the whole package. While Osborne and Kaypro have been praised for their software, the LNW provides much more. LNW Research, the manufacturer, is planning an add-on board to provide software and hardware compatibility with the IBM PC. (They already produce add-on boards for the IBM.)

## The Company

The LNW-80 started life as a series of kits: the first one was for an improved TRS-80 expansion interface; the second, for a group of improvements over the TRS-80; and the third, an assembled board allowing double-density operation of both 5- and 8-inch disk drives. (The kits have been severely criticized for being complex and hard to build. If you're thinking of building the kit, buy the documentation and look it over first.) Eventually, these kits were combined in an assembled package that was completely compatible with TRS-80 hardware and software. The LNW Model I was similar to the TRS-80 Model I without its hardware problems and with high-resolution graphics, an 80 by 24 screen, color displays, upper- and lowercase, and flexible support for different disk drives.

The Model II introduced CP/M compatibility, 96K bytes of bank-selected RAM, an improved BASIC, and a number of other features. It also included an internal loudspeaker, the use of gray tones to represent colors on a black-and-white monitor, and joystick ports. With the IBM compatibility will come even more flexibility and performance. Even with all these changes and additions, the LNW is extremely well integrated and as reliable as any microcomputer I have used.

LNW Research provides inexpensive upgrades to the owners of earlier models. For example, I recently paid $299.50 to add CP/M to my LNW Model I. The upgrade included the hardware installed by the factory and the CP/M software with LNW additions. Future upgrades are promised at very small prices.

The company also provides excellent software support. When LNW began including a lot of free software with the Model II, the company made it available to previous owners for only $299—almost a thousand dollars worth of software.

Although it's not available as I write this, the upgrade from CP/M 2.2 to CP/M Plus (a costly upgrade on most machines) is expected to cost $25. LDOS, giving TRS-80 Model III compatibility, is planned soon, and a version of DOSPLUS, for compatibility with the TRS-80 Model 4, is in the works. The IBM and 16-bit add-ons, which will plug into the bus and provide slots for a number of IBM cards, are also expected at a very reasonable price.

### At a Glance

**Name**
LNW-80 Model II

**Type**
8-bit microcomputer supporting nearly all TRS-80 Models I, III, and 4 software and CP/M; color display, high-resolution graphics, 96K RAM, and 16K ROM with paging

**Manufacturer**
LNW Research Inc.
2620 Walnut St.
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**Price**
$1195

**Supplied Software**
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**Disk-Drive Support**
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**Documentation**
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**Audience**
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## Physical Description

The LNW-80 measures 16.5 inches wide by 3.5 inches high and 22 inches deep (see photo 1). It weighs 26 pounds, most of it in the attractive 16-gauge steel case, a symbol of LNW Research's commitment to physical quality. A friend of mine who designs electronic equipment for the Navy looked over the machine's components and said it could survive on a battleship during combat. All edge connectors are gold-plated, all components are first quality, and most are soldered to the boards. (There are few loose connections with soldered joints.) There's a very quiet cooling fan and all connections (printer, disks, modem, etc.) are on the back of the case, which is open to provide easy access to the printed-circuit boards.

As a result the LNW is extremely reliable. It has an excellent power supply that seems to be immune to power fluctuations. Turned on almost continuously for 3 months, the only failures were due to a complete loss of power, and it can operate with line voltages from 90 to 130 volts.

The keyboard is excellent. It is mechanically like that of a Model I and thus needs software debounce (a timing loop that solves the problem of extra characters on the screen), but all operating systems now provide that. It has a numerical keypad like the Models I, III, and 4 with several additional keys for a total of 74. One is a control key for Electric Pencil or for Newscript that acts like a true control key when used with CP/M. Others are Caps Lock (which puts the computer into upper-case-only mode), Shift (which acts as if the Shift key were pressed), and High/Low (which chooses 1.7- or 4.0-megahertz operation). The four arrow keys are in a logically arranged cluster on the right-hand side of the keyboard, and there are three function keys that are LNWBASIC programmable. You may redefine nearly all of the keys using the CP/M mode or LNWBASIC. Finally, two widely separated reset keys reboot the machine when you press them simultaneously. Their placement keeps you from accidentally rebooting the system but may be a problem for some handicapped users.

The LNW has a Z80 processor and 96K bytes of RAM. In TRS-80 mode 48K is directly addressable by the user; the rest may be bank-selected. In CP/M mode the user has almost 61K of RAM available; various drivers use the rest. I believe 61K is more RAM than any other 8-bit CP/M-compatible machine provides. You may add another six 4164-byte memory chips to give you three more screens of graphics display.

There are four boards in the case: the keyboard substrate, the main processor board, an expansion board analogous to the TRS-80's expansion interface, and a disk controller board. There's also a small loudspeaker and a joystick port that is hardware-compatible with Apple joysticks. A small muffin fan cools the machine, but the case becomes perceptibly warm after about an hour's use.

## Graphics Features

The LNW has excellent color and high-resolution graphics. There are four modes: 0 is like the TRS-80; 1 provides high-resolution black and white (480 by 192 points) and an 80 by 24 character screen (if you use the proper software drivers); 2 gives you 8-color graphics with 160 by 192 resolution (much more than is available

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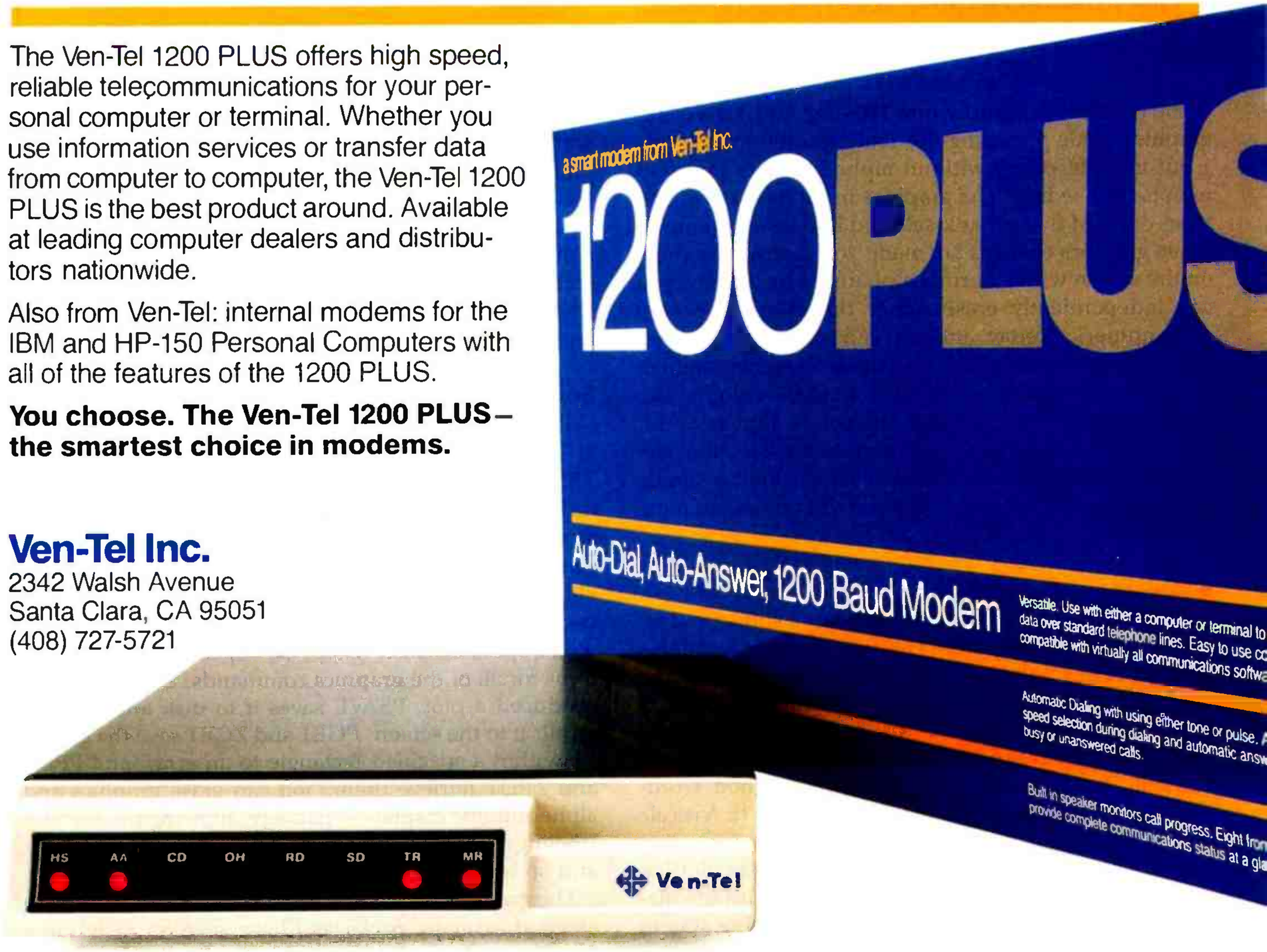


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| | |
|---|---|
| BLINK | – switch blinking cursor on and off |
| CALL address | – execute a machine language program |
| CIRCLE | – produce a circle, ellipse, or arc |
| COLOR | – specify the color of the next graphics command |
| CONV | – convert between various hexadecimal and decimal expressions |
| DEFKEY | – define a string assigned to a key |
| DESPOOL | – send the contents of a file to a printer while continuing computation |
| DISKEY | – show the defined keys |
| DLOAD filespec | – load a machine-language program |
| DO...UNTIL | – do a loop until a condition is met |
| DRAW string | – draw a figure specified by "string" |
| DRUN | – exit LNWBASIC and run a command-level program |
| FLS | – fill the screen with a character or color |
| GSUB name | – go to a named or numbered subroutine |
| GTO | – branch to a named or numbered routine |
| HIMEM | – set the high memory limit |
| JOY | – support use of joysticks |
| LABEL | – name a line for a branch by name |
| LCASE | – switch lowercase on or off |
| LINE | – draw a line between specified points |
| LOADKEY | – load a file of defined keys |
| LOC | – locate a string in the program text |
| MODE | – set the graphics mode (see text) |
| MOVE | – move a block of memory |
| NTROFF | – turn off the new trace facility |
| NTRON | – turn on the trace facility |
| PAGE | – bank-select graphics displays from extended memory to the video display |
| PAINT | – fill in a bounded graphics space with color |
| PCLS | – clear the graphics memory or fill it with a specified color or value |
| PGET | – save a part of the video display to an array |
| PLOAD | – load the graphics memory from a disk file |
| PLOT | – specify dot and dash patterns in a plotted line |
| POFF | – turn off the echo from video to printer |
| POINT | – test a graphics point for color |
| PON | – turn on the echo from video to printer |
| PPUT | – put array specifications on the video screen |
| PRESET | – erase a specified pixel or point |
| PSET | – turn on a specified pixel or point |
| PSAVE filespec | – save the hi-res memory to a disk file |
| QUICKEY | – switch the abbreviated key entry on and off |
| REPEAT | – switch the keyboard repeat and beep on and off |
| REST | – restore a data pointer to the start of a line |
| RS232 | – initialize the RS-232C interface |
| RSIN | – turn on (or off) input from the RS-232C interface |
| RSOUT | – turn on (or off) output from the RS-232C interface |
| SAVEKEY filespec | – save defined keys to a disk file |
| SOUND | – produce a tone of specified pitch, character, and duration |
| SPOOLOFF | – turn off spooling of printer output |
| SPOOLON | – turn on spooling of printer output |
| XSTR$(string) | – execute a string as a BASIC statement (see text) |
| ZGET | – similar to PGET but faster |
| ZPUT | – similar to PPUT but faster |

**Table 1:** *A summary of LNWBASIC commands and statements.*

in the normal black-and-white TRS-80); and 3 is a color-graphics mode providing the same resolution as Mode 1 but in eight colors without alphanumerics (an RGB monitor is needed). The graphics in Mode 1 are in 12K bytes of RAM that is bank-selected into lower memory; while graphics changes are made you can overlay them on the screen with a normal alphanumeric display, you can independently erase either the graphics or the alphanumeric overlay, and you can call graphics pages via LNWBASIC. This allows an unusual combination of graphics and printed output. If you use the color modes with a monochrome monitor, the colors appear as different intensities of gray. You may easily use all of the graphics modes with LNWBASIC; it has a syntax similar to the Radio Shack Color Computer's but it's much more powerful.

## Software

I believe the LNW-80 comes with more software than any other microcomputer. The two operating systems available are DOSPLUS (TRS-80 Model I compatible) and CP/M 2.2. By the time you read this, a version of LDOS to work with Model III disks, CP/M Plus, and a version of DOSPLUS to make the LNW act like a TRS-80 Model 4 should be available. Electric Pencil (a good word-processing program), Electric Spreadsheet (a Visicalc clone), Microterm (a smart-terminal program including 80-character lines for the LNW), and Chartex (a plotting program for bar graphs, etc.) all come free with the machine. An integrated small-business accounting system that includes general ledger, accounts receivable, accounts payable, and payroll is also provided. All of that software (except Chartex and the small-business programs) has been widely reviewed and is first quality. (The business software is an extensive, complete system that comes on six double-density disks with a manual almost two inches thick.) The most important piece of software, however, is LNWBASIC, which supports the LNW's advanced features, particularly color, graphics, and the additional memory.

## Some Features of LNWBASIC

The LNWBASIC commands are summarized in table 1. The graphics commands are similar to those for the TRS-80 Color Computer, but are more extensive. They include: DRAW, which produces a shape defined by a string and gives you a variety of options on how to present it on the screen; CIRCLE, which draws circles and ellipses or arcs; and LINE, which draws a line between two points on the screen. PAINT fills a bounded figure with a specified color, while PLOT specifies dot-dash patterns for all of the graphics commands. Once you have produced a plot, PSAVE saves it to disk and PLOAD recalls it to the screen. PGET and ZGET save the graphics within a specified rectangle to an array, and PPUT and ZPUT retrieve them. You can erase graphics and alphanumeric displays separately, allowing flexible plot labeling. Other commands, like PCLS, FLS, COLOR, and so on, support the machine's color abilities.

The graphics software is extremely flexible. It's at least as good as many packages I have seen on mainframe computers. Listing 1 gives you a very short program


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Vol. 1, No. 4

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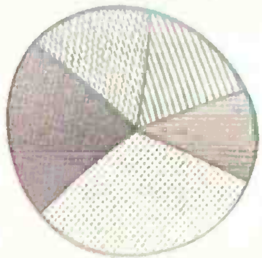

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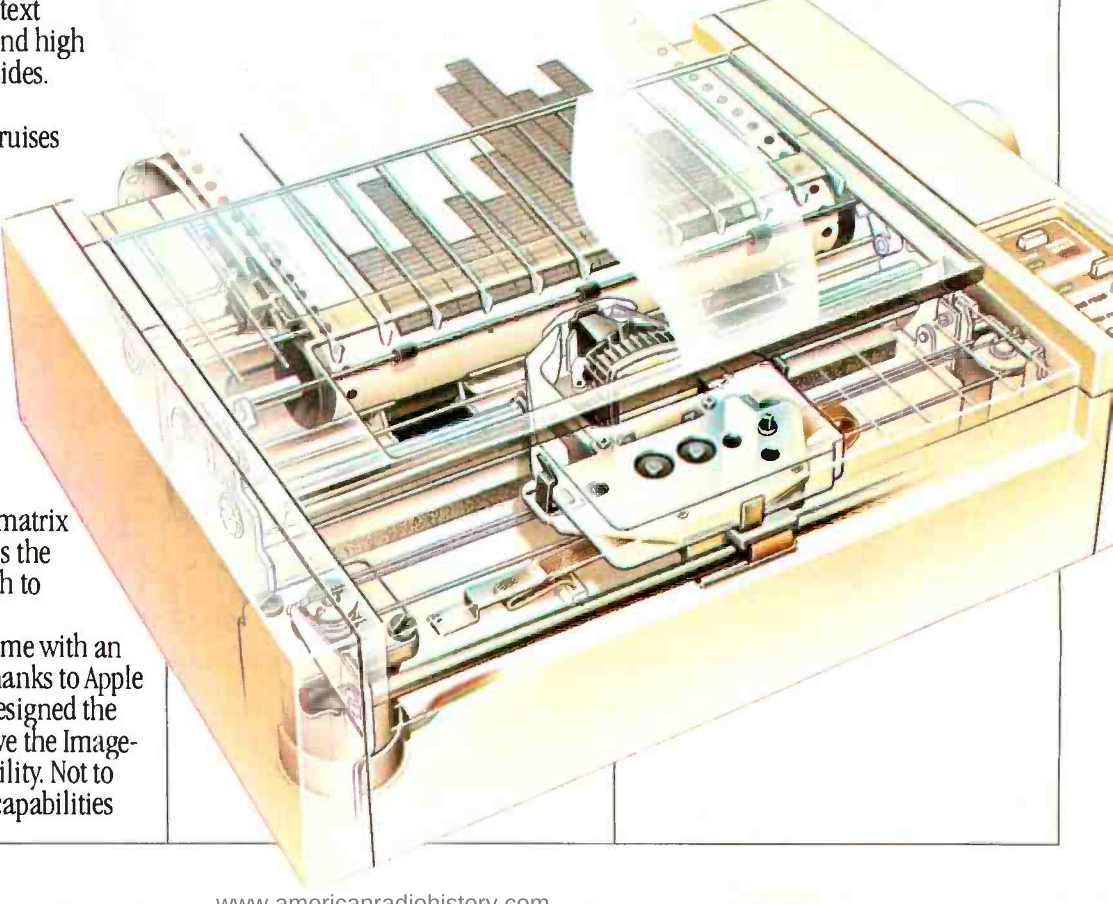

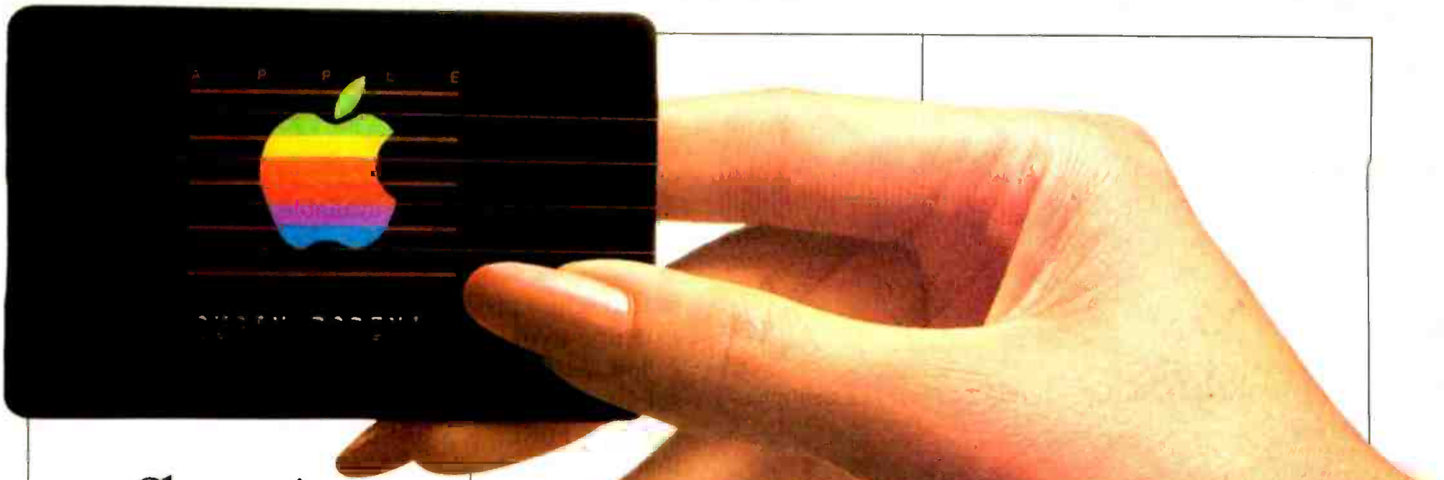


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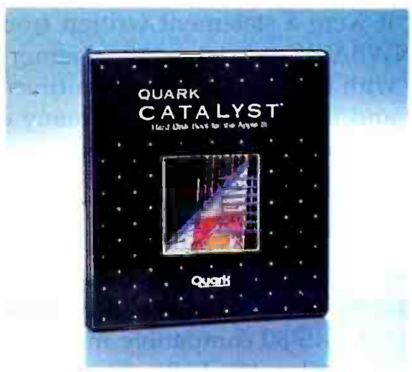


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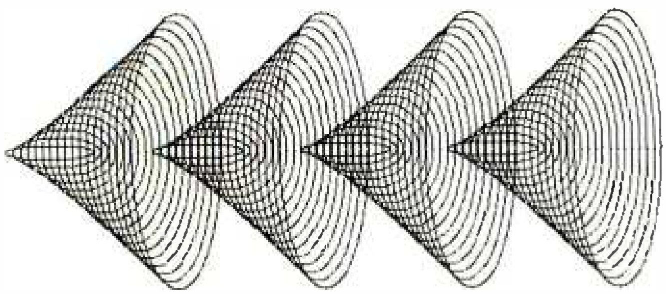


**Figure 1:** *The image produced by listing 1 as sent to a Centronics 739 printer.*

**Listing 1:** *The program that produces the image shown in figure 1.*

```
10 CLS: PCLS: MODE 1
20 J=0
30 FOR I=5 TO 90 STEP 5
40 CIRCLE J+30+I,100,30,I
50 NEXT I
60 J=100+J
70 IF J>300 GOTO 70
80 GOTO 30
```

whose result is shown in figure 1. (The figure is actually the image as sent to a Centronics 739 printer and is nearly identical to the screen image.)

LNWBASIC has many abilities that are only indirectly related to the LNW. You can redefine various keys (including but not restricted to the programmable keys) to produce a string; for example, "Shift-@" could produce "CMD"DIR:0 or perhaps a string of graphics characters (in Mode 0). You can enter BASIC commands with a single keystroke using QUICKEY. For example, "G" produces GOSUB—and there's an excellent trace and debugging facility. You can send screen output simultaneously to a printer and disk file. (A spooler sends printer output to a disk file and prints from the disk file while the machine does other things.) You can exchange input and output with the RS-232C port (and the printer and disk), creating the possibility of writing specialized smart-terminal programs in BASIC. Perhaps the most remarkable command is XSTR$(string) where "string" could be a function like A = SIN(B); you can enter this function from the keyboard or the disk and execute it as if it were a statement written from the program.

LNWBASIC resides in low memory. It doesn't compete with any high memory routines you may want to use, and it's compatible with many existing programs that live in upper RAM. It pushes your programs and data higher up and doesn't leave much room. To get around the memory problem there's a program called CREATOR that lets you assemble customized versions of BASIC with only the necessary functions. LNWBASIC is better than any of the enhanced BASIC packages I have seen for TRS-80 compatible machines.

The compiler, ACCEL3, can compile most LNWBASIC programs and is particularly compatible with LNW software; the few things that are not compatible are found only by trial and error. ACCEL3 can also compile HIRES graphics (see below) and is a particularly important piece of LNW software.

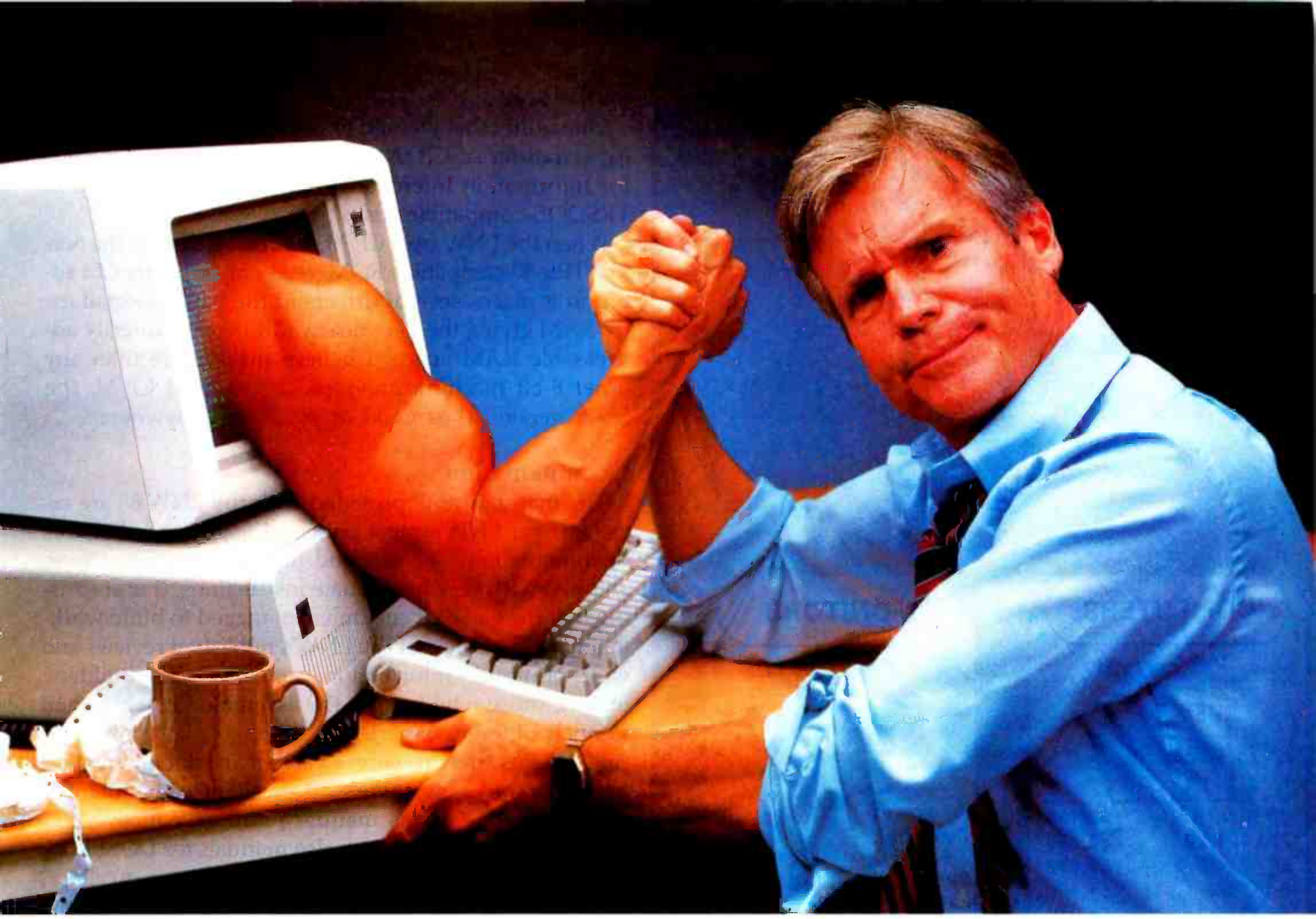
There is other software available and more is being developed all the time by the manufacturer, users groups, and independent programmers. For example, LNW Research sells a program called CHARM that allows a user to define an independent character set. Another program called AUTOPLOT plots data on the screen in a versatile set of formats and can send the output to various printers. HIRES is a BASIC-compatible graphics driver that's much faster than LNWBASIC but not as extensive. (It's sold by E&H Software, 11814 Coursey Blvd., Suite 249, Baton Rouge, LA 70816.) A graphics printer driver (sold by Excellonix, 637 No. Bristol St., Santa Ana, CA 92703) will send a high-resolution plot from the screen to various dot-addressable printers, and a variety of drivers for different alphanumeric screen displays are available from LNW Research. A Tektronix emulator, a perspective plotting routine, and other packages are public-domain software and are available from two LNW-oriented bulletin boards (see text box at end).

### CP/M for the LNW

Using the LNW with CP/M is like having a second computer. By the time you read this, CP/M Plus should also be available, but I've not seen it so my comments are on CP/M 2.2. Be aware that I strongly dislike CP/M: it's slow, cumbersome, difficult to use, not suited to graphics, and has few features of the more advanced TRS-80-compatible operating systems. It seems ironic that many people consider CP/M to be the professional's operating system while it is really the kludged outgrowth of a hobbyist's product; most TRS-80 operating systems were written by professionals and are of much better quality. In my opinion the only reason to use CP/M on the LNW is to read disks written on another machine or to run a CP/M program; however, I have yet to find a program I needed that was unavailable in a TRS-80 version.

The LNW version of CP/M is excellent, having all of the features of the normal 2.2 version with some important enhancements. It provides a full 80 by 16 or 80 by 24 screen, the control key is a true control key, and it follows the protocols of the ADM 3A terminal (in setting up word-processing programs, for example).

Two programs are particularly important: LNW.COM and SET.COM. LNW.COM lets you set disk-drive configurations to almost any standard—5¼-inch or 8-inch, 40-track, 80-track, double-sided, and so on. You can set up drives to read and write the 5¼-inch disks compatible with several other machines, including the Kaypro, Osborne, IBM PC, and Xerox 820. The program SET.COM allows even more specialized disk configurations. You can set the various parameters, such as skew tables, sector length, and so on, to custom-configure drives so they work with the disk format from almost





any machine. I have, for example, read Superbrain disks on the LNW.

One utility that I would like to see is missing: the ability to transfer ASCII (American National Standard Code for Information Interchange) files from CP/M disks to TRSDOS-compatible disks.

When the LNW uses CP/M, it bank-selects out the normal TRS-80-compatible ROM (read-only memory). In addition it places several drivers in the bank-selected extra RAM giving the user nearly 61K bytes of directly addressable RAM space. I believe that's more than any other 8-bit machine provides. If you need CP/M, the LNW version is as good as you'll find anywhere.

### Documentation

The manuals now provided with the LNW-80 are excellent; yet LNW's most criticized feature has been its documentation. The kits and the early machines were shipped with very inadequate instructions. It is surprising that the early kit customers managed to build working machines. Most of the LNW's published reviews and word-of-mouth information came from kit builders; luckily, those who bought the assembled machine had a much different experience.

LNW Research is very aware of its documentation problem, and now there's an excellent user's manual (called an "operations manual") and an equally good technical manual. There are also manuals for DOSPLUS, Level II BASIC, and LNWBASIC; all three are excellent. You must use the user's manual (116 pages) with the BASIC, LNWBASIC, and operating system manuals, but it is usable by both the expert and the complete novice. It may be necessary to shift between several different books, but learning to use the LNW is made easy by the many examples and cross-references.

The technical manual (179 pages) is also excellent and contains complete circuit diagrams. It should enable anyone experienced with hardware to repair and modify the LNW. The CP/M documentation is a thin but clear summary of the CP/M procedures and the LNW enhancements. That manual is not enough for a programmer, however, and if you intend to use the product, you should buy one of the more detailed descriptions of CP/M available. Very complete documentation for the rest of the software (Electric Pencil, and so on) is also included.

My greatest criticism of the documentation is that the user's manual and technical manuals were written for the Model I and only a barely adequate addendum is provided for the Model II. This addendum would make a high school English teacher cringe and a high school typing teacher ill. What is worse, the obscure descriptions of some features are so difficult to understand, even an expert will have problems. It's a good thing you can effectively use the LNW without reading the addendum.

### Service

There are relatively few LNW dealers at this time and local service is usually impossible. Therefore, there are

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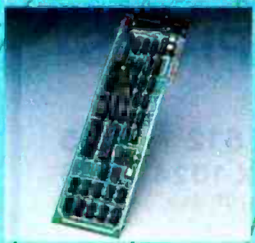

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only two recourses for a user with hardware problems: find a competent local technician or send it back to LNW Research. The technical documentation is good enough that a competent technician should be able to work on the machine. If you must send it back, LNW Research has excellent support. It can usually repair a machine and have it back in the owner's hands within three weeks—a better response time than many local dealers.

LNW Research also has a very knowledgeable technical support staff that can and will gladly answer most questions. My problems have always been solved by phone. If you buy an LNW, you have the particular advantage of working with a small company—personal and friendly service.

## Problems

I have few criticisms of the LNW-80. Mine didn't work when it first arrived, but that was due to UPS, not LNW Research, which helped me fix it quickly.

For several reasons I don't find it easy to use the 80 by 24 screen with the various drivers available. The drivers need upper memory that I want to use for other purposes; they slow up screen scrolling; and they're not compatible with my two most frequently used programs: a text editor (Newscript) and a smart-terminal package (ST80-III).

I would prefer a small separate keyboard—the LNW's design should allow this. The case soils easily, and the paint wore off the corners of mine after about 3 months.

However, the worst problem is that LNW Research's high standards for documentation fell again with the Model II. Its initial product documentation does not match the quality for subsequent releases. Let's hope that the company follows its own lead and publishes a high quality second release of Model II documentation.

## Overall

The LNW's greatest advantage is its compatibility with other machines—much of the TRS-80 line and most CP/M-compatible products. Second is its graphics capability followed by its use of 96K bytes of memory. The manufacturer's upgrade policy is equally important. I expect IBM-compatible hardware and software to be coming soon. The LNW's price is comparable to or better than its competition's, and its quality of construction is outstanding. Then too, it comes with as much or more software than any other 8-bit computer I know of. . . . It's hard to choose which one of the LNW's advantages is most important.

Yet the LNW is not very popular. Why? For one thing, large firms like Apple, Radio Shack, and IBM can afford large advertising budgets, while LNW Research cannot. But LNW Research faces a special public relations problem: it is known as a kit manufacturer. LNW is just not commonly known. Whenever I tell someone I own one, I have to explain what it is and then defend it against the "Trash-80" reputation. I don't know what LNW should do to improve its image, but for the sake of anyone who wants to buy an outstanding computer, I hope that it succeeds. In my opinion the LNW is the best 8-bit microcomputer available.■

### For More Information

**Newsletters**

| | |
|---|---|
| *LNW News*<br>*244 Mill Rd.*<br>*Yaphank, NY 11980* | *contains a lot of advertisements but useful material as well* |
| *The LNW USER Group Newsletter*<br>*4345 Manchester Rd.*<br>*Grand Island, NB 68801* | *mostly for kit builders and those with hardware experience, but something for everyone* |

**Bulletin Boards**

| | |
|---|---|
| *(516)924-8115*<br>*Yaphank, NY* | *run by Inflo Inc.; lots of free software and help* |
| *(504)291-8115*<br>*Baton Rouge, LA* | *run by E&H Software; also has lots of free software and help; especially graphics programs supporting HIRES* |

*Mahlon G. Kelly (268 Turkey Ridge Rd., Charlottesville, VA 22901), an associate professor of environmental sciences at the University of Virginia, is involved in research into the character of lakes.*

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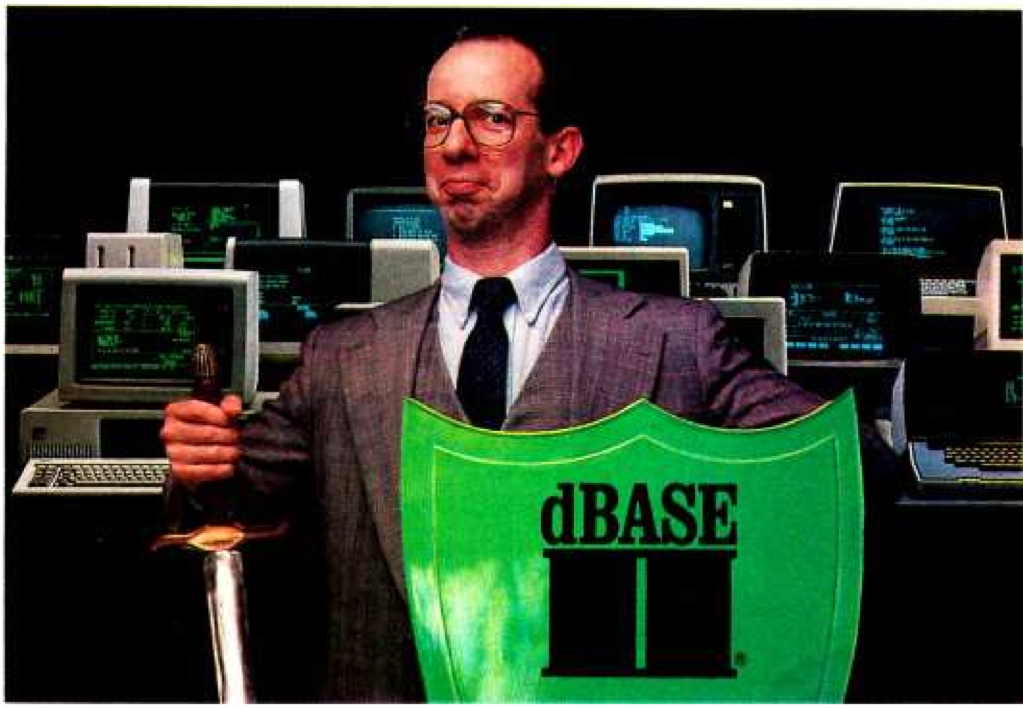


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# This Month's Features

A sneak preview of Apple's newest computer, the Apple IIc, is the highlight of this month's features. The new IIc is examined by West Coast Senior Technical Editor John Markoff and he reports that, with the icon character generator in ROM and a disk drive running under ProDOS, this lightweight, Apple IIe-compatible, transportable computer delivers a lot of bang at a price less spectacular than expected. Nevertheless, Cupertino's grown-up garage operation continues to be fruitful.

Like those classic science-fiction journeys into the human body, Brian Cameron tours the lap-portable TRS-80 Model 100's ROM. You can access ROM routines that'll make your Model 100 programs shorter and more efficient, using the information you'll gather from this excursion. Cameron, who has written a lot about his findings from mucking about inside Radio Shack computers, has once again proven that there are rewards for those willing to dig a little.

Speed and efficiency are key concerns of Drs. Roy Chaney and Brian Johnson. Here they explore a technique for realizing the true performance potential of Winchester disk drives. Memory caches and some sophisticated algorithms for prefetching data allow hard disks to move data at the megabit (and higher) speeds they were designed for.

Gregg Williams updates the Macintosh/Lisa story that appeared in February's BYTE with new information on models and prices. Authors Caceci and Cacheris explore the subject of fitting curves to data.

Following on the heels of April's Real-World Interfacing theme, Stephen Gates takes us into the laboratory to put an IBM to work collecting data, while Richard Hallgren offers up the software portion of his two-part series on using an Apple II for data acquisition.

Next, Roy Crosbie offers an explanation of ISIM, a language designed for writing computer simulations. As Crosbie reveals, a continuous-system simulation language running on micros under CP/M can add a new dimension to computer modeling. For those of us trying to glimpse the forest through a tangle of branches, John Snyder offers assistance with an article on a method for indexing open-ended trees. Finally, Richard Thomas illuminates the gains to be made in program maintainability by using intraprogram remarks to document software.

*—G. Michael Vose, Senior Technical Editor*

# The Apple IIc Personal Computer

## *A portable IIe compatible that runs ProDOS*

John Markoff
BYTE Senior Technical Editor

In an industry that sees dozens and dozens of personal computers introduced each year, and despite the fact that the venerable Apple II is rooted in seven-year-old technology, it's remarkable that Apple Computer has succeeded in keeping its II product line alive and even thriving. Now, in the face of stiff competition from both foreign and U.S. manufacturers and in the wake of its own introduction of two significantly more powerful desktop computers (Lisa and Macintosh), Apple Computer has introduced the fourth version of the Apple II product line, the Apple IIc (see photo 1).

### Evolving Apple II Technology

While the IIc will remain highly compatible with the Apple II product line from a software perspective, it is clearly not just "old wine in new bottles."

The IIc is what Apple Computer refers to as a "focused product." It is designed to fit into a market niche that places it in head-to-head competition with the IBM PCjr at the high end of the home market for personal computers. However, a great deal of flexibility is evident in both the IIc software and hardware architecture and peripherals. As such, you can expect to see the IIc appearing in a variety of other markets, including business and educational applications.

The IIc represents an evolution of Apple II hardware and software technology in a number of areas. First, it is truly portable. The system unit weighs just 7½ pounds and occupies a space of approximately 11½ by 12 by 2¼ inches. Its carrying handle folds into the backplane. A built-in half-height 5¼-inch disk-drive unit is accessed from the right-hand side of the case. The IIc and its optional 9-inch monochrome monitor are shown in photo 2.

Later this year, Apple intends to enhance the portability of the IIc when it introduces a full-screen, high-resolution flat-panel display (see photo 3). I'll discuss the flat-panel display later. Although a battery pack will not be available upon introduction, the IIc runs on virtually any 12-volt (V) power supply. The AC-to-DC converter has been isolated from the system, and, because the IIc has no slots, the power-supply capacity has been reduced from 45 to 35 watts. A small briefcase-size carrying case is available to hold the computer, flat-panel display, and other peripherals.

The IIc is based on the 65C02, a new CMOS (complementary metal-oxide semiconductor) implementation of the 6502 microprocessor. The 65C02 is an extension of the 6502's instruction set (with 27 new instructions) and offers faster graphics and arithmetic operations. The 65C02 runs virtually all existing Apple II software; however, software written to take advantage of the new instruction set will not be compatible with the IIe and II Plus. The new microprocessor has a clock speed of 1.023 MHz and will perform up to 500,000 eight-bit operations per second, performance figures that match the 6502's.

The IIc extends the use of custom-designed ICs (integrated circuits) beyond what was used in the original IIe design. In addition to the input/output unit (IOU) and memory-management unit (MMU), the IIc contains a custom timing-generator (TMG) chip that generates several time and control signals, a general logic unit (GLU) that provides miscellaneous logic control required by the system, and the disk-controller unit, which is referred to as the IWM (Integrated Woz Machine). The IWM is also used as a disk controller on the Macintosh. It is a one-chip LSI (large-scale integration) of the disk controller originally designed by Steve Wozniak for the Apple II.

The increased use of custom LSI ICs has permitted Apple to further lower the chip count of the IIc (see photo 4). In addition to its sixteen 64K-bit RAM (random-access read/write memory) chips (the computer comes with a standard 128K bytes of RAM), the IIc has only 21 chips. This is particularly striking when you consider that this is three chips fewer than the number of non-RAM ICs in the IIe, despite the fact that many functions performed by additional cards (disk controller, two serial interfaces, 80-column video circuitry) are now integrated into the IIc design.

Finally, the design of the IIc is based on a closed-hardware architecture giving the user no direct access to the system bus. However, in return for taking away the II's expandability, Apple included many of the features that have in the past required slots.

A quick look at the back of the IIc reveals connectors for two RS-232C serial ports, two video ports, an external disk-drive port, and a combination mouse/joystick port (see photo 5). Thus, in the slotless version of the IIc, users will have access to the functions that traditionally have taken as many as five of the computer's seven slots. While the Macintosh's relatively closed hardware architecture has created some controversy, the decision to restrict hardware expansion appears to be more clear-cut in the case of the IIc.

Portability and ease of use have clearly been gained at the expense of expandability. Apple has decided to market the IIc to a novice computer user who, it is argued, will have no desire to get inside the hardware, but instead will be interested in a computer that can be set up and run as simply as a stereo system. Toward that end Apple has separated the documentation into a setup guide and reference manual.

The software evolution of the IIc is more subtle, yet it may prove to have far-reaching consequences. The IIc will come with Apple's recently released ProDOS operating system, which offers a significant increase in performance over DOS 3.3. ProDOS includes Unix-like hierarchical file structures that are compatible with the Apple III SOS operating system.

Although the Apple IIc ROM (read-only memory) will appear very similar to the IIe ROM to programmers, it actually was redone almost completely. The ROM went through a dramatic "code crunch" according to Peter Quinn, manager of the IIc design team. Additionally, several bugs in the IIe ROM were removed and other features added, including improved interrupt-handling capability, a built-in windowing function, and a series of 32 graphics characters

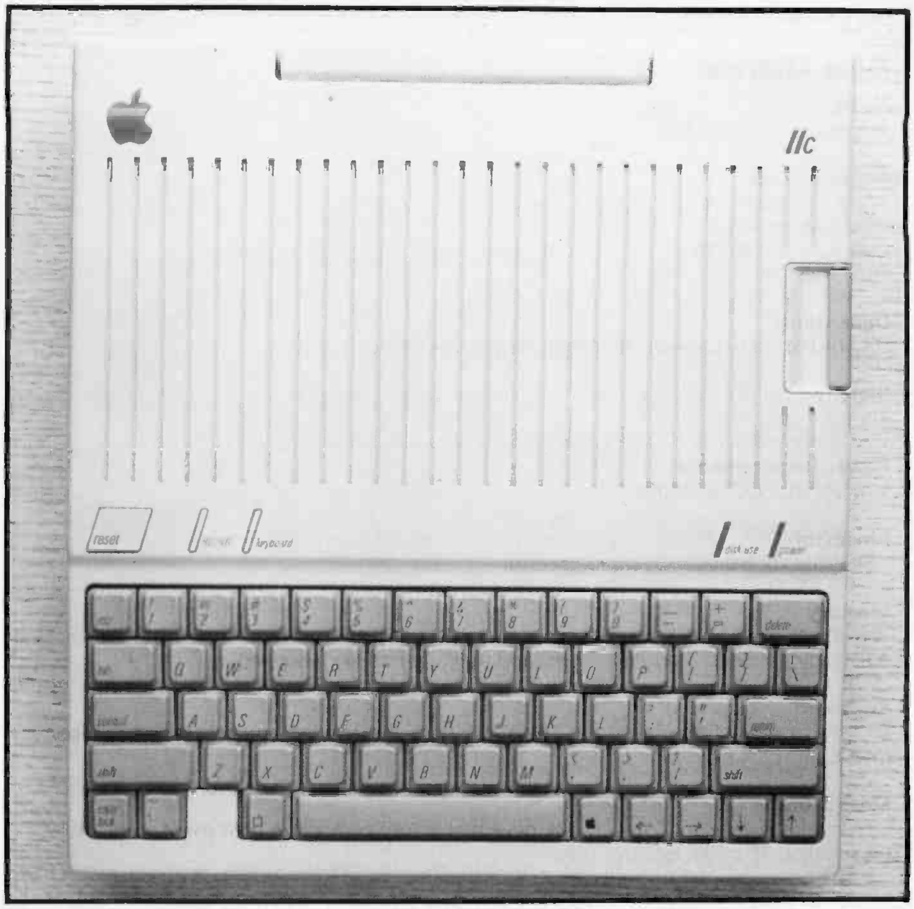


**Photo 1:** *A top view of the Apple IIc. It has a lower profile (2½ inches) and weighs less (7½ pounds) than the Apple IIe computer. The keyboard is the same in size and functional layout but is designed around a low-cost key switch that provides tactile and auditory feedback. The Reset key has been moved from one side of the keyboard to the other, and switches for 40/80-column mode and Dvorak and QWERTY keyboard arrangements have been added.*

**Photo 2:** *An optional 9-inch monochrome monitor is available for the IIc. When separated from the monitor, the system can be carried in a briefcase-size carrying case that includes room for the flat-panel display.*

## At a Glance

**Name**
The Apple IIc Computer

**Manufacturer**
Apple Computer Inc.
20525 Mariani Ave.
Cupertino, CA 95014
(408) 996-1010

**Dimensions**
Width: 11½ inches; depth: 12 inches; height: 2¼ inches

**Weight**
7½ lbs.

**Power Requirements**
9 to 20 volts DC, 35 watts

**Processor**
1-MHz 65C02 8-bit CMOS microprocessor

**Memory**
128K bytes of RAM; 16K bytes of monitor in ROM (includes self-test, Applesoft BASIC, 80-column routines, Mousetext icons, and interrupt-handling routines)

**Keyboard**
63 keys capable of generating the 128 ASCII characters; features auto-repeat and two-key rollover

**Mass Storage**
Built-in Alps half-height 5¼-inch disk drive that is fully compatible with the Apple Disk II; single-sided, 35-track, 16-sector disks

**Video Display**
Optional 9-inch monochrome monitor; flat-panel LCD will be introduced before the end of the year. RGB adapter to be offered at an unspecified future date. Video-display modes: 40-column text; 80-column text; low-resolution color graphics (40 horizontal by 48 vertical, 16 color); high-resolution color graphics (280 horizontal by 192 vertical, 6 color); double-high-resolution color graphics (560 horizontal by 192 vertical, 16 color). Text capacity: 24 lines by 80 columns. Character set: 96 ASCII (uppercase and lowercase). Display formats: Normal, Inverse, Flashing, Mousetext

**Other Features**
RF modulator; external AC-to-DC power converter; two RS-232C serial ports; video expansion port; external disk port

**Hardware Options**
Second disk drive; mouse; joystick; flat-panel LCD, carrying case

**Operating System**
ProDOS: single-user, single-task operating system; includes hierarchical directory structures, predefined and user-definable file types, file sizes up to 16 megabytes; compatible with DOS 3.3

**Available Software**
Includes almost all existing Apple II software. Specially designed packages from Apple: Appleworks integrated database management, word processing, and spreadsheet analysis; Access II communications program; Apple Logo II (requires 128K bytes of RAM); Apple Education Classics

**Prices**
Basic system unit: under $1300; other prices to be announced

found in the character-generator ROM. These characters, called Mousetext by Apple, are a series of icons designed to offer programmers access to a user interface that appears similar to that found on the Lisa and the Macintosh. They can be called directly and thus moved around on the screen faster than bit-mapped characters.

At the time of this writing, Apple was planning to price the IIc at "less than $1300." While this price is higher than some expected, Apple clearly has decided to go after the same market that IBM is trying to reach with the PCjr and has priced the IIc accordingly. Still, given equivalent features with the IIe, the IIc represents some price savings. But the trade-off for that price saving is the IIc's lack of an expansion slot. The amount of the price saving may determine the IIc's ultimate importance.

### A Computer for the Home

Apple has styled the IIc to reach a group of potential buyers that heretofore have been afraid or uninterested in personal computers. The IIc is, according to senior product designer Rob Gemmell Jr., "the cuddliest computer we have ever designed."

This is reflected in the IIc's case, which has a significantly lower profile than that of the IIe. Apple also has chosen a lighter, white color called "Apple Fog" for the case. The new color scheme is part of a general redesign effort that will affect all new Apple products. Originally code-named Snow White, the project led to a worldwide search for a design consultant. Ultimately, Apple settled on German designer Hartmut Esslinger, the designer of the Sony Walkman portable stereo. Esslinger set down the aesthetic design guidelines for the IIc and has since been retained by Apple to consult on future products.

The back panel of the case also reflects Apple's attempt to simplify system installation. Connectors are labeled with icons that represent modem, printer, and other ports. Frequently used interface cables make use of easy-to-fasten connectors. For example, Apple has chosen to use standard DIN 5-pin connectors to fasten the serial cables to the IIc.

Other external design features include a new door design for the internal disk drive (see photo 6), a miniphono headphone jack and volume-control knob that are recessed on the left side of the computer, and two switches set just behind the keyboard that control 40/80-column display and selection of a Sholes or Dvorak keyboard layout. The Dvorak option was available on the IIe, but it had to be accessed with jumpers and printed-circuit board trace cuts. The technical reference manual points out that you can change the key caps yourself, but it warns that if you break the switch stems you will void your warranty.

The IIc keyboard itself is functionally a duplicate of the IIe keyboard; it has 63 keys capable of generating the 128 ASCII (American National Standard Code for Information Interchange) characters. The actual mechanical design of the keyboard, however, is significantly different from keyboards on other Apple products. The IIc keyboard is laid out in a flatter fashion, in part because the IIc is designed to be used tilted up at a slight angle while resting on the handle, which folds down to serve as a stand. Although the keyboard is physically the same size as that of the IIe, the keys themselves are based on a new low-cost key switch that Apple has developed. The switch is not "full travel" (i.e., the keys don't depress deeply), but instead offers what Apple claims is improved tactile and auditory response.

It seems that no new version of the Apple II would be complete without altering the placement of the Reset key. This time it is placed just above and to the rear of the keyboard on top of the system case. As with the IIe, there are two levels of Reset. Holding down the Control key and the Reset key will cause a warm-start procedure with some programs. This leaves the resident program intact. Simultaneously holding down the open-apple key (to the left of the space bar) with the Control and Reset keys forces a cold start, which has the same effect as turning the power off and back on again.

## Display Options

Although the video output of the IIc is similar to that of the IIe, Apple has attempted to generalize the output options of the IIc as much as possible. The back panel offers two connectors: a standard RCA pin-plug jack for a video monitor and a 15-pin D-type connector for video expansion. The latter interface is designed to support a number of display options, including RGB (red-green-

**Photo 3:** *Apple has announced that a full-screen (560- by 192-pixel) flat-panel LCD will be available for the IIc before the end of 1984. The flat-panel display will support all the IIc's text and graphics modes and draw its power from the video expansion port.*

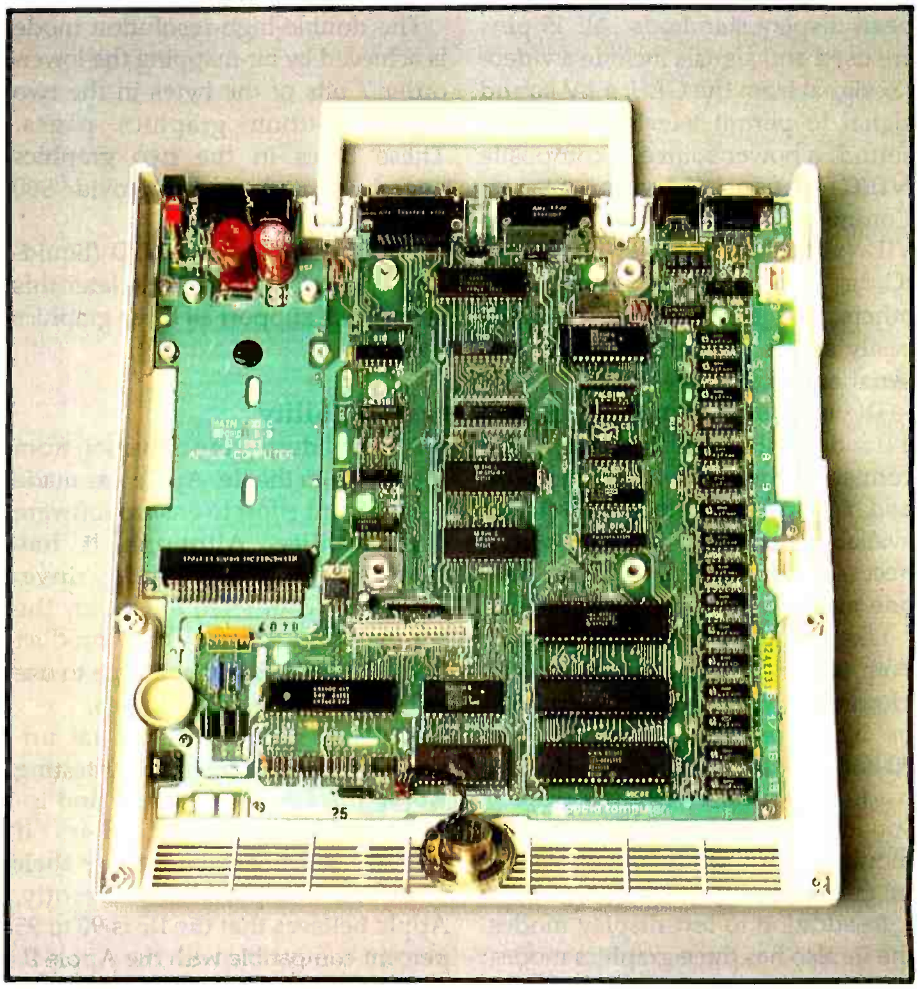

**Photo 4:** *The main circuit board of the Apple IIc. The IC count is now down to 21 (excluding RAM), including two serial ports, video circuitry, and a disk controller. By comparison, the IBM PCjr has more than 90 ICs.*

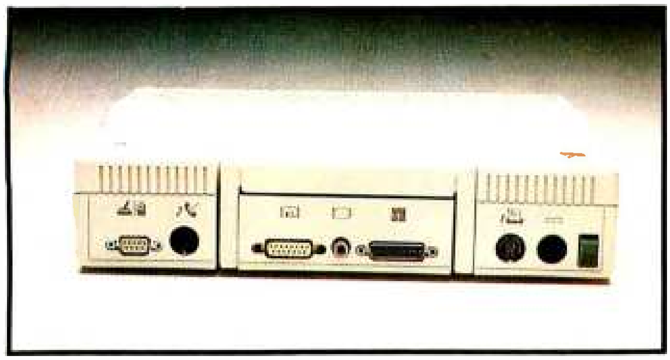

**Photo 5:** *The rear panel of the IIc. The panel consists of seven connectors and a main power switch. From left to right: a 9-pin D-type miniature connector for hand controls or a mouse; a 5-pin DIN (Deutsche Industrie Norm) connector for serial I/O (input/output) (port 2, normally for a modem); a 15-pin D-type connector for video expansion; an RCA pin-plug jack for a video monitor; a 19-pin D-type connector for linking a second disk drive; another 5-pin DIN connector for serial I/O (port 1, normally for a printer or plotter); a special 7-pin DIN connector for 9–15-volt DC power input; and the main power switch.*

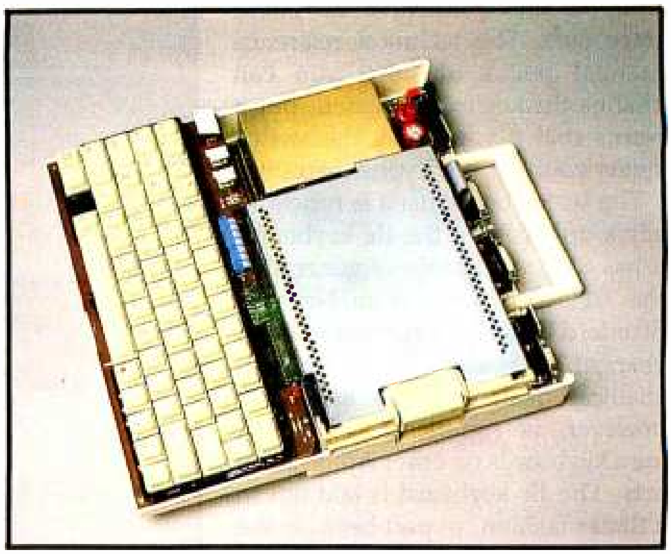

**Photo 6:** *View of the IIc's internal 5¼-inch disk drive. The drive was initially designed to face backward but in the final design faces the side of the case. The drive is heavily shielded and ventilated.*

blue) displays, the forthcoming flat-panel display, and a variety of European display standards. All 15 pins are used and signals include a videotex signal from the GLU, a 1-V sound signal to permit television speaker sound, a power source, a composite NTSC (National Television System Committee) video signal from the VID (video interface device) hybrid IC, a color-reference signal, and others. The intent is to let designers easily access all the hooks for both serial and composite data.

The basic system unit comes with a standard RF modulator designed to connect to the video expansion port, and an optional 9-inch monitor is available. An RGB adapter still is necessary, and Apple plans to have one available in the future.

Like the IIe, the IIc can produce both 40- and 80-column text displays. However, if you use an ordinary color or black-and-white television set, 80-column text will be too blurry to read. For a clear 80-column display, you must use a high-resolution video monitor with a bandwidth of 14 MHz or greater.

In addition to text-display modes, the IIc also has three graphics modes: low-resolution (40 horizontal by 48 vertical), 16 color; high-resolution (280 horizontal by 192 vertical), 6 color; and double-high-resolution (560 horizontal by 192 vertical), 16 color.

The double-high-resolution mode is achieved by bit-mapping the lower-order 7 bits of the bytes in the two high-resolution graphics pages. These bytes in the two graphics pages are interleaved to provide 560 dots per line.

When the flat-panel LCD (liquid-crystal display) is available later this year, it will support all three graphics modes.

## Compatibility

As it did during the transition from the II Plus to the IIe, Apple has made a significant effort to ensure software compatibility. Although it has switched to a half-height drive, Apple has continued to employ the 5¼-inch disk size for the II product line. The IIe also will continue to use 140K-byte single-sided drives.

In recent months, Apple has undertaken a major program of testing Apple II software on the IIc and informing software publishers if changes are needed to make their software compatible. Currently, Apple believes that the IIc is 90 to 95 percent compatible with the Apple II.

Compatibility problems, where they arise, may come from the ROM, the 65C02 microprocessor, unorthodox protection schemes, or illegal memory addresses. For example, programs that enter the monitor ROM at unpublished locations will not work. A more intriguing but apparently rare problem emerges from the fact that some programmers have discovered and used undocumented instructions for the 6502 microprocessor. These instructions no longer exist in the 65C02.

## Software

Apple has made the decision to endorse selected third-party software that has been specially designed for the IIc. Of the 21 products that Apple is introducing with the IIc, 17 are published by independent software publishers. The programs fall into the broad categories of education, entertainment, and productivity and come from such publishers as Microsoft, Software Publishing, The Learning Company, and Brøderbund Software. Apple itself is offering Appleworks, an integrated database-management, word-processing, and spreadsheet program; Apple Logo (see photo 7), redesigned to take advantage of the 128K bytes of RAM available in the IIc; Apple Education Classics; and the Apple Access II communication program.

Apple's endorsement is not an exclusive one. More than 100 other companies also are developing their

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**Photo 7:** *Part of the Apple Logo tutorial. Apple has limited the amount of printed documentation and increased the interactive on-line tutorials available with the IIc. The basic system comes with four disks of tutorials designed to offer 10 to 12 hours of instruction.*

software for the IIc. A software developers toolkit and a technical reference manual will be available to software publishers.

## Peripherals

Several peripherals designed to work with the IIc represent significant technological advances.

Apple has gone to the Japanese manufacturer Sharp for a full-screen flat-panel display that Apple hopes to have ready for introduction later this year. Several Japanese LCD manufacturers now are on the verge of introducing 80-character by 24-line flat-panel displays. Significantly, most of them will have an aspect ratio of 640 by 200 (width to height), corresponding to the IBM monochrome display. However, Apple has persuaded Sharp to manufacture a display for the IIc with an aspect ratio of 560 by 192. Apple currently has several working prototypes of the display. Recently, BYTE was shown a demonstration of one of these prototypes. The display differs from a CRT (cathode-ray tube) in appearance because of the square shape of individual pixels. (Individual pixels on an Apple monitor are twice as high as they are wide.) This makes characters on the display appear somewhat flattened;, however, characters in 80-column display mode appeared quite crisp, and the display also produced remarkable high-resolution graphics.

The Scribe printer, which is being announced simultaneously with the IIc, is an impressive plain-paper thermal-transfer printer with color capabilities. Although the final price of the Scribe has not been set, it is likely to be in the $300 range. Apple is taking some pains to separate the Scribe thermal-printing technology from other thermal-printing techniques that require specially sensitized or coated papers. By contrast, the Scribe will print on virtually any paper surface, ranging from Xerox copier paper to continuous form-feed paper. The Scribe also will print on projection transparencies.

Although the Scribe is being announced with the IIc, it is designed as a printer to function with the entire Apple product line, including the Macintosh and the Lisa. BYTE was shown printing samples of graphics screen dumps from the Macintosh that appeared to exceed the Imagewriter in quality. The Scribe has two resolution modes and can operate at either 80 cps (characters per second) in draft mode or 50 cps in letter mode.

Scribe technology is based on a proprietary print head that consists of 24 resistance elements that are arrayed in a vertical column. While printing, the head is pressed against a ribbon that consists of a polyester backing and a carbon-filled paraffin ink. The resistance elements are pulsed briefly, heating them and melting the ink to deposit it on paper.

The design of the print head permits a resistance element to rise to a temperature above 300°F and then drop to below 95°F (below the melting point of the wax in the ribbon) within the space of several hundred microseconds. The dot resolution of the Scribe can range as high as 160 horizontal by 144 vertical dots per inch in letter mode.

Color printing can be achieved by inserting a color ribbon that has different colors laid out in serial bands; the Scribe skips intermediate colors when printing in a particular color.

While the Scribe is a low-cost printer to purchase, the cost of printing will be high. Ribbon cost for an 80,000-character black ribbon will be in the neighborhood of $5, and color ribbons may cost as much as $8. Apple claims that the Scribe will be most compatible with "low duty cycle" applications such as those associated with students, homes, or executive workstations.

## Questions and Comments

Now that we've seen what the Apple IIc has going for it, what does it lack? First, there are the obvious shortcomings, such as its inability to run CP/M software. This is not an insubstantial omission, since Z80 cards are one of the most common additions to the Apple II beyond 80-column cards, serial cards, and disk controllers.

Second, Apple has chosen not to include a built-in modem. It seems reasonable to expect that a modem should be an integral part of any computer that is designed to be readily transportable. Apple's response is that it decided to leave the modem out for reasons of time, cost,

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and space. However, since lap-size computers selling for as little as $700 now include integral 300-bps modems, this may be the IIc's most significant design flaw.

Less obvious, perhaps, are problems associated with the decision to maintain media compatibility between the IIc and earlier versions of the Apple II. Certainly Apple is the only company that can get away with introducing a personal computer with just one 140K-byte single-sided drive.

Even in its half-height form, it seems that the 5¼-inch disk standard is not an ideal one for a truly portable computer. The drive adds considerably to the weight and size of the computer and, in fact, the Apple design team admitted that the internal drive created major headaches in terms of cooling the IIc. (The critical element in the cooling equation is the jacket of the 5¼-inch disk.)

The obvious alternative would have been to switch to the Sony 3½-inch disk drive used by the Macintosh. That drive is lighter and more compact and has more than twice the storage capacity in its single-sided version. The problem of transferring software from one medium to another doesn't seem insurmountable, particularly because Apple seems intent on marketing the IIc to first-time computer users.

Also less clear is the question of open- versus closed-hardware architecture. It seems obvious that, in the case of the IIc, expandability had to be sacrificed to achieve a genuinely portable computer. Peter Quinn, the director of engineering for the IIc, insists that, while Apple's two most recently released products have been slotless, the company has not backed away from its commitment to the principle of open architectures: "I think that within this division we're still very sold on open architecture, open slots, and I think any of our new products will ultimately reflect this, once we evolve into a new architecture," he says. ■

*John Markoff is a senior technical editor at BYTE. He can be contacted at 1000 Elwell Court, Suite 225, Palo Alto, CA 94303, (415) 964-0624.*

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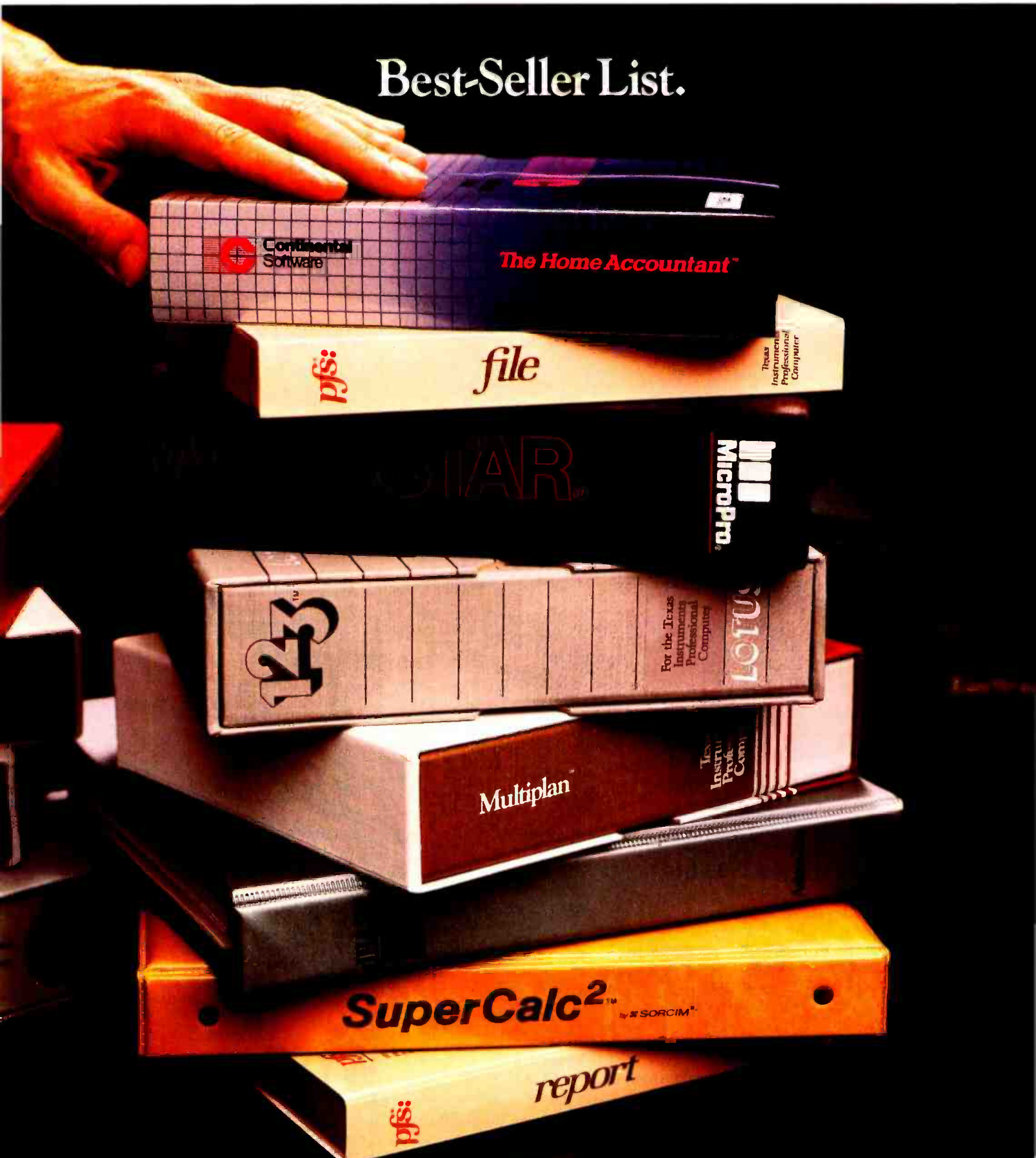


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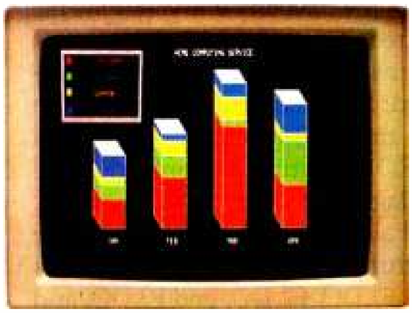

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# Inside the Model 100's ROM

*Explore the built-in software in the TRS-80 Model 100*

**Brian Cameron**
**Free-lance Writer**

The TRS-80 Model 100 is still a relatively new machine with not much software or information available for it yet. This probably will change, as it did for the original TRS-80 Model I and other early microcomputer systems. I hope to shorten the time it takes you to get information contained within the Model 100 by taking you on a walk through its ROM (read-only memory) chips, stopping at addresses you may find useful in your own BASIC or machine-language programs. I will show you the locations of the systems directory and your files and explain their formats. Finally, I will describe a program I wrote called DIR.CO. This program addresses a shortcoming of the Model 100 in that it shows the location and size of the files in the machine. DIR.CO will list each directory entry, even if the file has been erased, and give the starting address and length of each file. In some cases DIR.CO will provide even more information, such as the execution and entry addresses of a command file.

## The Directory

The file directory starts at hexadecimal location F962. Each directory entry is 11 bytes long. The first byte is a flag byte that describes the status of the file. The bits defined in the status byte are:

7—tells that the file really exists
6—identifies the file as a text (.DO) file
5—identifies the file as a command (.CO) file
4—shows that the program is in ROM if this bit is on
3—shows that the program is invisible if this bit is on
2—not used
1—not used
0—not used

The status byte is followed by a 2-byte starting address for the program and an 8-byte address containing the filename. The directory starts with the system entries. These are what the user is accustomed to seeing displayed in the main menu. The familiar system files are BASIC, TEXT, TELCOM, ADDRSS, and SCHEDL. Each of these files contains a status-flag byte of hexadecimal B0. The status-byte list, above, shows that this means the files are command type and that they are resident in ROM. The next two directory entries refer to programs called SUZUKI and HAYASHI. Both these filenames are preceded by a zero. The status flags for SUZUKI and HAYASHI are hexadecimal 88 and C8, respectively. In each case the invisible bit is on for these files. The user directory entries start at hexadecimal address F9AF.

### About Erased Files

An erased file has a status-flag byte of zero. All other files have the high-order bit of the status byte turned on. If you accidentally erase a file, you may be able to recover it. Start at the beginning of the user directory and move through it 11 bytes at a time until you come to the file you erased. Store a hexadecimal 80 in the first byte of the directory entry and the file will reappear. This, however, does not ensure that the file will be restored; to be recoverable it must have been the last file stored. The Model 100 ROM routine not only changes the flag to 00 when a file is erased, but it also closes any holes in the file structure. For example, if three files exist, F1.DO, F2.DO, and F3.DO, and you erase F2.DO, file F3.DO will close the gap that F2.DO left. This can be demonstrated with the DIR.CO program. Create several files and display their start and end addresses, then erase one of the files and invoke the DIR.CO program again. As long as the program erased was not the last directory entry, you will notice that the file previously listed after the erased file will now begin at a new address. Because of this file movement you cannot be assured that a file can be restored after a KILL command has been entered. It is unfortunate that the authors of the Model 100 ROM routines did not choose to simply mark a file as erased and then clean up any missing gaps at the next file save. Be careful if you attempt to recover a lost

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| BASIC Command | Internal Code (all hexadecimal) | ROM Entry Address (all hexadecimal) | BASIC Command | Internal Code (all hexadecimal) | ROM Entry Address (all hexadecimal) |
|---|---|---|---|---|---|
| ABS | E1 | 33F2 | LET | 87 | 09C3 |
| ASC | F9 | 294F | LINE | 92 | 0C45 |
| ATN | ED | 2F71 | LIST | A5 | 1140 |
| BEEP | B1 | 4229 | LLIST | A7 | 113B |
| CALL | B9 | 1DFA | LOAD | 9B | 4D70 |
| CDBL | F4 | 35BA | LOG | E8 | 3FCF |
| CINT | F2 | 3501 | LPOS | E4 | 10C8 |
| CLEAR | A7 | 40F9 | LPRINT | A0 | 0B4E |
| CLOAD | A8 | 2377 | MAX | B7 | 1D9B |
| CLOAD? | (same as CLOAD) | 2456 | MENU | BA | 5797 |
| CLOADM | (same as CLOAD) | 24A7 | MERGE | 9C | 4D71 |
| CLOSE | 9A | 4E28 | MOTOR | B6 | 1DEC |
| CLS | B0 | 4231 | NAME | BC | 2037 |
| COM | AD | 1A9E | NEW | BF | 20FE |
| CONT | A4 | 40DA | NEXT | 82 | 4174 |
| COS | EA | 2EEF | ON | 97 | 0A2F |
| CSAVE | A9 | 2280 | OPEN | 99 | 4CCB |
| CSAVEM | (same as CSAVE) | 22DD | OUT | 96 | 110C |
| CSNG | F3 | 352A | PEEK | EE | 1284 |
| CSRLIN | CA | 1D90 | POKE | A2 | 128B |
| DATA | 83 | 099E | POS | E5 | 10CE |
| DATE | AB | 1924 | POWER | B8 | 1419 |
| DAY | AC | 1955 | PRESET | B5 | 1C66 |
| DEF | A1 | 0872 | PRINT | A3 | 0B56 |
| DIM | 85 | 478B | PSET | B4 | 1C57 |
| DSKI | C8 | 5073 | READ | 86 | 0CD9 |
| DSKO | 98 | 5071 | REM | 8E | 09A0 |
| EDIT | 93 | 5E51 | RESTORE | 8B | 407F |
| END | 80 | 409F | RESUME | 95 | 0AB0 |
| EOF | EF | 1889 | RND | E7 | 313E |
| ERROR | 94 | 0B0F | RUN | 89 | 090F |
| EXP | E9 | 30A4 | SAVE | 9E | 4DCF |
| FILES | 9D | 1F3A | SAVEM | (same as SAVE) | 22CC |
| FIX | F5 | 3645 | SCREEN | BE | 1E22 |
| FOR | 81 | 0726 | SGN | DF | 3407 |
| FRE | E2 | 2B4C | SIN | EB | 2F09 |
| GOSUB | 8C | 091E | SOUND | B2 | 1DC5 |
| GOTO | 88 | 0936 | SPACE | FB | 298E |
| HIMEM | CC | 1DB9 | SQR | E6 | 305A |
| IF | 8A | 0B1A | STOP | 8F | 409A |
| INKEY$ | C9 | 4BEA | STR | F7 | 273A |
| INP | E3 | 1100 | STRING | C6 | 296D |
| INPUT | 84 | 0CA3 | TAB( | C0 | 0C01 |
| INPUT# | (same as INPUT) | 0C99 | TAN | EC | 2F58 |
| INT | E0 | 3654 | TIME | AA | 1904 |
| IPL | BB | 1A78 | USING | C2 | 4991 |
| KEY | AF | 1BB8 | VAL | F8 | 2A07 |
| KILL | BD | 1F91 | VARPTR | C3 | 0F7E |
| LCOPY | B3 | 1E5E | WIDTH | 90 | 1DC3 |
| LEN | F6 | 2943 | | | |

**Table 1:** *The BASIC command entry points and internal codes. For an explanation of the abbreviations, see September 1983 BYTE, page 154.*

file—if the files have been shifted after the erase command the results may be unpredictable.

## File Formats

Three types of files can exist on the Model 100: BASIC files (.BA), command files (.CO), and document files (.DO). A BASIC file starts at the address specified in the directory and continues through memory until three zeros are encountered. A document file also starts at the address specified in the directory, but it continues until a Control-Z hexadecimal 1A is encountered. A command file is a little more complicated because it must provide such information as the start address and the length of the program. At the address specified in the directory, you will find where the command file is stored. This is not where it is executed. The program, when invoked from the main menu, will be moved to its execution address and control will then be passed to it. The first two bytes of the file contain the start address, or the address where the file will be moved to in memory. The next two bytes contain the length of the program. This is the program proper and does not include the start-address bytes,

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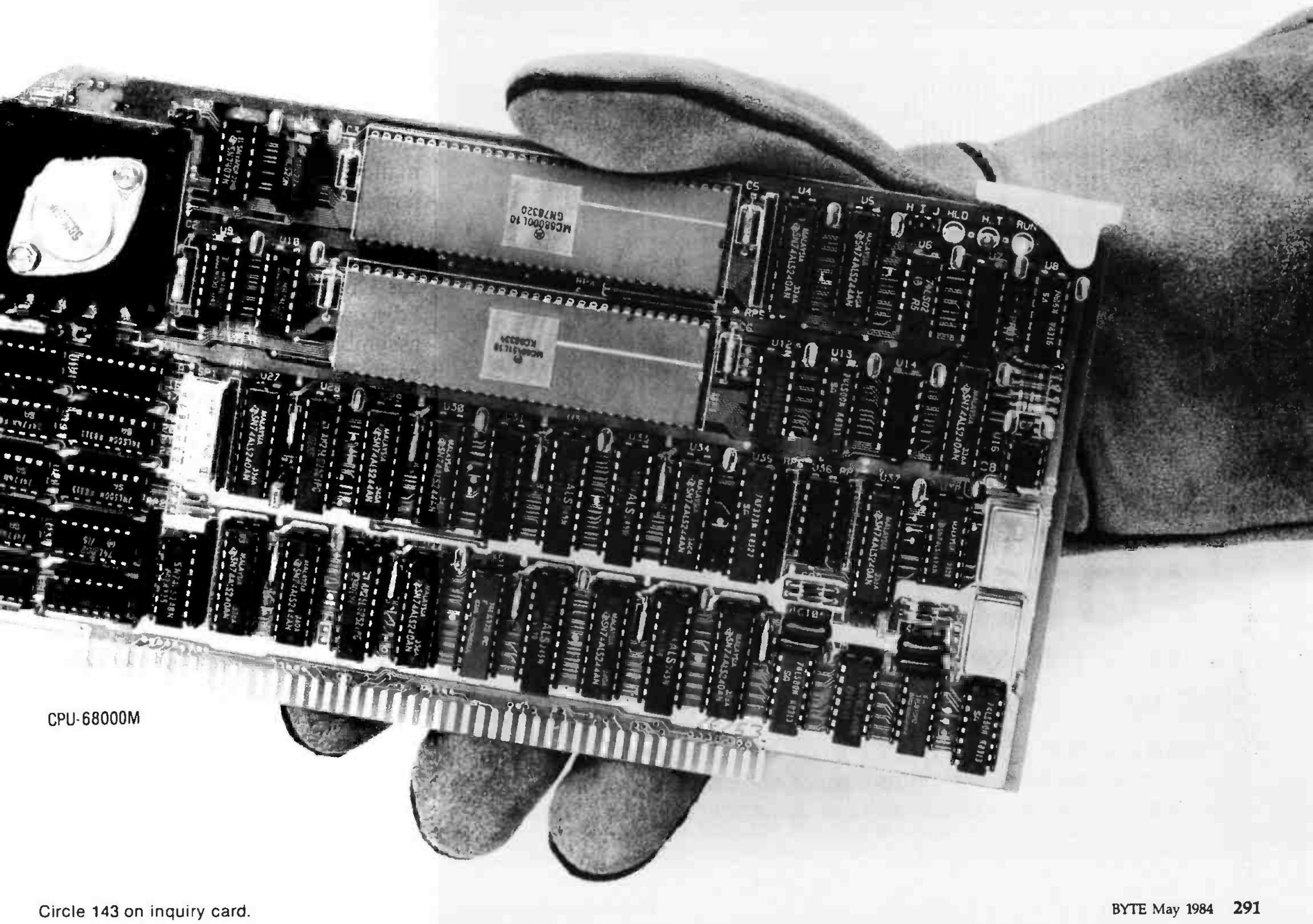

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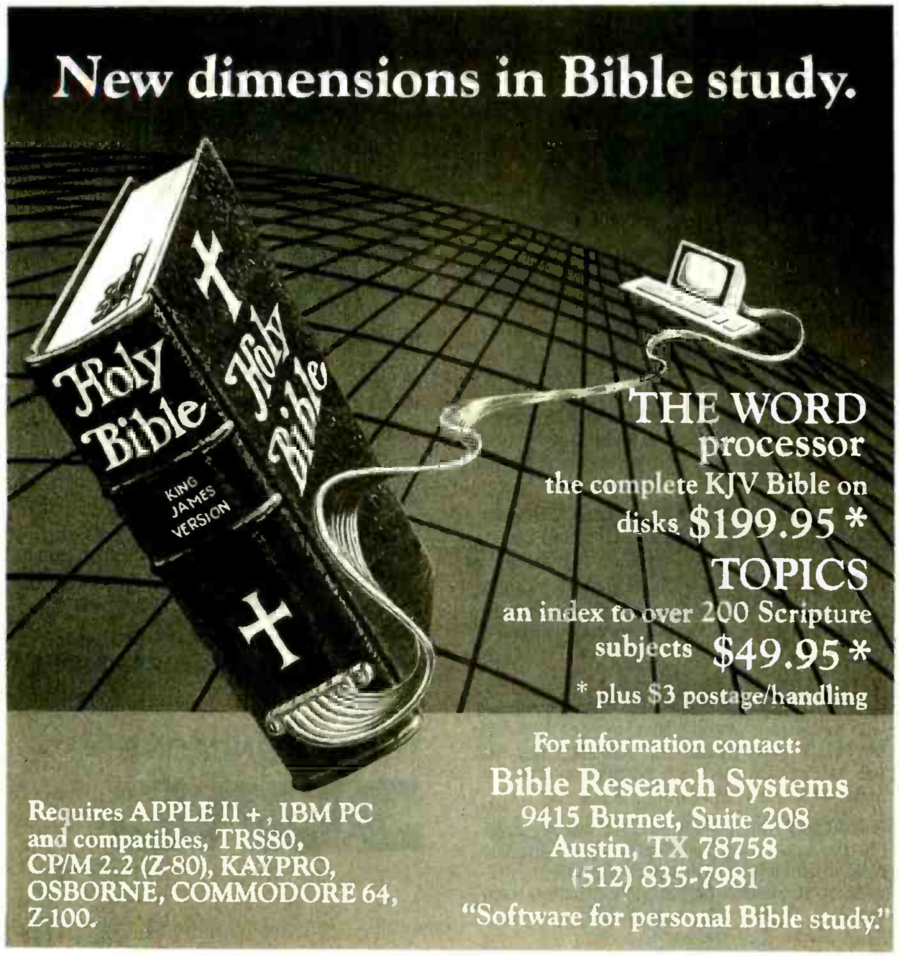



length bytes, or the entry bytes in its calculated length. The two bytes following the length contain the entry address of the program. This is where the program will start executing from, once control is passed to it. The entry address is not necessarily the same as the start address, but they can be the same if the program is to start at the first byte specified in the start address.

### ROM Routines

By understanding parts of the Model 100 ROM routines you will be able to shorten your programs and use the 32K bytes of ROM space that would normally be useless to your program. For example, there is no point in writing the code to clear the screen or home the cursor if these routines already exist in the machine. Because the Model 100 clears the screen when it leaves the menu, you should be able to use this function, as well as other routines (providing you can find them in ROM) and understand what each routine requires. To prove this capability, enter the BASIC command CALL 16945. This is the entry point for the BASIC CLS command. After you enter this command your screen will be blank. Table 1 gives a list of BASIC command entry points, as well as their internal representation.

Many other useful ROM routines are available in the Model 100. Table 2 is a list and description of addresses I discovered in the ROMs using a disassembler on an IBM 4341. You can easily incorporate these routines into your machine-language programs.

### The DIR.CO Program

The DIR.CO program in listing 1 is an extended version of the BASIC FILES command, but it provides much more information than just the names of the current files. If a directory entry exists for an erased file, its name will also appear in the list of files, with the comment *ERASED* beside it. Each file appears by itself on the screen. Pertinent information also appears with the filename. You move through the system files by pressing the Enter key, at which point the screen is cleared and the next file



*Text continued on page 303*

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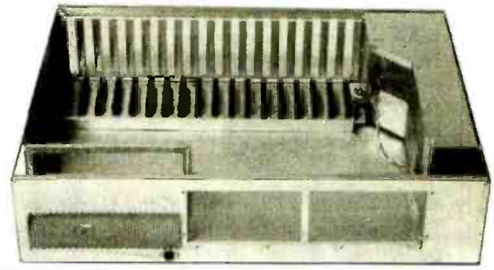

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12CB — Get a Character from Keyboard
This routine will wait for a character from the keyboard and return it in the A register. The carry flag will be set if it is a special character.

13DB — Check Keyboard
This routine checks to see if any characters are pending from the keyboard. The zero flag is set if no character is found. The zero flag is reset if there are keys waiting.

1470 — Print a Character
The character in the A register will be printed when this routine is called.

14A8 — Turn On Cassette
This routine will turn on the cassette motor.

14AA — Turn Off Cassette
This routine will turn off the cassette motor.

14B0 — Get a Character from the Cassette
A character is read from the cassette and returned in the A register. Upon entry to this routine, the C register must contain the current checksum. Upon exit, the C register will contain the updated checksum.

14C1 — Write a Character to the Cassette
This routine is similar to the cassette-read routine. The character to be written to the cassette must be in the A register, and the checksum must be in the C register. Upon return, the C register will contain the updated checksum.

190F — Get Time
Upon entry, the HL register pair must point to an 8-byte data area that will receive the system time. The format of the time returned is HH:MM:SS.

192F — Get Date
Upon entry, the HL register pair must contain the address of an 8-byte data area to receive the system date. The format of the date returned is MM/DD/YY.

1962 — Get Day
A call to this routine will return a 3-byte representation of the day of the week. Upon entry, the HL register pair must contain the address of the 3-byte area to receive the day.

1BE0 — Display Printable Characters
This routine displays the characters pointed to by the HL register pair, for the length contained in the B register. Only printable characters are displayed. If the value is greater than 7F or less than 20, then a blank is displayed in place of the character.

1E5E — Print LCD [liquid-crystal display] Screen
This routine will print the contents of the screen on the printer. This is the same entry point for the BASIC LCOPY command.

1FBE — Erase a .DO File
A call to this address will result in erasing a text file from the system. The HL register must contain the address of the files directory entry. The DE register pair must point to the start of the file. The start of file can be obtained from a call to 5AE3.

220F — Save a .DO File
This routine will create a directory entry for a text file. The filename must have previously been stored in RAM (random-access read/write memory) at location FC93.

2542 — Move from Address in HL to Address in DE
The data pointed to in the HL register is moved to the address specified in the DE register, for a length contained in the B register. This is a forward movement of data because HL and DE are both incremented.

27B1 — Display a String
This routine will display, on the LCD screen, the characters pointed to in the HL register. The display of characters is terminated when a zero is discovered in the string.

290C — Move from Address in BC to Address in DE
The data pointed to in the BC register is moved to the address specified in the DE register, for a length contained in the L register. This is a forward movement of data.

2EE6 — Move from Address in HL to Address in DE
The data pointed to in the HL register is moved to the address specified in the DE register, for a length contained in the C register. This is a backward movement of data because the HL and DE registers are decremented before each character moved.

3469 — Move from Address in DE to Address in HL
The data pointed to in the DE register is moved to the address specified in the HL register, for a length contained in the B register. This is a forward movement of data.

3472 — Move from Address in DE to Address in HL
Same as the call to address 3469 except that this is a backward movement of data.

39D4 — Convert and Display
The hexadecimal value in the HL register pair will be converted to a decimal number and will then be displayed at the current cursor position. (See the DIR.CO program listing for an example.)

**Table 2:** *The ROM routines. (All numerical values are in hexadecimal notation.)*

*Table 2 continued on page 296*

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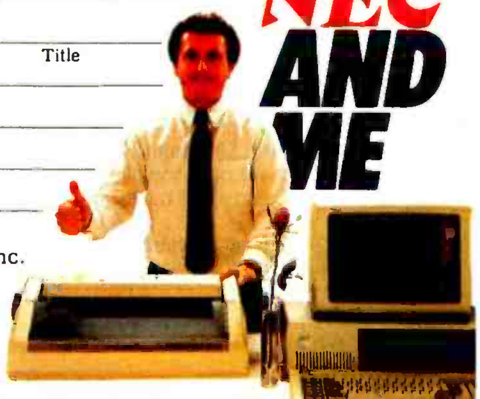

*PC WORLD Magazine, July 1983

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**40F1 — Check HL for Character**
The byte at the address pointed to by the HL register is checked to see if it is a valid uppercase letter. If it is not valid then the carry flag is set.

**40F2 — Check A for Character**
This is similar to the call to address 40F1, except that the A register is checked for a valid uppercase letter A–Z.

**4222 — Display CR LF**
Calling this address results in a carriage return and a line feed being displayed on the screen. The A register is destroyed.

**4229 — Beep**
This routine gives a short beep on the speaker. The A register is destroyed.

**422D — Home Cursor**
This routine does the same as the call to address 5D6A, except that the HL register is not touched. This probably is a better choice.

**4231 — Clear Screen**
This routine is also the same as the BASIC command CLS. The A register is destroyed.

**4235 — Protect the Bottom Line**
After calling this routine you are unable to write into line eight. The system uses this to protect the function-key displays.

**423A — Unprotect the Bottom Line**
This routine undoes a call to address 4235.

**423F — Scroll Lock**
After a call to this routine the screen will be locked. A line feed cannot cause the top line to disappear or a fresh line to appear on the bottom.

**4244 — Scroll Unlock**
This routine reverses the effect of a call to 423F, allowing a line-feed character to move lines of data, off the top of the screen.

**4249 — Turn Cursor On**
This routine causes the familiar block cursor to appear at the current cursor position.

**424E — Turn Cursor Off**
This routine will cause the block cursor to disappear.

**4253 — Erase Line**
This routine will erase the entire contents of the current screen line.

**4258 — Insert Line**
This routine will insert a blank line on the screen below the current cursor position.

**425D — Erase to End of Line**
This routine will clear the current line starting from the cursor position.

**4269 — Reverse Video**
After a call to this routine, characters typed on the screen will appear white with black backgrounds.

**426E — Normal Video**
This routine restores normal black characters on a white background.

**4270 — Send Escape Code**
Upon entry, the A register contains the escape code.

**427C — Move Cursor to (row, col)**
This routine can be used to position the cursor anywhere on the screen. Upon entry, the HL register points to the destination of the cursor

H = ROW
L = COLUMN

The A register is destroyed.

**428A — Erase Function Display**
This routine will remove the function-key display from the bottom of the screen.

**42A5 — Set (and display) Function Keys**
This routine will set the function keys according to the table pointed to by the HL register and display them. This routine is the same as a call to address 5A7C to set the keys, followed by a call to address 42A8 to display the setting.

**42A8 — Display Function Keys**
As stated in the routine above, this routine will display the settings.

**4644 — Get a Line from Keyboard**
This routine will get a line of input from the keyboard and exit back to the calling routine when the Enter key is pressed. The data can be found in the keyboard input buffer, located at address F685.

**4B44 — Display a Character**
The character in the A register is displayed on the LCD screen.

Table 2 continued on page 298

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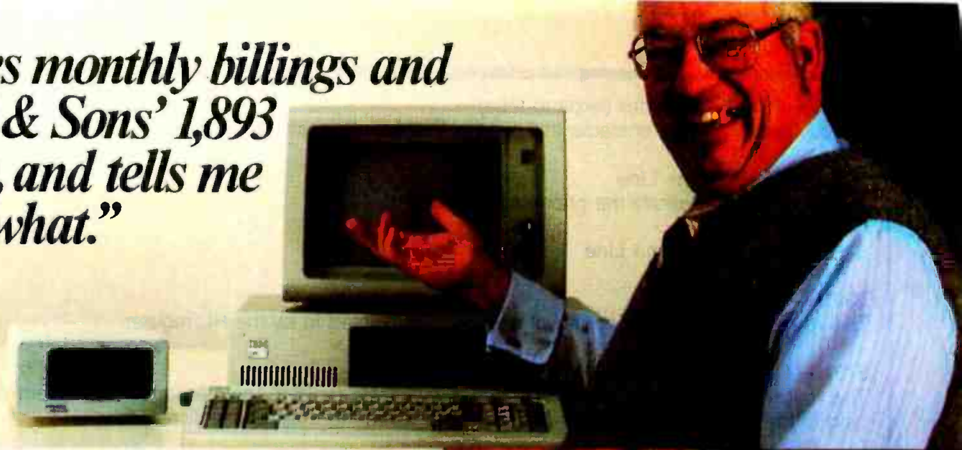

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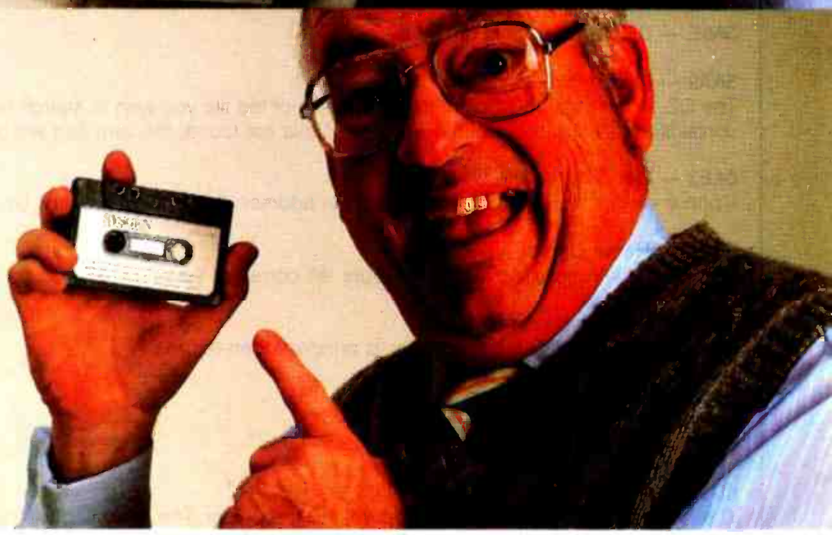

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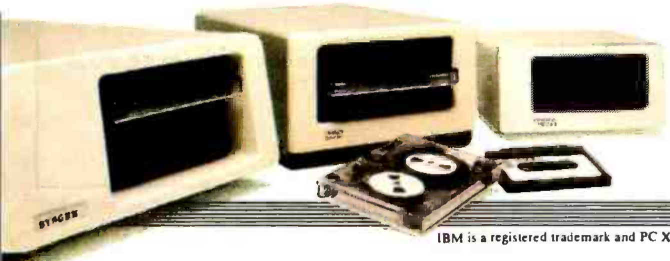

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*Table 2 continued:*

**4B55 — Print a Character (expand tabs)**
This routine will print the character that is in the A register, unless it happens to be a tab character, in which case the tab is expanded out two spaces.

**52BB — Drop Phone Line**
This routine will terminate the phone connection.

**52D0 — Connect Phone Line**

**532D — Dial a Number**
This routine will dial the specified phone number pointed to by the HL register.

**5791 — Display Message on New Line**
This routine will display a message pointed to by the HL register. The message must be terminated with a zero. If the cursor is not at the beginning of the line then a carriage return is done before the message is displayed.

**5797 — Main Menu**
This is the address of the main-menu routine.

**5970 — List Files**
This routine is called from the main menu to display the files on the LCD screen.

**59AD — Display Filename**
This routine is called to build a filename. The DE registers must point to a string of characters containing the filename. The HL registers must contain the address of a work area large enough to contain the filename, file type, the period separator, and a trailing zero. After the call the HL register no longer points to the start of the string so it is advised to PUSH the HL register before the call, and then POP the register before calling off to the routine to display the filename. For an example, see the routine called PUTFN in the DIR.CO program listing.

**5A58 — Display String of Characters**
Upon entry to this routine, the HL register must contain the address of a string of characters to be displayed on the screen. The string must be terminated with a 00. The A register is destroyed and HL points to the end of the string.

**5A79 — Clear Function Keys**
This routine clears the function-key table.

**5A7C — Copy Function Keys**
The HL register must contain the address of the function table that will be copied into the system function-key settings.

**5A9E — Display the Function Table**

**5AA9 — Find a Directory Entry**
The DE register pair must point to the address of the file you wish to search for. A zero must terminate the name. Upon exit, the HL register contains the start address of the file. If the file is not found, the zero flag will be set.

**5AE3 — Get Start of File**
Upon entry, the HL register must contain the address of the directory entry. Upon exit, the HL register will contain the start address of the file.

**5D6A — Home Cursor**
This routine will move the cursor to upper left corner of the screen. Registers A and HL are destroyed. (Also see address 422D.)

**5F2F — Wait for Space Bar**
This routine waits until the space bar is pressed, then returns.

**6CD6 — Cold Start Address**

**6CE0 — Warm Start Address**

**6D3F — Print a Character**
The character in the A register will be sent to the printer. The carry flag will be set if the print operation is canceled by break.

**6D6D — Return Number of Characters on RS-232C**
This routine will return the number of characters pending on the RS-232C queue. The results are returned in the A register. If there are no characters pending, the zero flag will be set.

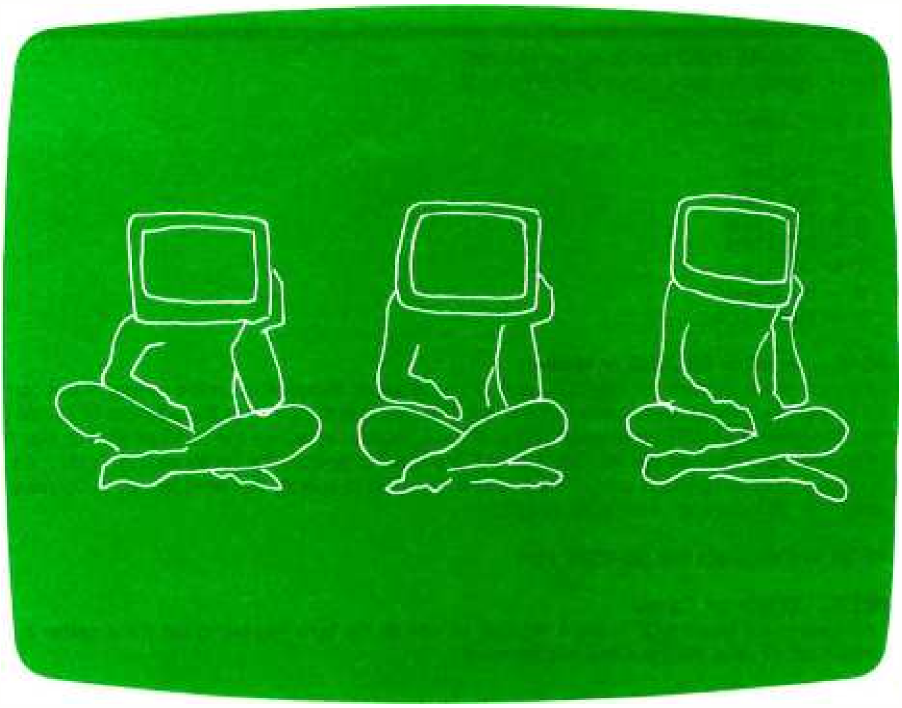
**6D7E — Get Character from RS-232C**
Upon return, the A register will contain a character from the RS-232C queue. The zero flag will be set if all is OK. The carry flag will be set if the Break key was pressed.

**6E0B — Send XON**
This routine will send an XON character (Control-Q) across the communication line. This character resets the XOFF code to stop the flow of data.

**6E1E — Send XOFF**
This routine will transmit an XOFF character (Control-S) across the communication line. This code is used to stop the flow of data to the Model 100. Data flow will resume only when you send an XON.

**6E32 — Send Character to RS-232C**
The character in the A register is sent to the RS-232C.

*Table 2 continued on page 300*



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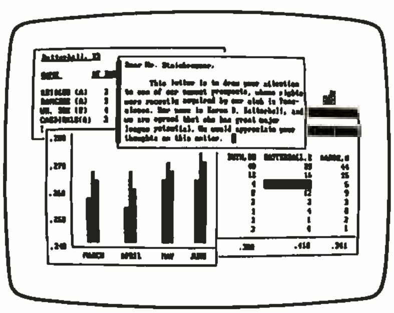

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6E75 — Set RS-232C bps [bits per second]
The H register contains the code from 1 to 9.

1 = 75 bps
2 = 110 bps
3 = 300 bps
4 = 600 bps
5 = 1200 bps
6 = 2400 bps
7 = 4800 bps
8 = 9600 bps
9 = 19200 bps

6EA6 — Initialize RS-232C or Modem
This routine will initialize the RS-232C port or the modem, depending on the setting of the carry flag. If it is set then the RS-232C is initialized. If it is reset the modem is initialized. The H register setting is the same as the address 6E75 call (see above). The L register contains the settings for the remaining UART parameters. Bit 0 of the L register specifies the number of stop bits. If this bit is off then one stop bit is set. If the bit is on then two stop bits are set. Bits 1 and 2 are used to specify the parity setting. A 00 means no parity. A setting of 01 means even parity. A setting of 10 means odd parity. Bits 3 and 4 are used to specify the word length. A 00 means a 6-bit word length. A 01 means a 7-bit word length. A 10 means an 8-bit word length.

6ECB — Deactivate the RS-232C Port

6EEF — Check for Carrier
This routine will return a 00 in the A register, as well as the zero flag being set, if the carrier is detected. If there is no carrier the A register will contain an FF and the zero flag will be reset.

6F46 — Write Header to Cassette
Writes the header and sync byte to the cassette.

6F5B — Write to Cassette
This routine writes the character contained in the A register to the cassette. This routine differs from the cassette-write routine at address 14C1 in that it does not perform a checksum.

6F85 — Read Header from Cassette
Reads the header and sync byte from the cassette.

702A — Read from Cassette
This routine reads a character from the cassette. No checksum is performed. The character is returned in the D register.

7242 — Scan Keyboard
This routine checks the keyboard for a character and returns with the status set. The A register contains the character, if one was found. The zero flag will be set if no character was found. The carry flag will also be set if the character found is not a normal character, for example, a function key. In the case of a special key being pressed, the A register will contain the following HEX code to represent the key pressed:

0 = function key 1
1 = function key 2
2 = function key 3
3 = function key 4
4 = function key 5
5 = function key 6
6 = function key 7
7 = function key 8
8 = Label key
9 = Print key
A = Shift-Print key
B = Paste key

7270 — Check for Character or Break
The zero flag will be set if no characters are waiting. The carry flag will be set if Break has been pressed.

7283 — Check for Break or Pause
The carry flag is set if Break or Pause has been pressed.

72C5 — Play Tone on Speaker
This routine will sound a tone on the speaker. The DE register must contain the frequency, while the B register must contain the duration.

744C — Turn LCD Pixel On
This routine will turn on a screen pixel at the location specified in the DE register pair. Register D must contain the X coordinate, and register E must contain the Y coordinate.

744D — Turn LCD Pixel Off
Similar requirements to the call at address 744C except the pixel will be turned off.

7EAC — Display Memory Free
This routine calculates the amount of free memory and displays it on the screen, along with the message "BYTES FREE." This familiar message appears in the main menu and at the startup of BASIC.

**Listing 1:** *The DIR.CO directory program.*

```
8085 MACRO ASSEMBLER, VER 2.0  ERRORS = 0 PAGE 1

E000                    ORG     0E000H
12CB            WAITCR  EQU     12CBH
4222            PUTCR   EQU     4222H
4B44            PUTC    EQU     4B44H
                ;
                ;*********************************************
                ; DIR.CO                                      *
                ;                                             *
                ; WRITTEN BY BRIAN CAMERON                    *
                ;                                             *
                ; A PROGRAM TO DISPLAY ALL TRS100 FILES       *
                ; (EVEN ERASED FILES) AND SHOW SUCH ATTRIBUTES *
                ; AS THE FILE LOCATION, SIZE, EXECUTION ADDRESS *
                ; AND ENTRY ADDRESS, WHERE APPROPRIATE        *
                ;*********************************************
E000            DIR     EQU     $
E000    11BAF9          LXI     D,0F9BAH        ;POINT TO USER DIR
E003            TOPDIR  EQU     $
E003    CD3142          CALL    4231H           ;CLEAR SCREEN
E006    CD2242          CALL    PUTCR           ;GET TO NEXT LINE
E009    1A              LDAX    D               ;GET CODE INTO A
E00A    FE00            CPI     0               ;IS FILE ERASED?
E00C    CA43E0          JZ      ERASED          ;YES
E00F    13              INX     D               ;POINT TO ADDR
E010    D5              PUSH    D               ;SAVE FOR LATER
E011    D5              PUSH    D               ;AND AGAIN
E012    1A              LDAX    D               ;GET FIRST BYTE OF ADDR
E013    FE00            CPI     0               ;POSSIBLY END OF DIR?
E015    C21EE0          JNZ     NOTEOD          ;NO
E018    13              INX     D               ;POINT TO SECOND BYTE OF ADDR
E019    1A              LDAX    D               ;GET IT
E01A    1B              DCX     D               ;POINT BACK ONE
E01B    FE00            CPI     0               ;IS IT END OF DIR?
E01D    C8              RZ                      ;YES
                ;
E01E            NOTEOD  EQU     $
E01E    13              INX     D               ;POINT TO SECOND BYTE OF ADDR
E01F    13              INX     D               ;POINT TO THE FN FT
E020    CD5BE1          CALL    PUTFN           ;DISPLAY IT
E023    D1              POP     D               ;GET BACK ADDR
E024    7B              MOV     A,E             ;MOVE FOR ADD
E025    C608            ADI     8               ;ADD FT OFFSET
E027    5F              MOV     E,A             ;MOVE IT BACK
E028    3E20            MVI     A,' '           ;LOAD A BLANK
E02A    CD444B          CALL    PUTC            ;SHOOT IT
E02D    1A              LDAX    D               ;GET FT CHAR
E02E    FE42            CPI     'B'             ;IS IT BASIC?
E030    CA66E0          JZ      BASIC           ;YES
E033    FE43            CPI     'C'             ;IS IT CODE?
E035    CAB4E0          JZ      CODE            ;YES
E038    FE44            CPI     'D'             ;IS IT A DOC FILE?

8085 MACRO ASSEMBLER, VER 2.0  ERRORS = 0 PAGE 2

E03A    CAFBE0          JZ      DOC             ;YES
E03D    E1              POP     H               ;CLEAR THE STACK
E03E    13              INX     D               ;POINT TO ...
E03F    13              INX     D               ;THE NEXT DIR ENTRY
E040    F239E1          JP      MORE            ;CARRY ON
                ;
                ;*********************************************
                ; WE GET HERE AFTER IT IS DETERMINED THAT THE *
                ; FILE WE ARE LOOKING AT HAS BEEN ERASED      *
                ; WE MAKE A SECOND CHECK FOR A ZERO BYTE IN THE *
                ; ADDRESS FIELD TO MAKE SURE WE ARE NOT AT THE *
                ; END OF THE DIRECTORY                        *
                ;*********************************************
E043            ERASED  EQU     $
E043    D5              PUSH    D               ;SAVE FLAG BYTE ADDR
E044    13              INX     D               ;POINT TO ADDR
E045    1A              LDAX    D               ;LOAD IT
E046    FE00            CPI     0               ;END OF DIR?
E048    13              INX     D               ;POINT TO PART 2
E049    C254E0          JNZ     NOEOD2          ;NO
E04C    1A              LDAX    D               ;LOAD IT
E04D    FE00            CPI     0               ;END OF DIR?
E04F    C254E0          JNZ     NOEOD2          ;NO
E052    D1               POP    D               ;RESTORE STACK
E053    C9              RET                     ;YOU GUESSED IT -- RETURN
                ;
E054            NOEOD2  EQU     $
E054    13              INX     D               ;POINT TO FN
E055    CD5BE1          CALL    PUTFN           ;SHOW IT
E058    21A5E1          LXI     H,EMSG          ;POINT TO MSG
E05B    CD585A          CALL    5A58H           ;SHOW IT
E05E    D1              POP     D               ;POINT TO FLAG BYTE
E05F    7B              MOV     A,E             ;GET ADDR
E060    C60B            ADI     11              ;OFFSET TO NEXT DIR ENTRY
E062    5F              MOV     E,A             ;SAVE IT BACK
E063    C339E1          JMP     MORE            ;CARRY ON
                ;
                ;*********************************************
                ; WE ENTER HERE WHEN WE DETERMINE THAT WE ARE  *
                ; LOOKING AT A BASIC FILE.  WE DISPLAY THE     *
                ; ADDRESS THAT THE FILE IS STORED AT FOLLOWED BY *
                ; THE SIZE OF THE FILE.  THE END OF FILE IS    *
                ; MARKED BY THREE ZERO BYTES IN A ROW          *
                ;*********************************************
E066            BASIC   EQU     $
E066    D1              POP     D               ;POINT TO ADDR
E067    21B0E1          LXI     H,STOMSG        ;POINT TO STORED MSG
E06A    CD585A          CALL    5A58H           ;SHOW IT
E06D    CD48E1          CALL    PTFL            ;POINT TO FILE
E070    CD6BE1          CALL    CONVD           ;DISPLAY ADDR
E073    CD75E1          CALL    PUT8            ;GET TO NEXT LINE

8085 MACRO ASSEMBLER, VER 2.0  ERRORS = 0 PAGE 3

E076    21DAE1          LXI     H,ENDADR        ;END ADDRESS MSG
E079    CD585A          CALL    5A58H           ;SHOW IT
E07C    2600            MVI     H,0             ;CLEAR HL ...
E07E    2E00            MVI     L,0             ;FOR SIZE COUNT
                ;
E080            BALOOP  EQU     $
E080    1A              LDAX    D               ;GET A CHAR
E081    FE00            CPI     0               ;END OF FILE?
```

*Listing 1 continued on page 302*

*Listing 1 continued:*

```
E083  CA8BE0          JZ    BASEND         ;YES
                ;
E086            BALP2 EQU   $
E086  13              INX   D              ;POINT TO NEXT CHAR
E087  23              INX   H              ;ADD 1 TO COUNT
E088  C380E0          JMP   BALOOP         ;DO IT AGAIN
                ;
E08B            BASEND EQU  $
E08B  CDAAE0          CALL  CKEOF          ;IN ORDER TO SHOW ...
E08E  CDAAE0          CALL  CKEOF          ;ITS END OF FILE
E091  E5              PUSH  H              ;SAVE IT FOR LATER
E092  D5              PUSH  D              ;MOVE ADDR TO
E093  E1              POP   H              ;HL REGISTER
E094  CD6BE1          CALL  CONVD          ;CONVERT AND SHOW IT
E097  CD75E1          CALL  PUT8           ;MOVE OVER ROVER
E09A  21C9E1          LXI   H,LENMSG       ;POINT TO LENGTH MSG
E09D  CD585A          CALL  5A58H          ;SHOW IT
E0A0  E1              POP   H              ;RESTORE THE COUNT
E0A1  CD6BE1          CALL  CONVD          ;CONVERT AND DISPLAY
E0A4  CD53E1          CALL  POPDR          ;RESTORE DIR POINTER
E0A7  C339E1          JMP   MORE           ;GET NEXT FILE
                ;
E0AA            CKEOF EQU   $
E0AA  13              INX   D              ;POINT TO THE NEXT BYTE
E0AB  23              INX   H              ;ADD ONE TO THE COUNT
E0AC  1A              LDAX  D              ;GET THE CHAR WHERE WE CAN LO
E0AD  FE00            CPI   0              ;POSSIBLE EOF?
E0AF  C8              RZ                   ;LOOKS GOOD
E0B0  C1              POP   B              ;CLEAR THE STACK
E0B1  C386E0          JMP   BALP2          ;CARRY ON
                ;
                ;**************************************************
                ; WE ENTER HERE WHEN WE HAVE FOUND A .CO FILE    *
                ; THE FILE ITSELF CONTAINS THE INFORMATION THAT  *
                ; DESCRIBES THE LOAD ADDRESS, SIZE OF FILE AND   *
                ; ENTRY ADDRESS                                  *
                ;**************************************************
E0B4            CODE  EQU   $
E0B4  D1              POP   D              ;POINT TO ADDR
E0B5  21B0E1          LXI   H,STOMSG       ;POINT TO STORED MSG
E0B8  CD585A          CALL  5A58H          ;SHOW IT
E0BB  CD48E1          CALL  PTFL           ;POINT TO THE FILE
E0BE  CD6BE1          CALL  CONVD          ;CONVERT AND SHOW IT

8085 MACRO ASSEMBLER, VER 2.0  ERRORS = 0 PAGE 4

E0C1  CD75E1          CALL  PUT8           ;GET TO NEXT LINE
E0C4  21BCE1          LXI   H,STMSG        ;POINT TO START MSG
E0C7  CD585A          CALL  5A58H          ;SHOW IT
E0CA  CD48E1          CALL  PTFL           ;POINT TO START OF FILE
E0CD  CD6BE1          CALL  CONVD          ;CONVERT AND DISPLAY
E0D0  D1              POP   D              ;RESTORE FILE POINTER
E0D1  CD75E1          CALL  PUT8           ;GET TO NEXT LINE
E0D4  21C9E1          LXI   H,LENMSG       ;POINT TO LENGTH MSG
E0D7  CD585A          CALL  5A58H          ;SHOW IT
E0DA  13              INX   D              ;POINT TO ...
E0DB  13              INX   D              ;LENGTH
E0DC  CD48E1          CALL  PTFL           ;GET THE LENGTH
E0DF  CD6BE1          CALL  CONVD          ;CONVERT AND DISPLAY
E0E2  D1              POP   D              ;RESTORE FILE POINTER
E0E3  CD75E1          CALL  PUT8           ;GET TO NEXT LINE
E0E6  21D2E1          LXI   H,ENMSG        ;ENTRY MSG
E0E9  CD585A          CALL  5A58H          ;SHOW IT
E0EC  13              INX   D              ;POINT TO THE ENTRY
E0ED  13              INX   D              ;ENTRY
E0EE  CD48E1          CALL  PTFL           ;GET THE ENTRY
E0F1  CD6BE1          CALL  CONVD          ;CONVERT AND DISPLAY
E0F4  D1              POP   D              ;RESTORE FILE POINTER
E0F5  CD53E1          CALL  POPDR
E0F8  C339E1          JMP   MORE           ;DO NEXT FILE
                ;
                ;**************************************************
                ; WE ENTER HERE WHEN WE DETERMINE THAT WE HAVE   *
                ; FOUND A .DO FILE.  WE DISPLAY THE STARTING     *
                ; LOCATION OF THE FILE AND THEN DETERMINE THE    *
                ; LENGTH BY SEARCHING FOR A CONTROL Z (1A)       *
                ;**************************************************
E0FB            DOC   EQU   $
E0FB  D1              POP   D              ;POINT TO ADDR
E0FC  21B0E1          LXI   H,STOMSG       ;POINT TO STORED MSG
E0FF  CD585A          CALL  5A58H          ;SHOW IT
E102  CD48E1          CALL  PTFL           ;POINT TO FILE
E105  CD6BE1          CALL  CONVD          ;CONVERT AND DISPLAY
E108  CD75E1          CALL  PUT8           ;GET TO NEXT LINE
E10B  21DAE1          LXI   H,ENDADR       ;END ADDRESS MSG
E10E  CD585A          CALL  5A58H          ;SHOW IT
E111  2600            MVI   H,0            ;CLEAR HL FOR ...
E113  2E00            MVI   L,0            ;SIZE COUNT
                ;
E115            DOLOOP EQU  $
E115  1A              LDAX  D              ;GET A CHAR
E116  FE1A            CPI   1AH            ;IS IT CNTRL Z?
E118  CA20E1          JZ    DOCDSP         ;YES
E11B  13              INX   D              ;POINT TO NEXT CHAR
E11C  23              INX   H              ;ADD 1 TO COUNT
E11D  C315E1          JMP   DOLOOP         ;GET MORE CHARACTERS
                ;

8085 MACRO ASSEMBLER, VER 2.0  ERRORS = 0 PAGE 5

E120            DOCDSP EQU  $
E120  E5              PUSH  H              ;SAVE
E121  D5              PUSH  D              ;MOVE ADDR TO
E122  E1              POP   H              ;HL REGISTER
E123  CD6BE1          CALL  CONVD          ;CONVERT AND DISPLAY
E126  CD75E1          CALL  PUT8           ;GET TO NEXT LINE
E129  21C9E1          LXI   H,LENMSG       ;POINT TO THE LENGTH MSG
E12C  CD585A          CALL  5A58H          ;SHOW IT
E12F  E1              POP   H              ;RESTORE COUNT
E130  CD6BE1          CALL  CONVD          ;CONVERT AND SHOW
E133  CD53E1          CALL  POPDR          ;RESTORE DIR POINTER
E136  C339E1          JMP   MORE           ;DO NEXT FILE
                ;
E139            MORE  EQU   $
E139  CD2242          CALL  PUTCR
E13C  218AE1          LXI   H,MOREMSG      ;POINT TO MSG
E13F  CD585A          CALL  5A58H          ;SHOW IT
E142  CDCB12          CALL  WAITCR         ;WAIT FOR A CHAR
E145  C303E0          JMP   TOPDIR         ;RESET AND CARRY ON
                ;
E148            PTFL  EQU   $
```

*Listing 1 continued on page 303*

*Listing 1 continued:*

```
E148   E1                 POP    H              ;GET RETURN
E149   D5                 PUSH   D              ;SAVE
E14A   E5                 PUSH   H              ;SAVE RETURN ADDR
E14B   1A                 LDAX   D
E14C   6F                 MOV    L,A            ;SAVE TOP PART OF ADDR
E14D   13                 INX    D              ;POINT TO NEXT BYTE
E14E   1A                 LDAX   D              ;GET SECOND PART OF ADDR
E14F   67                 MOV    H,A            ;SAVE BOTTOM PART OF ADDR
E150   E5                 PUSH   H              ;MOVE FILE START ...
E151   D1                 POP    D              ;TO DE REG
E152   C9                 RET
                   ;
E153             POPDR   EQU    $
E153   E1                 POP    H              ;GET RETURN ADDR
E154   D1                 POP    D              ;RESTORE DIR POINTER
E155   E5                 PUSH   H              ;RESTORE RETURN ADDR
E156   7B                 MOV    A,E            ;GET CURRENT POINTER
E157   C60A               ADI    10             ;POINT TO NEXT ENTRY
E159   5F                 MOV    E,A            ;RESTORE IT
E15A   C9                 RET
                   ;
E15B             PUTFN   EQU    $
E15B   D5                 PUSH   D
E15C   E5                 PUSH   H
E15D   21E8E1             LXI    H,FNBUF        ;POINT TO WORK BUFFER
E160   E5                 PUSH   H              ;SAVE START POINTER
E161   CDAD59             CALL   59ADH          ;BUILD THE FN.FT
E164   E1                 POP    H              ;POINT BACK TO START OF BUFF
E165   CD585A             CALL   5A58H          ;DISPLAY FN.FT
E168   E1                 POP    H


8085 MACRO ASSEMBLER, VER 2.0  ERRORS = 0 PAGE 6


E169   D1                 POP    D
E16A   C9                 RET
                   ;
E16B             CONVD   EQU    $
E16B   C5                 PUSH   B
E16C   D5                 PUSH   D
E16D   E5                 PUSH   H
E16E   CDD439             CALL   39D4H          ;CONVERT AND DISPLAY
E171   E1                 POP    H
E172   D1                 POP    D
E173   C1                 POP    B
E174   C9                 RET
                   ;
E175             PUT8    EQU    $
E175   E5                 PUSH   H
E176   CD2242             CALL   PUTCR
E179   2181E1             LXI    H,BLKS
E17C   CD585A             CALL   5A58H
E17F   E1                 POP    H
E180   C9                 RET
                   ;
E181   20202020 BLKS:    DB     '          '
E185   20202020
E189   00                DB     0
E18A   50524553 MOREMSG: DB     'PRESS ENTER TO CONTINUE...'
E18E   5320454E
E192   54455220
E196   544F2043
E19A   4F4E5449
E19E   4E55452E
E1A2   2E2E
E1A4   00                DB     0
E1A5   202A4552 EMSG:    DB     ' *ERASED* '
E1A9   41534544
E1AD   2A20
E1AF   00                DB     0
E1B0   2053544F STOMSG:  DB     ' STORED AT '
E1B4   52454420
E1B8   415420
E1BB   00                DB     0
E1BC   20535441 STMSG:   DB     ' START ADDR '
E1C0   52542041
E1C4   44445220
E1C8   00                DB     0
E1C9   204C454E LENMSG:  DB     ' LENGTH '
E1CD   47544820
E1D1   00                DB     0
E1D2   20454E54 ENMSG:   DB     ' ENTRY '
E1D6   525920
E1D9   00                DB     0
E1DA   20454E44 ENDADR:  DB     ' END ADDRESS '


8085 MACRO ASSEMBLER, VER 2.0  ERRORS = 0 PAGE 7


E1DE   20414444
E1E2   52455353
E1E6   20
E1E7   00                DB     0
E1E8   20202020 FNBUF:   DB     '            '
E1EC   20202020
E1F0   20202020
E1F4   00                DB  0
                   ;
                         END
NO PROGRAM ERRORS
```

*Text continued from page 292:*

appears. A BASIC or document file shows its start address and length. A command file shows the address where it is stored in the file system, followed by its start address at execution time. The length and entry address are also provided for a command file.

To get the program into your machine, you can enter DIR.CO into the TEXT program and then run it through a resident assembly language. This can present problems, however, because there are not many assembly languages available for the Model 100 yet. Even Radio Shack has not addressed this problem.

I took another approach. I entered the program on a system that supports an 8080 or 8085 cross-assembly language and then loaded the machine code generated by the cross-assembly language into the Model 100. You could even use a Z80 cross-assembly language if you keep in mind that all instructions must be of the 8080 subset. The language that I used was on an IBM mainframe. Most large timesharing systems support a library of cross-development software and this approach may be an alternative to a resident assembly language.

Another possibility is to enter the hexadecimal codes at the side of the DIR.CO program listing via the BASIC POKE command, although this is probably the most error-prone method.

To run the program, move the block cursor over the DIR.CO entry and press the Enter key, as you normally would to run a program. The system will make an obnoxious "beep" sound and return to the main menu because it thinks that the DIR.CO program is going to tread on unused memory. To run this program (or any other command-type program), you must move the high-memory pointer down to an address below the one in which the program is going to execute. You can enter BASIC and issue the command: CLEAR 512,57340, after which the DIR.CO program will execute properly, at least until another BASIC program resets the high-memory pointer. Another way to run this program from the main menu is to create a three-line BASIC program called DIR.BA, which will reset the high-memory pointer and run the DIR.CO program. This program looks like this:

```
10 CLEAR 512,57340
20 RUNM "RAM:DIR.CO"
30 MENU
```

Line 30 will return you to the main menu rather than leave you in BASIC. You could run this program instead of the DIR.CO program. The DIR.CO program incorporates several of the ROM routines that are found in table 2.

## Conclusion

The Model 100 is full of interesting little secrets. It will only be a matter of time until more is revealed about this versatile machine. ■

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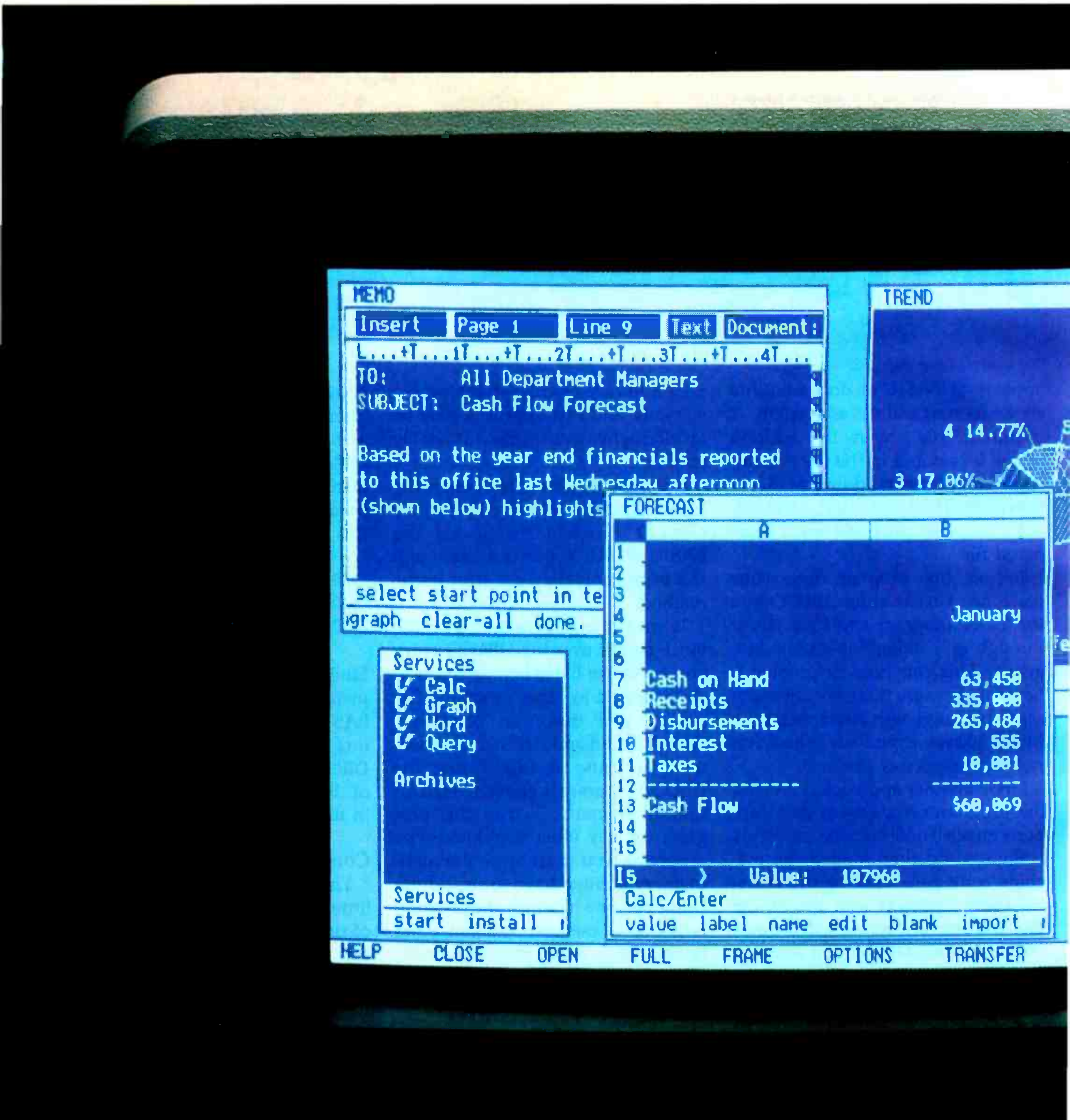

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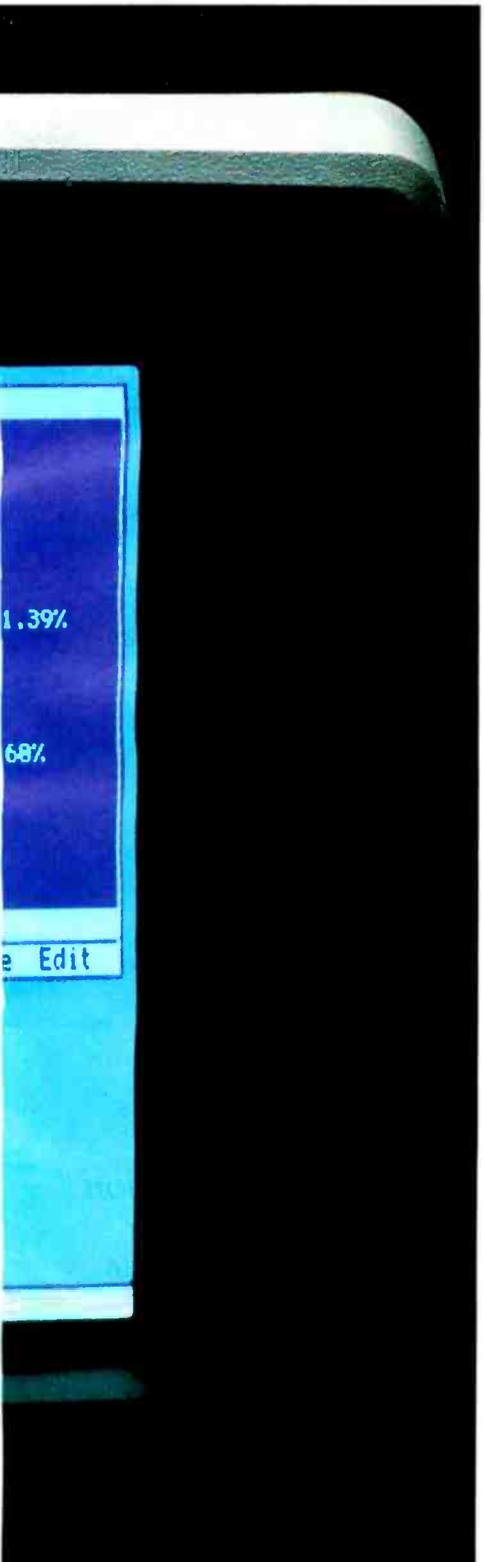


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# Maximizing Hard-Disk Performance

*How cache memory can dramatically affect transfer rate*


**Roy Chaney**
**University of Texas at Dallas**
**and**
**Brian Johnson**
**Percom Data Corporation**


Many personal computer users are looking for ways to increase both the disk-storage capacity and the performance of their computers. One popular approach is through the use of a Winchester hard-disk drive. Although this is a valid approach for increasing disk-storage capacity, the performance may not necessarily meet all of your expectations. At first glance, the performance specifications of typical Winchester disk drives give the impression that there will be a large performance increase, relative to floppy-disk drives. In fact, this is often only partially true. In this article, we'll try to explain why this is so, what memory caching is, and why it can help provide the high performance that most personal computer users desire.

Three main parameters affect the speed performance of any disk drive. The first is the instantaneous data rate while actually reading or writing disk data. The second is the rotational latency, or the time required for the disk to rotate into the correct position to begin transferring the desired data. The third parameter is the seek time, the time required to move the disk head into the proper position on the disk.

The tracks on a disk are concentric circular paths around the recording surface of the disk, similar to the grooves on an audio record except that they are not in a spiral form. To provide access to the desired data, the heads on the drive must be moved to the track where the data is to be found. On most floppy-disk drives, and on many Winchester drives, this technique of moving the heads from track to track is implemented by the use of a stepping motor. Both the rotational latency and the seek time are determined by electromechanical factors in the physical design of the disk drive and tend to be very expensive to improve. Each track on a disk surface is broken up into smaller units of information, sometimes called sectors, but we'll refer to them as *blocks*. These blocks are the smallest units of information that can be read or written on a disk. This terminology is compatible with that of PC-DOS 2.0 as used with the IBM Personal Computer (PC). For the IBM PC, one disk block corresponds to 512 bytes of data.

A manufacturer's performance specifications for a typical Winchester disk drive might report a disk transfer rate of about 490K bytes per second. This can be compared with a transfer rate of about 23K bytes per second for a 5¼-inch double-density floppy-disk drive like that used in the IBM PC. On the basis of this data, you might expect that the purchase of a Winchester disk drive would not only increase the disk capacity of the computer system but also would speed up the file transfers by as much as a factor of 21. These estimates, however, are not realized in practice. One reason for this is that the data is transferred from the drive faster than the computer can receive it. Few personal computers can accept a sustained data-transfer rate this high for very long. As a result, the data must be buffered in the disk controller, and the disk must be read only intermittently so that the average data-transfer rate between the disk and the computer is acceptable. The blocks in a disk track are frequently interleaved, or placed in a particular nonsequential order to match the average disk transfer rate to the speed of the computer. A typical interleave factor for a Winchester disk drive is 5. This means that when reading two logically sequential blocks, four blocks are skipped in between. Under these circumstances, the effective speed advantage for a typical Winchester disk system is frequently of the order of 3 or 4 over that of a 5¼-inch floppy-disk drive, providing transfer rates in the range of 60K to 90K bytes per second. Floppy-disk drives are also frequently interleaved, but not for the IBM PC.

At the same time, there are systems for the IBM PC that use excess computer RAM (random-access read/write memory), usually 64K to 320K bytes. These RAM-disk systems usually are pure software products that store disk data by simulating a disk drive, and they typically have a transfer rate of about 350K bytes per second. This rate is determined primarily by the processor speed and the bandwidth of the computer bus; having no electromechanical factors involved is an indication of the maximum possible data-transfer rate of the computer. This number is thus the approximate maximum transfer rate achievable on any disk subsystem attached to the IBM PC. The best you can hope for under any condition is a speed advantage of about 15 times over the floppy-disk drive. But this is still considerably higher than the advantage usually achieved with a real disk drive, so our first task is to understand why this is so.

So far, we have discussed what the data-transfer rate would be when the disk head was already at the correct position on the disk and the disk had already rotated into the correct position for the desired data. Our model gets more complex when the mechanical factors are included. For a real disk system (*not* a RAM disk), there always is a delay between the time when a data-transfer request is made and the time when the transfer actually starts. This delay is termed the access time and is the sum of two delays: rotational latency and seek time. Neither of these times is a fixed value; they are instead statistically derived times that are averaged over a range of common circumstances. Normally, 5¼-inch floppy-disk drives rotate at 300 rpm (revolutions per minute), or 5 revolutions per second. On the average, one-half of the revolution, or 100 ms (milliseconds), is required to get to the appropriate position to transfer the desired data. For a Winchester disk rotating at 3600 rpm, the corresponding time for one-half of a revolution is 8.3 ms. This time, normally referred to as the average rotational latency of a disk, indicates the average delay time that is encountered between the time of a request for a data transfer and the time the transfer actually begins, assuming that the head is already correctly positioned on the desired track.

The other mechanically determined delay is the seek time, the time required for the stepping motor to move the heads from the current track to the desired track; this is always a major portion of the access time. This time obviously depends on the distance between the respective tracks and the speed with which the heads can be moved. A disk manufacturer typically publishes an average seek time for a given drive, which is based on a track-to-track movement of an average distance. For statistical reasons, this average distance usually is taken to be one-third of the distance between the innermost and outermost tracks. For most floppy-disk drives, the head moves at a constant speed; therefore, the seek time is approximately proportional to the seek distance. For many Winchester drives, the head moves at a higher velocity for longer movements than for shorter movements. For a typical 5-inch Winchester disk drive, this average seek time is approximately 70 ms; for the IBM PC floppy-disk drive, it is approximately 125 ms.

As mentioned previously, the access time for a disk transaction is the sum of the rotational latency and the seek time. These figures are approximately 80 ms for a Winchester disk and approximately 225 ms for a floppy disk. These numbers are, of course, averages based on a completely random pattern of data requests, with all blocks on the disk considered equally likely to be accessed. This situation is not really typical of normal use, but the fact that the ratio of the access times is only about a factor of 3 in favor of the Winchester disk turns out to be remarkably indicative of the actual typical performance.

Now consider the impact of these numbers on the actual data-transfer rate to be expected. If we assume an average access time for each disk transfer, and if we assume that a typical disk transfer corresponds to 512 bytes of data, the transfer rate of the Winchester would be 6.4K bytes per second, and that of the floppy would be 2.3K bytes per second. Moving large contiguous blocks of data increases both of these numbers, but they illustrate why the actual average data-transfer rate is well below the peak rate for real disks. The reason behind this is that for both types of real disks, the access time dominates the data-transfer time. RAM disks, on the other hand, have no mechanical components and have essentially zero access time. The average data-transfer rate of 350K bytes per second is the same as the peak data-transfer rate, independent of the sequence or size of requested data transfers. This explains the enormous popularity of the RAM-disk concept today.

In actuality, the use of the average times previously calculated generally reflects pessimism about the time required for head movement between disk transfers. This is a result of the fact that the operating system (OS) usually does its best to try to keep the disk data blocks for a given file on the same or adjacent tracks. By doing this, head movement is minimized; when a single sequential file is being read or written, the real access time is much smaller than the average time specified by the disk-drive manufacturer. The OS, however, can do little to benefit certain types of programs that have several large files all opened simultaneously for random access. Thus you might see a transfer rate similar to the average one just described for a database-management system that transfers data to or from several large disk files, or for a compiler reading a large source file while generating both an object file and a listing file.

Multitasking also has a significant degrading effect on disk performance because there is no reason why files being accessed by different tasks would be near each other on the disk. In these cases, it is much more difficult for the OS to reduce the amount of head movement. It is common in multitasking systems to see

disk heads executing continual large seeks as the various tasks make data requests from files located at divers places on the disk. In this case, the average access time can be much longer than that indicated by the average times presented earlier. File servers for a LAN (local-area network) are an extreme case of the same problem.

## Caching

The technique of caching is often the solution to this problem. The objective of caching is to economically provide both the high performance of a fast, small, expensive memory (such as a RAM disk) and the large capacity of a large, slow, cheap memory (such as a Winchester disk). The technique of caching has been used successfully in memory systems for many large mainframe computers and minicomputers for several years. Examples include the IBM 370, the Data General (DG) Eclipse, the Digital Equipment Corporation (DEC) PDP-11/70, and many others. Let us discuss the use of caching in computer memories first, then we will generalize it to disk applications. For the moment, we will consider only "read" accesses to the memory, that is, those accesses that require data to be moved from memory to processor.

The word *cache* in French means "to hide" or "hidden," thus it is used in the context of computers to refer to a transparent memory. In the computers just mentioned, there are two types of memory. One is a small amount of high-speed, very expensive (cache) memory; the other is a large amount of slower, less expensive (main) memory. Copies of data located in certain parts of main memory are stored in cache memory. Whenever data accessed by the processor can be found in cache memory, it can be read at the fast speed; otherwise, it is read at the usual slower speed of the main memory. When the processor is successful in accessing data from the cache memory, it is referred to as a *hit*; otherwise, it is called a *miss*. If the fraction of the time that memory access results in a hit is high, the average time required to access data from memory is reduced, and the average performance is enhanced. All caching schemes depend on this one fundamental concept.

In the design of a cache-memory scheme, there are two technical problems that must be solved before you can effectively use this fast memory. The first is how to quickly determine whether the fast memory contains the information required by the processor. This problem is a serious one for memory caching primarily because the time for making this decision is very small (much less than 1 microsecond) in order to gain any advantage from the cache. This fast timing restriction does not affect disk caching. The more critical problem is determining the best algorithms to use to maximize the chances that the information required by the process will be available in fast memory. It is not, in general, possible to do this perfectly because it would be necessary to predict all future memory accesses. In effect, you would have to look into a crystal ball and predict what data the processor would need to access next so that the data could be moved from slow memory into fast memory before it was requested. If this could be done perfectly, all accesses would be fast-memory accesses.

Basically, two classes of algorithms attempt to provide an optimum choice of what data to keep in cache memory and when to move it there from slow memory. These algorithms attempt to partially predict future data accesses, given some information about current and past accesses, under the assumption that the future is likely to be an extrapolation of the past and the present.

One class of algorithm is called a *prefetch* algorithm. This type is based on the assumption that much data access is sequential in nature, and that access of some particular piece of data implies a strong likelihood that the next piece of data sequentially following the first will soon be wanted.

The second class of algorithm is called a *replacement* algorithm. This type is based on the premise that any data brought into the fast memory must displace data that is already there. The key here is to displace that data judged least likely to be needed again in the near future, based on some assumptions about the relationship between past usage and future usage of a particular piece of data. In effect, prefetch algorithms try to determine what data to bring into the cache before it is requested, and replacement algorithms try to determine what data to keep in the cache once it has been brought there. Of course, these two algorithms interact with each other because bringing in new data always requires the displacement of old data previously in the cache. A great deal of time and effort has been spent by computer manufacturers to determine effective prefetch and replacement algorithms. We will discuss details of these algorithms later.

Another important decision that must be made in the design of any cache-memory scheme is a choice of the amount of cache memory to be provided, relative to the size of the main memory that is to be cached. It also is frequently desirable to perform caching on blocks of data that are larger than the elementary units of information (bytes, for instance) because then the overhead of cache decision-making can be amortized over larger amounts of data, and the decisions do not need to be made as frequently. This unit of caching is frequently referred to as a *page* or a *cluster*.

## Disk Caching

We now turn from caching in general to the specific case of disk-performance enhancement through the use of the caching technique. Let's begin with a brief discussion of disk-file access. This discussion somewhat favors PC-DOS 2.0—that was the target OS that motivated most of our work.

When an application program requests transfer of data to or from a disk file, a series of operations that is essentially invisible to the user must be performed by the OS. That is, the user program does not know how they happen. These operations, however, do have a significant effect

*Text continued on page 314*

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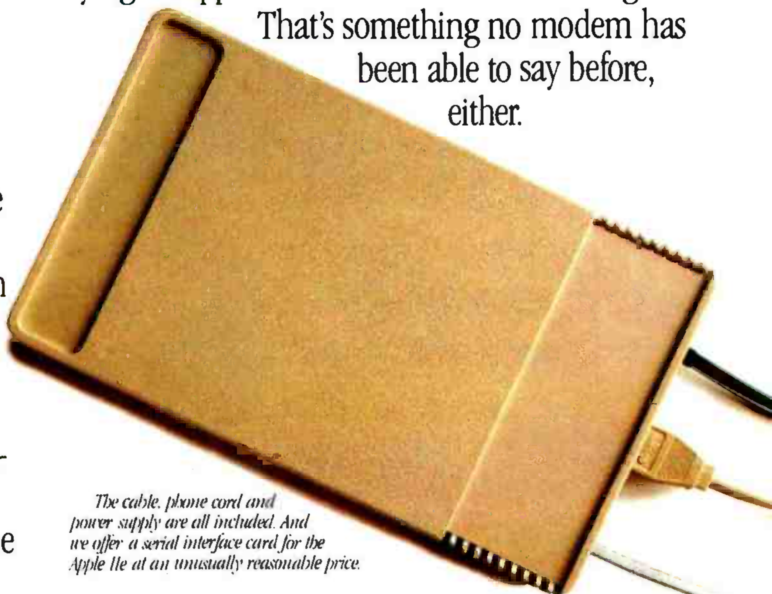

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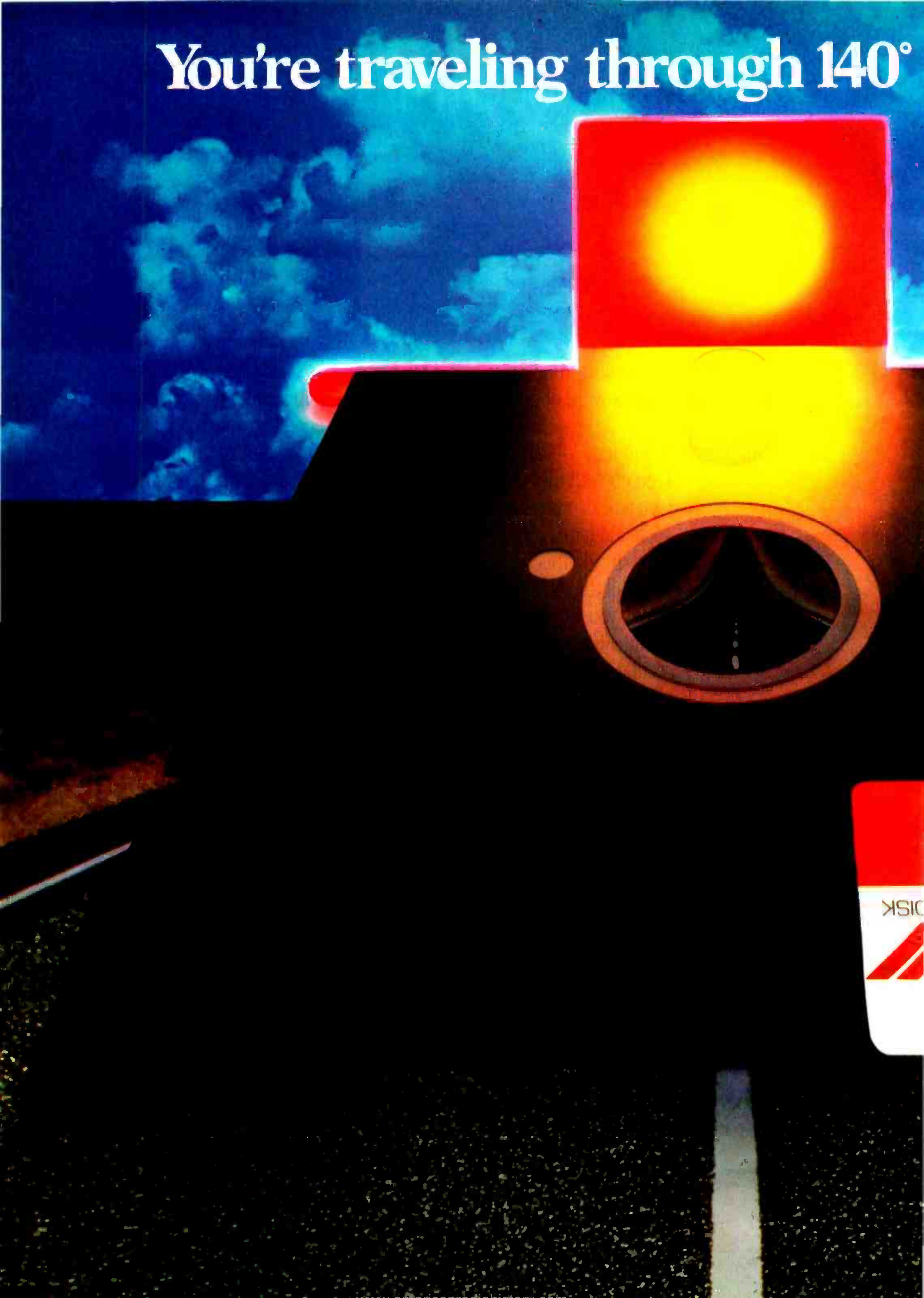
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Text continued from page 310:
on the implementation of caching algorithms and need to be discussed in that context.

First, let us describe what happens when an application program needs to read information from a file on the disk. The program requests that the OS open the file on the disk. The part of the OS that receives and dispatches all requests then forwards that request to a set of routines collectively called the file manager, which then goes to work to perform this operation. The file manager first looks into a special file (commonly called the directory) that contains the names of all of the files currently stored on the disk to see if the requested file is contained on the disk.

Assuming that the file is there, the file manager then looks into another section of the disk (commonly called the file-allocation table) to determine where the various parts of that particular file are physically stored on the disk. Some information is then returned to the application program that will be used when actually reading data from this file. In subsequent calls to the file manager, the program requests the actual transfer of data from the file now open, and it eventually makes a final call to the file manager to close the file.

The sequence of actions for a write operation is similar unless the file manager does not find the file already present; in this case, it updates the directory to contain the name of the new file and looks into the file-allocation table to find locations on the disk in which no data is currently stored, so that it can write the data onto empty portions of the disk. The important point in this discussion is that there is little, if any, direct relationship between the location of a logical block of data required by the program and the physical location of that data on the disk. The file-manager component of the OS is responsible for keeping track of the logical/physical relationship in a way that is invisible to the user.

The actual operations of reading and writing physical blocks of data to or from disk involves another component of the OS called the disk driver. The file manager tells the disk driver which physical blocks are required to be transferred, and the disk driver performs the actual data transfer. Done in this way, the disk driver does not need any knowledge of the nature or structure of files on the disk. This hierarchical relationship among the various components of the OS is very common; one file manager can work with multiple different disk drivers, and each disk driver need not duplicate the file-management function. As far as disk caching is concerned, the particular caching algorithms used will be very different depending on whether the caching is done at the level of the file manager (see figure 1a) or at the level of the disk driver (see figure 1b). The reason for this is that the file manager has a great deal more information about the organization of the files on the disk than does the disk driver. For example, it is easy for the file manager to know which blocks of data on the disk correspond to logically sequential data in a particular file, or part of the directory, or

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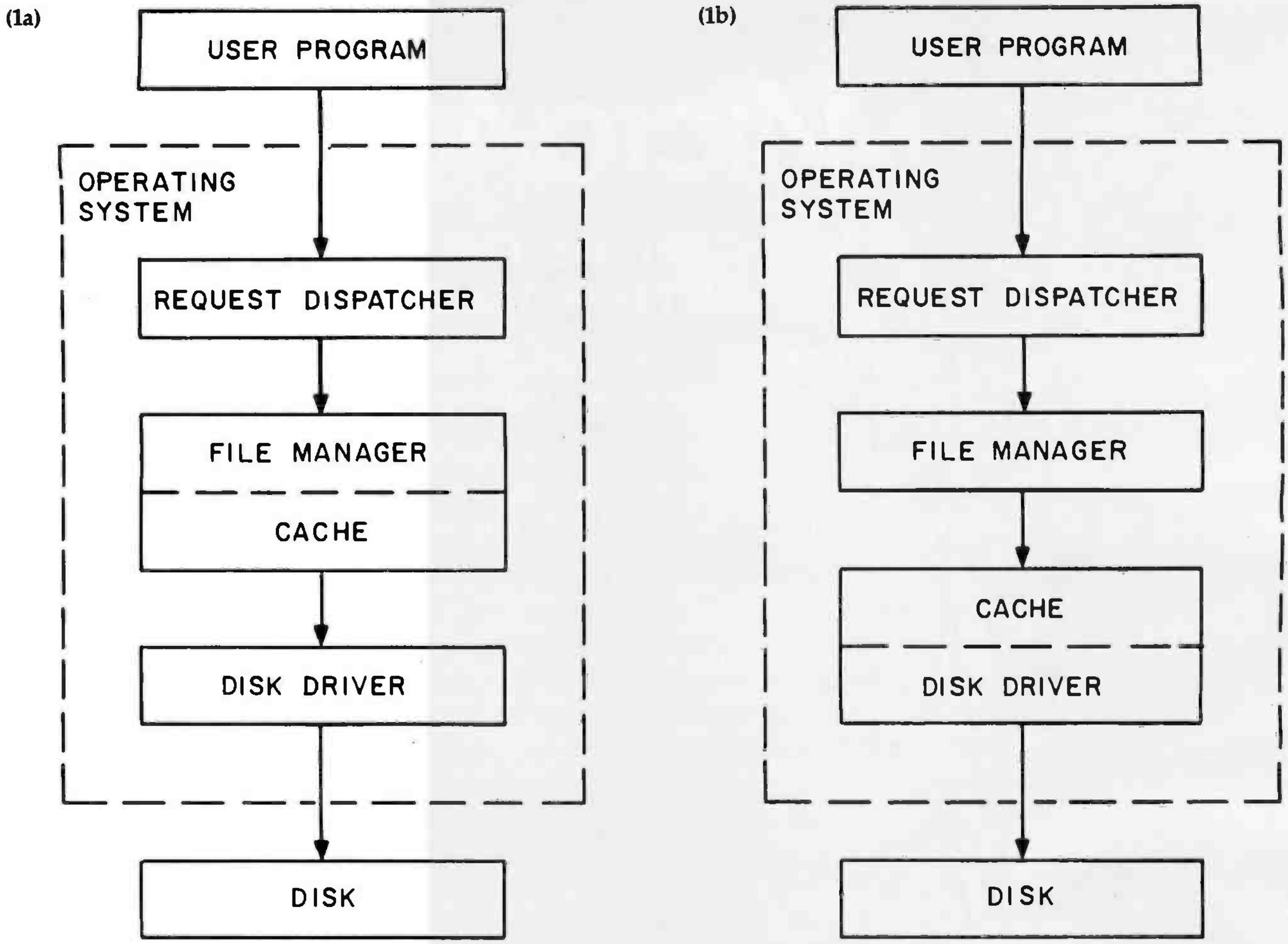


**Figure 1:** *A block diagram of the structure of a typical operating system and its interaction between a user program and the disk. Figure 1a shows the operation when the cache is implemented as part of the file manager; 1b shows the operation when the cache is implemented as part of the disk driver.*

part of the allocation tables. As a result, the file manager can make better guesses as to what to keep and what to displace in the cache. Disk caching at the file-manager level can therefore lead to somewhat more efficient cache algorithms because they are based on more knowledge of the structure of the files on the disk. The *problem* we face with the implementation of caching at the file-manager level is that the file manager is an integral part of the OS, and any disk caching at this level must be done by extensive modification to the OS. On the other hand, disk drivers are more loosely connected to the OS and frequently can be modified or replaced without direct changes to the system itself. In some cases, as in PC-DOS 2.0, disk drivers can be loaded separately from the OS when the system is booted.

Now let us discuss how memory-caching techniques can provide faster apparent data-transfer rates for Winchester disk drives. If we substitute references to the disk drive for all references to the slow main memory and references to main memory for references to the fast memory in the previous discussion on caching, then we can consider the disk to be the large slow memory and (part of) the computer main memory to be the cache memory. For a specific example, let us assume that we have a small amount (perhaps 256K bytes) of main memory that we would like to use as a cache for a Winchester disk with a capacity of 10 megabytes. Now, it is impossible for all of the data on the disk to be simultaneously stored into the cache because the disk is 40 times as large as the cache. However, if the amount of data actually needed from the disk is a small fraction of its total capacity (over some reasonable period of time), then it could be made to appear to a user's program that all of the data needed was available from the Winchester disk. We would like for that information already to be contained in the cache so that we will have a hit on the cache memory. Whenever we have a hit, we expect to achieve a data-transfer rate close to that of a RAM disk (350K bytes per second), because a cache is very similar to a RAM disk in its internal construction. A convenient way to understand the effect of cache memory on the disk drive is to plot the effective transfer rate of the disk versus the ratio of hits to misses on the cache memory. This plot is given in figure 2 for various values of disk-access times, assuming 1024-byte transfers and a cache-memory transfer rate of 350K bytes per second. It is clear from the plot that it is impossible to achieve the max-

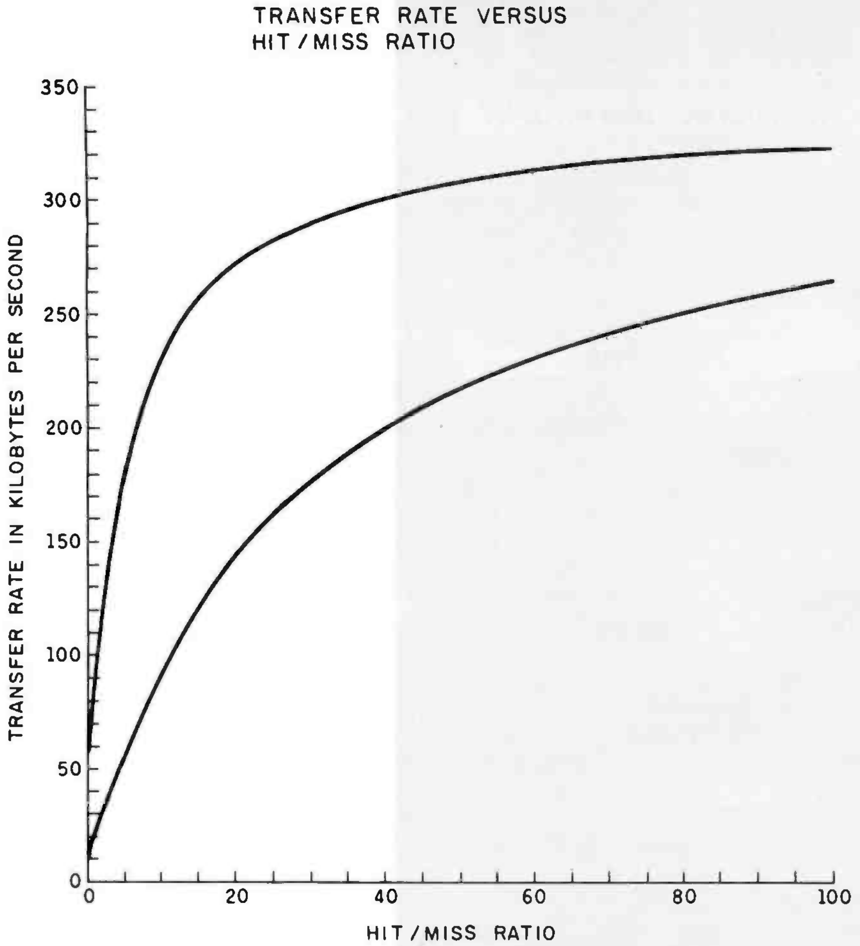


**Figure 2:** *A plot of the improvement in the transfer rate for a Winchester disk drive as a function of the hit/miss ratio for the cache memory. The upper curve is the case where the head is already positioned on the proper track, and the only delay is rotational latency. The lower curve is the average access time, including the average time needed for a seek.*

imum transfer rate of 350K bytes per second. However, for hit/miss ratios of 10 and greater, it is possible to achieve a significant improvement in the transfer rate over that of the disk without caching.

The improved-performance factor is plotted versus the hit/miss ratio in figure 3, which shows that it is possible to achieve an improvement of 3 by using a disk cache, relative to a disk operating at its maximum transfer rate (head always near the desired track). The improvement might be around 8 over a disk that is performing operations requiring a great deal of head movement. And all this can be done with a hit/miss ratio of 10. The design goal for a disk-cache scheme is to use some of the extra addressable memory available in 16-bit processors (typically of the order of 64K to 320K bytes) as cache space for the Winchester disk. By utilizing prefetch and replacement algorithms for transferring data into and out of the cache memory to maximize the number of hits, you can hope to achieve a hit/miss ratio of at least 10. Of course, the size of the cache memory also is an important parameter, and enlarging the size of the cache always increases the hit/miss ratio but adds extra cost.

Let us examine specific techniques that might be used to implement the prefetch and replacement algorithms to achieve the desired hit/miss ratio. There are two quite distinct approaches to the design of caching algorithms for disks. The choice between these two approaches is not simple, and it depends on how much the cache system knows about the file system. If the cache is implemented as part of the operating-system file manager, then the cache can make decisions based on knowledge of which files are open and of the relationships between physical disk locations and logical file structure. Frequently, caching at the file-manager level enables the cache to make special arrangements about caching the disk directory, the file-allocation table, and other frequently accessed global disk-data structures, and to attempt to decide what other data should be cached, based on educated guesses about the probable usage. If the cache is implemented as part of the disk driver, then the cache must make all decisions without any knowledge of file structure or logical data structures. The first approach can deliver higher performance at the cost of higher complexity; the second approach is always simpler but may require more care in the choice of the algorithm details because of its poorer knowledge base. Either approach is capable of delivering good performance, and some caching systems use both, providing directory caching in the file manager but doing most of the high-volume data caching at the driver level.

Now we will discuss prefetch algorithms in these two cases. As stated before, the prefetch methods are developed to anticipate the data needs of the processor and to attempt to place the data into the cache memory before it is actually requested by the processor. In the case of disk caching, it is much easier to anticipate the requirements of the processor than it is in the case of memory caching. The reason for this is that so many disk files are processed partially or wholly in a sequential manner. By assuming that the processor is soon going to need data in the region on the disk corresponding to data immediately following previously requested data, it is possible to predict with a high percentage of accuracy what data to prefetch in order to anticipate further requests from the processor.

There is one problem with this scheme: in most operating systems, sequential files are not placed on the disk in contiguous sequential locations. When a sequential file is written to the disk, the OS writes the information in clusters. Typically, these

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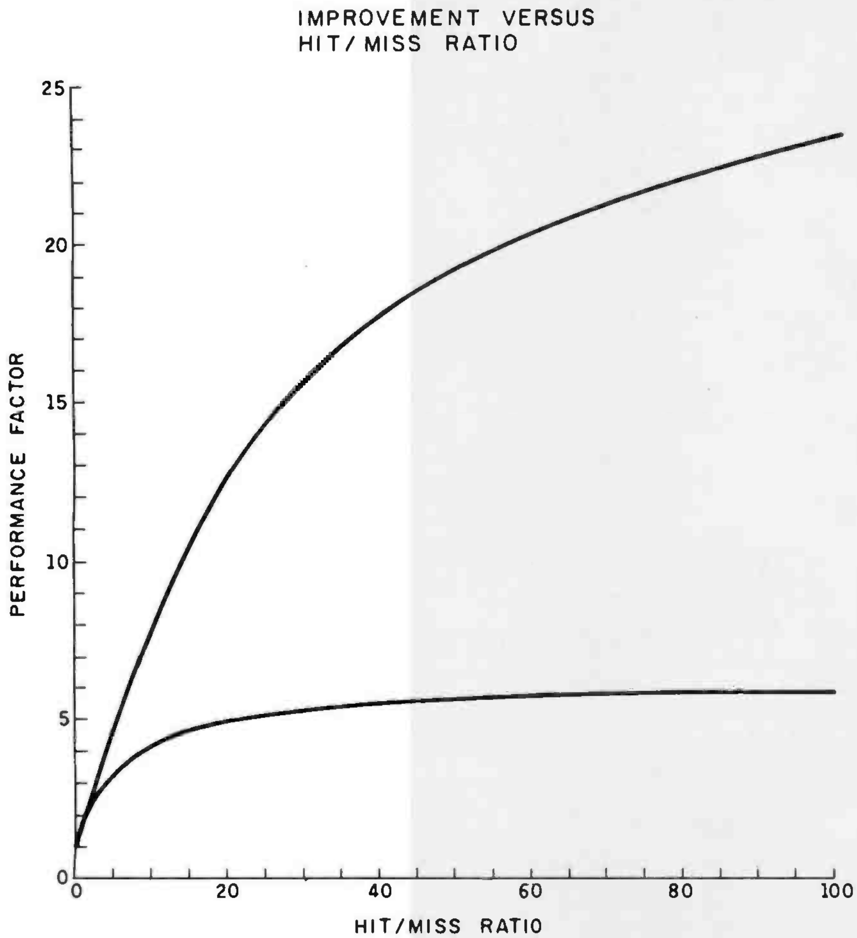


**Figure 3:** *A plot of the ratio of the effective transfer rate of the Winchester drive with the cache versus the uncached drive as a function of the hit/miss ratio. As in figure 2, the upper curve corresponds to rotational latency only, and the lower corresponds to average access time with a seek.*

clusters are composed of one or more contiguous disk blocks. The information is contiguous within a cluster. However, logically sequential clusters that correspond to sequential data in a file may not be physically contiguous, and physically contiguous clusters may not even correspond to the same file. For a freshly initialized disk (containing no files) onto which all of the files have just been copied, the file manager usually makes sure that the clusters for the files are physically contiguous and in sequential order. But after the disk has been used for a while and many files have been added, deleted, or modified, the disk becomes somewhat fragmented and adjacent clusters no longer necessarily correspond to adjacent data in a file. This fragmentation effect must be considered in the evaluation of the prefetch algorithm.

One of two similar prefetch algorithms is commonly used, depending on the implementation level of the cache. If the cache is part of the file manager, the prefetch algorithm is usually designed so that whenever some data is accessed from a particular file, the next cluster of the file is to be placed into the cache if it is not already there. This is done regardless of whether the access request is a hit or a miss. This algorithm is intended to ensure that after an initial miss on the first access to the file, the rest of the file accesses will have hit access to the cache.

The second algorithm is simpler and is usually used when the cache is part of the disk driver. Whenever a cache miss occurs, the required block, plus several other blocks occupying physically adjacent positions on the disk, are read from the disk under the assumption that physically contiguous data is likely to be logically contiguous data, i.e., the fragmentation is fairly low. In the first case, it is necessary for the cache system to know the physical arrangement of particular files on the disk. In the second case, that knowledge is unnecessary, and caching can be performed more mechanically, usually as part of the disk-driver software. The cache system need not be part of the OS or know anything about the nature of file storage. In this simpler driver-based case, fragments will occasionally be fetched from other, not-needed files unnecessarily if the read prefetch cluster is different from the OS cluster used to store the files. This is especially true if the disk is highly fragmented.

One standard version of the second algorithm always reads an entire track from the disk whenever any part of that track is accessed. It is possible to improve on that by not reading the part of the track preceding the requested block. Another version might use a cluster size that corresponds to those used by the OS. All of these algorithms are ultimately based on the notion that once the time has been spent to move the head into position to read some requested data, it is beneficial to read as much data from that area as seems likely to be wanted later.

Replacement algorithms are concerned with the decision of what data to displace from the cache when a data request requires new data to be cached. Three techniques that have been examined for use in mainframe memory caching are random replacement, first-in/first-out (FIFO), and least recently used (LRU). The names of these techniques give a strong indication of their operation.

The random-replacement technique picks the data to be displaced in a random manner without regard to any knowledge about the likely usefulness of that data. The FIFO method keeps a counter to indicate the order in which data has been brought into the cache and always displaces the oldest data that is in the cache. The LRU algorithm is a variation of the FIFO, but it remembers the order in which the cached data has been used by the processor.

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Using the LRU method, data that has been unused the longest is displaced. The LRU method depends on the premise that data used frequently by the processor should remain in cache and should displace data used infrequently.

Some evidence from research conducted by mainframe manufacturers indicates that for the case of memory-to-memory caching, performance is not strongly dependent on which replacement algorithm is chosen. The manufacturers, therefore, sometimes choose random replacement as being the easiest to implement. We felt, however, that for memory caching of disks, the LRU algorithm would be the most effective. Certain areas of the disk, such as the directory and the file-allocation table, are used extensively and frequently by the processor. Thus, it is particularly important to ensure that these areas are in the cache memory at all times. The fact that they are used frequently causes the LRU algorithm to make sure they remain in cache memory, making the LRU the most efficient replacement algorithm. If the cache is implemented within the file manager of the OS, such frequently used disk-data areas often are given special treatment so they are always in memory and not at the mercy of the replacement algorithm.

So far, we have been talking only about the use of the cache to enhance the transfer rate of the read operations from the disk. We also must consider how the cache is affected by writes from processor to disk. We should consider if the cache should even be involved in write operations. The answer is that the cache must at least be involved to the extent that it faithfully represents the data on the disk. If new data were written to a location on the disk that had previously been read to the cache, and this was not known to the cache, then the next read access to that data would be from the cache and the processor would receive old (erroneous) data.

One of the absolute requirements of any cache scheme is that it must be an exact duplicate of that part of the disk it represents. If data on the disk is modified by writing to the disk, then it is necessary to check whether that part of the disk also is in the cache. If the written part also is cached, there are two options. One option is to declare the part of the disk just written no longer in the cache, which prevents the processor from getting a hit on the old erroneous data; the second option is to update the cache copy of the data to reflect the modifications produced by the write onto the disk. One of these two options must be chosen to ensure that the processor receives the updated version of the data during a subsequent read operation.

**An absolute requirement of any cache scheme is that it must be an exact duplicate of that part of the disk it represents.**

Another question that should be asked is whether there is any advantage in caching write operations in a manner similar to that of read operations, or whether data should be transferred first from processor to cache and then from cache to disk. In fact, the answer is yes.

Now let us see how caching can be used to greatly enhance the effective transfer rate on write operations. We have shown that the cache must be involved in the write operation to disk, at least to the extent that it makes sure all data in the cache agrees exactly with the data on the disk. Let us look at one way this could be performed.

Suppose that when the processor needs to write information onto the disk, it writes the information into the cache and then immediately requests the transfer of that part of the cache memory to the disk. This algorithm is known as *write-through*. Assuming we are using an interrupt-driven disk driver, once the transfer is started, the processor does not need to be held up waiting for the write operation to complete and can proceed doing other useful work. Because the write operation is interrupt-driven, it can proceed independently of user tasks to perform the write to disk. This implementation on a user task makes the effective write performance of the disk essentially the same as for a RAM disk (350K bytes per second) because the user task is held up only for the length of time needed to transfer the data into the cache memory, after which regular processing may be resumed.

One minor penalty is paid for this greatly enhanced write throughput: a short duration of time during which the user task thinks that the data has been written successfully to the disk, but in fact the transfer has not actually taken place. Prior to the completion of the write operation, the cache memory and the disk do not contain identical copies of the data. This is not a problem for future read requests because the cache responds to all processor read requests for this data with the updated result. The problem could occur if the computer were turned off very quickly after the completion of a program, resulting in the cache not having time to flush its contents to disk.

Another difficulty that is more of a nuisance than a serious problem is that the transfer from cache to disk occurs after the user task thinks it has successfully completed its write to disk. Any disk errors detected during the transfer from cache to disk must therefore be handled in the cache or in the OS because the user task thinks it already has completed a successful write to disk before the disk error occurs. This might be a serious problem for disks with high error rates. However, our experience has been that the reliability of a Winchester disk drive is much higher than that of a floppy-disk drive, and that the only error you might get with any frequency from a Winchester disk drive occurs when the drive is not turned on. The improvement obtained by the RAM-disk equivalent performance on disk-write operations greatly outweighs the minor inconveniences of handling disk-write errors.

A second feature that can be implemented in the cache software with essentially no loss in transfer rate is performing automatic verify on write. Again, because the write operation into cache is complete and the user task has resumed, verification of the integrity of the disk-data write can be done essentially independently, in parallel with the user task, and does not adversely affect the transfer rate of the write requests. The user task still loses the time required to transfer the data, but the disk-access time is not lost because the access overhead is concurrent with execution of the user task. There also is a cluster effect in writing; it is more efficient to write large contiguous groups of blocks than it is to write widely separated single blocks. However, writing is determined by the user task, so there is not a great deal you can do in this area to improve efficiency other than to choose an optimum sequence for writing the blocks to disk. The average access time for writes can be reduced by choosing a sequence that minimizes the average head motion required.

At this point, let us note that when this form of write caching has been adopted, there is a choice of the timing of the actual cache-to-disk transfers. In some cases, particularly in transaction processing for database-management systems, there may be a tendency for a particular piece of data to be written several times in a short time span. In this case, it is wasteful to repeatedly update the disk copy of the data. It would be more efficient to wait until all writes were finished, then update the disk copy. This is usually accomplished by adopting what is called a *write-back* algorithm.

When write-back is used, the cache is not copied to disk until the replacement algorithm determines that the data should be displaced, because that part of the cache is needed for other data. Usually a *dirty* flag is kept for each cluster of the cache, which indicates that the data has been modified but not copied to disk. If the replacement algorithm decides to displace the data, and if the dirty flag is set, the data is "written back" to the disk. Frequently, a timer also is used, so that after some interval of time, while the disk is not too busy, that data is written back anyway. If this were not done, it would be necessary to do something special to flush the cache before powering down the computer; otherwise, the system would lose the updated contents of the cache. A long interval between writing the cache and updating the disk also makes the system more vulnerable to data loss in case of a system crash, unless the system crashes gracefully enough to remember to finish the update first. This grace is rare in small computers.

## Experimental Results

In order to determine experimentally the actual performance potential of a Winchester disk cache as a function of the various parameters discussed, we developed a cache driver for a Percom PHD-10 Winchester disk drive with 10-megabyte capacity, operating on an IBM PC with PC-DOS 2.0. Because PC-DOS 2.0 can use boot-time loading of disk drivers, it was particularly convenient to design the cache as part of the disk driver and not as part of the operating-system file manager. We used the write-through algorithm for all write operations to disk. The prefetch algorithm that we used is the cluster method but uses much larger clusters than the 2 to 4 blocks that are typical cluster sizes in PC-DOS 2.0. We used a cluster size equal to one track of the disk drive (16 blocks). Our choice was based on the hardware performance characteristics of the Winchester drive and its controller.

The data is organized on the disk, by interleaving, to optimize the transfer of an entire track of data. For this reason, we decided to transfer an entire track of data into the cache whenever a miss occurred. This may not be the optimal value for the cluster size because it is larger than the file-system cluster size, but we felt that this large cluster size would result in better overall performance for the cache-disk subsystem. This algorithm performs very well on relatively unfragmented disks.

The driver was constructed so that it would keep count of the number of read hits and misses on the cache memory. But first we must spend a little time quantifying what we mean

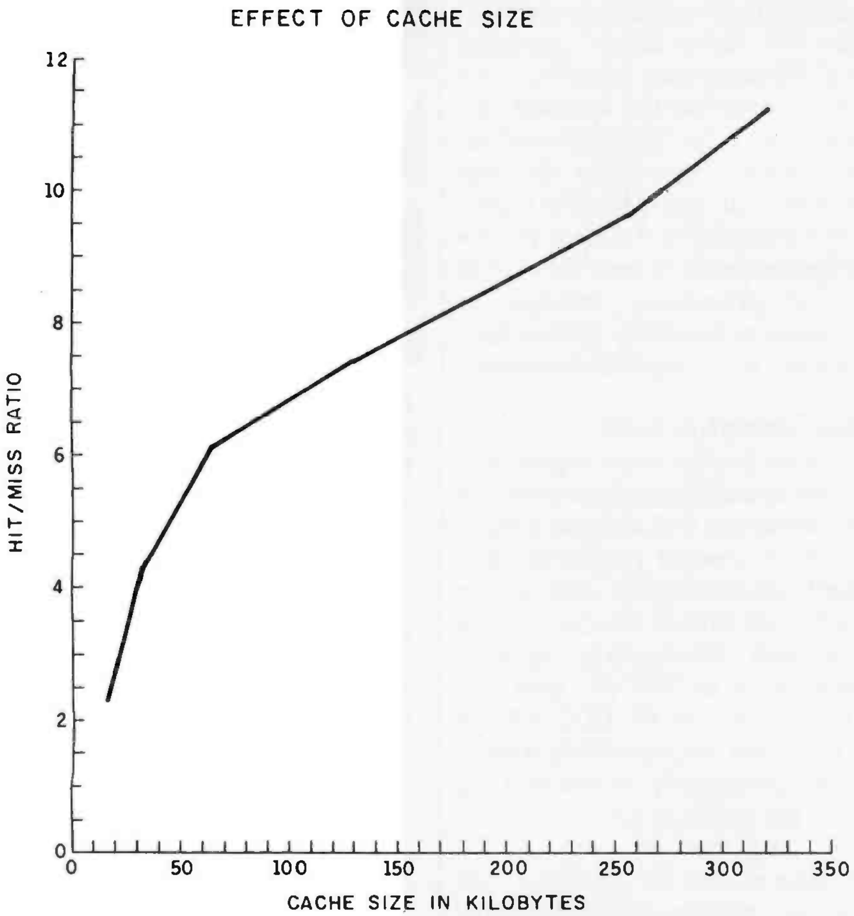


**Figure 4:** *A plot of the effect on the hit/miss ratio of changing the amount of computer memory allocated to caching. This plot corresponds to a mix of programs with little repetitive usage of the same files.*

by a hit and a miss.

Suppose the processor makes a read request for four blocks of data from the cache driver. We assume here that all four of the blocks either are contained in cache memory or are not (they are not part in and part out). We also will assume that all four blocks are located on the same track of the disk. These are not the assumptions made in the actual implementation of the hit/miss computation algorithms, but they make the algorithms easier to describe.

If the four blocks are contained in the cache, the hit count is incremented by 4 to indicate that we had a hit of four blocks. If they are not contained in cache, the first impression is that you should increment the miss count by 4 to indicate that we had a miss of four blocks. The problem with doing this is that the access time for the first missed block is much slower than the access time for the next three blocks, once the first block has been read.

In order to transfer the first block of data, the heads must move to the correct position on the disk. This, according to the drive manufacturer, requires an average of 80 ms. However, once the head is at the correct position on the track, the transfer of a single block requires only about 5.2 ms. Therefore, blocks 2, 3, and 4 can be transferred with a much smaller time penalty than that of the first block (this is the same premise on which the prefetch algorithm is based).

In order to take this effect into account fairly, we constructed the driver so it kept two miss counters. The first counter is called the hard-miss counter and is incremented by 1 for this example. The second is called the soft-miss counter and is incremented by 3 for this example. In the computation of the hit/miss ratios, the soft-miss count was multiplied by 0.065 (5.2 / 80.0) and added to the hard-miss count to get the effective miss count. This data then was used to directly compute the hit/miss ratio as a figure of merit of the efficiency of various cache sizes and replacement algorithms. We considered only the hit/miss ratio for reads because a user task is held up waiting for the transfer to take place

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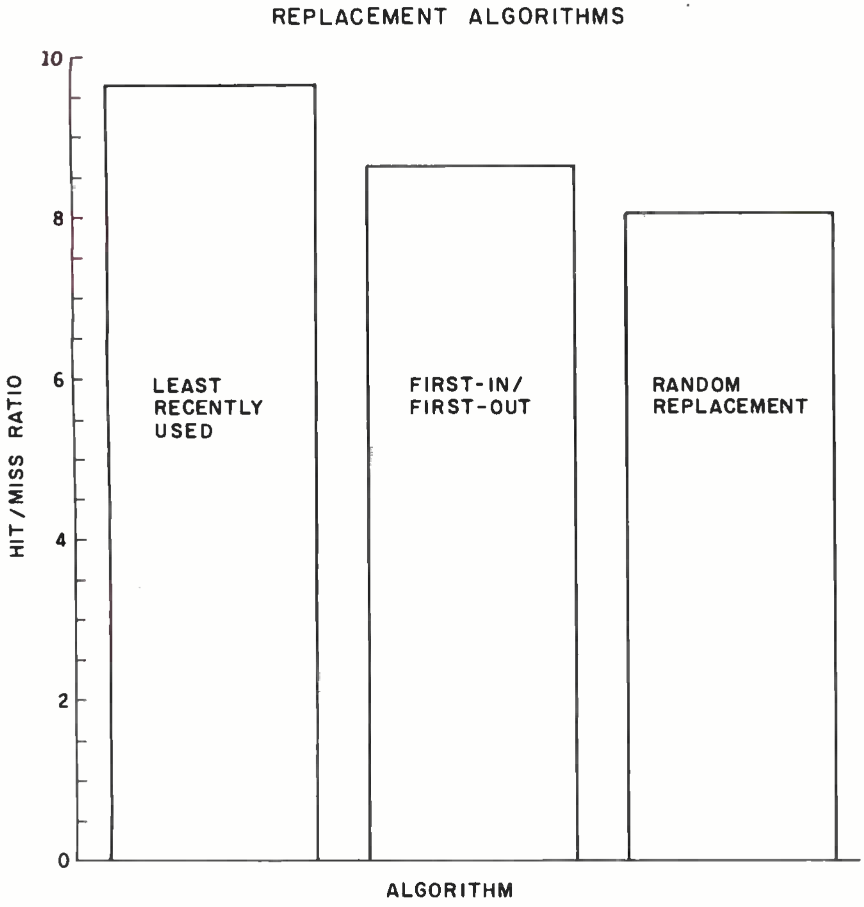


**Figure 5:** *A bar chart of the effect of the hit/miss ratio of using different replacement algorithms to determine which part of the cache to discard.*

only in the case of a read. All writes are automatically hits by this definition.

The hit/miss ratio depends very strongly on the I/O (input/output) characteristics of the particular tasks using the disk. To see why this is the case, imagine that we are repetitively performing operations that involve disk transfers totally contained in the cache memory. The hit/miss ratio continues to increase as we repeat operations on the same disk data.

You might ask, however, what conditions would correspond to repeated operations on the same files. Examples of this include running the same program several times (for instance, in a spreadsheet or a BASIC program), repeated editing or word processing of the same text file, or repeated editing and compiling using a language processor.

Our first choice for the mix of tasks was selected as a worst-case test of the advantages of caching. We picked a class of jobs that would use the disk extensively and would have the minimal repetitive usage of the same files. Our mix of tasks consisted of a C compilation of a medium-size program (350 lines) followed by a Pascal compilation of a long program (1000 lines). The compiled Pascal program was then linked to form an executable load module. The total number of blocks requested to be read by the processor was about 2000. We ran this same sequence of programs for each of the tests so that the effect of the mix of programs would not bias the conclusions for the relative efficiency of the various algorithms. In each case, the cache started empty.

Figure 4 shows the hit/miss ratio as a function of the cache size for the LRU replacement algorithm and a prefetch value of 16 blocks (whenever a miss occurs, one full track of data is prefetched). Notice that even for this worst-case mix of programs, the effective hit/miss ratio is almost 10 by the time you get to 256K bytes of caching memory and becomes greater than 10 for 320K bytes of caching memory. We may expect to achieve our goal of a hit/miss ratio of 10 using 256K bytes of dedicated caching memory for a better mix of programs.

We'll now look at the effect of various cache replacement algorithms on the hit/miss ratio. To do

*Text continued on page 330*

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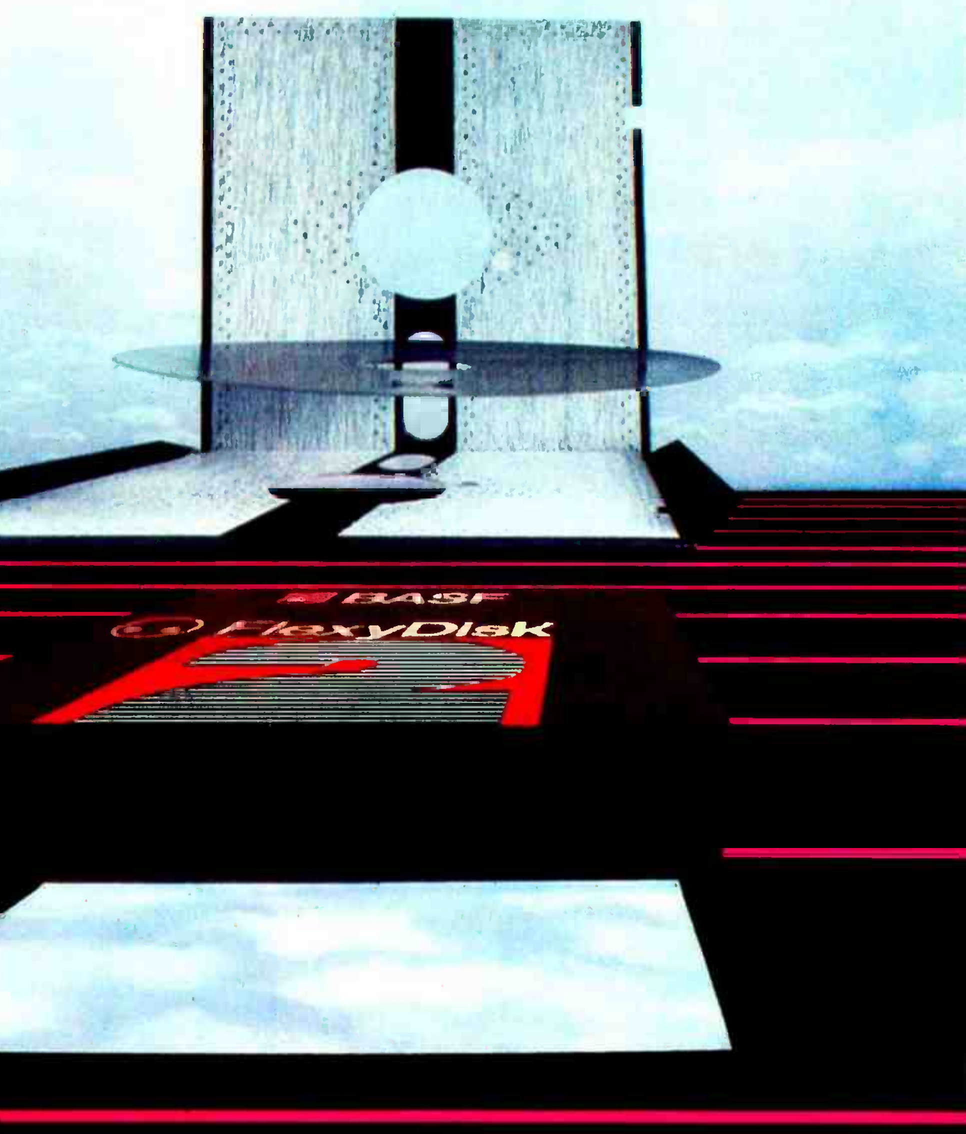


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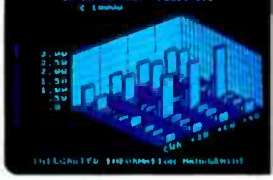

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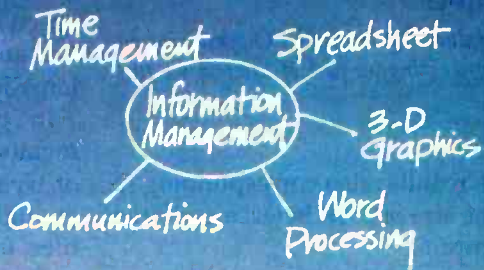


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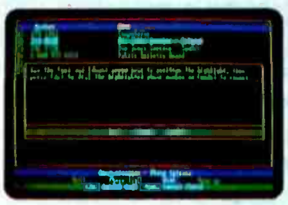

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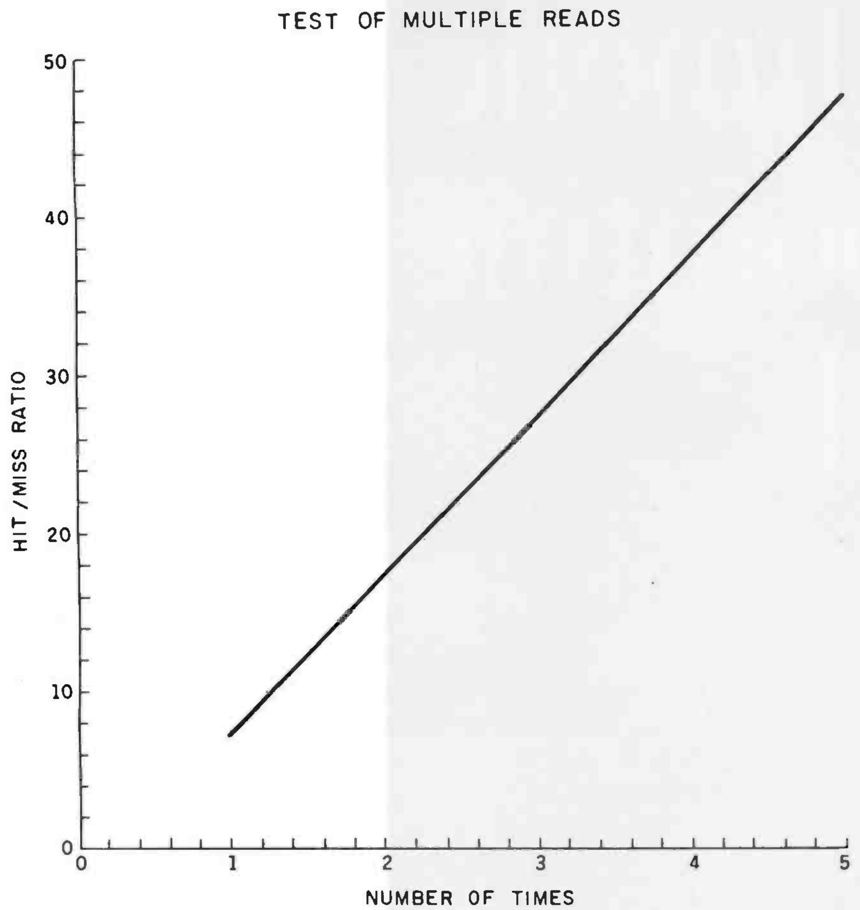



**Figure 6:** *A plot of the change in the hit/miss ratio produced by multiple I/O operations on the same set of files. This plot is for repetitive word processing on part of the text for this article, and it is typical of fully cached operation.*

*Text continued from page 326:*

this, the disk driver was modified to let us use any of the three algorithms in the cache module. Figure 5 shows the measured hit/miss ratios of the three different replacement algorithms. This data was collected using a cache memory allocation of 256K bytes. Notice that, as predicted, the LRU algorithm produces a slightly higher hit/miss ratio than either the FIFO or the random-replacement algorithms. Although the effect is not too large (10 to 20 percent), we thought it significant enough to justify the use of this algorithm even though it is somewhat more complex to implement.

To show how the caching driver might achieve an even greater hit/miss ratio for a more fortunate mix of programs, for our next example we took the text editing of this article, and we plotted the hit/miss ratio as a function of the number of times the word processor was executed for the purpose of writing part of this text. These results, also corresponding to a cache size of 256K bytes, are plotted in figure 6.

**Programs that are heavy on file access can show large improvement factors with the use of caching.**

The large increase in the hit/miss ratio from 7 to almost 50 when the word processor is used on the text file needs some explanation. When the word processor is first run, the files containing both it and the text file are loaded into the cache memory, then passed through to the processor. Unless they were previously in the cache, this results in a certain miss count that depends on the size of the word processor and the size of the text file. When the editing of the file is completed, the updated file is written out to the cache and then automatically transferred to the disk, but if the cache memory is sufficiently large, both the word processor and the updated text file also will remain in the cache. When the word processor is again used to edit the same text file, the cache will contain both. The second and all subsequent modifications to the file result in nothing but hits on the cache memory. In this case, which is referred to as being *fully cached*, you can therefore expect the hit/miss ratio to continue upward in a manner proportional to the number of times the word processor is used on the same file. Because word processing and computer programming frequently entail this sort of cyclic use of a small set of files, the benefits from disk caching for this type of computer usage are obvious from the plot. Of course, this speedup effect does not mean that all processing is speeded up; it only applies to time that would otherwise be lost during inefficient disk transfers. If a program is computation intensive, with little file access, its execution speed is largely unaffected. Programs that are heavy on file access can show large improvement factors.

In general, "tuning" the cache memory allocation consists primarily of trying to get the cache size large enough to hold virtually all of the files in use over some reasonable period of time. This situation may be compared with a RAM disk where the size choice is made in much the same way.

In some systems, attempts have been made to use small caches of 64K bytes or less. Our experience is that attempting to use too small a cache frequently degrades performance rather than enhances it, so it is important to accurately assess the needs and provide adequate memory for this purpose. At the same time, using a larger cache size than is needed for the normal mix of tasks done is simply wasteful and expensive. A larger than average utilization of disk data would necessitate a larger disk cache; a frugal user of disk data might get by with less.

It is useful to compare the cache concept with that of the RAM disk. The big advantage of disk caching

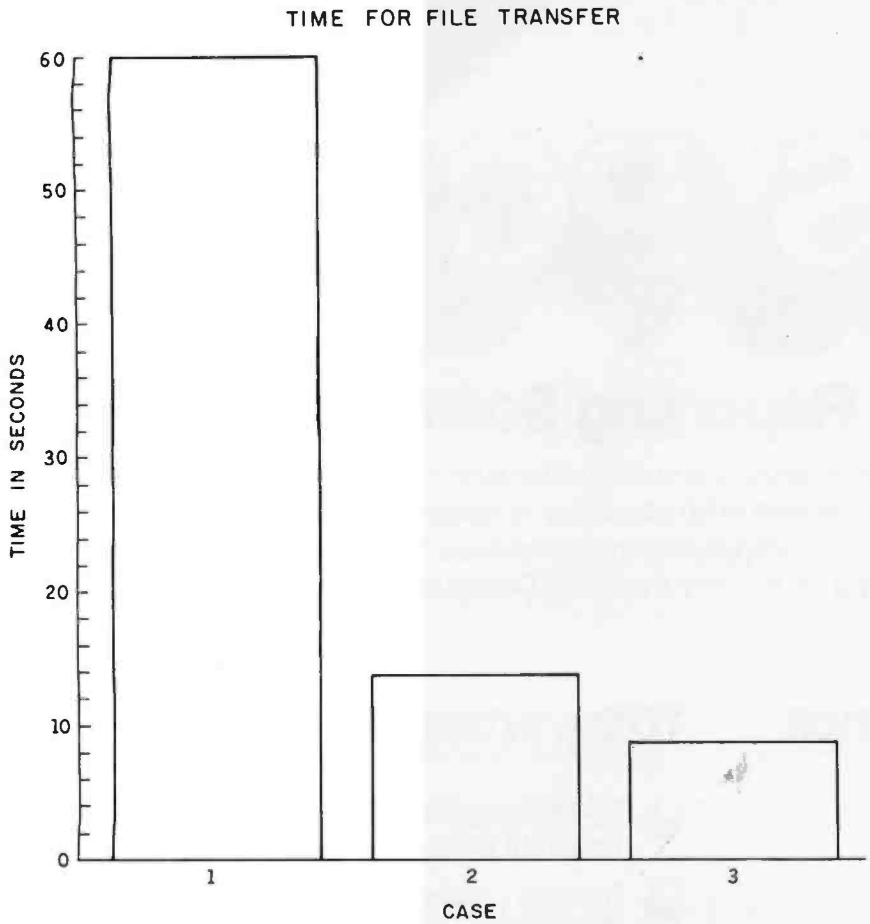



**Figure 7:** *A bar plot of the time required for a program to read a file of 100K bytes, perform minor processing on the data, and write the file back to disk. Bar 1 was obtained using a driver with no caching. Bar 2 was obtained using caching, but with the cache initially empty so that file and program data had to be read into the cache. Bar 3 was obtained under the fully cached condition where all of the required disk data was already contained in the cache.*

over a RAM disk is that the selection of which files are to be placed into the "fast disk" is completely automatic rather than manual, and the cache approach provides automatic, read-verified backup to the nonvolatile physical disk; consequently, it is unnecessary to remember to write the files back manually, and the risk of data loss due to power failure is minimized. The adverse effect of disk fragmentation can be overcome by occasionally performing a full backup and restore of all files on the disk. Doing this results in a completely compacted disk with all files completely contiguous. Thereafter, only those files that are modified will become fragmented, and the average fragmentation will be small. Besides the value of performing regular backup, this practice is beneficial even without caching.

Finally, to demonstrate that caching does produce a substantial improvement in overall system speed, we ran timing tests on two typical programs.

**The time spent in caching algorithms was insignificant compared with the time spent performing the actual data transfer.**

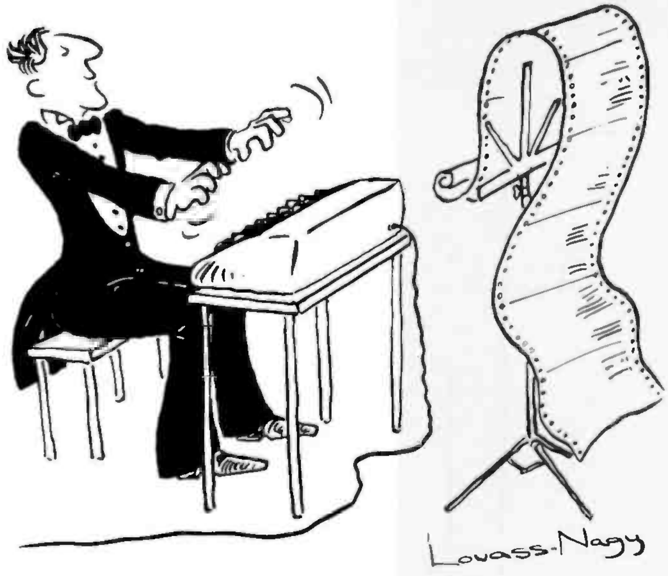
The first task is a file copy. This program reads a file one block at a time, performs some processing on the data, and writes the resulting data back to the disk into a different file. The two files were moderately far apart on the disk. Figure 7 shows the time required to carry out this task in three cases. In the first case, no caching was used. In the second case, caching was used, but the program and files were not already in the cache. The third was the fully cached case, with the program and files already in the cache from the second test. By using the caching driver, this test exhibits improvement, by more than a factor of four, in the total execution time for this program.

Figure 8 shows the time required to compile and link the program used to collect the data presented in figure 7. The improvement is not as dramatic in this example because these tasks are more computation intensive, with less time spent in disk operations. Nevertheless, there is a decrease of 30 percent in total execution time.

You might well ask whether you should consider the degradation in the transfer rate produced by using the more complex algorithms in the cache system. That is, are we slowing down the transfer rate by spending too much time in determining if the data is in cache memory, or in sophisticated prefetch and replacement algorithms? We found, at least in the case of PC-DOS 2.0, that the time spent in the various caching algorithms was insignificant in comparison with the time spent performing the actual data transfer. It therefore turns out that the cache memory has a transfer rate almost equal to a RAM-disk system whenever it contains the requested data. We have, of course, implicitly assumed this fact in our previous plots of transfer rate versus hit/miss ratio. In this regard, disk caching has an advantage over memory caching. In disk caching, the various algorithms are executed once, at most, for every block that is transferred; in memory caching, some of the algorithms are executed once for each byte or word that is transferred.

## Conclusion

We have determined that you can utilize the added addressable memory afforded by 16-bit processors in a very useful way to improve the overall effective transfer rate of Winchester systems and to provide apparent, sometimes dramatic, performance increases. For the case of cach-

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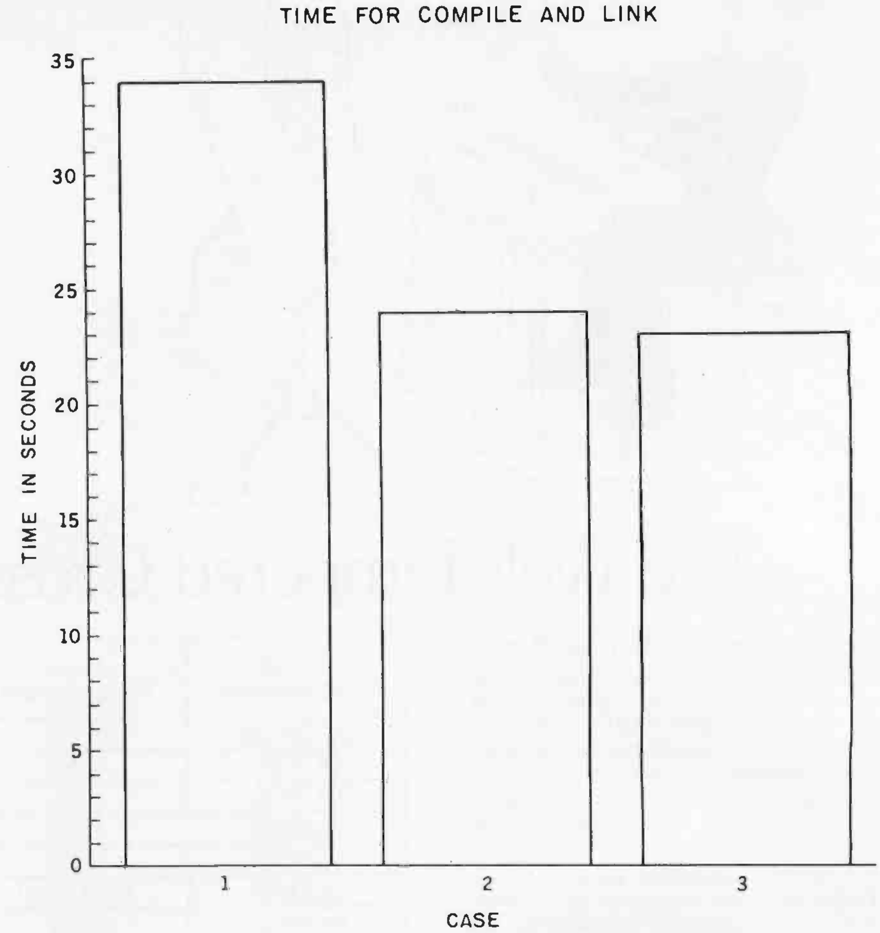


**Figure 8:** *A bar plot of the time required to compile and link a C program. As in figure 7, bar 1 was obtained with no caching, bar 2 was obtained with an empty cache, and bar 3 was obtained with fully cached operation.*

ing within the disk driver, the cluster prefetch method does a good job. We chose the cluster size based on characteristics of the disk hardware.

It appears that the LRU replacement algorithm delivers the best hit/miss ratio and should be used because the time spent in the actual transfer dominates the computation overhead. We also found that the complexity of the various algorithms had a negligible effect on the transfer rate.

On the basis of the example of the extremes between little repetitive usage and significant repetitive usage, we feel that the average single-user system can expect an overall hit/miss ratio greater than 10 for a cache size of 256K bytes. We generally attain hit/miss ratios of 20 to 50. These high ratios lead to an overall improvement in the disk transfer rate of 5 to 15, depending on the amount of head movement that occurs in the uncached disk. The effect of caching for the case where all of the files accessed are fully cached is that the transfer rate after the files first have been brought into cache is equal to that of a RAM disk. The improvement produced by utilizing a disk cache is significant for the case of single-tasking operating systems. It should be almost indispensable for a multitasking system, or for a Winchester disk drive used as a file server by several computers in a local-area network. ■

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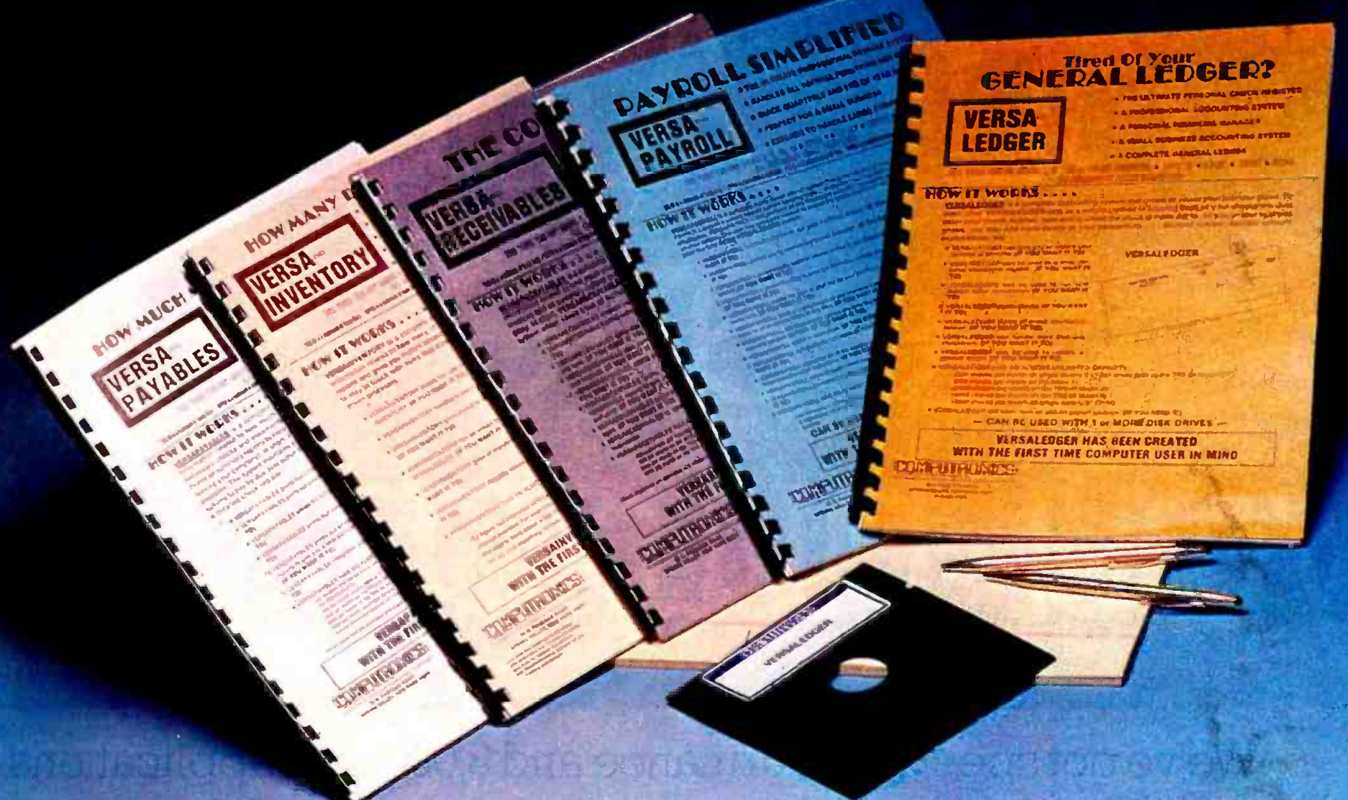


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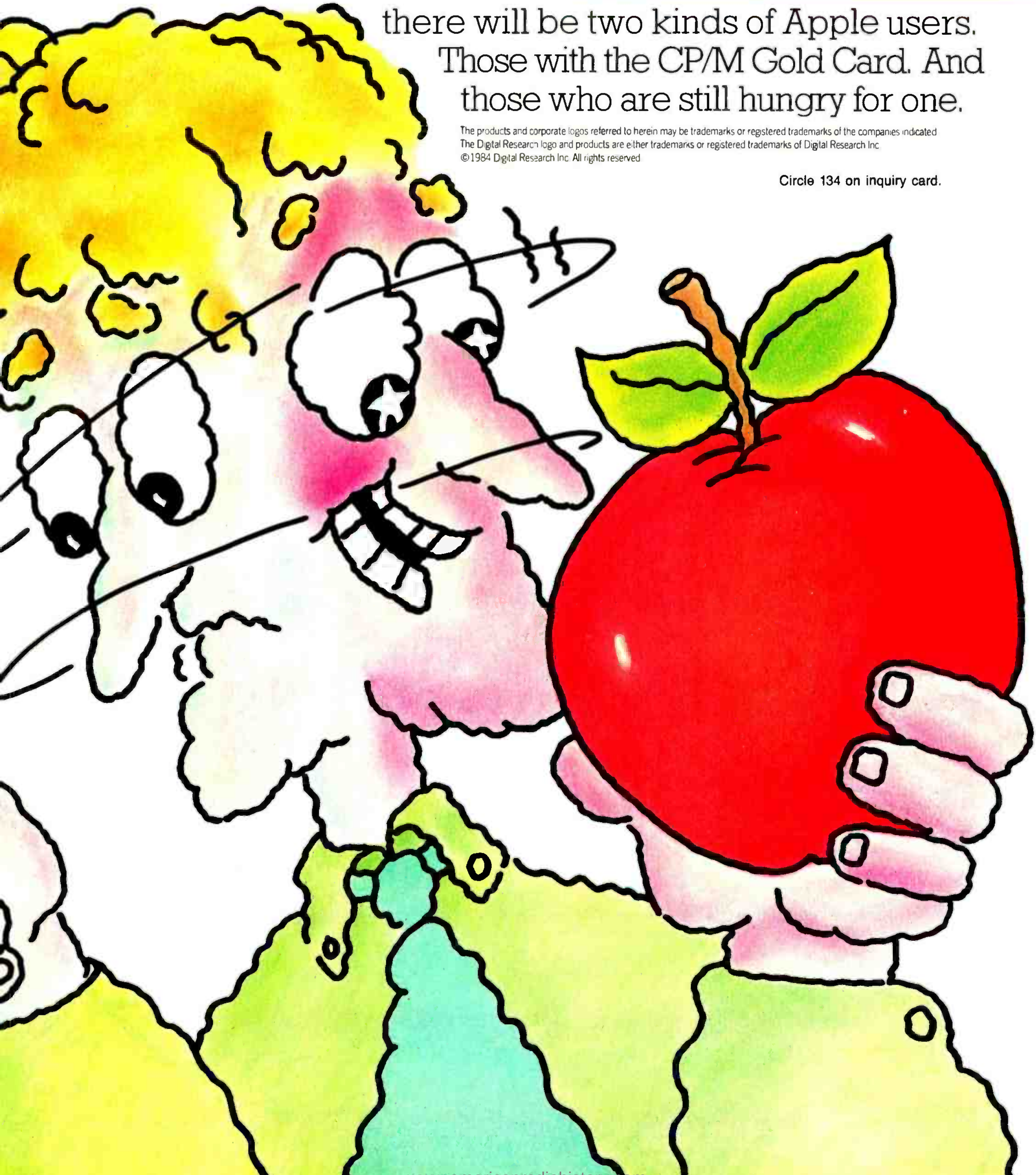

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# Update on Apple Macintosh and Lisa 2

Gregg Williams
BYTE Senior Technical Editor

The Macintosh and Lisa 2 are out, although a few unpleasant surprises occurred between the deadline for my articles appearing in the February BYTE (pages 30 and 84, respectively) and Apple's formal announcement on January 24. In a word, the Macintosh (or Mac) is more expensive than we thought it would be. At one time, Apple had decided on a $1995 price for the basic Macintosh, but the company changed this to $2495. Other changes include: Imagewriter (reported at $495), $495 if bought with a Mac, $595 otherwise; numeric keypad, $129 (up from $99); second disk drive, $495 (up from $395). Apple also announced a 300-bps (bits per second) modem for $225 and a 1200-bps modem for $495.

Apple has also formed the Apple University Consortium (AUC) to "further the use of computers in higher education" by making "commitments to supply large numbers of its new Macintosh personal computers to 24 leading universities," including Yale, Stanford, Dartmouth, Brown, and the University of Michigan. Apple requires member universities to create courseware and meet regularly together. Faculty and students will be able to buy Macintoshes at reduced rates; a source close to the University of Utah, an AUC member, said that the prices were $1200 for students and $900 for faculty.

Apple also announced three members of the Lisa 2 family: the Lisa 2, at $3495; the Lisa 2/5, at $4495; and the Lisa 2/10, at $5495. All units have 512K bytes of memory and one 3½-inch microfloppy-disk drive. The Lisa 2/5 adds an external 5-megabyte Profile hard disk, and the Lisa 2/10 adds an internal 10-megabyte hard disk. Lisa 1 owners can upgrade to a Lisa 2/5 for free until June 1, $595 afterward, or to a Lisa 2/10 for $2495. A 512K-byte memory upgrade is $1495. The Macintosh operating system (needed for a Lisa computer to run Macintosh software) comes free with the Lisa 2 computer and is available at extra cost for buyers of the Lisa 2/5 and 2/10. Apple also announced Apple Bus, a low-cost local network that will allow Macintoshes, Lisas, and (later) Apple II-family computers to share common peripherals.

## Commentary

Initial reaction to the Macintosh has been strongly, but not overpoweringly, favorable. A few traditional computer users see the mouse, the windows, and the desktop metaphor as silly, useless frills, and others are outraged at the lack of color graphics, but most users are impressed by the machine and its capabilities. Still, some people have expressed concern about the relatively small 128K-byte RAM (random-access read/write memory) size, the lack of any computer language sent as part of the basic unit, and the inconvenience of the single disk drive. Although Apple has said nothing officially, it is widely believed that Apple will offer a 512K-byte Macintosh upgrade by the end of 1984; since the Macintosh memory chips are soldered onto the printed-circuit board, this will not be a simple upgrade that most users will want to do at home. The Macintosh is largely a computer of unparalleled vision on Apple's part; however, that vision failed when the Mac was limited to 128K bytes of memory. It took no vision to see the need for a larger memory: much existing software (for the IBM PC, for example) already makes use of 256K- and 512K-byte memory spaces.

At the current prices, a usable system (Macintosh with one language, Mac Paint/Mac Write, Imagewriter printer, and second disk drive) will now cost $3879 ($100 less if you buy the Imagewriter with the system). This is considerably more than the $2984 possible package price quoted in my February article. Marketing decisions have compromised Steve Jobs's vision of "something really inexpensive so that everyone can afford it." Also, the higher price will probably decrease the influence of the machine on the market; this may make the difference between the Macintosh being just another successful computer rather than being the computer that is popular enough to be a surviving alternative to the looming IBM monopoly. ■

*Gregg Williams is a senior technical editor at BYTE. He can be reached at POB 372, Hancock, NH 03449.*

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# Fitting Curves to Data

## *The Simplex algorithm is the answer*

**Marco S. Caceci and William P. Cacheris**
**Florida State University**

Fitting functions to data is a frequent task in science and wherever you need to superimpose complex mathematical models on data. Most curve-fitting programs presently running on microcomputers are either locally written, brute-force stepping procedures, or Newton-Ralphson algorithms in BASIC and FORTRAN that have passed hands dozens of times. The Simplex algorithm we use is relatively recent (1965) and has been applied to curve-fitting problems only in the past few years, mostly in academic circles.

Consider a set of number pairs, $x_1$, $y_1$; $x_2$, $y_2$; . . .; $x_n$, $y_n$. It is easy to implement a linear fit, computing the parameters $a$ and $b$ of the "best" straight line, $y = a + bx$, passing through the points. Some pocket calculators have the necessary routines in firmware. And there are programs available that can fit any set of points to a polynomial or some "well-behaved" function. It would be convenient, however, to be able to fit sets of data points to more complicated functions, or, for that matter, to find an algorithm capable of fitting a set of data points to any function, no matter how complex.

Within the speed and memory limitations of the computer on which it runs, the program Simp is capable of computing the parameter values that best fit a particular set of data points given an analytical function with any number of variables and parameters. The program utilizes the Simplex algorithm and is written in Pascal/Z version 4.0.

### Problem Definition

It is easier to understand curve fitting if you start with an example. As a typical case of experimental data that provides useful information through a complex function, consider the Michaelis-Menten kinetic theory of enzyme action. The Michaelis-Menten equation has the form $y = a \times x / (b + x)$. Experimentally, you measure the initial reaction rates: $y$, for different substrate concentrations; $x$, in order to determine the value of constants; $a$ and $b$. The $a$ represents the maximum initial reaction rate and $b$ the enzyme's affinity for the substrate. The problem lies in determining the best values of $a$ and $b$ for a given set of $x$ and $y$ data.

Figure 1 represents a set of six experimental data points, $x_i$, $y_i$, and the curve described by the Michaelis-Menten function that best fits them. The points do not fall exactly on the curve because they are affected by experimental error, and they are redundant. Two would be enough to define the curve, but by providing a larger number, the errors tend to cancel and possibly can be estimated. A further assumption that simplifies the mathematics (and is usually true) is that the $x$ values are virtually error free; the only significant errors are in the experimental determination of the $y$ values.

In the equation $y = a \times x / (b + x)$, constants $a$ and $b$ do not vary within a set. Variables $x$ and $y$ do. The experimenter varies $x$, the independent variable, freely during the experiment; $y$, the dependent variable, is measured by the experiment, and its value (hopefully) depends on $x$. The Michaelis-Menten equation forms a model when applied to an experiment, and the constants in the equation become the model's parameters. This model has, therefore, one independent variable and one dependent variable and it is described by an equation with two parameters. To fit the curve you must estimate the "best" values for these parameters.

You can use two strategies to obtain a fit: linear and nonlinear parametric fit. If the model contains only linear equations (integral powers of the variables), you can use a linear algorithm. The great advantage of linear methods is that the solution is often immediate, i.e., they don't require an indefinite number of iterations. The main disadvantage is that many functions are not, and cannot be reduced to, linear equations.

The Michaelis-Menten equation in the example is not a linear equation, although you can manipulate it into a linear form. It is easy to prove that if you plot $1/y$ versus $1/x$, the result is a straight line whose slope is $b/a$, whose intercept is $1/a$, and whose equation is $1/y = 1/a + b/a \times 1/x$. You can find good values for $a$ and $b$ by drawing or computing the "best" straight line through the "manipulated" experimental points according to the least-squares criterion.

You can extend this approach by properly using matrix algebra to handle more than two parameters and/or polynomial expressions. It is generally not a good practice to transform nonlinear systems into linear ones even when it is possible. Not only is it somewhat cumbersome, since you must handle each different function in a different way, but the error distribution and the statistical weight of the data points change after such transformations. If you don't deal with this properly, it can result in substantial inaccuracies.

In general, to handle nonlinear functions you need nonlinear parametric fits. Unfortunately, all general-purpose, non-linear, curve-fitting algorithms developed to date have one annoying feature—namely, they are recursive. You must adjust the parameters in an iterative way with no idea of how many repetitions you will need to achieve convergence or even, for that matter, if you can. Nonlinear parametric fits also require initial estimates of the values sought.

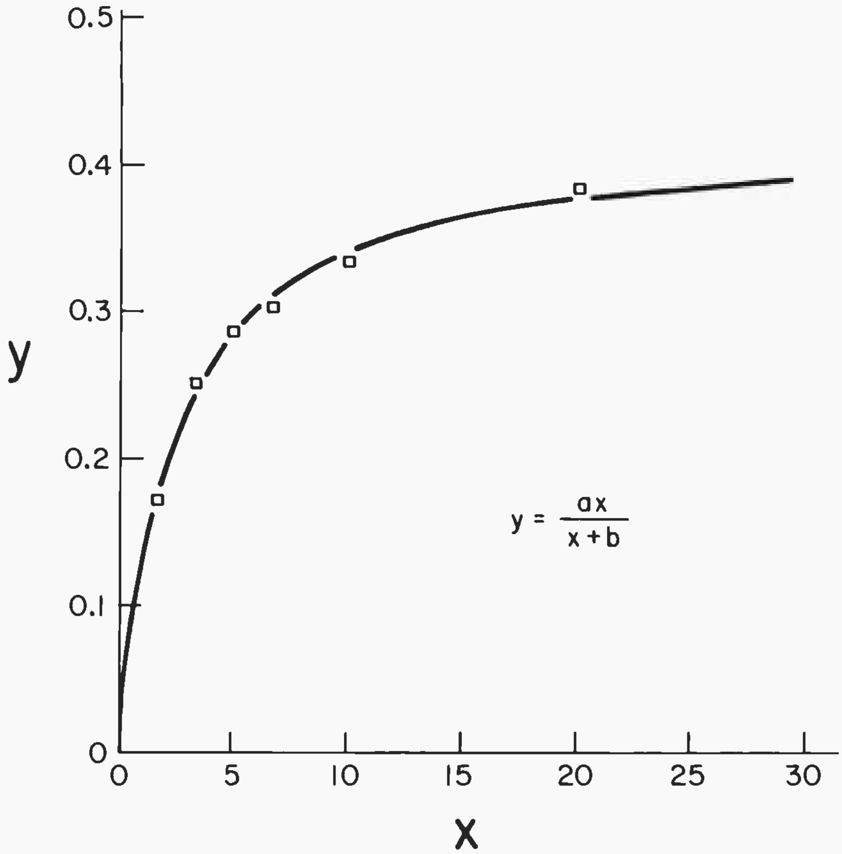


**Figure 1:** *Plot of experimental data: initial reaction rates ($y_i$) versus substrate concentration ($x_i$). The data obeys the Michaelis-Menten equation: $y = a \times x/(b + x)$. Note: the best-fit curve is also drawn.*

## The Response Surface

Getting back to the example, you need a method for finding the best values of $a$ and $b$ for a set of $x$ and $y$ data using a nonlinear approach. And you must be able to generalize this method for any kind of function.

First, you need a new representation of the data. If you choose arbitrary values for $a$ and $b$, you can determine the corresponding values of $y$ for each experimental $x$ from the equation. Good values for $a$ and $b$ can adequately predict $y$ values that are close to those experimentally measured.

Quantitatively, if you have $n$ data points, label each value of the independent variable as $x_1, x_2, \ldots, x_n$ and each value of the dependent variable as $y_1, y_2, \ldots, y_n$. Also, label your $n$ predicted values (as calculated by the equation using certain values for $a$ and $b$) for the dependent variable $y'_1, y'_2, \ldots, y'_n$. Any pair of $a$ and $b$ values thus produces a set of $y'_i$ predicted values corresponding to the experimental $x_i$ set.

The sum $(y_1 - y'_1)^2 + (y_2 - y'_2)^2 + \ldots + (y_n - y'_n)^2$ is called the sum of the squared residuals ($SS_R$) and can be written $\Sigma_i(y_i - y'_i)^2$. The lower this sum is, the better the curve fits. This is called the least-squares criterion. For random errors randomly distributed (usually a reasonable assumption), this is the best criterion of all.

If the error distribution is not random but known, you can usually assign a statistical weight $w_i$ to each data point. The least-squares criterion will then minimize the sum: $SS_R = \Sigma_i w_i (y_i - y'_i)^2$.

Thus, the problem of finding the best values for a function's unknown

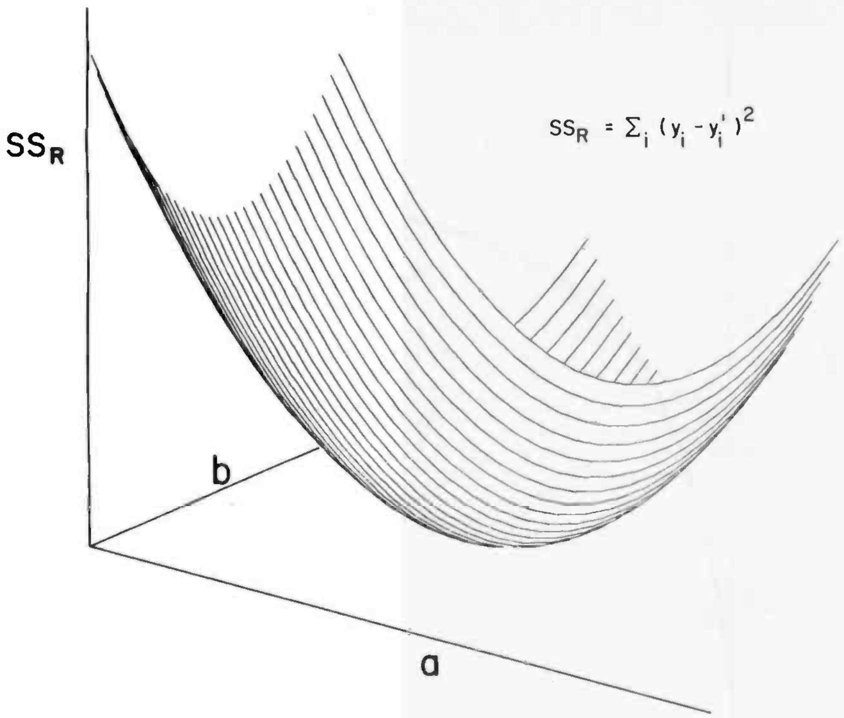


**Figure 2:** *Representation of the response surface,* $SS_R$ *versus* a *and* b. *The best values for* a *and* b *are those where the* $SS_R$ *value is the lowest. If you have poor* a *and* b *values, you will get large values for* $SS_R$.

parameters becomes the problem of finding the minimum of a new function, $SS_R$. In this example, we can picture $a$ and $b$ as the independent variables and $SS_R$ as the dependent one (figure 2). In general, if you have a function with $n$ parameters to be optimized, $SS_R$ describes an $(n+1)$-dimensional surface, called the response surface. If you have very bad parameter values, the surface point values are high. As you move toward better values, the response surface dips toward a minimum.

## Searching for the Minimum

The best values of $a$ and $b$ lie at the minimum of the function $SS_R = \Sigma_i w_i (y_i - y_i')^2$, and you need to find this minimum. Before discussing the Simplex algorithm, let's consider the most common alternatives.

The stepwise descent strategy consists of adjusting one parameter at a time, sequentially, until you find a minimum along that parameter, and then repeating the process until all values are stable. This algorithm is relatively easy to program and will converge virtually all the time, but it can be extremely slow to run, especially if there is a large number of parameters or any appreciable correlation between them.

Steepest descent methods adjust the parameter values along the direction of the response surface's fastest decrease. They involve fewer iterations, but they require knowledge or computation (by numerical differentiation) of $SS_R$'s first derivatives.

**A simplex is a geometric figure that has one more vertex than the space in which it is defined has dimensions.**

The Newton-Ralphson algorithm (and its many descendants) is the most popular nonlinear, least-squares fitting algorithm today. Although it is mathematically complex and always prone to divergence, it is fast (especially where the hardware supports matrix and floating-point operations), and speed is the most important consideration with computer time as expensive as it is.

Basically, the algorithm varies the parameters until the partial derivatives of $SS_R$ are all sufficiently close to zero. At each iteration, it computes the amount by which the parameters are changed, creating a square matrix that contains all the second derivatives of $SS_R$, then inverting this matrix and multiplying the result by the previous values of the first derivatives.

This approach often gives rapid convergence, but it also suffers substantial drawbacks. The program can diverge if it starts from inaccurate initial guesses. Considerable truncation errors can occur in the partial derivatives' calculations and in the matrix inversions, particularly when the installation does not support double-precision formats. Also, the numerical calculation of all the partial derivatives at each repetition requires massive amounts of computations.

The Marquardt algorithm and other more recent methods are mathematically equivalent to a mixture of the Newton-Ralphson and the steepest descent algorithms. It avoids the divergence problems of Newton-Ralphson without the unacceptable losses in speed. The amount and complexity of code generated in this way can, however, become substantial.

The Simplex method is relatively new; it was first proposed by J. A. Nedler and R. Mead in 1965. They used it to find mathematical function minimums. Since then, various applications to fitting problems have been developed.

A simplex is a geometric figure that has one more vertex than the space in which it is defined has dimensions. For example, a simplex on a plane (a two-dimensional space) is a triangle; a simplex in three-dimensional space is a tetrahedron, and so on.

The basic idea in the Simplex method is to build a simplex in the $M+1$-dimensional space described by the parameters you want to fit. For example, in the Michaelis-Menten equation above, there are two parameters, $a$ and $b$. You can consider them as axes in a plane on which we create a simplex (a triangle). Each vertex is then character-

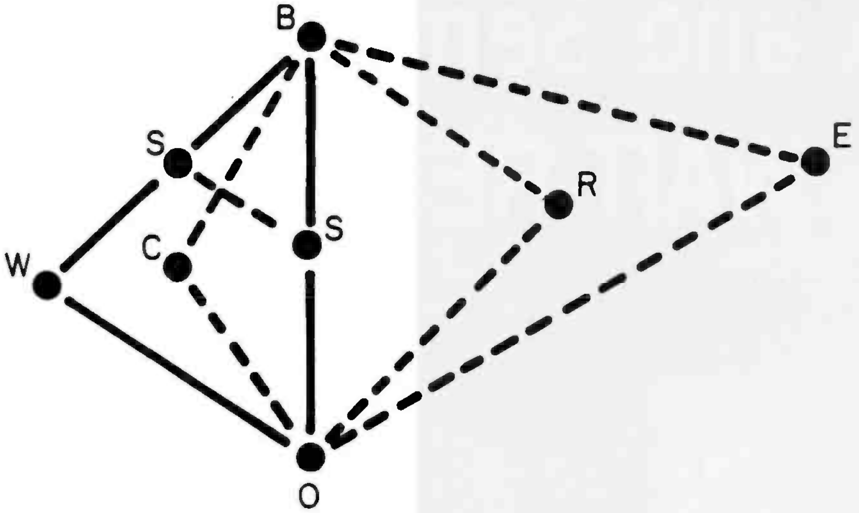


**Figure 3:** *Two-dimensional simplex BWO illustrating the four mechanisms of movement: reflection, expansion, contraction, shrinkage.* B = *vertex,* W = *worst vertex,* R = *reflected vertex,* E = *expanded vertex,* C = *contracted vertex, and* S = *shrunken vertexes.*

ized by three values: *a*, *b*, and the response $SS_R$.

To reach the lowest value of $SS_R$, the program moves the simplex ''downhill'', accelerating and slowing down as needed. It follows the rule: find which vertex has the highest (worst) response and which has the lowest (best), then reject the highest and substitute another one for it. The program computes the new vertex according to one of these mechanisms: reflection, expansion, contraction, and shrinkage.

If you want to create a reflected vertex, call *d* the distance from the worst vertex to *M*, the midpoint of all the other vertexes. For the triangle this is the distance from the vertex to the center of the line that connects the other two vertexes. The reflected vertex is located at a distance *d* from *M* on the line continuation that joins the rejected vertex to *M*.

If the response of the reflected vertex is neither worse than the rejected one nor better than the best one in the simplex, then the program accepts it. If the reflected vertex has a lower (better) response than the previous best, the program tests an expansion by reflecting twice the distance *d*. The expanded vertex is accepted if it has a lower response than the rejected one; otherwise, the program accepts the reflected one.

If the reflected vertex has a higher (worse) response than the rejected vertex, the program tests a contraction by moving the rejected one a distance of one-half *d* toward the midpoint. This contracted vertex is accepted if it produces a better (lower) response than the rejected one; otherwise, a shrinkage occurs and all vertexes, except the best one, move directly toward it by half of their original distance from it.

Figure 3 illustrates these four mechanisms and figure 4 gives the rules of simplex movement in flowchart form. Figure 5 shows an example of a simplex moving on $SS_R$'s contour plot for a two-parameter fit.

It is possible to make various modifications to the present algorithm. One common variant substitutes the shrinkage with a contraction beyond point *M*. And you can change the coefficients for the reflection, expansion, and contraction within certain limits.

The rules given above show clearly the advantages of the Simplex strategy:

- Divergence is impossible.
- You need to compute the response value only once or at most a few times for each iteration.
- You don't need any knowledge of derivatives or numerical differentiation. This avoids rounding-off errors and allows the handling of noncontinuous functions.
- No matrix operation is involved.

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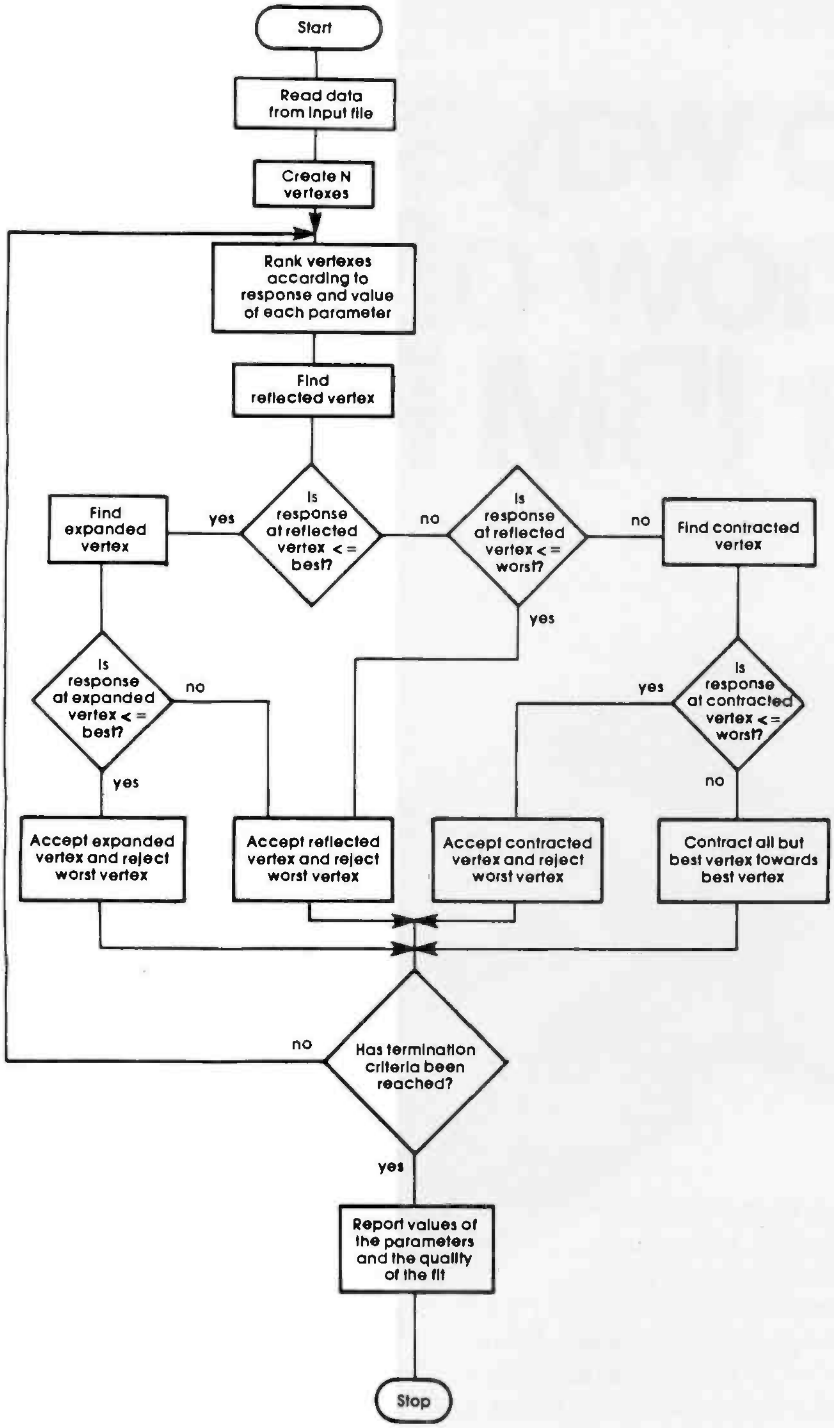


**Figure 4:** *Flowchart of the Simplex algorithm.*

Every function that you can write as computer code, you can optimize with the Simplex algorithm. In particular, to implement contour conditions, such as "parameter *r* must be positive, parameter *s* must be between one and ten, etc.," you assign very high values to $SS_R$ points corresponding to out-of-boundary parameter values to prevent the simplex from ever entering these regions.

## Program Description

Simp (listing 1) is written in Pascal/Z (Ithaca Intersystems) version 4.0 to run under the CP/M-80 operating system. This example contains about 200 statements and compiles into 19K bytes. Despite the care taken to try to avoid any nonstandard (Jensen and Wirth) expressions, some I/O (input/output) expressions are not standard, and you should be cautious about transporting Simp to other compilers. A version running on a Control Data Cyber-76 mainframe (Pascal 6000.3.4.0 compiler) is also presently available, and a BASIC translation for the Atari microcomputer is coming soon. To date, Simp has been used to fit functions with up to nine adjustable parameters, up to 200 data points, and two independent variables. The speed and memory limitations of the machine on which the program runs define the upper limit on these numbers.

To operate the program, you need only modify the function declaration and, in some cases, the constants' assignments and the I/O procedures. The only constants you must modify to accommodate different models are: *m*, the number of parameters to be fit; possibly *nvpp*, the total number of variables per data point; and *mnp*, the maximum number of data points. In the present example, *nvpp* is 2 (1 independent variable, *x*, and 1 dependent one, *y*) and *mnp* is 200.

The program input is in a disk file whose name is appended to the CP/M command. Procedure *enter* reads the input file. Simp directs *enter* to produce a screen output. If any error exists in the input file, you can easily detect it at this stage. If there are no errors, Simp redirects the output to the printer and invokes *enter* again. If you need additional data input or preprocessing of the data, you must modify procedure *enter* accordingly.

Next, Simp computes the starting simplex values, represented as a square matrix $n \times n$, where $n$ is the number of parameters you want to fit plus one. Each matrix row is a different vertex, for which the first $n-1$ columns are the individual parameter values, and the $n$th column stores the response value to be minimized from the procedure *sum_of_residuals*.

Procedure *sum_of_residuals* receives a set of parameter values, and from these, combined with the experimental data, computes the response surface value at the corresponding point. That is, it computes the sum of the squares of the differences between individual experimental dependent variable values and those

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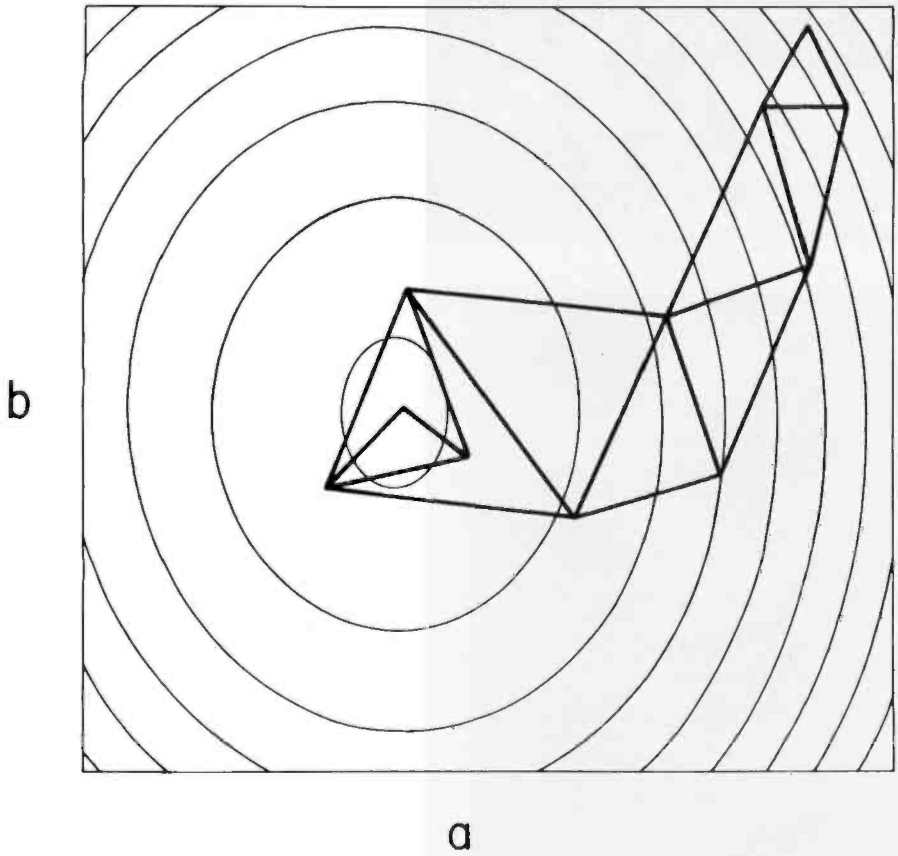


**Figure 5:** *An example of the simplex moving on the response surface's contour plot.*

calculated for the same independent variable values using the parameters being tested.

In this example, procedure *sum_of_residuals* gives identical statistical weight to all data points. In circumstances where the data points' statistical weight is not constant, you should modify the procedure.

Function *f* computes a single dependent variable value, *y'*, from the parameters and a given independent variable value. The program spends most of its time in this function, and you should be extremely careful to optimize its speed.

Simp calls procedure *order* to identify the highest and lowest values of the parameters and the response surface from among all the vertexes. It uses this information to compute the errors and make the decisions for the simplex's next movement. After Simp computes the vertexes of the first simplex from your initial guesses and their increments, procedure *first* outputs the values to the printer and then to the screen, as directed by the main part of the program.

The main program loop moves the simplex according to the rules previously given. Procedure *new_vertex* substitutes the rejected vertex with a new one. Simp exits the loop when the error (the percent difference between the extreme values) for all parameters falls below the necessary limits or reaches the maximum number of iterations. At each repetition *new_vertex* displays the new accepted vertex's values on the screen.

Once the program exits the main loop, procedure *report* directs the results to the screen and the printer. It also creates two files on the default disk drive, FIT.DAT and ERR.DAT. FIT.DAT contains the fitted points, that is, the $(x_i, y'_i)$ data points, where Simp copies the input $x_i$ values and computes their corresponding $y'_i$s using *a* and *b*'s estimated values. ERR.DAT contains the $(x_i, dy_i)$ data points, where the $x_i$s are from the input and the $dy'_i$s are from the computed residuals (the quantities $y_i - y'_i$). Both files begin with a series of six separated ones followed by the number of data points and then the data points themselves. If you need to post-process the data or if you change *nvpp*, procedure *report* will require modifications.

## Program Operation

You must create an executable file, SIMP.COM, from the source file, SIMP.PAS. In Pascal/Z, this is done by executing:

A>*pascal56 simp*
This creates SIMP.SRC.
A>*pasopt simp*
Optional optimizer. It saves a few bytes.
A>*asmbl main, simp/rel*
Creates SIMP.REL relocatable file.
A>*link simp/n:simp/e*
Creates SIMP.COM object code file.

The command A>*simp* <*infile*> invokes the program where <*infile*> is a valid CP/M filename. The disk input file, <*infile*>, is organized as follows:

- the maximum number of iterations (integer). Zero gives an infinite loop. Very generally speaking, the program usually converges in less than $20 \times m^2$ repetitions.
- your initial parameter guesses (*m* floating points).
- your initial parameter increments (*m* floating points). 0.0 blocks the corresponding parameter. The recommended values are one-tenth to one-half of your initial guesses.
- the maximum errors allowed ($m + 1$ floating points—one for each parameter and one for the sum of the squares of the residuals). The recommended values are $1E - 4$ to $1E - 6$.
- the data $(x_n, y_n; x_n, y_n; \ldots; x_n, y_n)$.

The program tolerates different input formats and any separator (space, tab, carriage return, line feed) should work. It is essential, though, to terminate the input file without any

Text continued on page 360

**Listing 1:** *Compiled listing of the program, Simp. It is written in Pascal/Z (Ithaca Intersystems) version 4.0 to run under the CP/M operating system.*

```
Stmt Level
  1   0   program simp;     {curve fitting with the simplex algorithm}
  1   0   {this  example fits  data  to a Michaelis-Menten  function}
  1   0
  1   0   {by Marco Caceci, with help from William Caceris.     1983}
  1   0   {Chem. Dept. Florida State University Tallahassee  FL32306}
  1   0   {no  copy-right.   SSSD  floppy  disk  copies  on  request}
  1   0
  1   0   {see Nelder J.A. & R. Mead, Computer J. 7, 308 (1965) and }
  1   0   {L.A. Yarbro & S.N. Deming,Anal. Chim. Acta 74, 391 (1974)}
  1   0
  1   0   const   date     = ' 5/22/83';
  1   1           memo     =
  1   1
  1   1   ' fit of a Michaelis-Menten function : y=ax/(b+x)';
  1   1
  1   1           m        = 2;     {number of parameters to fit}
  1   1           nvpp     = 2;     {total number of vars per data point}
  1   1           n        = m + 1;{some compilers don't like this}
  1   1           mnp      = 200;   {maximum number of data points}
  1   1
  1   1           alfa     = 1.0;   {reflection coefficient, >0}
  1   1           beta     = 0.5;   {contraction coefficient, 0to1}
  1   1           gamma    = 2.0;   {expansion coefficient, >1}
  1   1
  1   1           lw       = 5;     {width of line in data fields+1}
  1   1           page     = 12;
  1   1           root2    = 1.414214;
  1   1   type    vector   = array[1..n] of real;
  1   1           datarow = array[1..nvpp] of real;
  1   1           index    = 0..255;
  1   1   var     done     : boolean;       {convergence}
  1   1           i,j      : index;
  1   1           h,l      : array[1..n] of index;{number high/low paramts}
  1   1           np,                         {number of data points}
  1   1           maxiter,                    {max number iterations}
  1   1           niter    : integer;         {number of iterations }
  1   1           next,                       {new vertex to be tested}
  1   1           center,                     {center of hyperplane described
  1   1               by all vertexes of the simplex excluding the worst}
  1   1           mean,    error,
  1   1           maxerr,                     {maximum error accepted}
  1   1           p,q,                        {to compute first simplex}
  1   1           step     : vector;          {input starting steps}
  1   1           simp     : array[1..n] of vector;        {the simplex}
  1   1           data     : array[1..mnp] of datarow;     {the data}
  1   1           fname    : array[1..14] of char;         {filename}
  1   1           din,dout: text;             {input, output}
  1   1
  1   1   {~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}
  1   1
  1   1   function f (x : vector; d: datarow) : real;
  1   1           {x(1..m) the parameters, d has the data}
  1   1     begin
  1   2       f := x[1] * d[1] / (x[2] + d[1])
  2   2     end;
  2   1
  2   1   {~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}
  2   1
  2   1   procedure sum_of_residuals (var x : vector);
  2   1           {computes the sum of the squares of the residuals}
  2   1           {x(1..m) passes parameters. Result returned in x(n)}
  2   1     var    i          : index;
  2   2     begin
```

*Listing 1 continued on page 354*

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| Optional Winchester | YES | YES | YES | YES |
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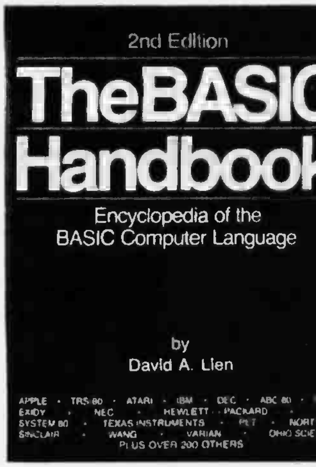


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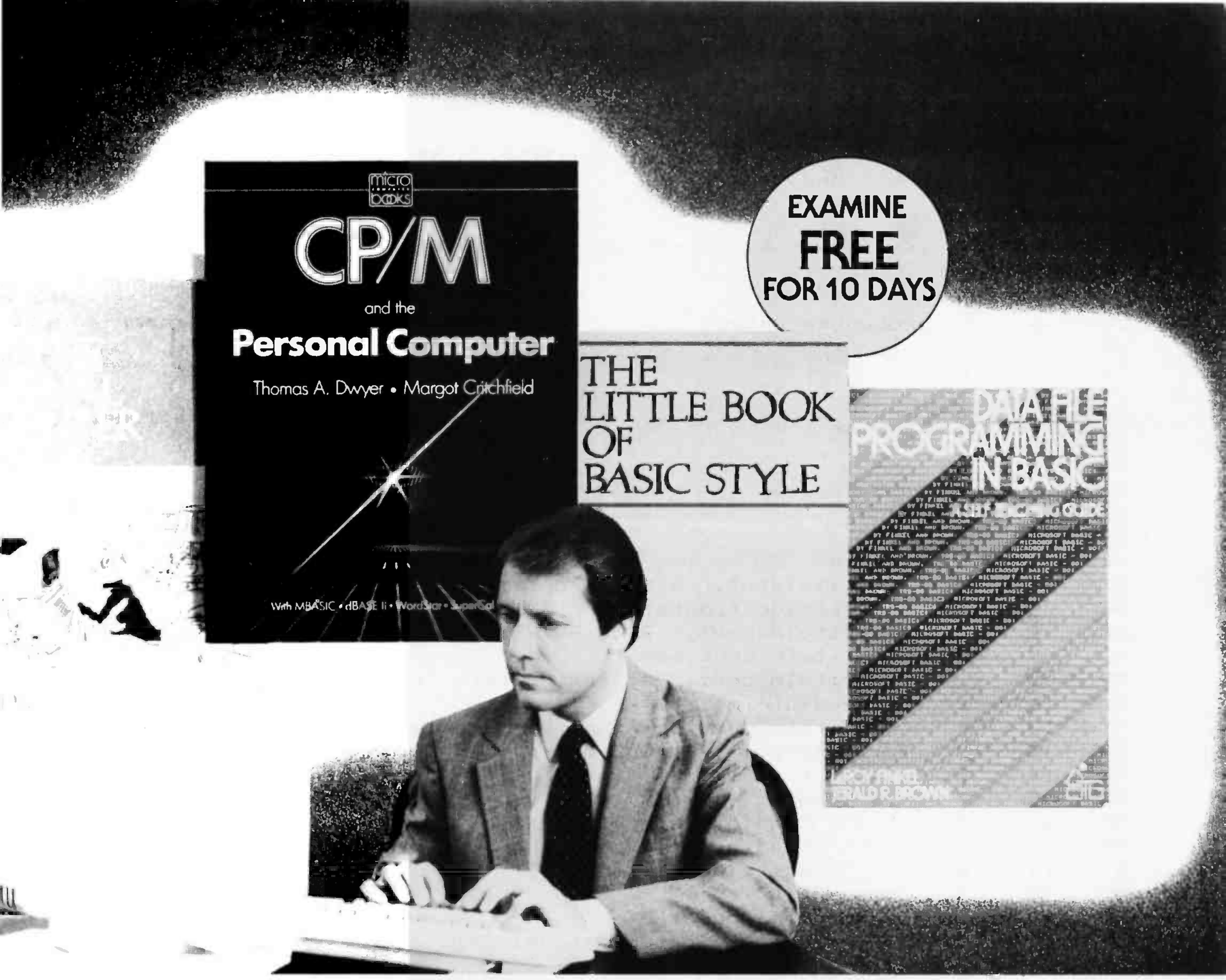


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Byte 5/84

*Listing 1 continued:*

```
 2   2       x[n] := 0.0;
 3   2       for i := 1 to np do
 4   3         begin
 5   4           x[n] := x[n] + sqr(f(x,data[i]) - data[i,2])
 6   4         end                           {loop}
 6   3     end;                              {sum_of_residuals}
 6   1
 6   1  {~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}
 6   1
 6   1
 6   1  procedure enter;          {enters data from disk file fname
 6   1                             file must terminate with EOF
 6   1                             immediately after last number.
 6   1                             data in the order:
 6   1                                     -maximum number iterations,
 6   1                                     -starting point coordinates
 6   1                                     -starting increments
 6   1                                     -maximum errors
 6   1                                     -data}
 6   1
 6   1    begin                                        {enter}
 6   2      write(dout,' SIMPLEX optimization version ');
 7   2      write(dout,date);
 8   2      writeln(dout,' @ MC/BC FSU');
 9   2      writeln(dout,memo);
10   2      writeln(dout,' accessing file ',fname);
11   2      read(din,maxiter);
12   2      writeln(dout,' max number of iterations is := ',maxiter:5);
13   2      write(dout,' start coord.:');
14   2      for i := 1 to m do
15   3        begin
16   4          read(din,simp[1,i]);
17   4          if (i mod lw) = 0 then writeln(dout);
19   4          write(dout,simp[1,i])
20   4        end;
20   2      writeln(dout);
21   2      write(dout,' start steps: ');
22   2      for i := 1 to m do
23   3        begin
24   4          read(din,step[i]);
25   4          if (i mod lw) = 0 then writeln(dout);
27   4          write(dout,step[i])
28   4        end;
28   2      writeln(dout);
29   2      write(dout,' max. errors: ');
30   2      for i := 1 to n do
31   3        begin
32   4          read(din,maxerr[i]);
33   4          if (i mod lw) = 0 then writeln(dout);
35   4          write(dout,maxerr[i])
36   4        end;
36   2      writeln(dout);
37   2      writeln(dout,' data:');
38   2      writeln(dout,' x':14,'y':14);
39   2      np := 0;
40   2      while not eof(din) do
41   3        begin
42   4          np := succ(np);
43   4          write(dout,' #',np:3);
44   4          for j := 1 to nvpp do
45   5            begin
46   6              read(din,data[np,j]);
47   6              write(dout,data[np,j])
48   6            end;
48   4          writeln(dout);
49   4        end                                      {while}
```

*Listing 1 continued on page 355*

*Listing 1 continued:*

```
50   3       end;                                          {enter}
50   1
50   1  {~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}
50   1
50   1  procedure report;
50   1    var   y, dy,
50   2           sigma    : real;
50   2           d1, d2   : text;          {disk out files}
50   2    begin
50   2      rewrite('FIT.DAT',d1);         {fitted y's}
51   2      rewrite('ERR.DAT',d2);         {residuals }
52   2      writeln(d1,' 1 1 1 1 1 1',np);        {dummy  arguments}
53   2      writeln(d2,' 1 1 1 1 1 1',np);        {for PLOT program}
54   2      writeln(dout,' program exited after',niter:5,' iterations ')
55   2      writeln(dout,' the final simplex is');
56   2      for j := 1 to n do
57   3        begin
58   4          for i := 1 to n do
59   5            begin
60   6              if (i mod lw) = 0 then writeln(dout);
62   6              write(dout,simp[j,i]:10)
63   6            end;
63   4          writeln(dout)
64   4        end;                             {do j}
64   2      writeln(dout, ' the mean is');
65   2      for i := 1 to n do
66   3        begin
67   4          if (i mod lw) = 0 then writeln(dout);
69   4          write(dout,mean[i])
70   4        end;
70   2      writeln(dout);
71   2      writeln(dout,' the estimated fractional error is');
72   2      for i := 1 to n do
73   3        begin
74   4          if (i mod lw) = 0 then writeln(dout);
76   4          write(dout,error[i])
77   4        end;
77   2      writeln(dout);
78   2      writeln(dout,' #':4,'x':10,'y':15,'y"':15,'dy':15);
79   2      sigma := 0.0;
80   2      for i := 1 to np do
81   3        begin
82   4          y := f(mean,data[i]);
83   4          dy:= data[i,2] - y;
84   4          sigma := sigma + sqr(dy);
85   4          writeln(dout,i:4,data[i,1]:15,data[i,2]:15,y:15,dy:15);
86   4          writeln(d1,data[i,1],y);
87   4          writeln(d2,data[i,1],dy)
88   4        end;
88   2      sigma := sqrt(sigma / np);
89   2      writeln(dout,' the standard deviation is',sigma);
90   2      sigma := sigma / sqrt(np - m);
91   2      write(dout,' the estimated error of the');
92   2      writeln(dout,' function is',sigma);
93   2    end;                     {report}
94   1
94   1  {~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}
94   1
94   1  procedure first;
94   1    begin
94   2      writeln(dout,' starting simplex');
95   2      for j := 1 to n do                     {vertexes}
96   3        begin
97   4          write(dout,' simp[',j:1,']');
98   4          for i := 1 to n do
99   5            begin                              {dimensions}
```

*Listing 1 continued on page 356*

*Listing 1 continued:*

```
100   6            if (i mod lw) = 0 then writeln(dout);
102   6            write(dout,simp[j,i])
103   6          end;                               {dimensions}
103   4        writeln(dout)
104   4      end;                                   {vertexes}
104   2    writeln(dout)
105   2  end;                                       {first}
105   1
105   1 {~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}
105   1
105   1 procedure new_vertex;    {next in place of the worst vertex}
105   1   begin
105   2     write(dout,'  --- ',niter:4);
106   2       for i := 1 to n do
107   3         begin
108   4           simp[h[n],i] := next[i];
109   4           write(next[i])
110   4         end;
110   2     writeln(dout)
111   2   end;                                      {new_vertex}
111   1
111   1 {~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}
111   1
111   1 procedure order;          {gives high/low in each parameter}
111   1                           {in simp. caution:not initialized}
111   1   var i, j        : index;
111   2
111   2   begin
111   2     for j := 1 to n do                      {all dimensions}
112   3       begin
113   4         for i := 1 to n do                  {of all vertexes}
114   5           begin                             {find best and worst}
115   6             if simp[i,j] < simp[l[j],j] then l[j] := i;
117   6             if simp[i,j] > simp[h[j],j] then h[j] := i
119   6           end                               {i loop}
119   5       end                                   {j lopp}
119   3   end;                                      {order}
119   1
119   1 {~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~}
119   1
119   1 begin                     {simplex}
119   1   read(fname);            {input file in CP/M command line}
120   1   reset(fname,din);       {fname is on disk}
121   1   rewrite('con:',dout);   {output goes to consolle}
122   1   enter;                  {get the data}
123   1   reset(fname,din);       {reset in file}
124   1   rewrite('lst:',dout);   {output goes to printer}
125   1   enter;
126   1
126   1   sum_of_residuals(simp[1]);     {first vertex}
127   1
127   1   for i := 1 to m do      {compute offset of the vertexes}
128   2     begin                 {of the starting simplex}
129   3       p[i] := step[i] * (sqrt(n) + m - 1) / (m * root2);
130   3       q[i] := step[i] * (sqrt(n) - 1) / (m * root2)
131   3     end;
131   1
131   1   for i := 2 to n do                        {all vertexes of the}
132   2     begin                                   {starting    simplex}
133   3       for j := 1 to m do simp[i,j] := simp[1,j] + q[j];
135   3       simp[i,i - 1] := simp[1,i - 1] + p[i - 1];
136   3       sum_of_residuals(simp[i])             {and their residuals}
137   3     end;
137   1
137   1   for i := 1 to n do                        {preset}
138   2     begin
```

*Listing 1 continued on page 357*

*Listing 1 continued:*

```
139   3        l[i] := 1; h[i] := 1
141   3      end;                                        {before calling}
141   1    order;
142   1
142   1    first;                         {pass to printer}
143   1    rewrite('con:',dout); {and}
144   1    first;                         {to screen}
145   1
145   1    niter := 0;                    {no iterations yet}
146   1
146   1    repeat                         {keep iterating}
147   2    done  := true;                 {wish it were...}
148   2    niter := succ(niter);
149   2
149   2    for i := 1 to n do center[i] := 0.0;
151   2    for i := 1 to n do             {compute centroid}
152   3      if i <> h[n] then            {excluding the worst}
153   3         for j := 1 to m do
154   4           center[j] := center[j] + simp[i,j];
155   2
155   2    for i := 1 to n do             {first attempt to reflect}
156   3      begin
157   4        center[i] := center[i] / m;
158   4        next[i] :=
159   4           (1.0 + alfa) * center[i] - alfa * simp[h[n],i]
159   4        {next vertex is the specular reflection of the worst}
159   4      end;
159   2    sum_of_residuals(next);
160   2
160   2    if next[n] <= simp[l[n],n] then
161   2       begin                       {better than the best ?}
162   3         new_vertex;                {accepted !}
163   3         for i := 1 to m do         {and expanded}
164   4           next[i] :=
165   4             gamma * simp[h[n],i] + (1.0 - gamma) * center[i];
165   3         sum_of_residuals(next);   {still better ?}
166   3         if next[n] <= simp[l[n],n] then new_vertex
168   3       end                         {expansion accepted}
168   2
168   2    else                           {if not better than the best}
168   2      begin
169   3        if next[n] <= simp[h[n],n] then
170   3          new_vertex                 {better than worst}
171   3        else                         {worse than worst}
171   3          begin                      {then: contract}
172   4            for i := 1 to m do
173   5              next[i] :=
174   5                beta * simp[h[n],i] + (1.0 - beta) * center[i];
174   4            sum_of_residuals(next);
175   4            if next[n] <= simp[h[n],n] then
176   4              new_vertex             {contraction accepted}
177   4            else                     {if still bad}
177   4              begin                  {shrink all bad vertexes}
178   5                for i := 1 to n do
179   6                  begin
180   7                    for j := 1 to m do
181   8                      simp[i,j] :=
182   8                        (simp[i,j] + simp[l[n],j]) * beta;
182   7                    sum_of_residuals(simp[i])
183   7                  end                {i loop}
183   6              end                    {else}
183   4          end                        {else}
183   3      end;                           {else}
183   2
183   2    order;
184   2    for j := 1 to n do             {check for convergence}
```

*Listing 1 continued on page 358*

*Listing 1 continued:*

```
185     3       begin
186     4         error[j] :=
187     4           (simp[h[j],j] - simp[l[j],j]) / simp[h[j],j];
187     4         if done then
188     4           if error[j] > maxerr[j] then
189     4             done := false
190     4       end
190     3
190     3     until (done or (niter = maxiter));
190     1
190     1     for i := 1 to n do               {average each parameter}
191     2       begin
192     3         mean[i] := 0.0;
193     3         for  j := 1 to n do
194     4           mean[i] := mean[i] + simp[j,i];
195     3         mean[i] := mean[i] / n
196     3       end;
196     1
196     1     report;                          {to consolle}
197     1     rewrite('lst:',dout);            {and do it again}
198     1     report;                          {to the printer}
199     1     writeln(dout,chr(page))
200     1   end                                {of simplex}
200     1   .

A>
```

**Listing 2:** *An example of a Simp input file. This file contains experimental data obeying the Michaelis-Menten equation.*

```
100
0.2 3
0.1 1
1e-4 1e-4 1e-4
1.68 0.172
3.33 0.250
5.00 0.286
6.67 0.303
10.0 0.334
20.0 0.384
```

**Listing 3:** *An example of the printer output from Simp for the Michaelis-Menten example. The computed values of* a *and* b *are given in "the mean is . . ." line.* The a = *4.238157E−01 and* b = *2.451927E+00. The equation is* y = *0.4238157* × x / (x + *2.451927).*

```
  SIMPLEX optimization version  5/22/83 @ MC/BC FSU
fit of a Michaelis-Menten function : y=ax/(b+x)
accessing file MM
max number of iterations is :=    100
start coord.:   1.999999E-01   3.000000E+00
start steps:    9.999999E-02   1.000000E+00
max. errors:    9.999998E-05   9.999998E-05   9.999998E-05
data:
              x               y
#  1  1.679999E+00  1.719999E-01
#  2  3.329999E+00  2.500000E-01
#  3  5.000000E+00  2.859999E-01
#  4  6.669999E+00  3.029999E-01
#  5  1.000000E+01  3.339999E-01
#  6  2.000000E+01  3.839999E-01
starting simplex
simp[1]  1.999999E-01  3.000000E+00  1.607578E-01
simp[2]  2.965924E-01  3.258818E+00  6.597012E-02
simp[3]  2.258818E-01  3.965925E+00  1.520970E-01
```

*Listing 3 continued on page 360*

*Listing 3 continued:*

```
program exited after    43 iterations
the final simplex is
 4.238141E-01   2.451970E+00   1.675719E-04
 4.238193E-01   2.451966E+00   1.675727E-04
 4.238136E-01   2.451845E+00   1.675722E-04
the mean is
 4.238157E-01   2.451927E+00   1.675723E-04
the estimated fractional error is
 1.321987E-05   5.095140E-05   5.036683E-06
   #      x              y              y"             dy
   1   1.679999E+00   1.719999E-01   1.723191E-01  -3.191828E-04
   2   3.329999E+00   2.500000E-01   2.440892E-01   5.910783E-03
   3   5.000000E+00   2.859999E-01   2.843664E-01   1.633465E-03
   4   6.669999E+00   3.029999E-01   3.098962E-01  -6.896257E-03
   5   1.000000E+01   3.339999E-01   3.403615E-01  -6.361544E-03
   6   2.000000E+01   3.839999E-01   3.775317E-01   6.468236E-03
the standard deviation is   5.284775E-03
the estimated error of the function is   2.642387E-03
```

*Text continued from page 348:*

character between the last digit and the EOF (end of file) mark to avoid a "read beyond EOF" error.

Listing 2 gives the input for this example. If you use a dedicated program to write <*infile*>, you can avoid many problems with inexperienced operators.

The printer output (listing 3) consists of the input data followed by:

- the number of iterations
- the values of the parameters and $SS_R$ at the vertexes of the last simplex
- the final mean values of the parameters and $SS_R$
- the estimated errors on those mean values
- for each data point: the experimental and the computed dependent variable values and the difference between the experimental and calculated values
- the standard deviation of the experimental points from the fitted function
- the estimated standard deviation of the "true" function points from the fitted ones

## Problems

Simp never diverges but this does not guarantee that no problems will develop. Programming or input errors are easily corrected while others are not.

Failure to converge and premature conclusion are usually the result of using the wrong input parameters along with truncation/round-off errors in the machine's arithmetics. Very large initial guesses and/or very small initial increments create a starting simplex with virtually identical responses at the vertexes. In cases like this, the program often ends prematurely.

If the acceptable errors are exceedingly large, the program may emerge while the simplex is still far from the minimum response, possibly along a saddle. If the acceptable errors are too small, on the other hand, the simplex can keep bouncing around the minimum until the maximum number of iterations is completed. This is due to the simplex's inability to contract further because of "quantum" round-off errors in the machine's arithmetics.

In many instances the results are largely insensitive to one or more of the fitted parameters. In these cases, the simplex travels great distances along these coordinates before coming to rest. When you know that a parameter is of only marginal significance in the fit (i.e., its value scarcely affects the results), it is a good idea to give it a large acceptable error. If you don't, Simp keeps changing that parameter, without noticing any effects on the response surface.

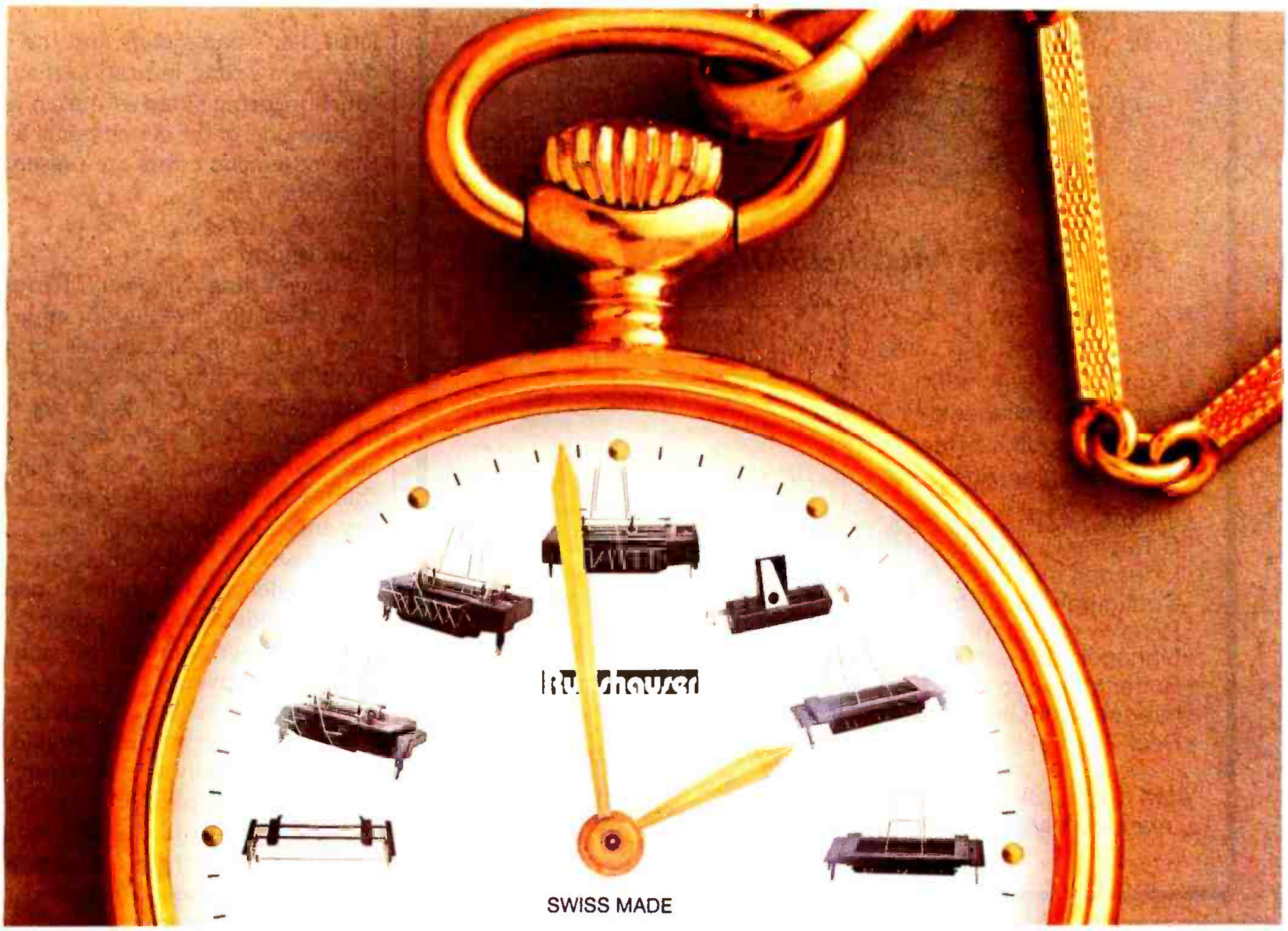
Last, sometimes the program gives results far from the expected, but the fitted curve matches the experimental data excellently. This happens when a particular function can be equally satisfied with more than one set of parameters (the response surface has more minima). When you suspect more than one solution exists, good starting guesses and small increments usually help. It is always a good practice to verify the uniqueness and precision of your results by running the program with different starting guesses.

Simp does not provide an estimate of the computed parameter errors. A good way to evaluate them is with the following Monte Carlo or sensitivity analysis:

- from the parameters *a*, *b*, etc., produced by Simp, compute the set, $x_1$, $y'_1$; $x_2$, $y'_2$; *etc.*, consisting of the independent variable's experimental values and the dependent variable's "expected" values. (Simp writes these points in FIT.DAT.)
- to this set, add random numbers with a Gaussian distribution mean = 0 and a standard deviation equal to the experimental data's computed by Simp to create a sufficiently large number, *m*, of simulated experimental point sets:

$$x_1,\ y^1{}_1;\ x_2,\ y^1{}_2;\ \ldots;\ x_n,\ y^1{}_n$$
$$x_1,\ y^2{}_1;\ x_2,\ y^2{}_2;\ \ldots;\ x_n,\ y^2{}_n$$
$$\ldots$$
$$x_1,\ y^m{}_1;\ x_2,\ y^m{}_2;\ \ldots;\ x_n,\ y^m{}_n$$

- run Simp on each of these simulated experimental sets.
- the new computed parameter values should approach the experimental data's. Their standard deviation is a reasonable estimate of the error in the computed parameters. A statistically significant difference between the mean value of the simu-

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lated data's parameters and the real data's is a strong indication that the function being fitted is not an adequate model of the system, or at least, that systematic errors are present in the data.

## Conclusion

Curve fitting is a very frequent task, at least in the scientific environment. The big advantages of the Simplex algorithm are not only its remarkable speed and the fact that the program can never diverge, but also the compact and elegant flowchart, which makes it ideal for didactics and for Pascal implementations. Simp uses no matrix operation and no knowledge of calculus is necessary to understand the purely geometrical description of the simplex movements given.

The program Simp provides a curve-fitting algorithm capable of handling virtually any function, no matter how complex, with any number of variables and parameters. It is a very handy tool for scientists and statisticians because of its remarkable speed, simplicity, and reliability.■


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**Authors' note:** *We would like to thank the Office of Basic Energy Sciences of the United States Department of Energy, which supported our work.*



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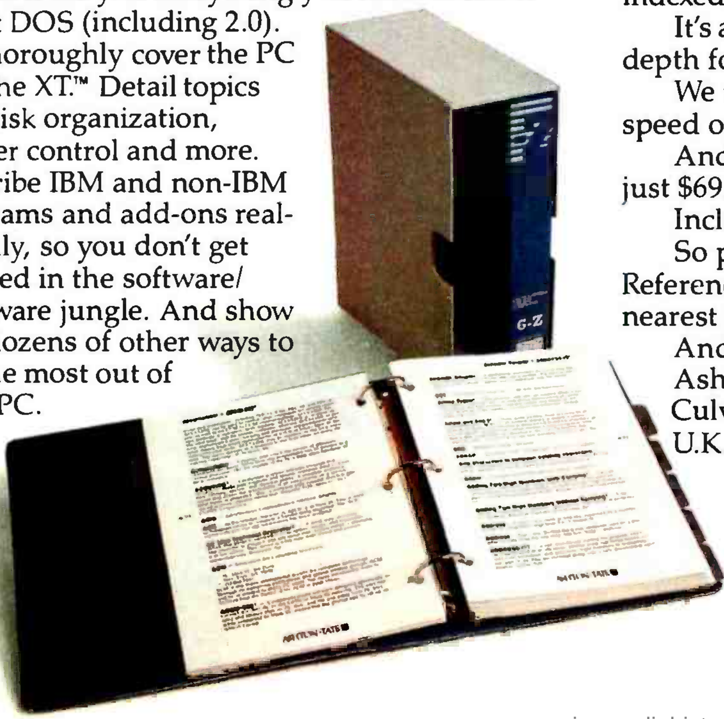


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I faced that same problem almost two years ago when our chemistry department received its first IBM PC, and I wanted to interface it to a variety of chemical laboratory instruments. We had only one of each type of instrument, so I was faced with the possibility of designing a custom interface for each of 10 or more instruments.

Fortunately, I had interfaced single instruments to a DEC LSI 11/23 and to an Apple, so I knew from my own previous mistakes that a little advanced planning would make this a much simpler project. Specifically, I realized that interfacing can be made much easier by using two simple concepts: first, buy commercially available hardware where possible, and, second, develop general-purpose software that can be used for almost any instrument.

By utilizing these two concepts, I found that even undergraduate chemistry students with little previous computer experience can produce research-quality interfaces, with complete software, in less than one week. If you follow the suggestions provided here, you should be able to design and implement an interface to the instrument of your choice in less time. All you need to do is be able to program in BASIC, FORTRAN, or some other language that allows the use of assembly-language subroutines.

The essential elements of this system are a commercially available data-collection board that fits in one of the slots of the IBM PC, a preamplifier and filter for conditioning the signal from the instrument, and a set of BASIC and assembly-language routines to perform tasks common to all of the instruments to be interfaced.

The utility of this approach arose fairly naturally from some initial design decisions. My major criteria for selection of equipment and software were ease of development and ease of use. Therefore, I judged it to be not cost-effective to spend time developing special-purpose A/D (analog-to-digital) converters, timers, or other equipment. Similarly, I chose to use BASIC for all purposes except the data-collection process itself because of the ease of programming, even for novices; when the programs are completely tested, they are converted to compiled BASIC to greatly increase their execution speed.

In order to encourage a variety of users, I put the (now several) IBM PCs on carts so that the computers can be wheeled from experiment to experiment. Each cart contains a 64K- or 128K-byte IBM PC with a color-graphics monitor adapter and green monitor; dual 320K-byte disk drives; a combination board containing an A/D converter, D/A (digital-to-analog) converter and programmable clock; and a preamplifier and filter combination. A typical system in use is shown in photo 1.

Each of the components on the cart is designed to accommodate interfaces to a variety of instruments. If you are attempting to develop a similar system, it may help to have a description of why I selected each component.

## Data-Acquisition Board

Several different manufacturers now market general-purpose data-

**Photo 1:** *The general-purpose laboratory interface station can be moved easily from instrument to instrument because it is on a laboratory cart. The IBM PC contains a color/graphics monitor board and a Tecmar Lab Master interface board. The preamplifier box is perched on top of the larger control device for the polarograph, in the center. The electrodes for the polarograph are at the right side of the photo.*

acquisition boards (see reference 4). These usually include a multichannel A/D converter, one or more D/A converters, and a programmable clock as standard features, with options such as programmable gain, higher acquisition rates, and DMA (direct memory access). For most scientific applications, a 12-bit A/D conversion is necessary; 8-bit A/D converters simply do not provide adequate resolution.

In addition, most laboratories now use nonintegrating A/D converters rather than integrating types because of the slow speed of the latter. The primary advantage of the integrating A/D converter is the reduction of noise; however, this can be accomplished instead through appropriate software used with the nonintegrating type. The A/D converters on almost all of the general-purpose data-collection boards now available are of the nonintegrating type.

While not essential, a programmable clock is highly recommended. Although timing can be controlled by carefully timed program loops, usually in assembly language, it is much more easily and accurately achieved in hardware.

For these reasons, I chose to use a Tecmar (6225 Cochran Rd., Cleveland, OH 44139, (216) 349-0600) PC-Mate Lab Master board with a 16-channel, 12-bit nonintegrating A/D converter with no programmable gain and a general-purpose clock/timer. The board also contains two D/A converters and a digital I/O (input/output) section that I do not routinely use, but which you may need if you plan to control the operation of your instrument as well as collect data from it.

## Connecting the Interface

In order to use the hardware interface in your lab, you must first connect the interface to the instrument. If the instrument has a recorder output, this is very easy to do; simply connect the A/D converter input to the recorder output wires. For signals below 1 volt maximum, the preamplifier should be interposed between the A/D converter and the instrument.

Often, particularly on more recently designed instruments, both a recorder output and a BCD (binary-coded decimal) or other computer-compatible output exist. If there is a computer output, no A/D converter is needed; instead, a digital I/O board, serial interface, or other hardware is required. Unfortunately, I found that the documentation provided by Tecmar on the digital I/O section of the interface board is almost no help to those who are not already familiar with this type of hardware.

Alternatively, if no suitable output

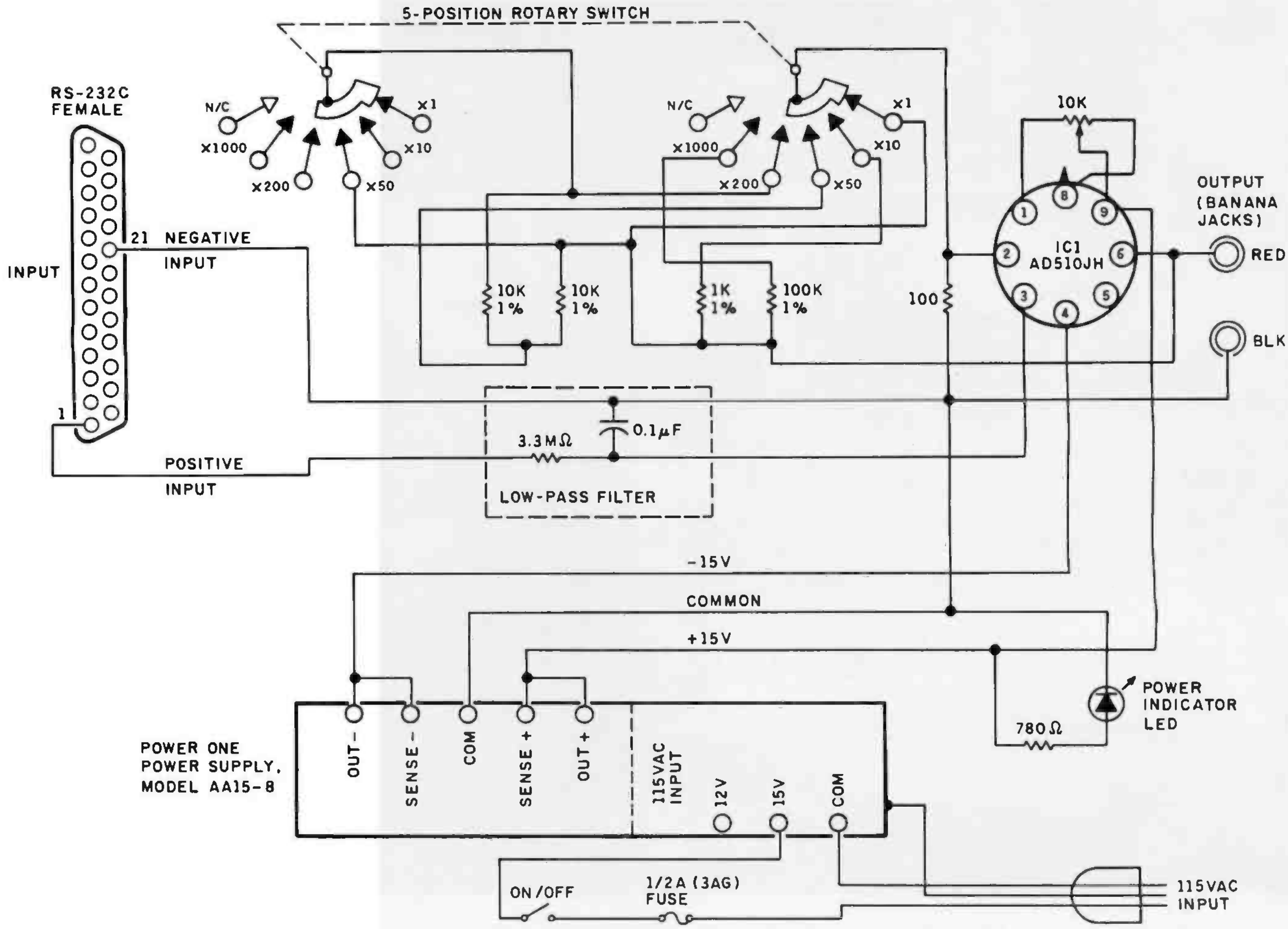


**Figure 1:** *The schematic diagram for the preamplifier described in the text. The low-pass filter is optional.*

is provided, it may be necessary for someone with knowledge of the electronics of the instrument to locate for you the portion of the circuitry needed to provide a suitable voltage output to the A/D converter. Where possible, this voltage should be in the volt range, rather than in millivolts (mV) or microvolts ($\mu$V). Fortunately, most instruments have recorder outputs and consequently are very easy to interface.

## Preamplifier

Depending upon the instrument being interfaced and the A/D board being used, varying amounts of preamplification are needed. I designed our system to accommodate a wide variety of possible inputs; hence, a simple amplifier circuit was included to permit five different gains between 1 and 1000. The amplifier schematic is shown in figure 1.

Alternatively, a programmable-gain A/D board may be desirable, although that option is usually much more expensive than a separate amplifier. There is another reason for separate preamplifiers, however. Instruments with full-scale outputs of under 10 mV are common in scientific laboratories because of the widespread availability of 10-mV strip-chart recorders. For these instruments, your best alternative is to build the preamplifier into the instrument itself, or at least to connect it so that it is as near as possible to the instrument. This reduces the amount of noise picked up by the low-level signal lines that, in effect, act as antennas to the various sources of electronic noise in the environment. In general, the shorter the distance between the instrument and the A/D board, the better the signal-to-noise ratio will be in the final data.

## Filter

The most general solution to noisy signals is software filtering, because the filter can be varied to best match the noise level. However, particularly for low-level signals and low data-collection rates, e.g., 1-mV signals at 60 Hz (hertz), I have found it useful to have a hardware filter because of the large amount of computation time required for extensive software-based filtering. For such instruments, I use the simple, passive, low-pass filter included in figure 1. This filter has a cutoff frequency of approximately 0.5 Hz, which is adequate for filtering out the most common noise signals that are 60 Hz or higher in frequency. More expensive filters, including active and notch filters, may be desirable for specific applications. Almost any "electronics for scientists" text can be consulted for more details.

## Data Collection

One aspect of interfacing that texts often neglect is the need for general-purpose programs to collect, plot, and process the instrumented data.

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However, by having a suitable library of general-purpose routines, you can shorten the development time for your specific interface considerably. By using the general-purpose data-collection, smoothing, and display routines described here, you can concentrate all of your efforts on developing the device-specific portion of the software and end up with a higher quality product in a much shorter time than if you "reinvent the chip" for each new interfacing project.

In order to provide high data-collection rates and a real-time plot, I wrote a data-acquisition routine in assembly language. The routine illustrated in listing 1 provides rates up to 2400 Hz with a real-time plot, and up to 20 kHz without plotting. Even faster rates are possible with special hardware settings of the standard Tecmar board, and rates up to 125 kHz are available as an optional feature. However, very few instruments will require higher rates than 20 kHz.

The routine in listing 1 assumes the use of the Tecmar Lab Master data-acquisition board, so that some of the code is device-specific and would need to be modified for use on other systems.

Although the listing is fully documented, several comments are required. First, using the excellent procedure suggested by Rollins (see reference 2), the routine begins with a header section to enable it to be converted by EXE2BIN to a binary file that can be loaded into memory with a BASIC BLOAD command. Second, high-resolution plotting is done using the BIOS VIDEO_IO routine, which is invoked with interrupt 16 (10 hexadecimal).

Three different clock rates are used, depending upon the desired data-collection rate. This is done to achieve maximum precision. For high data rates, the 1 MHz clock in the Tecmar board is used directly. For rates below 31 Hz, a 10-kHz subfrequency of the clock is used; to use the 1-MHz clock directly would require chaining several of the counters together. Rates of less than 1 Hz are counted with a 100-Hz subfrequency.

At very high data rates, it is possible that a conversion may take place

**Listing 1:** *An assembly-language data-collection routine for use with the IBM PC and the Tecmar Lab Master board.*

```
              TITLE   TIMER
;       S.C. GATES  DEPARTMENT OF CHEMISTRY, ILLINOIS STATE
;                UNIVERSITY, NORMAL, IL   61761
;       SUBROUTINE TO DO TIMED DATA COLLECTION FROM TECMAR BOARD
;       CALL FROM BASIC WITH CALL OF FORM:
;               CALL TIMER (A%(1),F%,P%,N%,C%,S%)
;       WHERE   A% IS ARRAY WHERE DATA ARE TO BE STORED
;               F% IS OVERRUN FLAG--SET TO ZERO UPON NORMAL EXIT
;                  OTHERWISE SET TO VALUE OF CX REGISTER TO GIVE
;                  NUMBER OF POINTS NOT COLLECTED
;               P% IS 0 TO OMIT REAL-TIME PLOT, OTHER TO PLOT
;               N% IS NUMBER OF POINTS TO BE COLLECTED
;               C% IS CHANNEL NUMBER OF A/D
;               S% IS NUMBER OF DATA POINTS PER SECOND
;                  S% MUST BE <= SPEED OF A/D
;                  IF S% <0 THEN MEANS WANT THAT MANY SEC/POINT
;
CSEG    SEGMENT
        ASSUME CS:CSEG,  DS:NOTHING
HEADER:
        DB      0FDH                ;CODE FOR BLOAD FILE
        DW      0
        DW      0
        DW      RTN_LEN
TEMP    DW      ?                   ;TEMP. STORAGE
PLOT    DW      ?                   ;PLOT FLAG
TEMPSI  DW      ?                   ;TEMP STORAGE FOR SI REGISTER
OVRUN   DW      ?                   ;OVERRUN OF A/D FLAG
;DEFINITIONS:
ADD0    =1808                       ;BASE OF TECMAR BOARD
ADD4    =ADD0+4                      ;A/D CONTROL BYTE
ADD5    =ADD0+5                      ;A/D CHANNEL NUMBER
ADD6    =ADD0+6                      ;A/D START
ADD8    =ADD0+8                      ;CLOCK DATA PORT
ADD9    =ADD0+9                      ;CLOCK CONTROL PORT
;
TIMER   PROC    FAR
        PUSH    BP                  ;SAVE BP
        MOV     BP,SP               ;SET BASE PARAMETER LIST
        MOV     DI,[BP]+6           ;GET DATA POINTS/SEC
        MOV     AX,[DI]             ;   INTO BX REGISTER
        MOV     BX,AX
        MOV     DI,[BP]+8           ;GET CHANNEL NUMBER
        MOV     AX,[DI]             ;   AND STORE AS AX
        MOV     DX,ADD5             ;   AND OUTPUT TO A/D
        OUT     DX,AL               ; (USE ONLY LOWER BYTE)
        MOV     DI,[BP]+10          ;GET NUMBER OF DATA POINTS
        MOV     CX,[DI]             ;  STORE IN CX REGISTER
        MOV     DI,[BP]+12          ;GET PLOT FLAG
        MOV     AX,[DI]             ;  STORE IN MEMORY
        MOV     PLOT,AX
        MOV     AL,128              ;SELECT A/D MODE (DISABLE AUTOINCREMENT,
        MOV     DX,ADD4             ;   EXTERN. START CONVERSION, ALL INTERRUPTS
        OUT     DX,AL               ;   GAIN=1)
        MOV     AX,0                ;SI IS X-VALUE OF POINT TO BE
        MOV     TEMPSI,AX           ;  PLOTTED--SAVE FOR LATER
        MOV     AX,6                ;SET UP HIGH-RES GRAPHICS MODE
        INT     10H
        MOV     DX,ADD6             ;RESET DONE FLIP-FLOP OF A/D
        IN      AL,DX
        MOV     DX,ADD9             ;SET DATA POINTER TO MASTER MODE REGISTER
        MOV     AL,23
        OUT     DX,AL
        MOV     DX,ADD8             ;SET MASTER MODE REGISTER FOR SCALER CONTROL=
        MOV     AL,0                ;   BCD DIVISION, ENABLE INCREMENT, 8-BIT BUS,
        OUT     DX,AL               ;   FOUT ON, DIVIDE BY 16, SOURCE=F1,
        MOV     AL,128              ;   COMPARATORS DISABLED, TOD DISABLED
        OUT     DX,AL
        MOV     DX,ADD9             ;SET DATA POINTER TO COUNTER MODE OF
        MOV     AL,5                ;   REGISTER 5
        OUT     DX,AL
        MOV     DX,ADD8             ;SET COUNTER 5 FOR COUNT REPETITIVELY,
        MOV     AL,33               ;BINARY COUNT,COUNT DOWN, ACTIVE HIGH
        OUT     DX,AL               ;TC, DISABLE SPECIAL GATE, RELOAD FROM LOAD,
        CMP     BX,31               ;CHECK IF >= 31 POINTS/SEC
        JGE     FAST                ;IF SO, JUMP TO FAST
        CMP     BX,0                ;CHECK IF > 0 POINTS/SEC
        JG      MED                 ;IF SO, JUMP
;  BRANCH TO HERE IF POINTS/SEC < 0, MEANS THAT WANT LESS THAN
;  ONE POINT/SEC.
SLOW:   MOV     AL,15               ;SET TO 100 HZ (NO GATE, RISING EDGE
        OUT     DX,AL               ;   OF F5)
        NEG     BX                  ;GET ABSOLUTE VALUE OF BX
        MOV     AX,BX               ;AND MULTIPLY BY 100 TO GET COUNT
        MOV     DI,100
        MUL     DI
        JMP     GO
;BRANCH TO HERE FOR 31 TO 20,000 POINTS/SEC--USE 1 MHZ CLOCK
FAST:   MOV     AL,11               ;COUNT AT 1 MHZ (NO GATE, RISING
        OUT     DX,AL               ;    EDGE OF F1)
        MOV     AX,10000            ;DIVIDE 1,000,000 BY PTS/SEC BY
        MOV     DI,100              ;  GETTING 10E6 INTO DX+AX
        MUL     DI
        DIV     BX                  ;BX=PTS/SEC; RESULT IN DX+AX, BUT
                                    ;   IGNORE DX, SINCE DX=0
```

*Listing 1 continued on page 371*

*Listing 1 continued:*

```
        CMP     AX,200          ;DISABLE INTERRUPTS IF >=5000
        JG      FAST2           ;    POINTS/SEC
        CLI
FAST2:  JMP     GO
;BRANCH TO HERE FOR 1 TO 30 POINTS/SEC--USE 10 KHZ CLOCK
MED:    MOV     AL,13           ;COUNT AT 10 KHZ (NO GATE, RISING
        OUT     DX,AL           ;    EDGE OF F3)
        MOV     AX,10000        ;CALCULATE NUMBER OF TICKS OF 10,000 HZ CLOCK
        CWD                     ;    PER DATA POINT BY DIVIDING
        DIV     BX              ;    10,000 BY POINTS/SEC
;START CLOCK TICKING AT DESIRED RATE
GO:     MOV     DX,ADD8         ;    AND LOAD COUNTER 5 WITH TICKS
        DEC     AX              ;(COUNT TO ZERO, SO DECREMENT AX
        OUT     DX,AL           ;    FOR CORRECT COUNT)
        MOV     AL,AH
        OUT     DX,AL           ;    8 BITS AT A TIME
        MOV     DI,[BP]+14      ;GET OVERRUN FLAG ADDRESS
        MOV     WORD PTR [DI],0         ;ZERO THE FLAG
        MOV     OVRUN,DI        ;AND STORE THE FLAG ADDRESS
        MOV     DI,[BP]+16      ;GET ADDRESS OF DATA ARRAY
        MOV     DX,ADD9         ;LOAD COUNTER 5 FROM LOAD REGISTER
        MOV     AL,112          ;    AND ARM (START COUNTING)
        OUT     DX,AL
        MOV     DX,ADD4         ;ENABLE EXTERNAL START (PINS 3 + 4 OF
        MOV     AL,132          ;  CONNECTOR J2 MUST BE CONNECTED)
        OUT     DX,AL
;BEGIN DATA COLLECTION; COLLECT UPON EXTERNAL START TRIGGER
DONE:   MOV     DX,ADD4         ;CHECK IF DATA READY
        IN      AL,DX
        CMP     AL, 128         ;BY CHECKING READY BIT (BIT 7)
        JB      DONE            ;LOOP UNTIL READY
        TEST    AL,64           ;SEE IF DATA OVERRUN FLAG SET
        JNE     ERRMESS         ;IF SO, NOTIFY BASIC PROGRAM AND EXIT
        MOV     DX,ADD5         ;YES, DONE, SO GET LOW BYTE OF DATUM
        IN      AL,DX
        MOV     [DI],AL         ;AND STORE IT
        INC     DI              ;GO TO NEXT LOCATION IN ARRAY (1 BYTE LATER)
        MOV     DX,ADD6         ;GET HIGH BYTE AND STORE IT
        IN      AL,DX
        MOV     [DI],AL
        INC     DI
        CMP     PLOT,0          ;DON'T PLOT IF PLOT FLAG=0
        JZ      NOPLOT
;PLOT ROUTINE STARTS HERE
        MOV     TEMP,CX         ;SAVE CX FIRST
        MOV     AH,AL           ;GET HIGH BYTE JUST TAKEN
        MOV     AL,[DI-2]       ;AND LOW BYTE FROM STORAGE SO AX=DATUM
        ADD     AX,2047         ;CALCULATE Y-VALUE TO PLOT =
        CWD                     ;     199-((DATUM+2047)/21)
        MOV     BX,21           ;DIVIDE BY 21--QUOTIENT IN AX
        DIV     BX
        MOV     DX,AX           ;RESULT INTO DX
        NEG     DX              ;NEGATE AND ADD TO 199
        ADD     DX,199
        MOV     SI,TEMPSI       ;GET X-VALUE OF LAST POINT ON SCREEN
        INC     SI              ;GO TO NEXT LOCATION ON SCREEN
        CMP     SI,640          ;TEST IF AT RIGHT EDGE OF 640 X 200
        JL      M1              ;  SCREEN
        MOV     SI,0            ;IF SO, GO TO LEFT EDGE TO PLOT
M1:     MOV     CX,SI           ;GET X-VALUE INTO CX
        MOV     TEMPSI,SI       ;SAVE X VALUE
        MOV     AX,3073         ;AH=12,AL=1 TO WRITE DOT TO SCREEN
        INT     10H             ;PLOT POINT
        MOV     CX,TEMP         ;RESTORE CX
NOPLOT: LOOP    DONE            ;DECREMENT CX AND LOOP IF >0
;BRANCH TO HERE UPON FINISH OR OVERRUN
NOGO:   MOV     DX,ADD4         ;TURN OFF A/D
        MOV     AL,0
        OUT     DX,AL
        STI                     ;RESTORE INTERRUPT SERVICE
        POP     BP              ;RESTORE BP
        RET     12              ;6 ARGUMENTS IN CALL X 2=12
ERRMESS: MOV    DI,OVRUN        ;SET OVERRUN FLAG SINCE A/D GOING
        MOV     WORD PTR [DI],CX   ;TOO FAST
        JMP     NOGO
TIMER   ENDP
RTN_LEN         EQU     $-TEMP  ;LENGTH OF ROUTINE FOR HEADER
CSEG    ENDS
        END     HEADER          ;NEEDED FOR A .BIN FILE CONVERSION
```

**Listing 2:** *General-purpose data-collection, graphing, and smoothing program in IBM PC BASIC (DOS 1.10).*

```
10 REM GENERAL PURPOSE DATA COLLECTION PROGRAM
20 REM S. GATES, DEPARTMENT OF CHEMISTRY, ILLINOIS STATE UNIVERSITY, NORMAL, IL
30 REM
40 REM Some FOR...NEXT loops are compressed to speed execution
50 CLEAR,31000: BLOAD "TIMER.BIN",31000: TIMER=31000     'Get timer routine
60 DIM A%(1000),B(1000),SG%(9)
70 WIDTH 80:CLS
80 INPUT " Do you wish to process data that have already been collected?";Y$
90 IF Y$="y" OR  Y$="Y" THEN Y=4: GOTO 300
100 INPUT "Enter your name, please"; NAM$
110 D$=DATE$: T$=TIME$: INPUT "Enter the sample identification, please."; S$
```

*Listing 2 continued on page 372*

before the previous data point has been read from the A/D converter. This is referred to as an overrun. Thus the program must check for the occurrence of an overrun. Upon finding one, the assembly routine sets a flag that can be read by the BASIC program once the data collection is finished.

At very high data-collection rates, interrupt-driven processes occurring in the computer, such as interrupts by the system clock, may interfere with data collection. Indeed, initially this program was limited to 6 kHz until I realized that the interrupts from the system clock were taking too much time. For this reason, at rates above 5 kHz, the subroutine turns off interrupts with a CLI (clear interrupt flag) instruction; when data collection is completed, the interrupts are again enabled by using an STI (set interrupt flag) instruction.

At low-to-moderate data-collection rates, it is useful to have a real-time plot. This is done for each data point collected by loading the low and high bytes of the data point into a register and converting it so that the screen displays a −10-volt A/D reading at the bottom and a +10-volt reading at the top—i.e., so that the full screen is used for the display.

When this assembly-language routine is linked to a higher level program, such as a compiled BASIC or FORTRAN program, only minor changes are required. The Header section must be removed, so that the code starts at Temp. The Timer procedure must be made Public, and the last line of the routine must include an End statement instead of an End-Header statement. After assembly, the subroutine is linked to the calling program using Link in the normal fashion; EXE2BIN does not need to be run in that case.

## Sample BASIC Program

A short interpreter BASIC program for the IBM PC that uses the assembly-language routine is shown in listing 2. The program sets aside a region of memory for the routine; the location chosen in line 30 may vary depending upon the amount of memory available in the system. The value 31500 is correct for a 64K-byte system using Advanced BASIC.

After the data has been collected, the overrun flag is checked, and the data is displayed in the high-resolution graphics mode. The data is scaled to fill the entire screen.

Once the data has been collected and displayed, you usually will need to remove high-frequency noise. A simple method for doing this in software is shown in listing 2. It uses a

*Listing 2 continued:*

```
120 PRINT "Please enter 3 lines of experimental description, including":
    PRINT "Sample preparation, instrument settings, etc."
130 FOR I=1 TO 3: LINE INPUT L$(I): NEXT I
140 INPUT "Enter the channel number (0 to 15)"; C%
150 INPUT "Enter the number of data points to collect.";N%
160 INPUT "Enter the number of data points/second desired. "; S
170 S%=S: IF S< 1 THEN S%=-1!/S   'Convert to proper format for timer routine
180 PRINT "Type any key to start count-down for data collection."
190 I$=INKEY$:IF I$="" THEN 190
200 CLS: FOR I=10 TO 0 STEP -1: LOCATE  12,40 : PRINT I: FOR J=1 TO 500:NEXT J:
    NEXT I                         'Count down;  J loop is delay between counts
210 F%=0                           'Initialize overrun flag
220 P%=1:IF S% > 2000 THEN P%=0    'Plot if < 2000 pts/sec
230 CALL TIMER(A%(1),F%,P%,N%,C%,S%)     'Collect data; all variables MUST be
                                                                     INTEGER!
240 IF F%<> 0 THEN PRINT "Warning--data taken too fast": N%=N%-F%
250 FOR I=1 TO N%
260      IF A%(I) > 32767 THEN A%(I)=A%(I)-65535!
270      A%(I)=A%(I)/.2047:      'Store input as mV, assuming -10 to 10V range
280 NEXT I
290 CLS: PRINT " Enter a 1 to plot data on the screen":
    PRINT " A 2 to store the data in a file.": PRINT " A 3 to smooth the data":
    PRINT " A 4 to get another file":PRINT " A 5 to exit": INPUT Y
300 ON Y GOSUB 340,510,670,770,890
310 GOTO 290
320 '******* SUBROUTINES *********
330 REM Screen plotting routine
340 SCREEN 2 :KEY OFF
350 DEF FNSCALE(Z%)=190-190*(Z%-YMIN)/(YMAX-YMIN)
360 INPUT "Enter the label for the graph",LAB$
370 CLS:YMAX=A%(1): YMIN=A%(1)
380 FOR I=1 TO N%
390      IF A%(I)<YMIN THEN YMIN=A%(I) ELSE IF A%(I)> YMAX THEN YMAX=A%(I)
400 NEXT I
410 YPLOT=FNSCALE(A%(1))
420 PSET (60,YPLOT),0                 'Go to first point
430 FOR I=2 TO N%: XPLOT=60+579*(I-1)/(N%-1): YPLOT=FNSCALE(A%(I)):
    LINE -(XPLOT,YPLOT): NEXT I
440 LOCATE  25,40 : PRINT LAB$;: LOCATE  1,1 : LINE (60,0)-(639,190),,B 'label
    and box plot
450 LOCATE  25,8 : PRINT "1";: LOCATE  25,75 : PRINT N%;: LOCATE  1,1 :
    PRINT YMAX;: LOCATE  24,1 : PRINT YMIN;      'Label axes
460 LOCATE 6,1: PRINT "Type any key to continue";
470 Y$=INKEY$:IF Y$="" THEN 470
480 RETURN
490 REM ********
500 REM Subroutine to store data in a file
510 INPUT "Enter the name of the file in which the data are to be stored.";FILN$

520 OPEN FILN$ FOR OUTPUT AS #2
530 WRITE #2,NAM$,D$,T$               'Save name, date, time
540 WRITE #2, S$                      'Save sample description
550 FOR I=1 TO 3: WRITE #2,L$(I): NEXT I    ' and conditions
560 WRITE #2,N%,S%          'number of points, sampling rate
570 FOR I=1 TO N%: WRITE #2,A%(I): NEXT I
580 CLOSE #2: RETURN
590 REM ********
600 REM Subroutine to compute second-order 9-point Savitzky-Golay smooth
610 REM     including smooths at both beginning and end of data
620 REM It computes a "smoothed" value for each point by adding together
630 REM       the 4 points on either side of it, plus itself, each multiplied
640 REM       times the corresponding coefficient.
650 REM It then computes the "smoothed" value for each successive point
660 REM       using the original data array.
670 DATA -21,14,39,54,59,54,39,14,-21: 'Savitzky-Golay coefficients
680 RESTORE
690 FOR I=1 TO 9:READ SG%(I):NEXT I     'Get coefficients
700 FOR I=1 TO N%: B(I)=0:DF%=0: FOR J=-4 TO +4: IF I+J< 1 OR I+J>N% THEN 720
710      B(I)=B(I)+A%(I+J)*SG%(J+5):DF%=DF%+SG%(J+5)
720 NEXT J:B(I)=B(I)/DF%:NEXT I          'Divide by sum of coefficients used
730 FOR I=1 TO N%: A%(I)=B(I): NEXT I  'Store back in original array
740 RETURN
750 REM ********
760 REM Subroutine to read previously collected data from disk file
770 INPUT "Enter the name of the file to be processed. " ; FILN$
780 OPEN FILN$ FOR INPUT AS #2
790 INPUT #2, NAM$,D$, T$
800 INPUT #2,S$
810 FOR I=1 TO 3: LINE INPUT #2,L$(I): NEXT I
820 INPUT #2,N%,S%
830 PRINT NAM$,D$,T$: PRINT S$: FOR I=1 TO 3: PRINT L$(I): NEXT I
840 PRINT "Number of points= "; N%, "Points/sec= "; S
850 FOR I=1 TO N%: INPUT #2,A%(I): NEXT I
860 CLOSE #2: PRINT "Type any key to continue"
870 Y$=INKEY$: IF Y$="" THEN 870
880 RETURN
890 END
```

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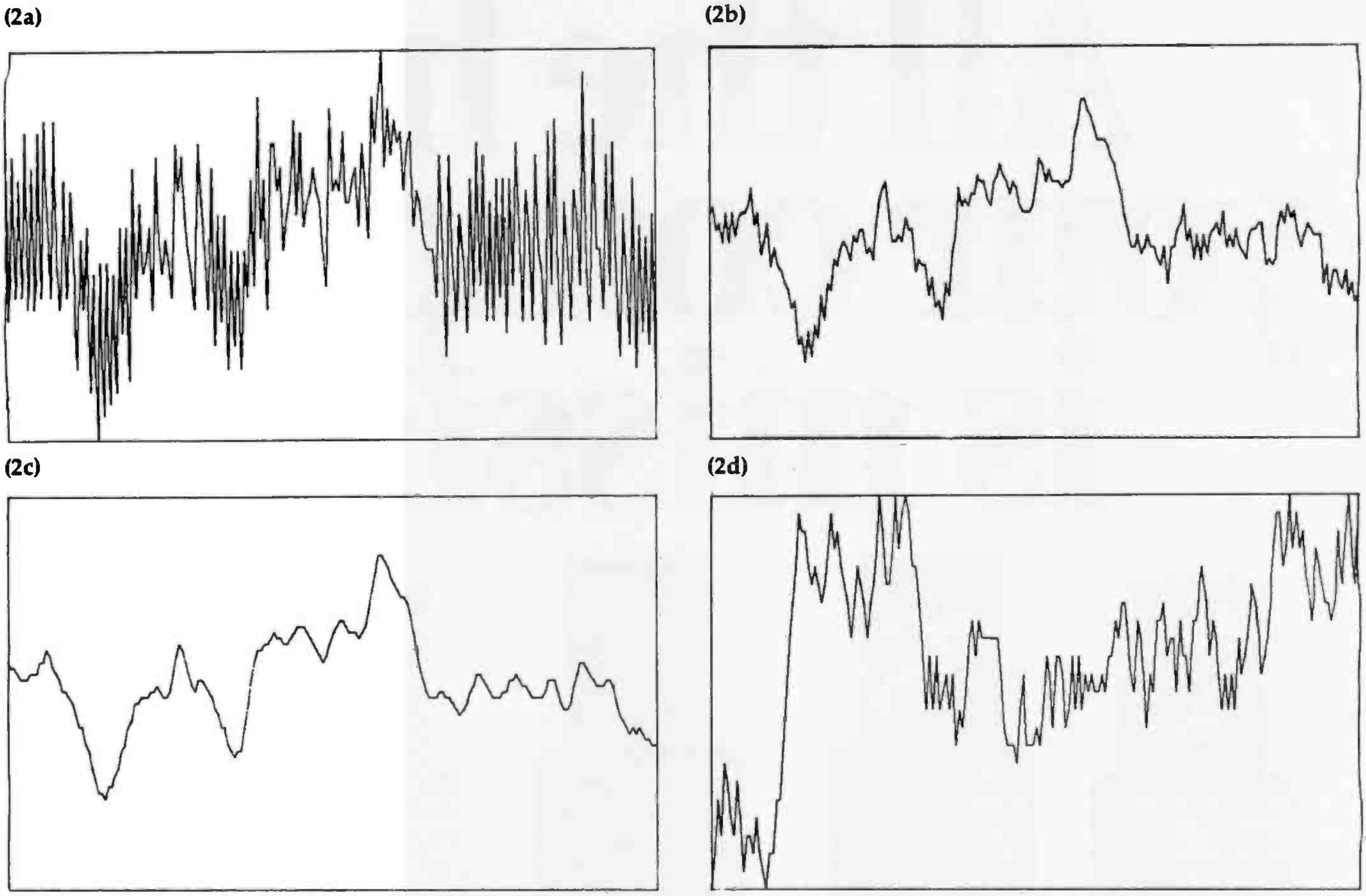


**Figure 2:** *The effect of filtering on noise levels can be very significant. Figure 2a shows 200 data points taken from an instrument over a period of 20 seconds. Ideally, the signal should be a straight line, but instead shows both long-term and short-term noise. In figure 2b, data from the same instrument is passed through a digital (software) filter once; in figure 2c, it is passed through the filter twice. In figure 2d, data from the same detector is passed through a hardware low-pass filter.*

"Savitzky-Golay" type smoothing algorithm (see reference 3), which is a rapid, easily implemented smoothing technique that is equivalent to fitting a least-squares line through the data. The order of the fit and the number of points included in the fit can be modified to provide varying amounts of smoothing. A second-order, 9-point smooth is the one most often used in my lab. In picking which software filter to use, you may find an article by Cram et al. quite useful (see reference 1). For severe noise problems, other techniques such as ensemble averaging or filtering using fast Fourier transforms may prove useful.

The usefulness of the filtering process is illustrated in figure 2. Figure 2a shows data collected from the detector of a high-performance liquid chromatograph, without filtering. In figure 2d, data was collected from the same detector, but with the low-pass hardware filter being used. In figure 2b, the data is exactly the same as the unfiltered data (figure 2a), except that it has been passed through the Savitzky-Golay second-order, 9-point filter contained in listing 2. In figure 2c, the data from figure 2a has been passed through the Savitzky-Golay filter twice; the reduction in the noise is striking. I often use a combination of hardware and software filtering for optimum results.

## Examples of Use

I offer a four-week course to science students that teaches them to interface to a variety of scientific instruments using the techniques described in this article. Students spend one week learning BASIC, two weeks learning the concepts of interfacing and writing simple programs, and one week interfacing the computer to a specific chemical laboratory instrument.

Although the students learn to write data-collection and display routines in BASIC, for their final project they use the Timer routine in listing 1. Using the standardized interfacing system, in one week's time they have written complete data-collection and analysis programs for a number of different instruments, including a pH meter, a UV (ultraviolet)-visible spectrophotometer, a differential scanning calorimeter, a high-performance liquid chromatograph (HPLC), and a polarograph. Even though these programs were written in one week's time, each of these programs is now in routine use in our teaching or research laboratories.

I'll use two examples to show how quickly and easily instruments can be interfaced using this approach.

One student interfaced an IBM PC to a polarograph, using the circuitry shown in figure 1. The polarograph already has a sophisticated preampli-

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## Using the Tecmar A/D Board

*The Tecmar board can be given instructions, and have information read from it, in one of two ways: either the I/O (input/output) mode or the memory-mapped mode can be used. In the I/O mode, various functions of the board are accessed through ports, which are addressed with INP and OUT instructions in BASIC, or IN and OUT instructions in assembly language. In the memory-mapped mode, the functions are accessed at a series of consecutive memory locations; this requires PEEK and POKE instructions in BASIC, or any memory-addressing instruction in assembly language, such as MOV or TEST.*

*The choice between these two modes is largely a matter of personal preference. The memory-mapped mode is slightly faster but the board is configured at the factory for the I/O mode, which is probably the simpler mode to program. In either mode, you must select the base address, which is the first of 16 consecutive addresses used to communicate with the various functions on the board. The base I/O address set at the factory is 1808. However, other base addresses, as well as the memory-mapped mode, may be selected using the appropriate jumpers or switches.*

*Other options available on the board include auto-incrementing of the A/D (analog-to-digital) converter (automatically switching the channel from which data is being taken), and the range of the signals coming from or going to the instrument. In addition, three types of inputs to the A/D converter are selectable by appropriate jumper settings: single-ended, pseudo-differential, and true differential. The single-ended setting is normally used, but the differential modes are particularly useful with low-level signals in environments with large amounts of electromagnetic noise. It is also possible to use interrupts to signal the computer when the A/D board has data ready for storage.*

*The system described in the text uses a −10-V to +10-V bipolar range for the A/D board, clock triggering of the A/D board, and a single-ended input. Only one instrument is normally connected, so the auto-incrementing feature is disabled, as are interrupts. Timer 5 is used to trigger the A/D board.*

*The clock portion of the Tecmar board provides a general-purpose mechanism for timing various events or for providing timed pulses for triggering various events. At least 18 different modes of operation are possible, each with several options. To the average user, this number of possibilities can prove highly confusing at best.*

*For triggering the A/D board at specific intervals, however, the process is fairly straightforward. The clock circuitry contains a 1-MHz clock, which is further subdivided either by powers of 10 (BCD scaling) or by powers of 16 (binary scaling), depending upon the option selected. Any one of five counters can be loaded with a count, which is then either incremented or decremented every time the clock "ticks."*

*For example, with a BCD scaling of divide-by-100, the clock provides a 10-kHz output. Assuming the count is in a downward direction, then the 16-bit counter can be loaded with a value of 99 to provide an output pulse to the A/D board every 0.01 second (i.e., 10 kHz ÷ 100 = 100 Hz). Note that the counter provides an output to the A/D board when it attempts to go below zero (called the "terminal count"); hence, the counter is set to 99 rather than to 100.*

*To connect the counter pulses to the A/D converter, the output from the specific counter must be directed to the trigger input of the A/D converter. Because of the pin placement on the Tecmar board, the easiest method for doing this is to connect the output of counter 5 to the A/D converter by jumpering pins 3 and 4 of connector J2.*

*All of the functions of the clock are controlled using two I/O ports accessible to any program. Although these ports are termed control port and data port, both ports are needed to set up the correct timing sequence. In a typical use of the timer, the control port is first directed to point to an internal register called the master mode register. You then select the various control options by loading a 16-bit word into the master-mode register via the data port; this selects options such as whether an 8- or 16-bit I/O bus is being used, what is to be used as a source of the clock frequency, and so forth.*

*Most of the information, however, is loaded into another internal register, the "counter-mode register." There is one such register for each of the five counters. Hence, the program uses the control port to select which counter-mode register is to be used; in this case, the one for register 5 is selected. The counter-mode register is then loaded, through the data port, with the various options selected for that register. Options include whether to count up or down, whether to count in binary or BCD, and which subfrequency of the clock is to be used. Special options are available if the counters are to be used as a time-of-day clock.*

*When the program is ready to begin collecting data, the appropriate counter must be loaded with the correct count and "armed," i.e., started counting. Assuming that the A/D converter has been set to recognize the signal from the clock as a trigger by enabling the external start bit, the A/D converter will automatically initiate a conversion (data collection) every time the counter register goes to zero. Hence, the program only needs to wait until the A/D converter signals that it has completed a conversion and then store the data; no timing loops need to be written. The A/D converter will continue to be triggered by the clock until the clock output is turned off by the program.*

fier system, so a 10-volt signal could be readily obtained. Hence, the student set the preamplifier on the interface cart to a gain of 1, attached it to the recorder output of the polarograph, used no filtering, and set the Timer routine to collect data for a period of time determined by the potential range scanned.

The major task of the student, then, was to understand the theoretical basis of the instrument readings and to design a program in BASIC to analyze the data. In order to accomplish this, the student had to fit a least-squares line to a sawtooth wave function, determine the inflection point in the curve, and calculate the distance between the two least-squares lines at the inflection point. The A/D readings were then converted to current values in microamperes and the time scale was converted into the applied potential in millivolts.

Students in the analytical chemistry class now use data collected with this system from a series of standard lead samples to calculate the amount of lead in leaded gasoline. Photo 2 shows data collected by a group of students for a standard sample of lead.

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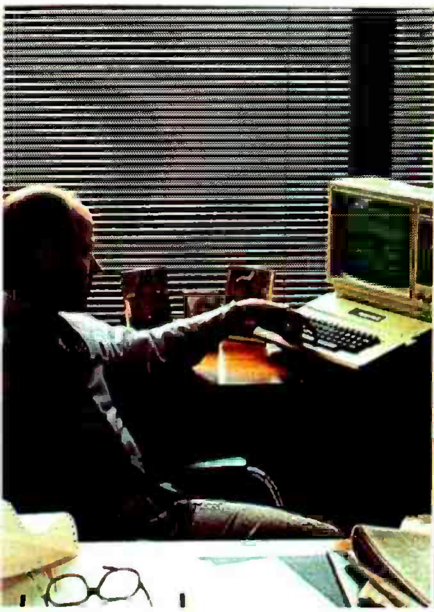
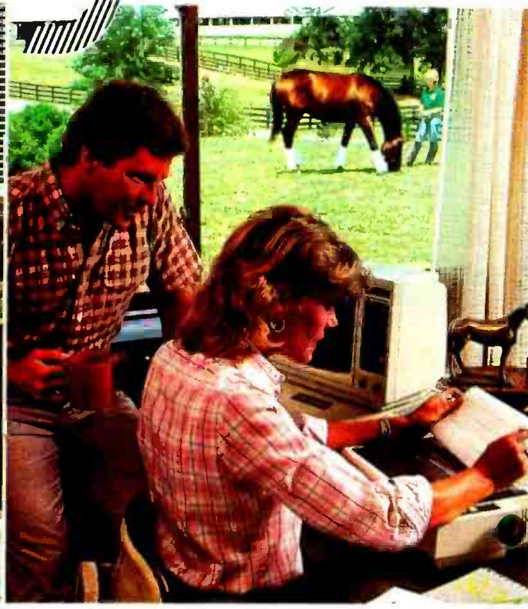
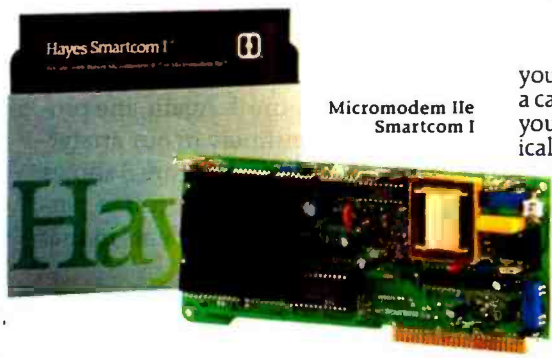


"Thanks for the prompt reply. Sure was a lot faster than waiting for the mail!"



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

"Attn. Prod., Sales, Purch.: Recommend 50% blue, 30% red screen for closest match."

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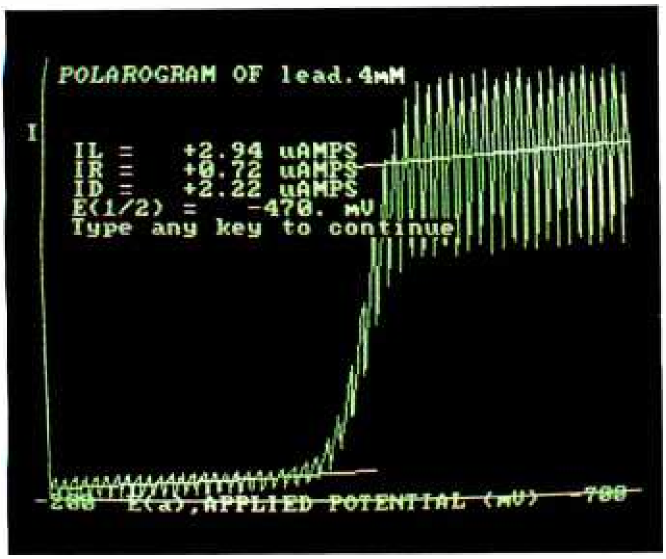


**Photo 2:** *Students taking our analytical chemistry laboratory course analyze the amount of lead in gasoline using the interface described in the text. The diffusion current (ID on the display) is proportional to the concentration of the lead in the sample.*

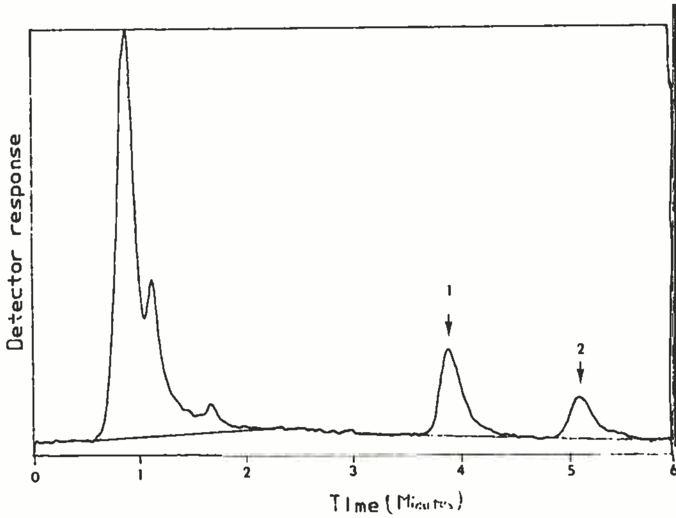


**Figure 3:** *A common problem in chemical laboratory work is to measure the areas of peaks. Each peak in this figure is integrated by the computer program; the peaks of interest are peaks 1 and 2, which are caffeine and benzyl alcohol, respectively. The benzyl alcohol peak serves as an internal standard for measuring the caffeine. The straight lines under each peak are the baselines determined by the computer during the integration process. The large initial peak is a group of unidentified substances. The sample is a cup of instant coffee.*

A second example of an instrument that students have interfaced is a high-performance liquid chromatograph. The normal output of the HPLC is a 10-mV signal displayed on a strip-chart recorder; hence, the preamplifier was set to a gain of 1000 to provide a 10-volt signal to the A/D converter.

The student writing the program divided it into two sections: a data-collection portion and a data-analysis portion. In the data-collection portion, all of the parameters of the instrument and the sample to be analyzed are recorded, thus providing a permanent record of the conditions of the analysis. The program also asks for the names of the substances being analyzed, if known, and whether an internal standard is being used.

The data collection is done using the assembly-language routine, with a real-time plot of the data. If more than a predefined number of points are collected, the data is "bunched," or averaged, together. The Savitzky-Golay smooth is then performed, and the smoothed data and identifying information are stored in a disk file.

In the second section of the program, the peaks in the data are integrated, and the area of each peak is compared to that of an internal standard. Proper integration involves deciding where each peak starts and stops and then selecting the appropriate baseline to be subtracted from each peak. The results of this process are shown in figure 3. Again, the program is used routinely in our analytical laboratory course; figure 3 shows an analysis of caffeine in coffee performed by a group of students in that course.

## Conclusions

One of the many advantages of the revolution in "home" computers is that powerful but inexpensive computers can be used in scientific or industrial laboratories, even by those with relatively limited computer skills. Utilizing off-the-shelf components and simple programming languages, extremely sophisticated data-collection and data-processing systems can be developed very rapidly.

The system described here represents a hardware and software solution to the problem of data collection and analysis in a wide variety of commonly encountered laboratory situations. By making only minor modifications, you should be able to adapt it to other types of hardware and to other types of instrumentation with an extremely wide range of applications, not only in chemistry, but in other scientific and industrial areas as well.■

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*Stephen C. Gates, Ph.D. (Department of Chemistry, Illinois State University, Normal, IL 61761), is assistant professor of biochemistry. He teaches a course in computer interfacing and does research on computerized chemical analysis of biological samples.*

**Program Available:** *A disk with copies of the programs described in the article is available. Write to the author for information.*

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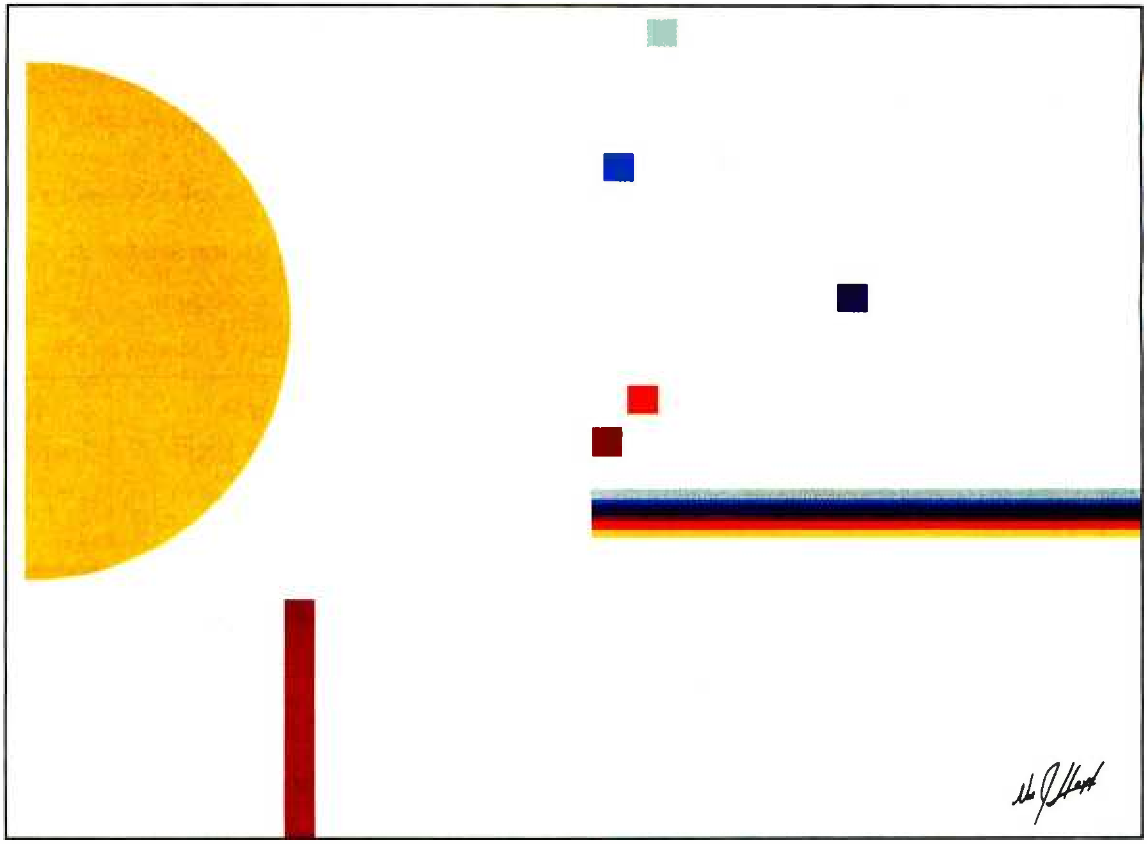

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# Putting the Apple II Work

## Part 2: The Software

*A high-speed system for the acquisition and analysis of data*

**Richard C. Hallgren**
**Michigan State University**

Last month, I described the overall system approach and provided you with construction details and preliminary testing. In this concluding part, I'll discuss the software I've developed that makes the system operational.

### System Software

The software that enables the computer to collect and display the data can best be visualized by breaking down the total program set into a number of subroutines:

1. A main routine written in Applesoft BASIC is responsible for calling all machine-language subroutines, displaying the data on the high-resolution graphics screen, and storing the data on disk.
2. A machine-language routine that controls the digital section of the analog-to-digital (A/D) converter and provides high-speed transfer of the binary data into the Apple II.
3. A machine-language routine that scrolls the displayed data horizontally across the video display.
4. A machine-language routine that enables you to mix text with the data displayed on the high-resolution graphics screen.

The Applesoft program expects the machine-language routines to be stored on disk drive 1 and to have the following names:

A/D — routine that controls the digital section of the A/D converter
Shift — routine that scrolls the data
Hires — routine that writes text onto the high-resolution graphics screen
Table — graphics character look-up table

After you have loaded these programs and stored them onto a disk initialized with the Hello routine, execute the Applesoft routine. If the program jumps to the A/D routine but never returns, you probably have one of two problems:

1. The program did not enter the A/D routine correctly. Usually, you will get strange characters appearing on the screen, and/or the keyboard will not respond without turning the power off and then back on.
2. Absolutely nothing happens. Make sure that the $\overline{IRQ}$ signal is getting to pin 30 on the interface connector.

Once you get the program to go to the A/D routine and to return, the end is in sight. If the data does not plot correctly, check the section in the Applesoft routine that supports this. For example, if you try to scroll the data and the computer does strange things, take a close look for mistakes in the scroll subroutines.

### Applesoft Routine

Listing 1 gives the program with comments. This BASIC routine first loads all the machine-language routines and then loops until the operator is ready to digitize data. Once the operator indicates that data is to be taken, the program jumps to the machine-language A/D routine that proceeds to digitize and store a predetermined quantity of data. Program control then returns to the Applesoft routine. The data is then plotted on the high-resolution graphics screen, and text is added to the plots. You then have the option of reviewing the data by scrolling it back and forth across the video display. If the data is "good," you can store the data on disk. If the data is not good, you can initiate the acquisition of a new block of data.

### A/D Machine-Language Routine

The machine-language A/D converter subroutine is called from the BASIC program by executing CALL −28656. This forces the computer to execute the subroutine stored at memory location 9010 hexadecimal.

(Unless otherwise indicated, all addresses are hexadecimal.) Listing 2 gives the program with comments. Upon entering this subroutine, the contents of the accumulator, the contents of the X and Y registers, and the processor status are saved. The subroutine then clears the Y register and loads the X register with the 8 most significant bits (MSBs) of the memory address defining the upper limit of the block of memory reserved for data storage. The memory address for the lower limit of the block reserved for data storage is loaded into memory locations 0A (least significant bits or LSBs) and 0B (MSBs). These two memory locations serve as a pointer to the current location in memory in which a byte of data is to be stored.

The system interrupt logic is disabled while the 8 MSBs of the current data-storage address (the contents of memory location 0B) are compared with the 8 MSBs of the maximum allowable address (the contents of the X register). If the maximum limit has not been reached, the program jumps to memory location 9038. If the maximum limit has been reached, the subroutine restores the contents of the accumulator, the contents of the X and Y registers, and the processor status. After that, the return from subroutine (RTS) command forces the computer to return to the BASIC calling routine.

At memory location 9038, the subroutine enables the system interrupt logic and waits a few machine cycles to see if it is time to take another sample. The sampling rate is determined by connecting the output of the crystal-controlled oscillator and frequency-divider logic to the interrupt request line ($\overline{IRQ}$) going to the 6502. If it is not time to take another sample, the subroutine returns to memory location 9026, where the interrupt logic is disabled. If it is time to take another sample, the interrupt logic forces the computer to jump to memory location 9040. This address was determined by the Hello program, which was executed when the DOS (disk operating system) was initially booted.

At memory location 9040, the three

**Listing 1:** *A/D converter main routine written in Applesoft BASIC.*

```
10  REM  HIGH SPEED A/D CONVERTER
20 D$ = ""
22  PRINT D$;"BLOAD A/D,D1"
24  PRINT D$;"BLOAD HIRES,D1"
25  PRINT D$;"BLOAD TABLE,D1"
26  PRINT D$;"BLOAD SHIFT,D1"
32  VTAB 10: PRINT "PRESS THE SPACE BAR WHEN YOU ARE": PRINT "READY TO DIG
    ITIZE DATA."
40  GET K$
42  IF K$ <  >  CHR$ (32) THEN  GOTO 40
44  GOTO 2100
100  REM  SCROLL DATA TO THE LEFT
102  IF K1 > 28600 THEN  RETURN
112  POKE  - 30875,230: POKE  - 30869,227: POKE  - 30751,0: POKE  - 30744,
     232: POKE  - 30742,28: POKE  - 30865,26: CALL  - 30976
130  HCOLOR= 1: FOR I = 1 TO 14
132 Y = ( PEEK (K1 + DI * I)) / 1.5
134  HPLOT 195 + I,175 - Y: NEXT I
136 K1 = K1 + DI * 14
140  HCOLOR= 2: FOR I = 1 TO 14
144 Y = ( PEEK (K2 + DI * I)) / 1.5
146  HPLOT 195 + I,175 - Y: NEXT I
148 K2 = K2 + DI * 14
150  HCOLOR= 3: FOR I = 1 TO 14
154 Y = ( PEEK (K3 + DI * I)) / 1.5
156  HPLOT 195 + I,175 - Y: NEXT I
158 K3 = K3 + DI * 14:SL = 1
199  RETURN
200  REM  SCROLL DATA TO THE RIGHT
202  IF K1 < 25230 THEN  RETURN
212  POKE  - 30875,227: POKE  - 30869,230: POKE  - 30751,27: POKE  - 30744
     ,202: POKE  - 30742,255: POKE  - 30865,254: CALL  - 30976
221  IF SL = 0 THEN  GOTO 230
222 K4 = K1 - 210 * DI:K5 = K2 - 210 * DI:K6 = K3 - 210 * DI
230  HCOLOR= 1: FOR I = 14 TO 1 STEP  - 1
234 Y = ( PEEK (K4 - DI * I)) / 1.5
236  HPLOT 14 - I,175 - Y: NEXT I
238 K4 = K4 - DI * 14:K1 = K4 + 210 * DI
240  HCOLOR= 2: FOR I = 14 TO 1 STEP  - 1
244 Y = ( PEEK (K5 - DI * I)) / 1.5
246  HPLOT 14 - I,175 - Y: NEXT I
248 K5 = K5 - DI * 14:K2 = K5 + 210 * DI
250  HCOLOR= 3: FOR I = 14 TO 1 STEP  - 1
254 Y = ( PEEK (K6 - DI * I)) / 1.5
256  HPLOT 14 - I,175 - Y: NEXT I
258 K6 = K6 - DI * 14:K3 = K6 + 210 * DI
299  RETURN
2100  REM  DIGITIZE DATA
2102  HOME : TEXT : VTAB 10: PRINT "DATA IS BEING DIGITIZED."
2132  POKE  - 28643,112: POKE  - 16143,0: CALL  - 28656
2200 K1 = 24576:K2 = 24577:K3 = 24578:DI = 3: GOSUB 3000: GOSUB 10000
2250  GET K$
2254  IF K$ =  CHR$ (8) THEN  GOSUB 100
2256  IF K$ =  CHR$ (21) THEN  GOSUB 200
2258  IF K$ =  CHR$ (32) THEN  GOTO 2100
2260  IF K$ =  CHR$ (27) THEN  GOTO 4000
2299  GOTO 2250
3000  REM  PLOT DATA
3010  HCOLOR= 1: HGR2
3030  FOR I = 0 TO 209:Y = ( PEEK (K1 + DI * I)) / 1.5
3032  HPLOT I,175 - Y: NEXT I
3034 K4 = K1:K1 = K1 + 210 * DI
3036  HCOLOR= 2
3038  FOR I = 0 TO 209:Y = ( PEEK (K2 + DI * I)) / 1.5
3040  HPLOT I,175 - Y: NEXT I
3041 K5 = K2:K2 = K2 + 210 * DI
3042  HCOLOR= 3
3044  FOR I = 0 TO 209:Y = ( PEEK (K3 + DI * I)) / 1.5
3046  HPLOT I,175 - Y: NEXT I
3048 K6 = K3:K3 = K3 + 210 * DI
3049  RETURN
4000  REM  ESCAPE SUBROUTINE
4002  TEXT : HOME
4010  VTAB 4: PRINT "PRESS THE KEY CORRESPONDING TO YOUR": PRINT "CHOICE:"
4014  VTAB 10: PRINT "R  TO RETURN TO CURRENT DATA"
4016  VTAB 12: PRINT "S  TO SAVE CURRENT DATA ON DISK"
4018  VTAB 14: PRINT "D  TO DIGITIZE NEW DATA"
4019  VTAB 16: PRINT "H  TO STOP"
4020  VTAB 20: GET K$
4022  IF K$ = "D" THEN  GOTO 2100
4023  IF K$ = "R" THEN  POKE  - 16304,0: POKE  - 16299,0: POKE  - 16297,0:
      GOTO 2250
4024  IF K$ = "R" THEN  POKE  - 16304,0: POKE  - 16299,0: POKE  - 16297,0:
      GOTO 2250
4026  IF K$ = "H" THEN  END
4028  IF K$ = "S" THEN  GOTO 4050
4029  GOTO 4020
4050  HOME
```

*Listing 1 continued on page 384*

AD7570 A/D converters are simultaneously instructed to begin the conversion of their respective input signals. The subroutine then loops until all three units have finished their conversion cycles. The subroutine then proceeds to load the digitized signal from the first AD7570 into the accumulator. The contents of the accumulator are then transferred into the memory location determined by the contents of memory locations 0A (containing the 8 LSBs) and 0B (containing the 8 MSBs) and the contents of register Y (which are added to the contents of memory location 0A).

After the data has been stored, the Y register is incremented. The subroutine tests the Y register to see if the increment caused the register to be equal to zero (a transition from #FF to #00). Such a transition indicates that memory location 0B then needs to be incremented. The subroutine then proceeds to load and store data into successive memory locations until all three converters have been serviced. A return from interrupt (RTI) command then forces the computer to return to the point in the program where the interrupt request was detected. The subroutine ultimately ends up back at memory location 9026, where the interrupt logic is again disabled and a test is made to see if the maximum allocated data-storage address has been exceeded.

Once the data has been digitized and stored, program control returns to the BASIC routine. The first 209 data samples from each input channel are displayed on the high-resolution graphics screen. Differentiation of the data is achieved by using a unique color for each input channel. The full width of the graphics display is not utilized for data so that reference text can be added on the right-hand side of the screen.

## High-Resolution Text Generator

The text-generator software is used to write textual information on the high-resolution graphics screen. This capability lets you identify data points and display the magnitude of selected data points along with the data. The character set for the graphics generator was purposely limited

*Listing 1 continued:*

```
4060  VTAB 10: PRINT "ENTER THE NAME OF THE DATA FILE"
4064  VTAB 14: INPUT K$
4070 D$ = ""
4072  PRINT D$;"BSAVE ";K$;",A$6000,L$1000,D1"
4099  GOTO 4000
10000  REM  IDENTIFY PLOTS AND ADD TEXT
10002  POKE 54,0: POKE 55,143: POKE  - 16299,0
10010  VTAB 23: HTAB 1: PRINT "PRESS <-- OR --> TO SCROLL THE DATA."
10050  VTAB 24: HTAB 1: PRINT "PRESS SPACE BAR TO DIGITIZE MORE DATA."
10052  VTAB 14: HTAB 32: PRINT "PRESS ESC"
10054  VTAB 15: HTAB 32: PRINT "TO EXIT."
10060  HCOLOR= 1
10062  HPLOT 215,12 TO 219,12: HPLOT 215,20 TO 219,20: HPLOT 217,12 TO 217
     ,20: HPLOT 223,20 TO 223,12 TO 227,20 TO 227,12: HPLOT 231,20 TO 231,
     12 TO 235,12 TO 235,16 TO 231,16
10064  HPLOT 239,12 TO 239,20 TO 243,20 TO 243,12: HPLOT 249,20 TO 249,12 TO
     247,12 TO 251,12
10066  HPLOT 257,20 TO 261,20 TO 259,20 TO 259,12 TO 257,14
10070  HCOLOR= 2
10072  HPLOT 216,32 TO 220,32: HPLOT 216,40 TO 220,40: HPLOT 218,32 TO 218
     ,40: HPLOT 224,40 TO 224,32 TO 228,40 TO 228,32: HPLOT 232,40 TO 232,
     32 TO 236,32 TO 236,36 TO 232,36
10074  HPLOT 240,32 TO 240,40 TO 244,40 TO 244,32: HPLOT 250,40 TO 250,32 TO
     248,32 TO 252,32
10076  HPLOT 258,32 TO 262,32 TO 262,36 TO 258,36 TO 258,40 TO 262,40
10080  HCOLOR= 3
10082  HPLOT 216,52 TO 220,52: HPLOT 216,60 TO 220,60: HPLOT 218,52 TO 218
     ,60: HPLOT 224,60 TO 224,52 TO 228,60 TO 228,52: HPLOT 232,60 TO 232,
     52 TO 236,52 TO 236,56 TO 232,56
10084  HPLOT 240,52 TO 240,60 TO 244,60 TO 244,52: HPLOT 250,60 TO 250,52 TO
     248,52 TO 252,52
10086  HPLOT 258,52 TO 262,52 TO 262,56 TO 258,56 TO 262,56 TO 262,60 TO 2
     58,60
10099  RETURN
```

**Listing 2:** *This routine provides high-speed data transfer from the A/D converter to the Apple II.*

```
9010   8D 00 90   STA   $9000      Save accumulator
9013   8E 01 90   STX   $9001      Save X register
9016   8C 02 90   STY   $9002      Save Y register
9019   08         PHP              Save processor status
901A   A0 00      LDY   #$00
901C   A2 63      LDX   #$70       Load X register with maximum
                                   data storage address
901E   A9 00      LDA   #$00
9020   85 0A      STA   $0A        Memory locations $0A and $0B
9022   A9 60      LDA   #$60       contain the start address for
9024   85 0B      STA   $0B        data storage
9026   78         SEI              Disable interrupt
9027   E4 0B      CPX   $0B        Compare current data storage
9029   D0 0D      BNE   $9038      address with maximum address
902B   AD 00 90   LDA   $9000      Restore accumulator
902E   AE 01 90   LDX   $9001      Restore X register
9031   AC 02 90   LDY   $9002      Restore Y register
9034   28         PLP              Restore processor status
9035   60         RTS              Return to calling routine
9036   EA         NOP
9037   EA         NOP
9038   58         CLI              Enable interrupt
9039   EA         NOP
903A   4C 26 90   JMP   $9026
903D   00         BRK
903E   00         BRK
903F   00         BRK
9040   A9 01      LDA   #$01       Start A/D conversion
9042   8D F0 C0   STA   $C0F0
9045   A9 00      LDA   #$00
9047   8D F0 C0   STA   $C0F0
904A   AD 61 C0   LDA   $C061      Check and see if all conversions
904D   2A         ROL              are complete
904E   B0 FA      BCS
9050   AD F1 C0   LDA   $C0F1      Load data from input #1
9053   91 0A      STA   ($0A),Y    Store data
9055   C8         INY              Increment LSD of data storage
                                   address
9056   D0 02      BNE   $905A      Branch on result not zero
9058   E6 0B      INC   $0B        Increment MSD of data storage
                                   address
905A   AD F2 C0   LDA   $C0F2      Load data from input #2
905D   91 0A      STA   ($0A),Y    Store data
905F   C8         INY              Increment LSD
9060   D0 02      BNE   $9064      Branch on result not zero
9062   E6 0B      INC   $0B        Increment MSD
```

*Listing 2 continued on page 386*

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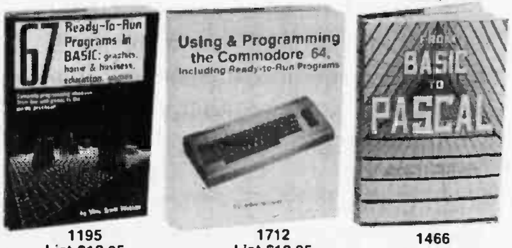


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to numbers and uppercase letters to conserve memory. Listing 3 gives the high-resolution graphics, text-generator program, and table 1 is the graphics character look-up table. The program takes the textual character that is to be displayed on the graphics screen and matches it to a corresponding graphics character contained in the look-up table. This graphics character is then displayed on the screen by loading it into the correct memory location in page 2 of the high-resolution-graphics memory block. By using this subroutine, you avoid having to "draw" text on the graphics screen using the PLOT commands. The routine is initialized by using POKEs to insert the subroutine entry address into memory locations (decimal) 54 and 55. Any PRINT statements that follow will force the text that was to be printed to be displayed on the graphics screen.

## Data-Scroll Routine

The information that is routed to the video display when the Apple is in the high-resolution-graphics mode comes from an 8192-byte block of memory that is defined (for the secondary picture-page buffer) between memory locations 4000 and 5FFF (see figure 1). The rationale that determines the relationship between a dot's position on the screen and the dot's position in the picture-page buffer is not all that obvious to me. The best that I have been able to do is to map out the relationship between a dot's position on the screen and a memory-address location in the picture-page buffer.

Seven of the 8 bits in each byte contained in the picture-page buffer are displayed as dots; the eighth bit determines the color of the other 7 dots. A total of 40 bytes is displayed on each horizontal line of the video display. The LSB of the first byte in a line is displayed on the left-hand edge of the screen, followed by the second bit, the third bit, etc. A total of 280 dots (40 bytes × 7 dots) is displayed on each of the 192 lines (24 lines × 8 dots) that can be displayed on the screen.

In order to help myself understand the picture-page memory map, I con-

*Text continued on page 395*

*Listing 2 continued:*

```
9064    AD F3 C0    LDA    $C0F3      Load data from input #3
9067    91 0A       STA    ($0A),Y    Store data
9069    C8          INY               Increment LSD
906A    D0 02       BNE    $906E      Branch on result not zero
906C    E6 0B       INC    $0B        Increment MSD
906E    40          RTI               Return from interrupt
```

**Listing 3:** *High-resolution text-generator routine.*

```
8F00    08          PHP               Save processor status
8F01    48          PHA               Save contents of accumulator
8F02    84 4E       STY    $4E        Save contents of Y register
8F04    C9 8D       CMP    #$8D       Test for carriage return
8F06    F0 07       BEQ    $8F0F
8F08    C9 8C       CMP    #$8C       Test for line feed
8F0A    D0 05       BNE    $8F11
8F0C    18          CLC
8F0D    90 5C       BCC    $8F6B
8F0F    F0 5C       BEQ    $8F6D
8F11    A5 25       LDA    $25        Relate cursor position to HGR2
                                      screen position
8F13    4A          LSR
8F14    29 03       AND    #$03
8F16    09 40       ORA    #$40       Define HGR page #2
8F18    85 2B       STA    $2B
8F1A    A5 25       LDA    $25
8F1C    6A          ROR
8F1D    08          PHP
8F1E    0A          ASL
8F1F    29 18       AND    #$18
8F21    85 2A       STA    $2A
8F23    0A          ASL
8F24    0A          ASL
8F25    05 2A       ORA    $2A
8F27    0A          ASL
8F28    28          PLP
8F29    6A          ROR
8F2A    18          CLC
8F2B    65 24       ADC    $24
8F2D    85 2A       STA    $2A
8F2F    68          PLA
8F30    29 7F       AND    #$7F
8F32    48          PHA
8F33    A9 88       LDA    #$88       MSB of graphics character
                                      look-up table
8F35    4A          LSR
8F36    4A          LSR
8F37    4A          LSR
8F38    85 27       STA    $27
8F3A    68          PLA               Match text character to graphics
                                      character position in look-up
                                      table
8F3B    48          PHA
8F3C    2A          ROL
8F3D    26 27       ROL    $27
8F3F    2A          ROL
8F40    26 27       ROL    $27
8F42    2A          ROL
8F43    26 27       ROL    $27
8F45    29 F8       AND    #$F8
8F47    85 26       STA    $26
8F49    A0 00       LDY    #$00
8F4B    B1 26       LDA    ($26),Y    Get first row of graphics design
                                      from look-up table
8F4D    84 4F       STY    $4F
8F4F    A0 00       LDY    #$00
8F51    48          PHA
8F52    68          PLA
8F53    51 2A       EOR    ($2A),Y
8F55    91 2A       STA    ($2A),Y    Store graphics design in screen
                                      memory block
8F57    A4 4F       LDY    $4F
8F59    A5 2B       LDA    $2B
8F5B    18          CLC
8F5C    69 04       ADC    #$04
8F5E    85 2B       STA    $2B
8F60    C8          INY
8F61    C0 08       CPY    #$08
8F63    D0 E6       BNE    $8F4B      Jump if all rows not finished
8F65    E6 24       INC    $24        Increment LSD of cursor position
8F67    A5 24       LDA    $24
8F69    C5 21       CMP    $21
8F6B    90 10       BCC    $8F7D
```

*Listing 3 continued on page 388*

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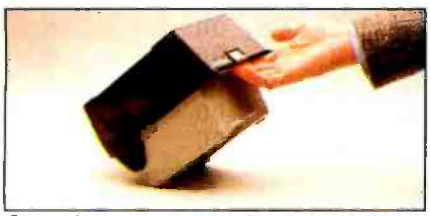

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*Listing 3 continued:*

```
8F6D    A5 20       LDA    $20
8F6F    85 24       STA    $24
8F71    E6 25       INC    $25       Increment MSD of cursor position
8F73    A5 25       LDA    $25
8F75    C5 23       CMP    $23
8F77    90 04       BCC    $8F7D
8F79    A5 22       LDA    $22
8F7B    85 25       STA    $25
8F7D    A4 4E       LDY    $4E       Restore Y register
8F7F    68          PLA              Restore accumulator
8F80    28          PLP              Restore processor status
8F81    60          RTS              Return to calling routine
```

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8900- | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | Space |
| 8908- | 10 | 10 | 10 | 10 | 00 | 00 | 10 | 00 | ! |
| 8910- | 24 | 24 | 24 | 00 | 00 | 00 | 00 | 00 | " |
| 8918- | 24 | 24 | 7E | 24 | 7E | 24 | 24 | 00 | # |
| 8920- | 10 | 78 | 14 | 38 | 50 | 3C | 10 | 00 | $ |
| 8928- | 00 | 46 | 26 | 10 | 08 | 64 | 62 | 00 | % |
| 8930- | 0C | 12 | 12 | 0C | 52 | 22 | 5C | 00 | & |
| 8938- | 20 | 10 | 08 | 00 | 00 | 00 | 00 | 00 | ' |
| 8940- | 20 | 10 | 08 | 08 | 08 | 10 | 20 | 00 | ( |
| 8948- | 04 | 08 | 10 | 10 | 10 | 08 | 04 | 00 | ) |
| 8950- | 10 | 54 | 38 | 7C | 38 | 54 | 10 | 00 | * |
| 8958- | 00 | 10 | 10 | 7C | 10 | 10 | 00 | 00 | + |
| 8960- | 00 | 00 | 00 | 00 | 00 | 18 | 18 | 0C | , |
| 8968- | 00 | 00 | 00 | 7E | 00 | 00 | 00 | 00 | – |
| 8970- | 00 | 00 | 00 | 00 | 00 | 18 | 18 | 00 | . |
| 8978- | 00 | 40 | 20 | 10 | 08 | 04 | 02 | 00 | / |
| 8980- | 3C | 42 | 62 | 5A | 46 | 42 | 3C | 00 | 0 |
| 8988- | 10 | 18 | 14 | 10 | 10 | 10 | 7C | 00 | 1 |
| 8990- | 3C | 42 | 40 | 30 | 0C | 02 | 7E | 00 | 2 |
| 8998- | 3C | 42 | 40 | 38 | 40 | 42 | 3C | 00 | 3 |
| 89A0- | 20 | 30 | 28 | 24 | 7E | 20 | 20 | 00 | 4 |
| 89A8- | 7E | 02 | 1E | 20 | 40 | 22 | 1C | 00 | 5 |
| 89B0- | 38 | 04 | 02 | 3E | 42 | 42 | 3C | 00 | 6 |
| 89B8- | 7E | 42 | 20 | 10 | 08 | 08 | 08 | 00 | 7 |
| 89C0- | 3C | 42 | 42 | 3C | 42 | 42 | 3C | 00 | 8 |
| 89C8- | 3C | 42 | 42 | 7C | 40 | 20 | 1C | 00 | 9 |
| 89D0- | 00 | 00 | 18 | 18 | 00 | 18 | 18 | 00 | : |
| 89D8- | 00 | 00 | 18 | 18 | 00 | 18 | 18 | 0C | ; |
| 89E0- | 20 | 10 | 08 | 04 | 08 | 10 | 20 | 00 | < |
| 89E8- | 00 | 00 | 3E | 00 | 3E | 00 | 00 | 00 | = |
| 89F0- | 04 | 08 | 10 | 20 | 10 | 08 | 04 | 00 | > |
| 89F8- | 3C | 42 | 40 | 30 | 08 | 00 | 08 | 00 | ? |
| 8A00- | 38 | 44 | 52 | 6A | 32 | 04 | 78 | 00 | |
| 8A08- | 18 | 24 | 42 | 7E | 42 | 42 | 42 | 00 | A |
| 8A10- | 3E | 44 | 44 | 3C | 44 | 44 | 3E | 00 | B |
| 8A18- | 3C | 42 | 02 | 02 | 02 | 42 | 3C | 00 | C |
| 8A20- | 3E | 44 | 44 | 44 | 44 | 44 | 3E | 00 | D |
| 8A28- | 7E | 02 | 02 | 1E | 02 | 02 | 7E | 00 | E |
| 8A30- | 7E | 02 | 02 | 1E | 02 | 02 | 02 | 00 | F |
| 8A38- | 3C | 42 | 02 | 72 | 42 | 42 | 3C | 00 | G |
| 8A40- | 42 | 42 | 42 | 7E | 42 | 42 | 42 | 00 | H |
| 8A48- | 38 | 10 | 10 | 10 | 10 | 10 | 38 | 00 | I |
| 8A50- | 70 | 20 | 20 | 20 | 20 | 22 | 1C | 00 | J |
| 8A58- | 42 | 22 | 12 | 0E | 12 | 22 | 42 | 00 | K |
| 8A60- | 02 | 02 | 02 | 02 | 02 | 02 | 7E | 00 | L |
| 8A68- | 42 | 66 | 5A | 5A | 42 | 42 | 42 | 00 | M |
| 8A70- | 42 | 46 | 4A | 52 | 62 | 42 | 42 | 00 | N |
| 8A78- | 3C | 42 | 42 | 42 | 42 | 42 | 3C | 00 | O |
| 8A80- | 3E | 42 | 42 | 3E | 02 | 02 | 02 | 00 | P |
| 8A88- | 3C | 42 | 42 | 42 | 52 | 22 | 5C | 00 | Q |
| 8A90- | 3E | 42 | 42 | 3E | 12 | 22 | 42 | 00 | R |

**Table 1:** *Graphics character look-up table.*

*Table 1 continued on page 390*

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*Table 1 continued:*

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 8A98- | 3C | 42 | 02 | 3C | 40 | 42 | 3C | 00 | S |
| 8AA0- | 7C | 10 | 10 | 10 | 10 | 10 | 10 | 00 | T |
| 8AA8- | 42 | 42 | 42 | 42 | 42 | 42 | 3C | 00 | U |
| 8AB0- | 42 | 42 | 42 | 24 | 24 | 18 | 18 | 00 | V |
| 8AB8- | 42 | 42 | 42 | 5A | 5A | 66 | 42 | 00 | W |
| 8AC0- | 42 | 42 | 24 | 18 | 24 | 42 | 42 | 00 | X |
| 8AC8- | 44 | 44 | 44 | 38 | 10 | 10 | 10 | 00 | Y |
| 8AD0- | 7E | 40 | 20 | 18 | 04 | 02 | 7E | 00 | Z |

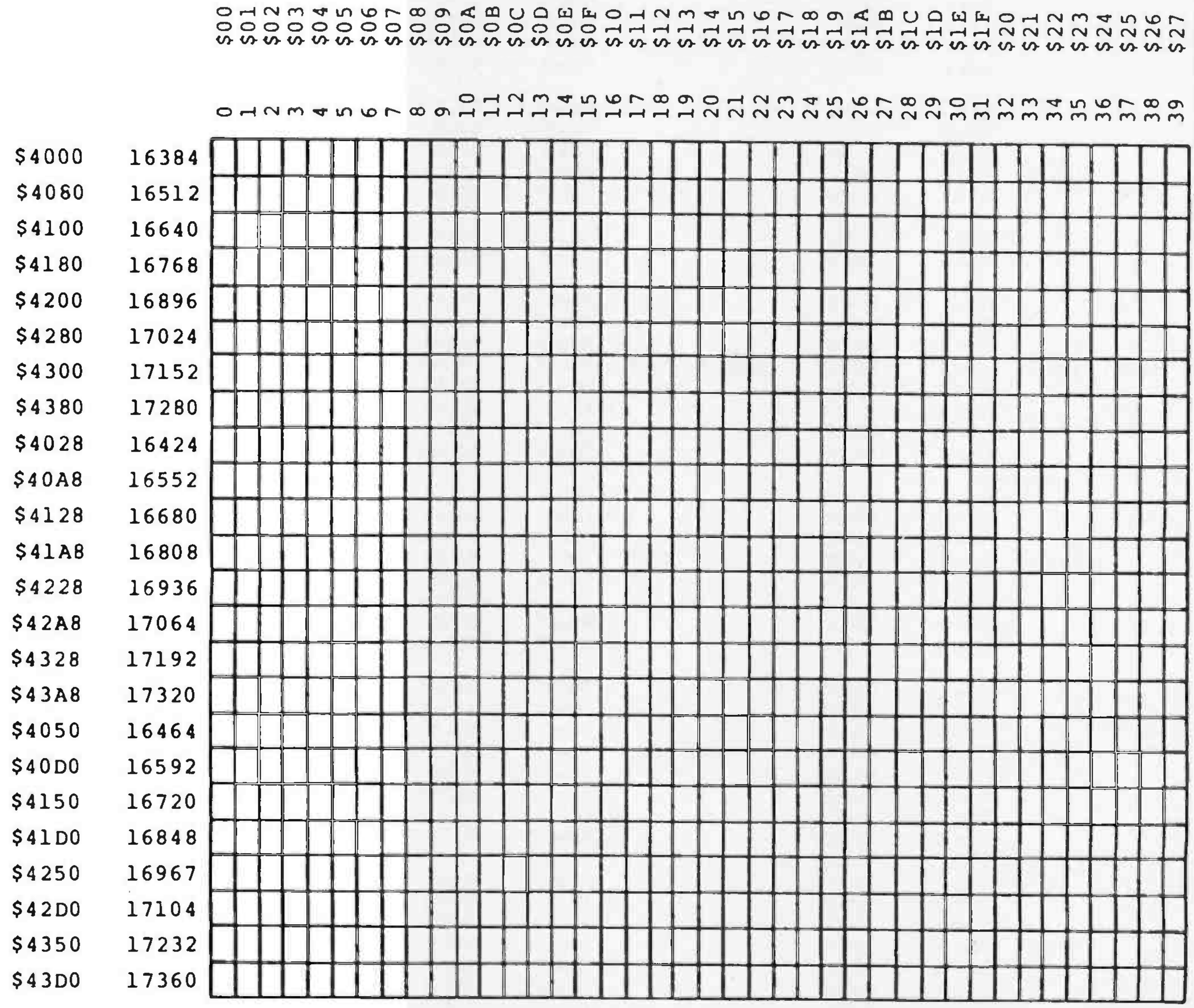
**Listing 4:** *Right-to-left scroll routine.*

```
8700   A9 00      LDA  #$00    Initialize base address
8702   8D FE 87   STA  $87FE
8705   A9 40      LDA  #$40
8707   8D FF 87   STA  $87FF
870A   A9 02      LDA  #$02    Initialize block counter
870C   8D FD 87   STA  $87FD
870F   A0 08      LDA  #$08    Initialize box counter
8711   8D F7 87   STA  $87F7
8714   20 50 87   JSR  $8750   Jump to main routine
8717   18         CLC
8718   A9 28      LDA  #$28    Set up for second block
871A   6D FE 87   ADC  $87FE
871D   8D FE 87   STA  $87FE
8720   CE FD 87   DEC  $87FD
8723   D0 EA      BNE  $870F   Jump if second block not
                                  complete
8725   A9 06      LDA  #$06    Number of boxes remaining (two
                                  boxes reserved for text)
8727   8D F7 87   STA  $87F7
872A   20 50 87   JSR  $8750   Jump to main routine
872D   60         RTS          Return to calling routine
8750   AD FE 87   LDA  $87FE   Save base address
8753   8D FB 87   STA  $87FB
8756   AD FF 87   LDA  $87FF
8759   8D FC 87   STA  $87FC
875C   A9 08      LDA  #$08    Initialize row counter
875E   8D FA 87   STA  $87FA
8761   AD FB 87   LDA  $87FB   Set up LSB of left hand side of
                                  screen
8764   8D E6 87   STA  $87E6
8767   18         CLC
8768   69 02      ADC  #$02    Set up shift distance
876A   8D E3 87   STA  $87E3
876D   18         CLC
876E   69 1A      ADC  #$1A
8770   8D F0 87   STA  $87F0   Set up LSB of right hand side of
                                  screen
8773   8D F3 87   STA  $87F3
8776   EE F3 87   INC  $87F3   Next byte
8779   AD FC 87   LDA  $87FC   Set up MSB of
877C   8D E4 87   STA  $87E4      left hand side of screen
877F   8D E7 87   STA  $87E7
8782   8D F1 87   STA  $87F1      right hand side of screen
8785   8D F4 87   STA  $87F4
8788   20 E0 87   JSR  $87E0   Jump to shift routine
878B   18         CLC
878C   A9 04      LDA  #$04    Add 4 to MSB of
878E   6D E4 87   ADC  $87E4
8791   8D E4 87   STA  $87E4      left hand side of screen
8794   8D E7 87   STA  $87E7
8797   8D F1 87   STA  $87F1      right hand side of screen
879A   8D F4 87   STA  $87F4
879D   CE FA 87   DEC  $87FA   Decrement row counter
87A0   D0 E6      BNE  $8788   Jump if box not complete
87A2   18         CLC
87A3   A9 80      LDA  #$80    Set up next box address
87A5   6D FB 87   ADC  $87FB
87A8   8D FB 87   STA  $87FB
87AB   A9 00      LDA  #$00
87AD   6D FC 87   ADC  $87FC
87B0   8D FC 87   STA  $87FC
87B3   CE F7 87   DEC  $87F7   Decrement box counter
87B6   D0 A4      BNE  $875C   Jump if block not complete
87B8   60         RTS          Return to calling routine
```

*Listing 4 continued on page 391*

*Listing 4 continued:*

```
87E0    A2 00       LDX   #$00      Set up byte counter
87E2    BD 02 40    LDA   $4002,X   Shift 2 bytes (14 points) left
87E5    9D 00 40    STA   $4000,X
87E8    E8          INX             Increment counter
87E9    E0 1C       CPX   #$1C
87EB    D0 F5       BNE   $87E2     Jump if shift not complete
87ED    A9 00       LDA   #$00      Clear right most 14 points
87EF    8D 1C 40    STA   $401C
87F2    8D 1D 40    STA   $401D
87F5    60          RTS             Return to calling routine
```



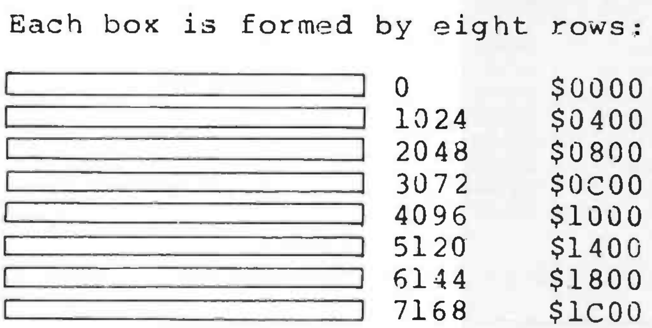
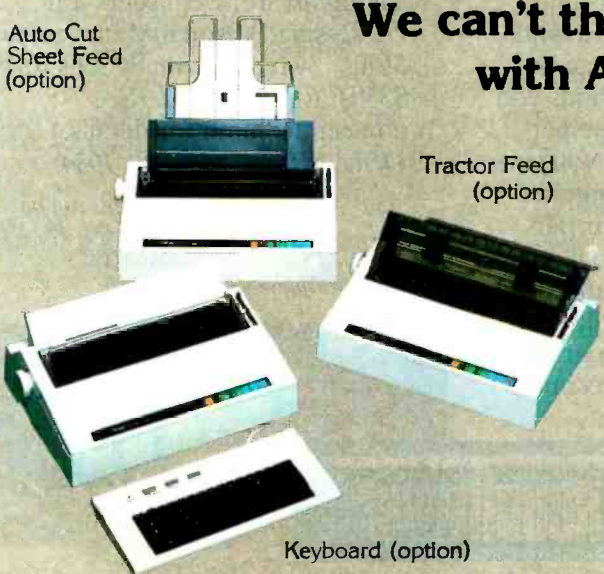




**Figure 1:** *A map of the Apple II's high-resolution graphics screen.*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Row 1 | $4000 | | | Row 1 | $4028 | | | Row 1 | $4050 |
| | | Row 2 | $4400 | | | Row 2 | $4428 | | | Row 2 | $4450 |
| | | Row 3 | $4800 | | | Row 3 | $4828 | | | Row 3 | $4850 |
| | Box 1 | Row 4 | $4C00 | | Box 1 | Row 4 | $4C28 | | Box 1 | Row 4 | $4C50 |
| | | Row 5 | $5000 | | | Row 5 | $5028 | | | Row 5 | $5050 |
| | | Row 6 | $5400 | | | Row 6 | $5428 | | | Row 6 | $5450 |
| | | Row 7 | $5800 | | | Row 7 | $5828 | | | Row 7 | $5850 |
| | | Row 8 | $5C00 | | | Row 8 | $5C28 | | | Row 8 | $5C50 |
| | | Row 1 | $4080 | | | Row 1 | $40A8 | | | Row 1 | $40D0 |
| | | Row 2 | $4480 | | | Row 2 | $44A8 | | | Row 2 | $44D0 |
| | | Row 3 | $4880 | | | Row 3 | $48A8 | | | Row 3 | $48D0 |
| | Box 2 | Row 4 | $4C80 | | Box 2 | Row 4 | $4CA8 | | Box 2 | Row 4 | $4CD0 |
| | | Row 5 | $5080 | | | Row 5 | $50A8 | | | Row 5 | $50D0 |
| | | Row 6 | $5480 | | | Row 6 | $54A8 | | | Row 6 | $54D0 |
| | | Row 7 | $5880 | | | Row 7 | $58A8 | | | Row 7 | $58D0 |
| | | Row 8 | $5C80 | | | Row 8 | $5CA8 | | | Row 8 | $5CD0 |
| | | Row 1 | $4100 | | | Row 1 | $4128 | | | Row 1 | $4150 |
| | | Row 2 | $4500 | | | Row 2 | $4528 | | | Row 2 | $4550 |
| | | Row 3 | $4900 | | | Row 3 | $4928 | | | Row 3 | $4950 |
| | Box 3 | Row 4 | $4D00 | | Box 3 | Row 4 | $4D28 | | Box 3 | Row 4 | $4D50 |
| | | Row 5 | $5100 | | | Row 5 | $5128 | | | Row 5 | $5150 |
| | | Row 6 | $5500 | | | Row 6 | $5528 | | | Row 6 | $5550 |
| | | Row 7 | $5900 | | | Row 7 | $5928 | | | Row 7 | $5950 |
| | | Row 8 | $5D00 | | | Row 8 | $5D28 | | | Row 8 | $5D50 |
| | | Row 1 | $4180 | | | Row 1 | $41A8 | | | Row 1 | $41D0 |
| | | Row 2 | $4580 | | | Row 2 | $45A8 | | | Row 2 | $45D0 |
| | | Row 3 | $4980 | | | Row 3 | $49A8 | | | Row 3 | $49D0 |
| Block 1 | Box 4 | Row 4 | $4D80 | Block 2 | Box 4 | Row 4 | $4DA8 | Block 3 | Box 4 | Row 4 | $4DD0 |
| | | Row 5 | $5180 | | | Row 5 | $51A8 | | | Row 5 | $51D0 |
| | | Row 6 | $5580 | | | Row 6 | $55A8 | | | Row 6 | $55D0 |
| | | Row 7 | $5980 | | | Row 7 | $59A8 | | | Row 7 | $59D0 |
| | | Row 8 | $5D80 | | | Row 8 | $5DA8 | | | Row 8 | $5DD0 |
| | | Row 1 | $4200 | | | Row 1 | $4228 | | | Row 1 | $4250 |
| | | Row 2 | $4600 | | | Row 2 | $4628 | | | Row 2 | $4650 |
| | | Row 3 | $4A00 | | | Row 3 | $4A28 | | | Row 3 | $4A50 |
| | Box 5 | Row 4 | $4E00 | | Box 5 | Row 4 | $4E28 | | Box 5 | Row 4 | $4E50 |
| | | Row 5 | $5200 | | | Row 5 | $5228 | | | Row 5 | $5250 |
| | | Row 6 | $5600 | | | Row 6 | $5628 | | | Row 6 | $5650 |
| | | Row 7 | $5A00 | | | Row 7 | $5A28 | | | Row 7 | $5A50 |
| | | Row 8 | $5E00 | | | Row 8 | $5E28 | | | Row 8 | $5E50 |
| | | Row 1 | $4280 | | | Row 1 | $42A8 | | | Row 1 | $42D0 |
| | | Row 2 | $4680 | | | Row 2 | $46A8 | | | Row 2 | $46D0 |
| | | Row 3 | $4A80 | | | Row 3 | $4AA8 | | | Row 3 | $4AD0 |
| | Box 6 | Row 4 | $4E80 | | Box 6 | Row 4 | $4EA8 | | Box 6 | Row 4 | $4ED0 |
| | | Row 5 | $5280 | | | Row 5 | $52A8 | | | Row 5 | $52D0 |
| | | Row 6 | $5680 | | | Row 6 | $56A8 | | | Row 6 | $56D0 |
| | | Row 7 | $5A80 | | | Row 7 | $5AA8 | | | Row 7 | $5AD0 |
| | | Row 8 | $5E80 | | | Row 8 | $5EA8 | | | Row 8 | $5ED0 |
| | | Row 1 | $4300 | | | Row 1 | $4328 | | | Row 1 | $4350 |
| | | Row 2 | $4700 | | | Row 2 | $4728 | | | Row 2 | $4750 |
| | | Row 3 | $4B00 | | | Row 3 | $4B28 | | | Row 3 | $4B50 |
| | Box 7 | Row 4 | $4F00 | | Box 7 | Row 4 | $4F28 | | Box 7 | Row 4 | $4F50 |
| | | Row 5 | $5300 | | | Row 5 | $5328 | | | Row 5 | $5350 |
| | | Row 6 | $5700 | | | Row 6 | $5728 | | | Row 6 | $5750 |
| | | Row 7 | $5B00 | | | Row 7 | $5B28 | | | Row 7 | $5B50 |
| | | Row 8 | $5F00 | | | Row 8 | $5F28 | | | Row 8 | $5F50 |
| | | Row 1 | $4380 | | | Row 1 | $43A8 | | | Row 1 | $43D0 |
| | | Row 2 | $4780 | | | Row 2 | $47A8 | | | Row 2 | $47D0 |
| | | Row 3 | $4B80 | | | Row 3 | $4BA8 | | | Row 3 | $4BD0 |
| | Box 8 | Row 4 | $4F80 | | Box 8 | Row 4 | $4FA8 | | Box 8 | Row 4 | $4FD0 |
| | | Row 5 | $5380 | | | Row 5 | $53A8 | | | Row 5 | $53D0 |
| | | Row 6 | $5780 | | | Row 6 | $57A8 | | | Row 6 | $57D0 |
| | | Row 7 | $5B80 | | | Row 7 | $5BA8 | | | Row 7 | $5BD0 |
| | | Row 8 | $5F80 | | | Row 8 | $5FA8 | | | Row 8 | $5FD0 |

**Table 2:** *Picture-page buffer/memory-address organization as discussed in the text.*

# WE ALL AGREE

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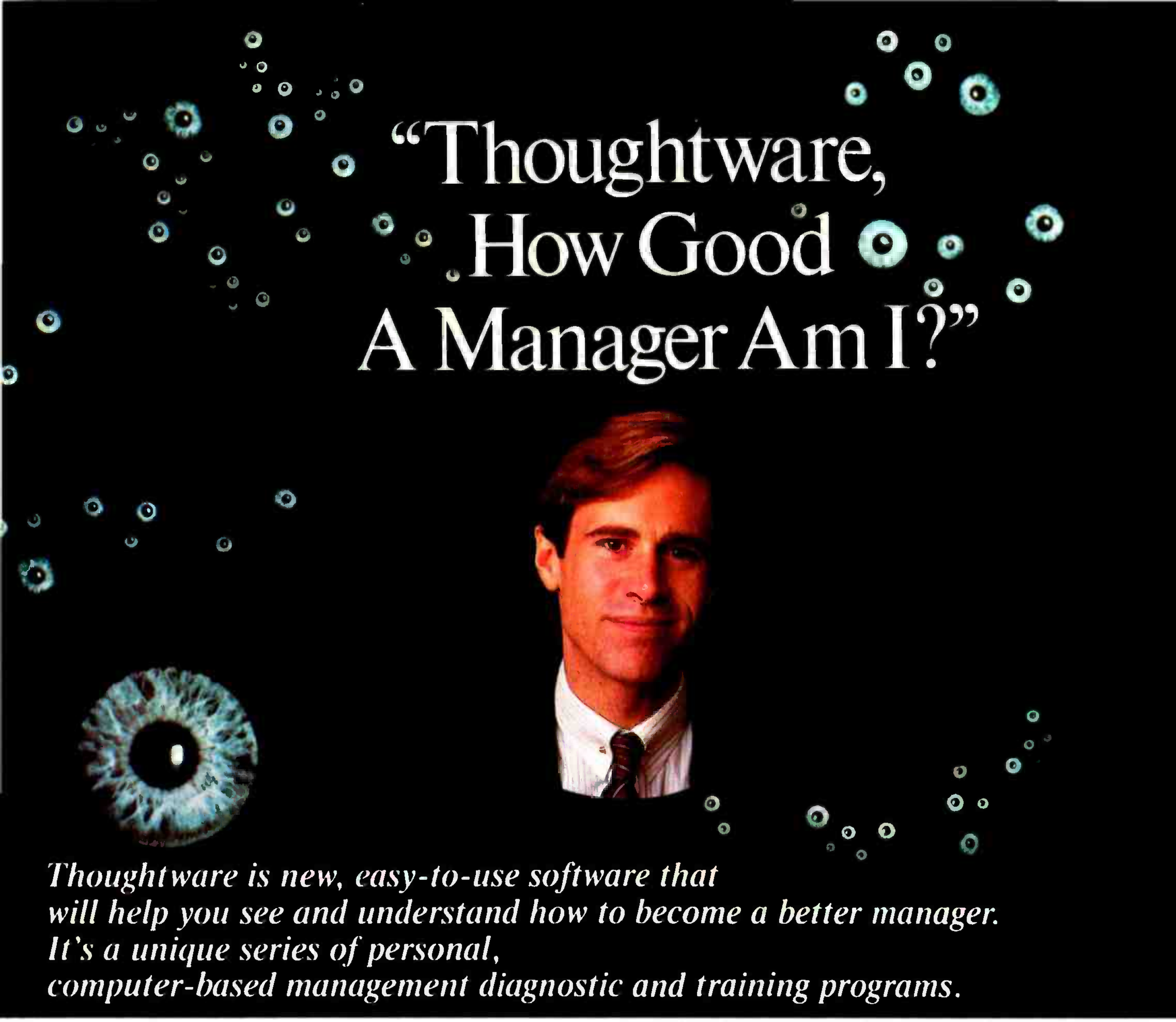


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**Listing 5:** *Left-to-right scroll routine.*

```
8700   A9 00      LDA  #$00     Initialize base address
8702   8D FE 87   STA  $87FE
8705   A9 40      LDA  #$40
8707   8D FF 87   STA  $87FF
870A   A9 02      LDA  #$02     Initialize block counter
870C   8D FD 87   STA  $87FD
870F   A0 08      LDA  #$08     Initialize box counter
8711   8D F7 87   STA  $87F7
8714   20 50 87   JSR  $8750    Jump to main routine
8717   18         CLC
8718   A9 28      LDA  #$28     Set up for second block
871A   6D FE 87   ADC  $87FE
871D   8D FE 87   STA  $87FE
8720   CE FD 87   DEC  $87FD
8723   D0 EA      BNE  $870F    Jump if second block not
                                   complete
8725   A9 06      LDA  #$06     Number of boxes remaining (two
                                   boxes reserved for text)
8727   8D F7 87   STA  $87F7
872A   20 50 87   JSR  $8750    Jump to main routine
872D   60         RTS           Return to calling routine
8750   AD FE 87   LDA  $87FE    Save base address
8753   8D FB 87   STA  $87FB
8756   AD FF 87   LDA  $87FF
8759   8D FC 87   STA  $87FC
875C   A9 08      LDA  #$08     Initialize row counter
875E   8D FA 87   STA  $87FA
8761   AD FB 87   LDA  $87FB    Set up LSB of right hand side of
                                   screen
8764   8D E3 87   STA  $87E3
8767   18         CLC
8768   69 02      ADC  #$02     Set up shift distance
876A   8D E6 87   STA  $87E6
876D   18         CLC
876E   69 FE      ADC  #$FE
8770   8D F0 87   STA  $87F0    Set up LSB of left hand side of
                                   screen
8773   8D F3 87   STA  $87F3
8776   EE F3 87   INC  $87F3    Next byte
8779   AD FC 87   LDA  $87FC    Set up MSB of
877C   8D E4 87   STA  $87E4       right hand side of screen
877F   8D E7 87   STA  $87E7
8782   8D F1 87   STA  $87F1       left hand side of screen
8785   8D F4 87   STA  $87F4
8788   20 E0 87   JSR  $87E0    Jump to shift routine
878B   18         CLC
878C   A9 04      LDA  #$04     Add 4 to MSB of
878E   6D E4 87   ADC  $87E4
8791   8D E4 87   STA  $87E4       right hand side of screen
8794   8D E7 87   STA  $87E7
8797   8D F1 87   STA  $87F1       left hand side of screen
879A   8D F4 87   STA  $87F4
879D   CE FA 87   DEC  $87FA    Decrement row counter
87A0   D0 E6      BNE  $8788    Jump if box not complete
87A2   18         CLC
87A3   A9 80      LDA  #$80     Set up next box address
87A5   6D FB 87   ADC  $87FB
87A8   8D FB 87   STA  $87FB
87AB   A9 00      LDA  #$00
87AD   6D FC 87   ADC  $87FC
87B0   8D FC 87   STA  $87FC
87B3   CE F7 87   DEC  $87F7    Decrement box counter
87B6   D0 A4      BNE  $875C    Jump if block not complete
87B8   60         RTS           Return to calling routine
87E0   A2 1B      LDX  #$1B     Set up byte counter
87E2   BD 00 40   LDA  $4000,X  Shift 2 bytes (14 points) right
87E5   9D 02 40   STA  $4002,X
87E8   CA         DEX           Decrement counter
87E9   E0 FF      CPX  #$FF
87EB   D0 F5      BNE  $87E2    Jump if shift not complete
87ED   A9 00      LDA  #$00     Clear left most 14 points
87EF   8D 00 40   STA  $4000
87F2   8D 01 40   STA  $4001
87F5   60         RTS           Return to calling routine
```

*Text continued from page 386:*

sider the total display to be made up of three *blocks*; each block is made up of eight *boxes*; each box is made up of eight *rows*. Table 2 shows a breakdown of the picture buffer organized so that each row has a memory address associated with it that defines the leftmost 7 dots (plus the associ-

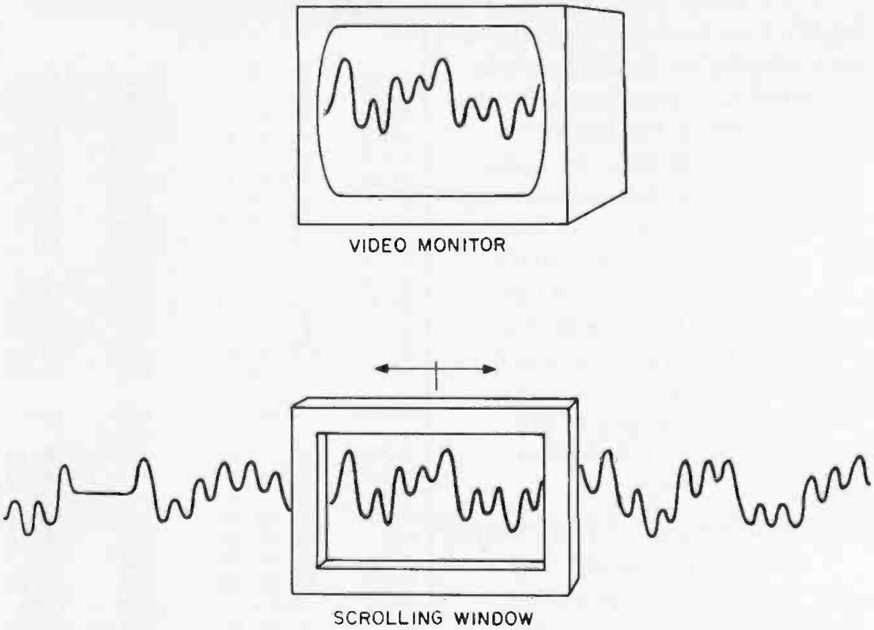


**Figure 2:** *A representation of how the scrolling-window software described in the text relates to the data displayed on the video monitor.*

ated color bit) for each horizontal line displayed on the screen. Notice that the memory address for each horizontal line on the display is not in sequential order with respect to magnitude, but that there is a repeating pattern.

The data-scroll routines let you control a window that permits examination of blocks of 209 adjacent samples of data. The position of this window is controlled by the left and right arrow keys (see figure 2). The data-scroll routines are broken up into two machine-language programs. Listing 4 gives the machine-language program that shifts data from right to left across the screen; listing 5 gives the routine that shifts data from left to right.

Without going into exhaustive detail, these routines move the contents of the picture-buffer memory so that the displayed data shifts either 14 data points to the left or the right on the screen. The rightmost (or leftmost) 14 data points are cleared so that new data can then be shifted in. The subroutines have to take into consideration the picture-buffer structure shown in table 2 (it would have been a lot easier if the picture buffer had been organized in a simple sequential manner). The shifting effect results in a window that can move back and forth across the memory block containing the digitized data.

## Conclusion

I encourage those of you with modest data-acquisition and data-analysis requirements to consider the use of a system similar to the one described here. In our laboratory, we have found it to be a relatively inexpensive way to pursue research interests and have no doubt that it will continue to be a valued part of our laboratory in the years to come. The only items required are an Apple II and the circuitry and listings presented here. ■

*Richard C. Hallgren is an associate professor in the Department of Biomechanics, Michigan State University, East Lansing, MI 48824. He works on applications of microprocessor-based systems to scientific research.*

**Author's Note:** *If you do not have either the time or capability to construct such a project, please write to me and I will direct you to a source for the hardware and the system software.*

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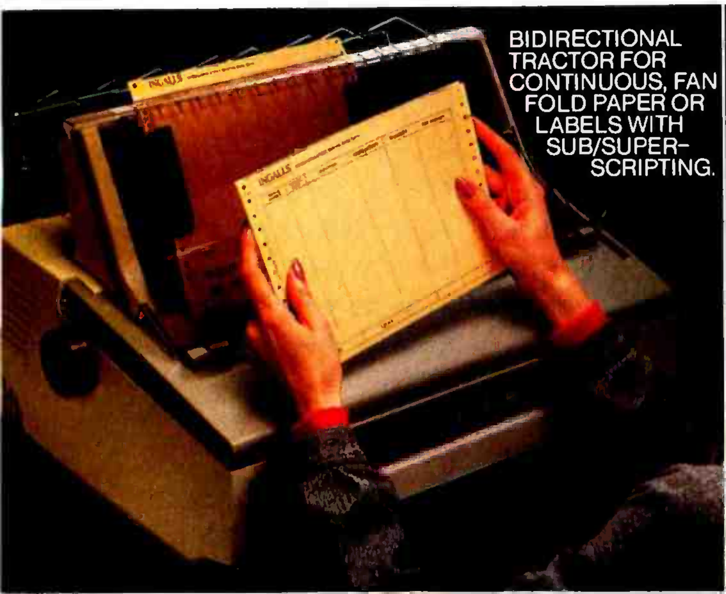



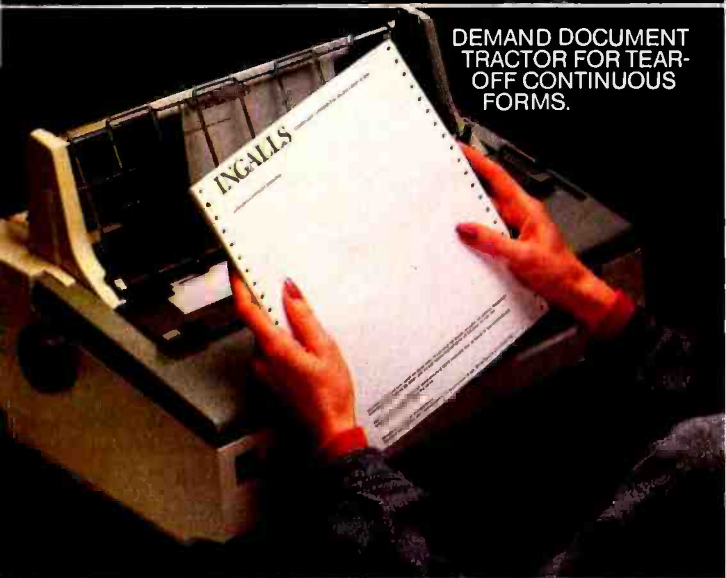


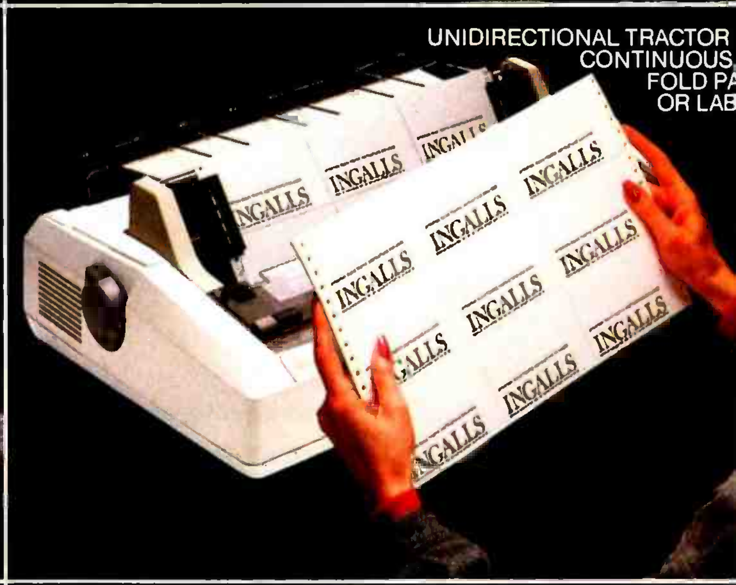



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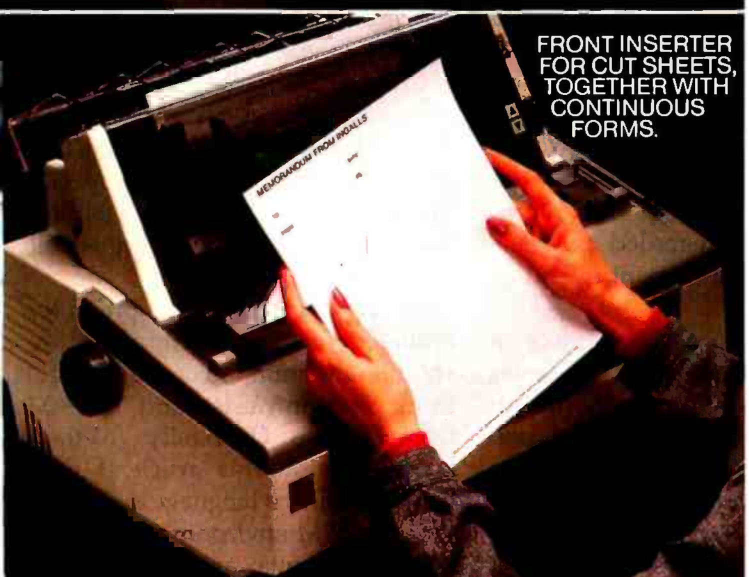



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**California State University**

The key to effective simulation is the availability of a mathematical model of the relationships between the system variables including accurate data. When this model is accurately programmed and validated, useful simulations can be performed. This programming usually involves the use of advanced techniques such as the solution of differential equations, random-number generation, graphics, and statistical analysis. Many simulation models involve thousands of relationships between variables.

It is hardly surprising that simulation, which is widely used by many who are not expert programmers, should have stimulated the development of special software aids including special simulation languages.

### Discrete and Continuous Languages

There are two groups of simulation languages that have a sufficiently wide area of application to warrant the title "general purpose." These are the discrete and the continuous simulation languages. Discrete simulation languages are applied mainly to problems arising in management sciences and operational research studies, particularly queuing systems. These systems remain in a particular state until an event occurs that causes a change in the state of the system.

This article, however, is mainly concerned with the second group, continuous-system simulation languages (CSSLs). A continuous system, as its name suggests, is one whose state changes continuously. The mathematical description of a continuous system is based on differential equations. A differential equation can be regarded as a relationship between a quantity and its rate of change.

For example, consider a piece of metal at a temperature of $x$ degrees F (Fahrenheit) cooling in an ambient temperature of 70°F. The rate of cooling is approximately proportional to the temperature difference

$$\text{Rate of cooling} = k(x-70)$$

Mathematical notation uses the $dx/dt$ to represent the rate of change of the quantity $x$ with time $t$. The notation $x'$ is also used—in the example, $x'$ is the rate of cooling of the metal object in °F/second.

The differential equation $x' = k(x-70)$ describes a continuous system in which the temperature $x$ is changing continuously as time passes. Simple models of this kind can be solved easily, but computer simulation comes into its own when more complex systems are involved with more complex differential equations.

In many practical applications it may be necessary to solve dozens or even hundreds of equations simultaneously. One of the main advantages of using a CSSL is that the numerical techniques necessary for solving these equations are built into the language. It is only necessary to specify the differential equation in a natural notation and the language does all the work.

Of the several CSSLs presently available for microcomputers, we should mention micro-DYNAMO from Addison-Wesley and TUTSIM from Twente University (Netherlands). Within this article, I shall focus on ISIM, a language developed for the CP/M environment. We will explore the syntax and capabilities of ISIM by creating a simulation of a rocket launch.

### ISIM—A CSSL for Microcomputers

ISIM is a development of the ISIS language (see text box), modified to run under the CP/M operating system. Even so, ISIM retains most of the notable features of its parent, several of which are unique to CSSLs on any kind of computer.

We start our description of the language with the way of defining differential equations. We have already

## CSSLs Before the Micro

*To appreciate current developments, we should know something about the history of CSSLs. The very first simulation languages for continuous systems date back to the mid-1960s when even general-purpose programming languages were still in their infancy. These early languages often required that the system be represented by a block diagram with function blocks representing operations such as integration, addition, multiplication, etc. The simulation program was prepared in the form of a table of connections of the inputs and outputs of the function blocks, one line per block. These languages are called* block-structured *and were popular because of the similarity of the block diagrams to analog computer flow diagrams. At that time, analog computers were widely used for continuous system simulation because of the limited power and speed of the available digital computers and block-structured languages were often used to check analog computer solutions.*

*As digital computers increased in power, they came to be used more for simulation in their own right, and the limitations of block-structured languages led to the development of* statement-structured *languages that bore a closer resemblance to general-purpose languages such as FORTRAN and Algol. These new languages featured a structure that simplifies simulation programming as well as special built-in functions to make system description easier. However, such languages were heavy users of computing resources, especially memory, so their use was confined to large mainframe systems. Perhaps the best known and most widely used CSSL of this vintage was the IBM product for the System 360: CSMP (Continuous-System Modeling Program). This type of CSSL is widely used for large-scale simulation of mainframes and the more powerful minicomputers.*

*In the 1970s, a number of simulation languages with rather different characteristics were developed. This was a period that saw a rapid expansion in the use of inexpensive minicomputers that were incapable of supporting full-scale CSSLs. Instead, CSSLs were developed specifically to exploit the advantages of minicomputers, particularly their ability to provide hands-on, interactive computing. These languages included ISIS, developed at the University of Salford (England) by Dr. John Hay and the author, and the DARE series of languages developed by Korn and Wait at the University of Arizona.*

*ISIS was an interpreter language written in FORTRAN (initially for the DEC PDP-8). It provided the basis for the ISIM language.*

seen one example; another is listed below:

```
VEL' = G * (THRUST - DRAG)
           /W - G
```

Readers familiar with FORTRAN or BASIC should be reasonably comfortable with this example. The only unusual feature is the use of a prime (′) to represent differentiation. We would use a second derivative (e.g., VOUT″) to define a second-order differential equation.

A complete model of a system will often contain a mixture of differential and algebraic equations. For example:

```
DYNAMIC
  W = 3000 - 40 * T
  DRAG = K * Y' * * 2
  Y " = G * (THRUST - DRAG)
     /W - G
```

These equations are a very simplified model of the launch phase of a rocket. The first statement uses the key word DYNAMIC to introduce the equations. *W* is the weight of the rocket plus fuel that is initially 3000 pounds, but is falling at the rate of 40 pounds per second. DRAG is the drag force that is proportional to velocity squared. The final statement relates the acceleration of the rocket *Y″* to the THRUST of the rocket motors, the DRAG, the weight *W*, and the gravitational acceleration *G*. THRUST is treated as a constant in this case and is set elsewhere in the program.

The part of the program depicted above is called the DYNAMIC region. It specifies the differential and related equations to be solved between an initial time (usually zero) and a user-specified final time. The solution proceeds in a step-by-step manner using a time increment that is also set by the user.

Before the DYNAMIC region can be processed, a certain amount of initialization of the model is needed. Time *T* must be set to zero and the initial values of *Y*, *Y′*, and THRUST (all zero) must also be set. These operations need only be performed once and this occurs in the INITIAL region that precedes the DYNAMIC region as follows:

```
INITIAL
  Y = 0; Y' = 0; T = 0
  THRUST = 7000
```

ISIM, along with most other CSSLs, also has a TERMINAL region for any calculations or output to be made after the completion of a run.

To be of any utility, a simulation needs output statements. Because CSSLs are concerned with time histories, the most useful types of output are tabulated numerical output or graph plots. These can be easily provided by ISIM statements of the form:

```
OUTPUT T, Y, Y'
for a table of values of T, Y,
and Y' and
PLOT T, Y, 0, TFIN, 0, 50,000
   for a graph of Y against T.
```

The OUTPUT statement automatically prints headings, selects number formats, and prints one line of output at regular intervals controlled by the user by setting the value of system variable CINT (communication interval). A sample of the output produced is shown below:

| T | Y | Y′ |
|---|---|---|
| 1.0000 | 0.0000 | 0.0000 |
| 2.0000 | 21.659 | 43.319 |
| 3.0000 | 86.984 | 87.330 |

The PLOT statement produces a graph plot of *Y* against *T* on a graphics terminal. The additional parameters specify that *T* will be plotted between zero and its maximum value TFIN (time final), another system variable set by the user. *Y* will be plotted from zero to 50,000 (the estimated maximum altitude of the rocket for this run).

## Encore Presentations

So far, our program is concerned with describing the system that is to be simulated and the form of output. All CSSLs also provide facilities for controlling a sequence of simulation runs, since it is rarely sufficient to simply make one run of the simulation with fixed parameters. Multiple runs may be made for several reasons: to observe the behavior of the system with different values of key parameters or initial conditions; or to run the same case with a different step-length for the numerical integration routine, to check on accuracy; or to run it with different OUTPUT or PLOT statements, and so on. (In simulation terminology, we are performing an experiment on the model.)

ISIM provides a slightly unusual but very flexible approach to defining the experiment compared to most other CSSLs. The conventional approach is to use RUN-control commands that change values and output requirements, and call for a single run. Setting up a sequence of runs using this approach can involve long lists of commands specifying each change with a RUN command for each run. The ISIM method is to incorporate the definition of the experiment into the program in a control section of code that appears before the model definition. This section of code can be written using looping and branching statements based on FORTRAN DO and IF statements. A run of the model is called using a SIM statement. This structure sees the experiment as a main program and the model as a subroutine. As an example, an experiment that calls for three runs with THRUST set to 6500, 7000, and 7500 pounds, and uses a time step (CINT) of 1 second to a final time (TFIN) of 50 seconds, can be programmed as follows:

```
:   ROCKET PROBLEM
    CINT=1.0; TFIN=50
    DO 10 THRUST=6500,7000,7500
    RESET; SIM
10  CONTINUE
```

The colon (:) signifies a comment line. The DO statement is like a FORTRAN DO. The 10 is a label that defines the range of the DO loop. CONTINUE is a do-nothing statement that simply provides a convenient place to terminate the DO. RESET initializes the model to the state it had before its last run and SIM calls for the simulation to be run. In the example, three simulation runs will be made with THRUST set to 6500, 7000, and 7500 pounds.

Our complete program is shown in listing 1.

ISIM has a number of other features, including functions and subroutines and special simulation functions. A feature common to most CSSLs is the PREPARE statement. The keyword PREPARE is followed by a list of variables. Rather than being tabulated or plotted, the value of the variables are stored in a disk file at each time step. They are then available at the end of a series of runs to be plotted in a variety of ways, the user having the choice of which variables and which runs are to be plotted. These graphs can be produced on a graphics terminal or as character plots on a video display terminal or printing terminal.

## Interactive Features

The full power of ISIM cannot be appreciated without some reference to its command structure, for it is through ISIM's commands that the interactive power of the language is made available. The ISIM system is always in one of two modes, command mode or program mode. In command mode the system prompt is "$" and in program mode it is "?".

When in program mode, ISIM statements are entered from the keyboard. The ISIM processor checks each line for syntax errors as it is input and generates an immediate error message when a fault is detected. Correct lines are translated to an intermediate code that is interpreted at run time (similar to the Pascal p-system).

To switch to command mode, type "$" followed by an ISIM command. Commands are available to list all or part of the current program ($LIST), to change, delete, or insert lines in the program ($CHANGE, $DELETE, or $INSERT), and to execute the program ($START). Alternatively, the program can be saved to a CP/M file ($SAVE), the program buffer can be cleared ($KILL), or a new program can be read from a file ($READ).

After a program has been executed, further commands can be used. The final value of any variable can be requested by using the command $VAL followed by the variable name. If the program contains a PREPARE statement, the $GRAPH or $TGRAPH command will produce graphs on a graphics terminal or alphanumeric terminal respectively.

Nor is this type of interaction confined to the end of a program run. Execution of the program can be interrupted and temporarily suspended in one of two ways: either at a predetermined point by inserting an INTERACT statement in the program at the point of interruption, or by simply pressing any key on the keyboard during program execution.

Once the program is suspended it is possible to request values of variables or change them, using the $VAL command. It is even possible to change the time step or the method of solving the differential equations for the remainder of the run. One can also change the output specification: the $OUTPUT or $PLOT commands override the effect of existing program statements, if any, and $XOUT or $XPLOT reverts to the programmed situation.

When these features are taken as a whole, they provide the ISIM user with the ability to interact with the computer in the development, execution, and evaluation of simulation models. The single-user environment of most microcomputers lends itself particularly well to this type of operation. Larger mainframes and multi-user minicomputers, though capable of handling larger programs, are often unable to support this degree of interaction. In many ways the microcomputer provides an ideal basis for interactive simulation, especially the more powerful 16-bit systems that can address more memory than the 8-bit systems.

**Listing 1:** *This rocket simulation model is run with three different values of thrust.*

```
:    ROCKET PROBLEM
     CINT = 1.0;TFIN = 50
     DO 10 THRUST = 6500,7000,7500
     RESET;SIM
10   CONTINUE
INITIAL
     Y = 0;Y' = 0;T = 0
:    THRUST IS NOW SET IN EXPERIMENT
DYNAMIC
     W = 3000 - 40*T
     DRAG = K*Y'**2
     Y' = G*(THRUST - DRAG)/W - G
     OUTPUT T,Y,Y'
     PLOT T,Y,0,TFIN,0,50000
```

## Where Do We Go from Here?

Shortage of memory restricts the power of the simulation system in two ways. One is that provision of a full range of facilities such as are present in ISIM takes a lot of code, more than can be handled at one time in 64K bytes of memory. Disk overlays are necessary, although no disk swapping occurs during actual execution of a simulation run. ISIM uses nine overlays. Second, the amount of memory that can be allocated for the user program is also restricted. The much larger available memory space of the 16-bit systems will largely eliminate these problems and an IBM PC (Personal Computer) version of ISIM is due to be released early in 1984.■

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**Software Information**

*To obtain software mentioned in article contact Crosbie, Hay, and Associates, POB 943, Chico, CA 95927.*

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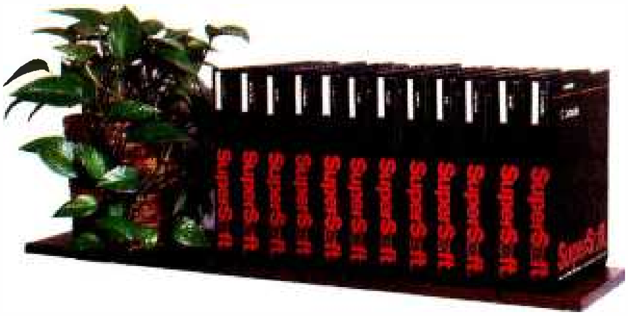


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| With IBM PC* BASIC | With SuperSoft BASIC with BCD math |
|---|---|
| 10 A=.99 | 10 A=.99 |
| 20 PRINT A | 20 PRINT A |
| 30 END | 30 END |
| Output: .9899999 | Output: .99 |

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- Boolean operators OR, AND, NOT, XOR, EQV, IMP
- Supports random and sequential disk files with a complete set of file manipulation statements
- IEEE floating point available soon as an option
- No run time license fee

| | |
|---|---|
| Requires: | 128K memory |
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## For CP/M-86®, MS DOS, and PC DOS

*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.

# Indexing Open-Ended Tree Structures

*How to "walk" through a "grove" of A-trees in search of hierarchical nodes*


**John Snyder**
**Disc Inc.**


One challenge to software designers is the problem of how to keep track of the elements within a hierarchy. For example, in a multilevel, menu-driven system, users always start with a main menu that lists the major functions. They select a major function, which may result in another menu of subfunctions. If it does, they then select a subfunction, which may result in still another menu of sub-subfunctions. When a function is completed, there should be a flexible, automatic selection of another function (e.g., return to the main menu or go directly to another subfunction menu).

Another example of a hierarchical structure is an assembly process, where, instead of a main menu, there is an assembled part and, instead of subfunctions, subparts.

Both examples represent open-ended tree structures. That is, each node may be a terminus, or it may be the origin of any number of subnodes.

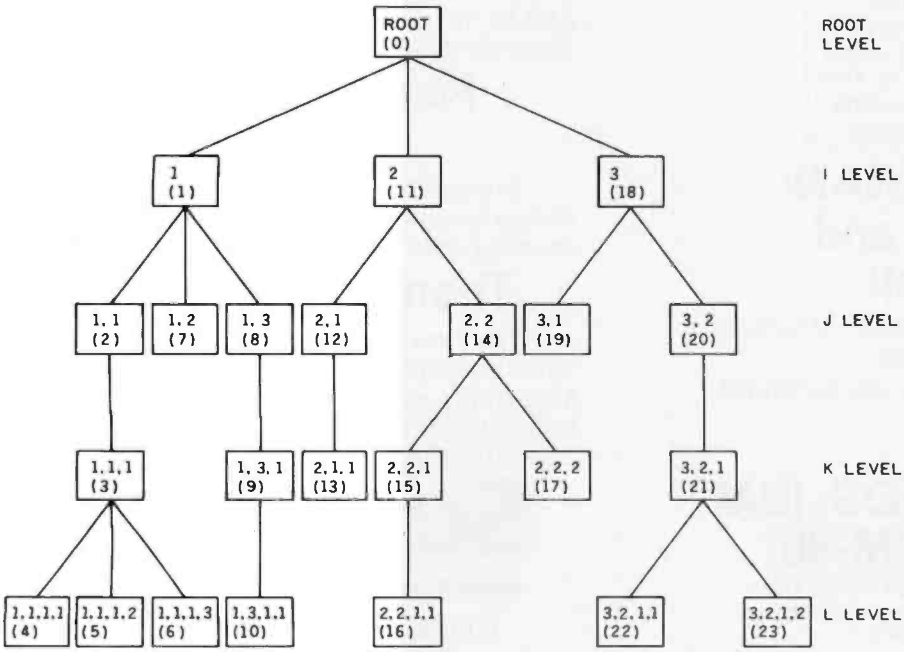


**Figure 1:** *In this sample A-tree, each box denotes a node. Each node is identified by two numbers: its subscript node number and, in parentheses, its element number. The subscript levels are depicted to the right of the tree.*

## Problems with Open-Ended Trees

For the purpose of menu (or similar selection-driven) processing, subscripts are the easiest index to use. For example, if we start each subscript with zero, then the main menu is 0, 0, 0, . . ., and the *I*th selection from the main menu is *I*, 0, 0, . . ., and so on.

Assuming that the depth of the tree is the longest chain of nodes, the tree can be structured as an array with its dimension equal to the depth, and it can be indexed by conventional subscripts (*I*, *J*, *K*, . . .). Actual entries in this multidimensional array may be record numbers, function codes, or whatever the application dictates. However, such an array will be lightly filled and subject to the restriction that entry *I*, *J*, *K* can exist only if entry *I*, *J* exists.

What is needed is a structure for looking up entry values that are indexed by subscripts without the prohibitive overhead of this potentially huge array.

## The A-Tree Solution

Instead of using a single multidimensional array, two one-dimensional arrays are used to effect a solution. The first array describes the tree structure and is called an A-tree ("A" for awkward). This array has one element for each node of the tree. By "walking" through the tree from top to bottom and from left to right, you can discover the relationship between the nodes of the tree and the array elements.

Figure 1 illustrates a sample A-tree. Each node is marked with its subscript reference number and with its A-tree element number in parentheses. The absence of unused lower-level subscripts emphasizes the open-ended depth of the tree. The values of the A-tree array describe the tree structure. Each element contains the number of subnodes originating from the node to which the element corresponds. The first three columns of table 1 list the A-tree array that corresponds to the sample tree in figure 1.

Clearly, the array uniquely defines the tree structure. Now, once you locate an entry in the A-tree array, the corresponding entry in the second array will contain the data needed for processing. Thus, the second array is a parallel reference array for the A-tree array.

| Subscript Node Number(s) (I, J, K, ...) | A-Tree Element Number (N) | A-Tree Element Value (A) | Element Value Sum (S) | A-Tree Difference Value (D) |
|---|---|---|---|---|
| Root | 0 | 3 | 0 | 0 |
| 1 | 1 | 3 | 3 | 2 |
| 1, 1 | 2 | 1 | 6 | 4 |
| 1, 1, 1 | 3 | 3 | 7 | 4 |
| 1, 1, 1, 1 | 4 | 0 | 10 | 6 |
| 1, 1, 1, 2 | 5 | 0 | 10 | 5 |
| 1, 1, 1, 3 | 6 | 0 | 10 | 4 |
| 1, 2 | 7 | 0 | 10 | 3 |
| 1, 3 | 8 | 1 | 10 | 2 |
| 1, 3, 1 | 9 | 1 | 11 | 2 |
| 1, 3, 1, 1 | 10 | 0 | 12 | 2 |
| 2 | 11 | 2 | 12 | 1 |
| 2, 1 | 12 | 1 | 14 | 2 |
| 2, 1, 1 | 13 | 0 | 15 | 2 |
| 2, 2 | 14 | 2 | 15 | 1 |
| 2, 2, 1 | 15 | 1 | 17 | 2 |
| 2, 2, 1, 1 | 16 | 0 | 18 | 2 |
| 2, 2, 2 | 17 | 0 | 18 | 1 |
| 3 | 18 | 2 | 18 | 0 |
| 3, 1 | 19 | 0 | 20 | 1 |
| 3, 2 | 20 | 1 | 20 | 0 |
| 3, 2, 1 | 21 | 2 | 21 | 0 |
| 3, 2, 1, 1 | 22 | 0 | 23 | 1 |
| 3, 2, 1, 2 | 23 | 0 | 23 | 0 |

**Table 1:** *A tabular representation of the sample A-tree. The first two columns contain the data from figure 1. Column 3 holds A(N), the element value that corresponds to N. Column 4 shows each node's* sum, *a number used to calculate its* difference, *which is shown in column 5.*

## The A-Tree Searching Method

The definition is simple enough, and the structure is certainly space efficient, but now that you have it, what do you do with it? Obviously, the A-tree cannot be interrogated by any conventional search method. You certainly do not want to do a "tree walk" to look up an entry every time.

It turns out there is a fairly effective—if not simple—method of scanning the A-tree array through the use of a *difference table*. This difference table is developed as follows: if $N$ is an A-tree element number, and $A(N)$ is its corresponding A-tree element value, first define the *sum* ($S$) for this element as $S(0) = 0$ and $S(N) = S(N - 1) + A(N - 1)$ for $N$ greater than 0. Then define the *difference* ($D$) for this element as $D(N) = S(N) - N$.

The last two columns of table 1 list the sums and differences for our sample tree in figure 1. You can now use the A-tree array and its associated difference values to find any subscripted reference. (The sums are only intermediate calculation figures; they are not actually used in the search.)

The basic algorithm is as follows: if $N$ is an A-tree element number that corresponds to a given node, and you wish to find the element number corresponding to the $I$th subnode originating from the given node, then, first, check $A(N)$ to make sure it exists, i.e., $A(N)$ cannot be less than $I$; then calculate $V = D(N) + A(N) - I$; finally, scan for the first occurrence of $V = D(M)$ with $M$ greater than $N$. Such an occurrence is guaranteed, and $M$ will correspond to the desired node.

Since the root is always element zero (0), and since the algorithm can be repeated for as many subscript levels as are necessary, you can find the element number of any combination of subscripts through successive scans.

For example, suppose you wish to find the A-tree element corresponding to subscripts 3, 2, 1 in the sample tree. Using table 1, start at the root and look for 3. Since $A(0) = 3$, you know 3 exists. Then, calculate

$$\begin{aligned} V &= D(0) + A(0) - 3 \\ &= 0 + 3 - 3 \\ &= 0 \end{aligned}$$

So, starting with element number 1, scan the differences for the first 0, located at element number 18. Looking now for 3, 2 (3, 2 exists because $A(18) = 2$), calculate

$$\begin{aligned} V &= D(18) + A(18) - 2 \\ &= 0 + 2 - 2 \\ &= 0 \end{aligned}$$

Scanning from element number 19, you will find the first difference of 0 at element 20. Finally (3, 2, 1 exists because $A(20) = 1$), calculate

$$\begin{aligned} V &= D(20) + A(20) - 1 \\ &= 0 + 1 - 1 \\ &= 0 \end{aligned}$$

Scanning from element number 21, you will find the first difference of 0 at element 21 and that completes your search. (This method can be mathematically proven by induction through the subscript levels.)

Programming this is much easier than it sounds at first, and it can be quite fast when you use string scan instructions. You can speed it up even more by saving the subscripts of the last node found and the pointers to each of its upward chain nodes. This enables you to start the next search with the lowest common node to the last node.

## Updating the A-Tree

Adding entries to or deleting entries from an existing A-tree is slightly tedious and involves shifting portions of the array. To add a new node, first check that a *back chain*, or entry for the next highest subscript value, exists. Then add 1 to the element value of the next highest subscript. Finally, insert a 0 in the appropriate location (a difference table search can be used to find this location), and shift all remaining entries up by one position.

To delete a node, reverse this procedure. First, check that no *forward chain* exists, that is, that the A-tree entry for the element to be deleted has a value of 0. Then, subtract 1 from the element value of the next higher subscript. Finally, delete the entry by shifting all remaining entries down by one position.

These procedures assume that you can insert or delete a *middle* node for a given subscript level. For example, you can add an entry between 2, 3 and 2, 4 as a new 2, 4, making the existing 2, 4 now 2, 5, and so on down the line. If doing this causes problems, you can modify these procedures to only allow adding or deleting the last entry at a subscript level.

## Comments on Applications

In actual use of an A-tree, you must determine the maximum number of nodes allowed in the tree and the maximum number of subscripts to be allowed for reference. If the A-tree reference array is being used for a limited resource, such as record numbers, it may be useful to keep deleted reference entries at the end of the reference array for reuse when new entries are added.

Note that each entry of the A-tree is the start of another complete A-tree. That is, every A-tree consists of a "nest" of A-trees. In the part assembly example, it may be useful to have a separate index on the A-tree array by part number. Such an index provides direct reference to each nested A-tree subpart. To demonstrate the handiness of the A-tree, imagine that you wish to find all of the unassembled subparts that constitute a given part. To do so, you need only search for all of the A-tree entry values of 0 between the given subpart and the next subpart at the same subscript level.

The reference array entries need not be unique. In fact, the same item may appear any number of times in a given tree. If such duplication is extensive and includes not only individual nodes but all subordinate subnodes, you can use reference "pointer" nodes. That is, after the first occurrence of a subtree, any other occurrences of the same subtree are represented by terminus nodes that point to the subtree's starting node.

You can even make "reentrant" references, pointing from one node to a node linked above it. Pointer nodes allow cross-branching and make the connectedness (and hierarchy) of the tree unlimited.

## Sample Programs

To illustrate the structure of A-trees, I have included listings 1, 2, and 3, functions written in C that perform the A-tree search algorithm. Routines Searcher and Findindx are open-ended (they do not know the overall length of the A-tree or the number of subscript levels it contains). As long as the lowest subscript value passed is 0, they will terminate properly. To accomplish this, it is necessary to define several work arrays (used exclusively by these functions) as arguments. ■

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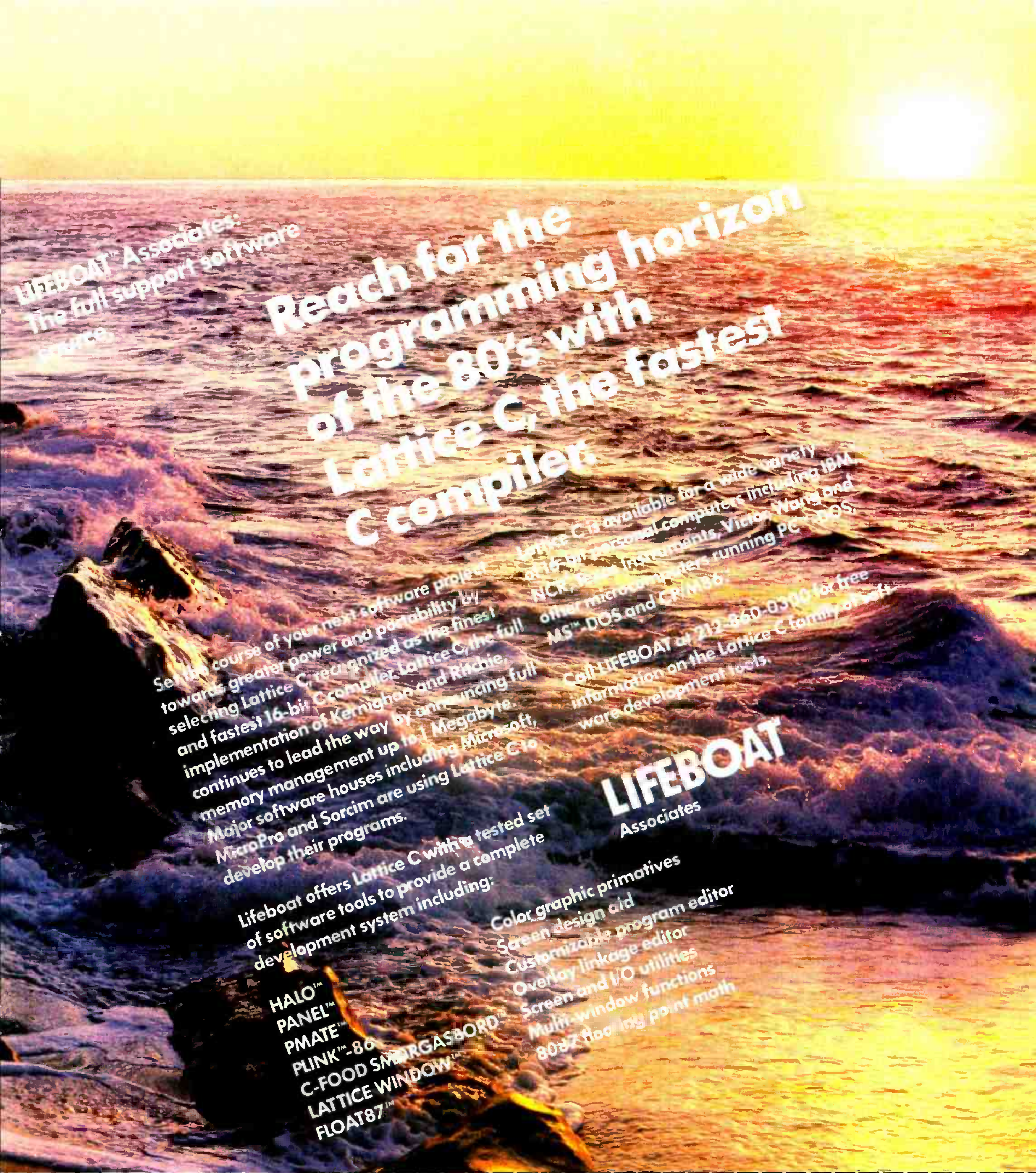
**Listing 1:** *Routine Calcdiff, written in C, determines the A-tree's difference values.*

```
/******************************************************************************
**                                                                          **
**      name            calcdiff -- Calculate the difference table for an   **
**                                  A-Tree                                  **
**                                                                          **
**      synopsis        calcdiff(atree, adiff, size);                       **
**                      int *atree;     Pointer to input A-Tree             **
**                      int *adiff;     Pointer to output difference table  **
**                      int size;       Number of entries in atree[]        **
**                                      and adiff[]                         **
**                                                                          **
**      description     If N is an A-Tree element number and A(N) is its    **
**                      corresponding A-Tree element value, first define    **
**                      the "sum" for this element as                       **
**                              S(0) = 0 and                                **
**                              S(N) = S(N-1) + A(N-1) for N>0.             **
**                      Then define the "difference" for this element as    **
**                              D(N) = S(N) - N.                            **
**                                                                          **
******************************************************************************/
calcdiff(atree, adiff, size)
int *atree, *adiff, size;
{
        int sum = 0, count = 0;
        do {
```

*Listing 1 continued on page 410*

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IBM and PC, ® TM International Business Machines
MS, TM Microsoft
CP/M86, TM Digital Research

*Listing 1 continued:*

```
            *adiff++ = sum - count;
            sum += *atree++;
      } while (++count < size);
      return;
}
```

**Listing 2:** *This routine, Searcher, finds the lowest common node between the previous and current sets of subscripts. This information is used to search in routine Findindx.*

```
/******************************************************************************
**                                                                           **
**      name          searcher -- Optimizer "front end" for findindx         **
**                                 function.                                 **
**                                                                           **
**      synopsis      index = searcher(atree, adiff, subs, last, inds);      **
**                    int index;      Output index to atree[] corres-        **
**                                    ponding to input subscript values.     **
**                                    Set to -1 if entry does not exist.     **
**                    int *atree;     Pointer to input A-Tree                **
**                    int *adiff;     Pointer to input difference table      **
**                    int *subs;      Pointer to input subscript array,      **
**                                    i.e., subs[0] = I, subs[1] = J, etc.   **
**                    int *last;      Pointer to array containing saved      **
**                                    values of last subs array (saved by    **
**                                    findindx)                              **
**                    int *inds;      Pointer to array containing saved      **
**                                    values of index corresponding to       **
**                                    each last[] value, i.e., inds[0] is    **
**                                    index for last[0],0,0,..., inds[1]     **
**                                    is index for last[0],last[1],0,...     **
**                                                                           **
**      description   searcher locates the lowest common node between the    **
**                    current set of subscripts and the last set of sub-     **
**                    scripts, adjusts pointers accordingly, and calls       **
**                    findindx to complete the search.  Note subs and last   **
**                    must be long enough to always allow an extra (zero)    **
**                    subscript at the end.  (Also, adiff, last, and inds    **
**                    could be local to calcdiff, searcher, and findindx.    **
**                    However, this would not allow them to be of arbi-      **
**                    trary length.)                                         **
**                                                                           **
******************************************************************************/
searcher(atree, adiff, subs, last, inds)
int *atree, *adiff, *subs, *last, *inds;
{
        int index = 0;
        while (*subs && *last && *subs == *last) {
                index = *inds++;
                subs++;
                last++;
        }
        atree += index;
        adiff += index;
        index = findindx(atree, adiff, subs, last, inds, index);
        return(index);
}
```

Listing 3: *The Findindx routine performs the actual search within the A-tree algorithm.*

```
/*****************************************************************************
**                                                                          **
**      name            findindx -- Search A-Tree for entry corresponding   **
**                                  to a given set of subscripts and return **
**                                  the index.                              **
**                                                                          **
**      synopsis        index = findindx(atree, adiff, subs, last, inds,    **
**                              index);                                     **
**                      int index;      Output index to atree[] corres-     **
**                                      ponding to input subscript values.  **
**                                      Set to -1 if entry does not exist.  **
**                      int *atree, *adiff, *subs, *last, *inds;            **
**                                      See function searcher for defin-    **
**                                      itions                              **
**                      int index;      Input starting index value set by   **
**                                      searcher                            **
**                                                                          **
**      description     If N is an A-Tree element number corresponding to   **
**                      a given node, and we wish to find the element number **
**                      corresponding to the Ith sub-node originating from  **
**                      the given node:                                     **
**                              (1)  First, check A(N) to make sure it      **
**                                   exists, i.e., A(N) cannot be less      **
**                                   than I                                 **
**                              (2)  Calculate  V = D(N) + A(N) - I         **
**                              (3)  Scan for the first occurrence of       **
**                                   V = D(M)  with M>N                     **
**                      Such an occurrence is guaranteed, and M will cor-   **
**                      respond to the desired node.  findindx performs this **
**                      algorithm recursively until a zero value subscript  **
**                      is encountered.                                     **
**                                                                          **
*****************************************************************************/
findindx(atree, adiff, subs, last, inds, index)
int *atree, *adiff, *subs, *last, *inds, index;
{
        int value;
        if (*subs == 0) {
                *last = 0;
                return(index);
        }
        if (*atree < *subs) {
                *last = 0;
                index = -1;
                return(index);
        }
        value = *adiff + *atree - *subs;
        do {
                index++;
                atree++;
        } while (value != *++adiff);
        *inds++ = index;
        *last++ = *subs++;
        index = findindx(atree, adiff, subs, last, inds, index);
        return(index);
}
```

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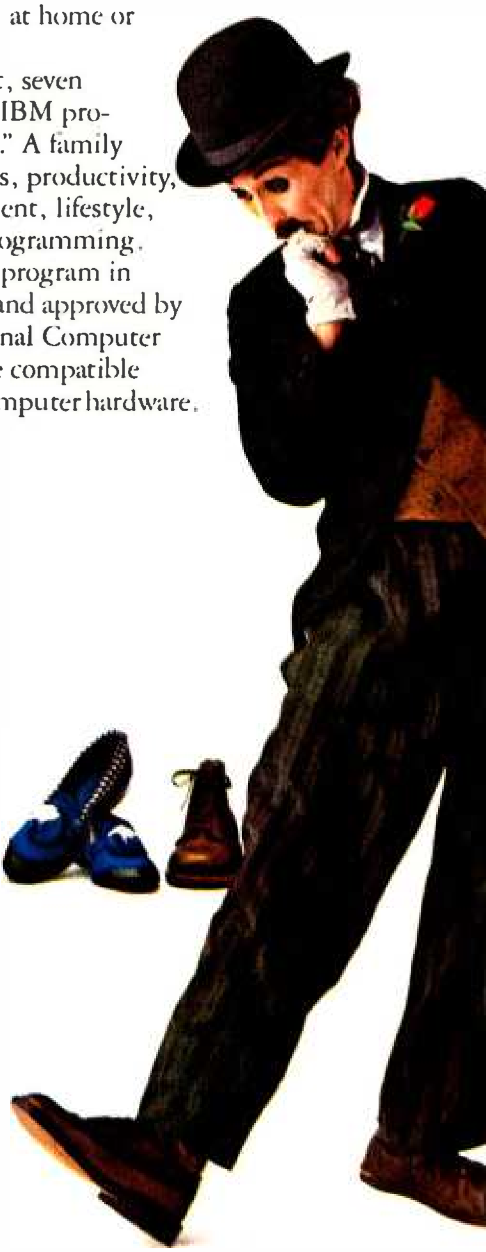

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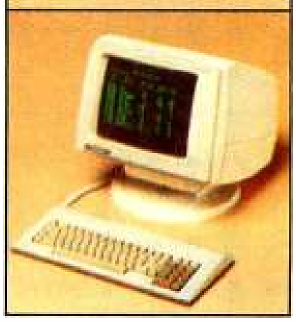

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# Using Comments to Aid Program Maintenance

*Complex software can be maintained more easily by the judicious use of remarks embedded within program code*

**Richard A. Thomas**
**Engineering and Mining Journal**

*DOCUMENTATION—noun (Latin documentum, "warning") 1. The promised literature that fails to arrive with the supporting hardware; 2. A single, illegible, photocopied page of proprietary caveats and suggested infractions; 3. The detailed, unindexed description of a superseded package.*
—From *The Devil's DP Dictionary* by Stan Kelly-Bootle

Real-life documentation comes disturbingly close to Kelly-Bootle's comic assessment, a fact bemoaned by programmers who have to set up, modify, or maintain software. Documentation is a critical part of program maintenance, and maintaining programs has been estimated to consume up to 50 percent or more of the average electronic-data-processing budget in a company.

Programming "comments" are a more important aspect of documentation than is generally recognized. Often these comments, written into the program code, are the only form of documentation a maintenance programmer uses when trying to navigate an unfamiliar program. In theory they are the programmer's guide to how a program works.

Comments are part of the "internal" documentation written for the programmer, as differentiated from the end-user's manual. But the industry is, as yet, without a standard for such comments or a widely accepted format for their placement. As many companies have found, rarely does this internal documentation—which includes flowcharts, pseudocode, and the listing itself, as well as the comments—contain all the information necessary for maintaining a program.

What internal documentation is present, according to Robert Glass and Ronald Noiseux in their *Software Maintenance Guidebook*, "is frequently out of date and thus, unreliable." Of the different types of often unreliable internal documentation, comments are perhaps the worst offenders. These remarks turn out to be inadequate, misleading, or dead wrong as much as half the time. And for better or worse, they tend to be the most long-lived documentation because they are embedded in the code itself.

## Problems with Comments

Comments are intended for people, not compilers. As such, they are most often set off by delimiters, the first of which signals the compiler to ignore the material that follows until it sees some terminating delimiter. Assembly language and all higher-level languages have some notation for setting off program comments. In assembly language, an asterisk or semicolon in column 1 identifies the line as a comment; in COBOL, an asterisk appears in column 7; in FORTRAN, a "C" is used in column 1; in RPG, an asterisk appears in column 7; and in APL, a special "jot" symbol is used.

According to one computer-industry study done in England, 10 generations of maintenance programmers maintain an average program before it is discarded and rewritten. If the intra-program documentation in this average program is up to date and explicit, many man-hours of code deciphering will be saved over the life of the program. If the comments are redundant, out of date, or otherwise misleading, maintaining the program will consume many budget dollars, frequently more than if the code had been completely uncommented.

Hence, comments sometimes are not only useless but also result in substantial hidden costs that pad the data-processing maintenance department's time sheets.

Why do comments so often fail to lower maintenance costs, and in some cases actually increase them? Problems with comments in listings appear to fall into one of five general categories:

1. Comments are present but not useful in understanding the code, usually because they are redundant, self-indulgent, or vague.
2. Comments are incorrect translations of the associated code.
3. Too many comments exist, causing distraction.

**Often these comments are the only form of documentation a programmer uses to navigate an unfamiliar program.**

4. Comments are absent altogether, leaving the maintenance programmer to guess at code meanings.
5. Comments are outdated, not having been maintained along with the code.

The first problem is the most common. Comments frequently echo the code, with no added value accruing to the reader. Redundancy is often the result of adhering to an arbitrary standard that specifies *x* number of comments for *y* number of coded lines. The programmer may find nothing much to say about the last three lines of code that the code does not say itself. The result is a trivial comment like "Multiply M by N and add result to total."

Redundancy also occurs because a programmer does not understand the meaning behind the program's application. For example, the programmer may insert comments like "Multiple price by quantity" or "Subtract Velocity1 from Velocity2 and divide result by Time" that echo the code, unaware that, in fact, "Revenue" and "Acceleration," respectively, are being calculated.

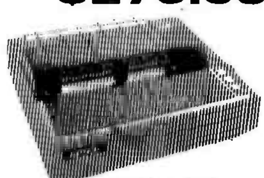
A programmer's egoism may also contribute to the lack of usefulness of the comments. Ed Yourdon, in his book *Techniques of Program Structure and Design*, writes, "Many programmers seem to write comments as personal messages to themselves, that is, to remind themselves of the purpose of the particular instruction or program statement they used. The personal note, though, may be completely indecipherable to anyone else."

Often a programmer's comments are vague and imprecise, seemingly written with the unconscious assumption that the maintenance programmer is a part-time telepath who can divine meanings from the ether. Some authors feel this supports the widespread belief that programmers hate to document and are notoriously bad writers. Yourdon further suggests that some software creators strike the superior attitude: "Any decent programmer ought to be able to understand this."

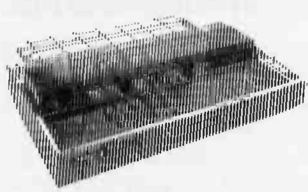
The second category, comments that don't even remotely agree with the associated code, is particularly costly. The maintenance programmer looking at such comments is, in a sense, starting from below zero on the understanding scale, not even knowing that the comment has actually said nothing related to the code. The maintenance programmer then falls victim to what Gerald Weinberg calls the "psychological set."

Loosely defined, the psychological set is a blind spot caused by what you believe to be true. If, as a programmer, you read an erroneous comment and then delve into the code, you will be hindered by what you "know." Yourdon and Weinberg both cite experiments indicating that maintenance programmers might at times be better off stripping all comments from the code before trying to debug or modify a listing. With some experienced programmers, this is already standard operating procedure.











The third category, too many comments, may come as a surprise to new programmers operating under the general academic edict that "more is better." The problem most often springs from arbitrary decrees concerning code/comment ratios (discussed earlier), from programmers not having enough to do, or from abortive attempts to document a particularly tricky or obscure piece of logic.

Since a maintenance programmer working in a high-level language is required to remember a wide range of variables, many of which are irrelevant to the present assignment, the addition of a barrage of unnecessary comments compounds the problem by distracting or misleading the programmer and thus reducing the readability of the code.

The fourth category, uncommented programs, resides at the opposite end of the spectrum. Yourdon does not mince words about the importance of comments in listings:

> In my opinion, there is nothing in the programming field more despicable than an uncommented program. A programmer can be forgiven many sins and flights of fancy . . . however, no programmer, no matter how wise, no matter how experienced, no matter how hard-pressed for time, no matter how well-intentioned, should be forgiven an uncommented program.

Reasons for not commenting a program vary considerably, but the result is usually the same—maintenance programmers wandering around for hours, chewing up pencils and scratching their heads, trying to puzzle out what 10 lines of code do in a 20-page listing.

Here are some reasons why code goes uncommented: (1) documentation gets skipped on "rush" projects; (2) the programmer believes the program is only going to be used once; (3) the programmer mistakenly thinks comments will take up too much space (a consideration only in very small microsystems); (4) the programmer believes the program will run substantially faster without comments; (5) the program is simple, and the programmer feels no one could misunderstand it; (6) the programmer is lazy.

The final category of problems, outdated comments, is only a subset of a larger problem, namely, outdated documentation. As I mentioned earlier, programs are around a long time before being put to pasture. The accompanying documentation, both internal and external, frequently becomes marginal or useless after a few changes are made in the software.

Many programmers simply do not bother to change comments to reflect their modifications. Usually, no review is made to discover whether comments have also been updated during maintenance. Getting the program back up and running is a company's only concern. Often when updates or refinements are made in the code, the maintenance programmer will document these changes at the top of the module or program, leaving a host of now-irrelevant comments in the body of the listing, to be tripped over by the next generation.

## Historical Treatment in Literature

After examining a sizable portion of the available information on program comments in both books and magazines, I can offer a few short generalizations.

First, most books on electronic data processing treat the subject superficially or not at all. This is especially true of journals, which, paradoxically, run a fair share of articles on documentation but seem unaware that this includes comments. On the other hand, those books that do treat the subject in some depth are very new (late 1970s through the early 1980s); hence, the ideas embodied in them are not yet widely disseminated. And, finally, much of the available literature is divergent, strongly opinionated, and somewhat dogmatic.

Regarding this last point, the most evident debate centers on how many comments are appropriate. Several authors advise liberal use of comments; some even presume to offer a numerical guideline (surprisingly, Yourdon recommends an average of one comment for every two to three lines of code). Other sources caution that the programmer be stingy with comments, using them only where absolutely necessary. Still others suggest that the question of how many comments misses the point—it is quality that counts.

Another debate concerns standards. Should they be applied to program comments, or will suggested guidelines suffice? Standards are accused of stifling creativity in some literature, while elsewhere they are lauded as the only means for controlling output.

A third controversy revolves around where important internal documentation should be physically located. While most internal documentation currently resides in manuals and other media separate from the actual code, several theorists believe the main documentation should be embedded within the code itself. Glass and Noiseux's text on maintenance "... recommends the 'heresy' that the listing be the place where most software documentation is placed. Nearly every requirement for documentation describing a program can be met and, in fact, probably exceeded by requiring the same information in the listing."

### Combating the Problem

Given the existence of high program-maintenance costs in the electronic-data-processing industry and the importance of comments to the maintenance programmer, what seems to be needed is a more structured approach to the use of comments. This means more extensive treatment in universities and colleges, specifically in programming and design classes, and the development within industry of more effective standards and other means for controlling how comments are used.

The suggestion that educators play a larger role in developing standards may raise the ire of instructors who feel they have treated the area sufficiently. What I suggest is a more formal approach to the use of programming comments with emphasis on (1) debunking the "many-comments" myth; (2) determining when to add comments in a program's development cycle; (3) deciding what to comment; (4) establishing where the comments are best placed, assuming options exist; and (5) working toward the "egoless programming" model, all detailed below.

Perhaps the dogma about the positive value of many comments should be de-emphasized and replaced by a better understanding of how and why comments should be used. Comments are a form of "defensive code" that should protect a maintenance programmer, much like "idiot-proofing" a program protects the data-entry clerk or the user.

The brief survey that accompanies this article (see the text box on page 421) is my own invention. Not meant to be a scientific sampling, the responses are from 100 people who work in the data-processing field, teach, or edit computer journals. The survey points out that many data-processing professionals append comments after they are finished coding, a practice that goes relatively undisputed (and largely unaddressed) in the classroom. However, several writers suggest that this temporal separation is far from optimal.

According to Eric Weiss in *Computer Usage—Fundamentals*, "Too often, programmers wait until they have finished their programs before turning to documentation. THIS IS A SERIOUS MISTAKE. The programmer can save effort and time, and make his documentation much better, simply by documenting his program as he prepares it." Yourdon reinforces this: "Documentation can be just as useful during the design and implementation of a program as it is afterward. The very act of writing documentation usually forces the programmer to reexamine the basic workings of his programs."

Authors' opinions vary on which specific elements of a program require comments. However, a few generalizations are available to guide the new programmer. Among the most important of these is Weinberg's

## Comments on Comments

*The survey results below represent a sampling of 100 data-processing executives, teachers, and computer-magazine editors, all of whom have had experience with program analysis. Participants were not selected by means of any statistical pattern, and their responses are meant only as a straw poll on the subject of programming comments.*

1. *Does your organization use any project-documentation standard? (sample size (N) = 100 respondents; average number of years experience = 8)*

   *Yes: 67*
   *No: 33*

2. *If your answer to question 1 is Yes, does the standard contain any rules or guidelines concerning the use of comments in program listings? (sample subset = 67)*

   *Yes: 23*
   *No: 15*
   *I don't know: 29*

3. *When do you insert or attach comments to programs that you are creating? (N = 100)*

   *Before: 8*
   *During: 73*
   *After: 35*

   *(11 people checked more than one answer: 5 checked all three, 6 checked During and After coding)*

4. *How useful are other people's comments in helping you to understand, modify, and/or maintain their programs? (where 1 = very useful, 5 = no value, and 10 = harmful)*

   *Average = 341 points divided by 100 respondents = 3.41*

5. *When maintaining/modifying someone else's code, do you change old comments to reflect your updates?*

   *Rarely: 24*
   *Usually: 28*
   *Frequently: 11*
   *Always: 37*

6. *How successful were the creators of COBOL in their attempt to make a language "self-documenting"?*

   *Unsuccessful: 21*
   *Somewhat successful: 65*
   *Very successful: 14*

reminder that the whole idea of a comment is to prepare the mind of the reader for a proper interpretation of the instruction to which it is appended. A brief sampling of authors' suggestions on what should be commented includes the following recommendations:

- Comment all data, since understanding data is often the key to understanding the program.
- Distinguish between true constants and initialized variables via comments.
- Introduce all modules with comments—a practice that often helps the programmer recognize that a module is not functionally cohesive. (Some authors even suggest putting the pseudocode at the top of each module.)
- Comment all "tricky" or obscure logic; however, it is better to make such logic "untricky." As a rule it is better to rewrite such code.

Most authors agree that comments *should* be physically offset from the associated code. Weiss suggests that comments can be handled more easily as insertions between instructions than as attachments to the instructions themselves; the comments can then be changed readily without having to retype or repunch any instruction, which may allow new errors to creep in.

In other scenarios, comments can be consistently indented or even highlighted with underlines or boldface. Glenford Myers suggests in his book *Software Reliability: Principles and Practices* that comments be offset to the extreme right of a listing, permitting a programmer to examine the code without interruption. In his words, comments "should be analogous to footnotes in a book."

A programmer should view the code as a part of the entire project rather than his or her personal, fragile baby. With regard to comments, this means recognizing that a given piece of code does not rise and set by its creator's word. Other people will rework it, probably many times over. Ego pursuit can even blind the programmer to the fact that a module may have unintended interactions with other modules, a problem for which the art of comment writing has few remedies.

Classroom discussions on the five concepts above cannot singlehandedly combat the future drain on financial resources caused by poor commenting. The electronic-data-processing industry must also establish and support more explicit standards or guidelines for using comments.

"Programs written to standards, whatever else may be said about them, are usually more predictable and therefore often easier to get aboard more quickly. That, in turn, contributes to preventing maintenance," say Glass and Noiseux, who express a preference for general guidelines over less flexible standards. They further call for an audit to see that comments are inserted properly.

Unfortunately, the industry appears remiss in driving these points home. An unexpectedly high percentage of the data-processing professionals surveyed have no project-documentation standard in their companies (see survey question 1).

Two other points about standards for comments are worth mentioning.

First, their quality must be high—clear, concise, well-written—or they will simply be ignored. Second, as William McGee emphasizes in *Effective Program Development—The Choices*, supervisors' reinforcement must be positive and regular, with support from all levels of management. Standards alone will not produce high-quality documentation.

## The Future

Comments are necessary because programs are cryptic. In this writer's opinion, it is a safe bet that compilers of the future will support more self-documenting, more English-like programming languages, thereby reducing the need for comments.

However, current efforts at making languages self-documenting have met with only limited success. The industry's greatest attempt to create a self-documenting language—COBOL—was only partly successful (see the final survey question).

Until self-documenting languages achieve better results, industry will operate on a "show-me" basis. Companies are slow to incorporate new approaches without concrete cost/benefit data. And no panaceas will permanently roll back maintenance costs into insignificance. Glass and Noiseux conclude: "No matter how well the preventive maintenance task is performed, we must face the onerous fact that the majority of the effort will be simply hard work. Only by thorough, painstaking attention to the detail of the program can some problems be resolved." ■

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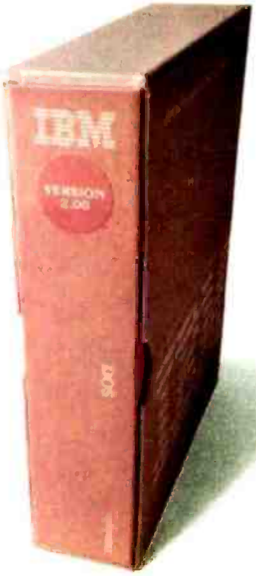


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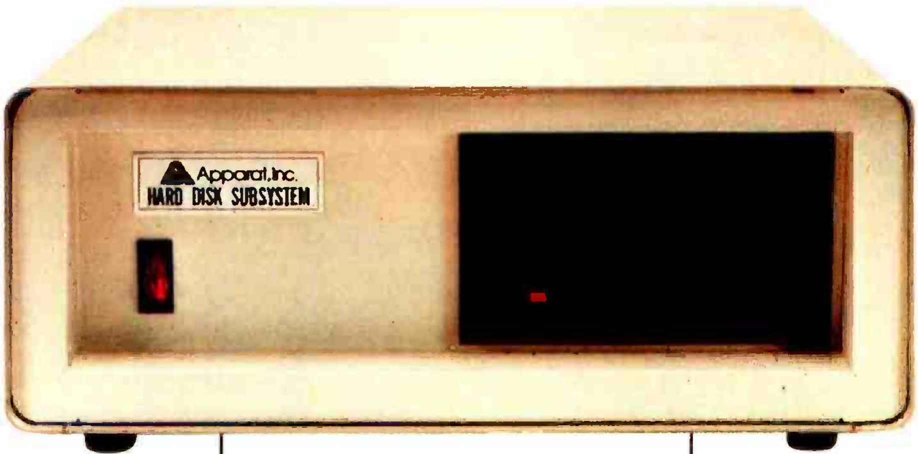


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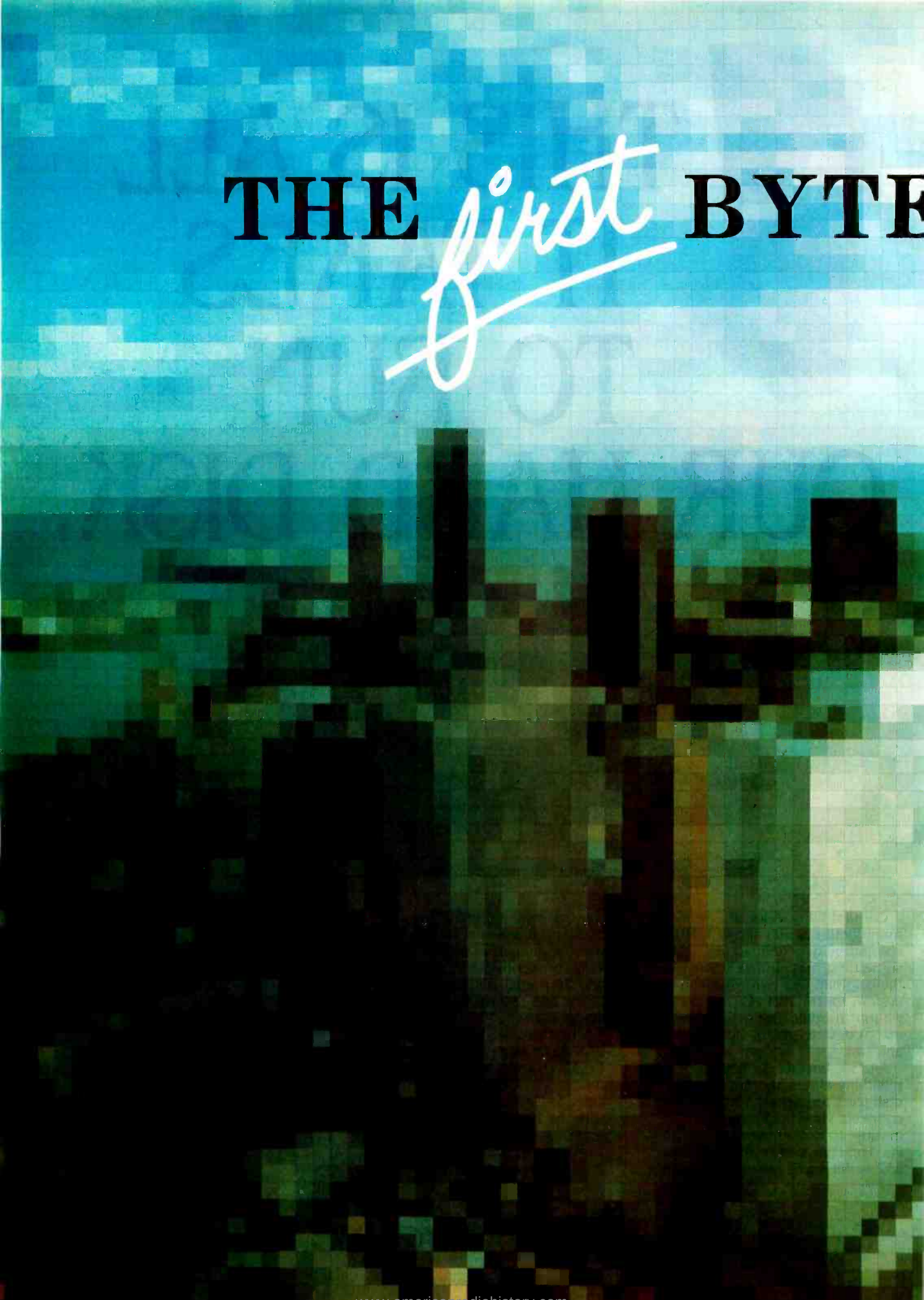
THE first BYTE

# BYTE's User to User

## Conducted by Jerry Pournelle

### Heathkit Happiness

Dear Jerry,

I was very disappointed with the "Heathkit Horror" letter written to you by Mr. Richard J. Townsend (January, page 452). I feel very strongly that Mr. Townsend didn't convey the whole story of his experience with his H-100 kit.

Building a Heathkit is not an electronic experience; it is an experience in following a long, detailed checklist. My wife knows very little about electronics but has successfully completed several Heathkits. She uses her skills as a seamstress (which includes following instructions) to complete the kits.

My rampant curiosity over Mr. Townsend's letter led me to call a Heath store with the same, but hypothetical, problem. We worked with the assumption that the board was ruined when it was half completed. I was offered several options. I could buy a blank board for $25 and start over again. I could then finish the new board with the unused components. I might have to buy replacement parts for the ones I couldn't salvage from the ruined board. If the parts were not on hand, they could be ordered to arrive in 5 to 10 days. This option would cost between $40 and $75, a cheap lesson in carefulness.

If I were really in a hurry, and free with my money, I could buy the entire disk-controller kit (H-207) for about $395 and start fresh. Again, if not on hand, the delay would be no more than 5 to 10 days.

This consultation was conducted over the telephone, free of charge and mine for the asking. Mr. Townsend probably could have had this information had he asked for it.

Digging a little deeper, I figured that the "local Heath store" for Orinda, California, was probably the El Cerrito store. I gave the "We Won't Let You Fail" folks there a call to find out how Mr. Townsend's problem could fall through the cracks. When I called, the problem had been long solved. The end of the story for Mr. Townsend was a brand-new, fully assembled, functionally checked, disk-controller board.

According to the Heath folks, this is the current policy for customers that fry that particular board during construction. That is part of the attitude that makes me a loyal Heath/Zenith customer. It would be a cold day in a fiery place before I would expect Radio Shack or IBM to serve their customers out of pocket like that.

**Daniel J. Epright**
**Murfreesboro, TN**

*Thanks for tracking down the end of the story. I know the Zenith folks were pretty upset when they saw Townsend's letter, but it arrived there during a blizzard in Illinois, and I missed the rest.*

*I agree that assembly of Heathkits is in large part an exercise in carefully following instructions. I know five or six people who've built their own Z-100s, and they're all happy with them. They also understand their computers better. If you have the time, it's not a bad way to get into the computer revolution. . . .*Jerry

### In Defense of CB-80

Dear Jerry,

I've noticed Modula-2 growing on you over the last several months. I don't want to start a contest between it and CB-80 but merely address an issue you raised in your January User's Column on page 80.

To me, it was good news, not bad news, to discover that CB-80 does no range checking on array indices. It seems to me that wherever an index could get out of range, the program has to check it anyway so as not to crash, even if there is an error message. Much array work is controlled by loops. In those situations, the speed gained by skipping the range check may be valuable. In other words, automatic, low-level range checking would be, in any actual case, either unnecessary or inadequate at run time. True, its absence can put a burden on the programmer—one more possible mystery to debug—but I think it's worth the burden. Of course, the new structure certainly ought to have been documented.

CB-80's not checking ranges and not insisting on a DIM statement (being satisfied with a declaration) are the very things that provide a way to write functions that operate on arrays. The installment of my series in the February *Lifelines* offers the idea in the course of a discussion of array structure. In particular, you can write function KILARY%, which recovers the space of an array as you suggest. It is a bit cumbersome, I admit, and you need one for each dimensionality. And it sure would be nice if we could pass arrays to functions more easily. Still, it does the job; to me, the overall speed and simplicity are worth the effort in the relatively few cases where they're needed.

One other point. As I understand it, the unassigned value of a string is not exactly a default, but no value at all. The compiler allocates a word of space to each string mentioned in the source; the value of that word is zero until the string is assigned, at which time the value becomes a pointer (SADD) to the string. The assignment NULL$ = "" compiles a constant consisting of a length word of zero and, at run time, copies that constant to a new place whose address is placed in the allocation for NULL$. The address of the allocation, of course, is VARPTR(NULL$).

**John S. Coggeshall**
**Philadelphia, PA**

*Of course, one person's bug is another's feature; my problem with CB-80 is that it's all too easy (for me, anyway) to write code that can sometimes let a subscript exceed its intended range; the resulting crash gives no indication whatever that this is the problem.*

*The original CB-80 really was Compiled CBASIC; that meant you could compile your program under CBASIC, which, being only pseudocompiled and then interpreted, was very slow but had range and dimension checking. This made it simple to test programs, and when they ran properly under CBASIC, you could compile them for speed.*

*Alas, the last versions of CB-80 have nifty features that were not added to CBASIC.*

*Programming "philosophy" varies with the programmer. Those who spend a lot of time writing programs will generally prefer speed of execution to programmer convenience. In my case, though, programming is something I do along with many other things, and I need all the help the computer can give me. One of the values of Pascal is that once you get a program past the compiler, the program generally does what you wanted it to do. CBASIC used to work that way; CB-80 doesn't. I hate to think like a computer: I want the compiler to catch my mistakes.*

*Incidentally, Digital Research tells me it's looking at a number of possible upgrades to CB-80, including having a special compiler that would do range checking and other debugging assistance. That should be good news to CB-80 enthusiasts. . . .* Jerry

## Jerry Quixote

Dear Jerry,

Yesterday I opened my latest purchase of software for my IBM PC. It's a 6805 cross-assembler by Avocet Systems of Dover, Delaware. I am aware of your software disclaimer crusade and I thought that you should see what I found in my licensing agreement.

Sit down.

The manufacturer actually guarantees the software will work or it will fix it; if the company can't fix it, it will give my money back.

I have included a copy of that section of the disclaimer where Avocet doesn't disclaim anything.

Don't get cocky, but I think you may have knocked over a small windmill.

**Thomas Quinn**
**Blue Bell, PA**

*I saw the Avocet people at CP/M East, just after my tirade about the company's previous disclaimer appeared in print. They were very polite and said they intended to make real changes in the licensing agreement. However, I never received the update. Thanks. It's quite reasonable. That's an agreeable surprise.*

*Now for the larger windmills. . . .* Jerry

## Almost Persuaded

Dear Jerry,

A couple of comments concerning FORTH: first, Leo Brodie, who wrote *Starting FORTH*, has completed a sequel, *Thinking FORTH*, to be published this spring by Prentice-Hall. I have read the manuscript and it is excellent. The first part of the book, in which he discusses general precepts of programming, will be of interest even to non-FORTH programmers. I hope that you will have an opportunity to read the book.

FORTH, unlike most computer languages, was developed and refined "in the field" by practicing programmers who faced real-world tasks and demands. Its structure and methods stem directly from the need to get the job done with minimum use of critical resources: computer memory, computer power, and programmer time. FORTH was thus designed so that programs written in it would be easy to write, modify, and maintain.

FORTH, like Modula-2 and Pascal, is compiled, but in FORTH compilation is immediate upon the definition of a word, and the new word is called merely by invoking its name. This frees the programmer from various intermediary complexities (separate compilation, linking, etc.). More important, it allows for immediate, on-the-spot testing and use of each small unit, which permits the programmer a natural and iterative process of development.

The immediacy of the compilation, and the brevity of definition that allows, enables the programmer to interact with the program as it is written. In situations in which the feedback from one's actions is immediate, one can achieve a state of mind in which one's efforts and effects each shape the other and consciousness merges with the process so that one

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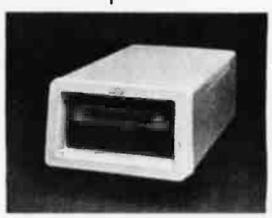

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becomes "lost" in the work—a maximally productive state of mind. This state of mind is familiar to most artists. In their work with brush, pencil, or clay, they are in immediate contact with their medium—they can try something, see what it does, and let that result shape their next step. It is familiar to actors, to athletes, and to all who get immediate feedback as they work.

It is unfamiliar to most programmers simply because most programming languages are structured and implemented in a way that presents a barrier to immediate feedback, that erects a wall of time and procedures between idea and result, and that discourages impromptu casual experimentation that leads to serious experimentation that leads to this creative state of mind.

Although a computer program is purely a work of the mind, few programming languages pay attention to how the mind works: the way people deal with "chunks" of information, the relatively small number of "chunks" that can be active at any one time, the importance of *names* for these chunks, the processes of analysis—dividing large tasks into small tasks—and synthesis—combining these pieces synergistically into a whole—and the importance of immediate, interactive feedback, as described above. The programmers who created FORTH perhaps did better than they realized, because FORTH's structure matches in all important ways the processes by which people create expressions of their ideas.

Moreover, FORTH's internal structure and mechanisms are so few and so simple that the programmer can look inside it and understand exactly how it works; such an understanding is also a key component of a good tool, because the programmer gains from it a strong sense of control and confidence that enables him or her not only to get the most from the FORTH as he or she received it, but also to extend the language to address novel situations and unique problems.

That is why FORTH programmers become so devoted to this language: like any good tool, it *fits*. It is shaped to match the user, and thus feels like a natural extension of the user's own capabilities. It doesn't get in the way but allows the user to focus on the problem at hand. And because FORTH so well matches the way we work, it even helps in solving the problem. Who could ask for more?

**Michael Ham**
**Iowa City, IA**

*You make such a good case for FORTH that I'm tempted to try it. Alas, I don't seem to have any good current implementation for any of the machines I have, and I suspect that by the time I get one, I'll have lost the impulse; but perhaps not.*

*I know something of the creative mood you speak of; indeed, I'm reminded of some of my best programming efforts, which were done in BASIC, when I first started playing with these machines. Those programs have long since been converted to more efficient languages, but their concepts remain pretty good.*

*Certainly FORTH produces devoted and enthusiastic followers! . . .* **Jerry**

### More on Modula-2

Dear Jerry,

I am following with great interest your comments on the fascinating language Modula-2. I have two questions: Are there any publications, in addition to Dr. Wirth's book? What is the address of the


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| n | Time (seconds) | Result* |
|---|---|---|
| 30 | 2.2 | $2.48199 \times 10^6$ |
| 40 | 4.9 | $8.1533 \times 10^6$ |
| 50 | 9.2 | $2.053552 \times 10^7$ |
| 60 | 15.6 | $4.369284 \times 10^7$ |
| 70 | 24.5 | $8.272824 \times 10^7$ |
| 80 | 36.3 | $1.4384182 \times 10^8$ |
| 90 | 51.5 | $2.3429192 \times 10^8$ |
| 100 | 70.4 | $3.6250627 \times 10^8$ |

*Computed to single precision (24-bit mantissa), so trailing digits may be nonsense

**Table 1:** *NS16032 timing results.*

| n | Time (seconds) | Result* |
|---|---|---|
| 30 | 246.45 | $2.48199 \times 10^6$ |
| 40 | 584.04 | $8.1533 \times 10^6$ |
| 50 | 1107.93 | $2.05355 \times 10^7$ |
| 60 | 1899.90 | $4.36928 \times 10^7$ |

*Computed to single precision (24-bit mantissa), so trailing digits may be nonsense

**Table 2:** *Timing results of largest cases that fit into the Olivetti M20 (in BASIC).*

Modula Research Institute? I thank you in advance for the information.
**A. Vargas**
**New York, NY**

*The documents that come with Volition Systems Modula-2 are about the best introduction to the language I know of. I know of no other Modula-2 introduction in print except for Wirth's book, which some claim to be a sure cure for insomnia. Dr. Michael Hyson and I are writing a tutorial and introduction that ought to be in print next fall.*

*A lot of Modula-2 software is in the public domain and can be obtained from Modula Research Institute, 950 North University Ave., Provo, UT 84604. . .* **Jerry**

## Timing the NS16032

Dear Jerry,

Seeing your reminder in the December 1983 User's Column (Kazango!, page 92) galvanized me into—well, reduced sloth. Table 1 shows the $n \times n$ time results for an NS16032 CPU with NS16081 FPU running at 10 MHz and no wait states. The program is the Pascal version. Table 2 illustrates the results from my Olivetti M20.
**Richard Mateosian**
**Berkeley, CA**

*That 16032 is fast! The chip looks awfully good; a lot of minicomputers can't do what the 16032 can do. Now all we have to do is get systems using it . . .*

*Bill Godbout tells me he'll have an S-100 version running fairly well late this spring, but it will be for development work only; users will have to wait a year or so. . .* **Jerry**

## QX-10 CP/M Utilities

Dear Jerry,

You've mentioned that Barry Workman is putting a number of CP/M utilities into Epson QX-10 format, available for a reasonable charge. What are they, and how can they be gotten hold of? I love the machine, but as you know, obtaining formatted software is a royal pain in the neck. Naively I contacted my dealer, expecting her to access some programs. She referred me to an "Epson Hot Line," which turned out to be a wholesale distributor of Epson programs in California. The only way that software could be obtained, however, would be by having my dealer contract to buy programs from them. Help!
**Irene Matiatos**
**Jackson Heights, NY**

*Barry has a number of CP/M general-purpose utilities, such as disk catalogs, directory handlers, erased-file recovery programs, etc., which he sells at reasonable prices. Recently he put a number of them over onto the Epson QX-10.*

*I have an experimental copy of Wordstar for the Epson; it seems to work fine.*

*For the utilities, you need to talk to Barry Workman at (818) 796-4401. For Epson Wordstar, you'll need to write Micropro; it should have it commercially available by now. . .* **Jerry**

## Another Valdocs User

Dear Jerry,

I couldn't disagree more strongly with your distaste for the Epson QX-10. I've had mine for a year, am a beta site for Valdocs, and have been through nearly every version of that marvelous piece of software.

Is the QX-10 slow? Absolutely not. I touch-type at a fairly high speed and have no problems whatsoever. Disk operations can be somewhat less speedy than I'd like—block moves, for instance, are definitely tedious—but on balance, I see little difference between my QX-10 with Valdocs and an IBM PC running Wordstar. (Timing differences, that is. For ease of use, keyboard excellence, and on-screen display, the QX-10 cannot be beaten.) I did add the Comrex hard disk, which significantly improves speed and flexibility.

I use the QX-10 daily, have written many hundreds of thousands of words on it, and am totally satisfied. As West Coast Editor for *Popular Science*, I use the QX-10 to transmit my copy to New York and to receive proof copies back. I get electronic-mail news releases from JPL and a Los Angeles PR agency, both of which have installed QX-10s and are happy. I expect to receive considerably more electronic mail as the Valdocs program improves.

I am frequently asked for computer recommendations, as you are. The only machines I recommend to writers are the QX-10, for those who can afford it, and the Kaypro, for those who can't. In any office setting, where word processing is important, the QX-10 is a superb machine and Valdocs is the only way to go. I'll stand by that until I see something better.

By the way, the new Titan board, which converts the QX-10 into an IBM PC look-alike and which serves as a 256K-byte RAM disk for Valdocs, should make the

machine even more attractive. I hope to have one installed in my QX-10 within a few weeks.

This letter was written on my QX-10 and printed out on my antique MX-80. Valdocs lets the MX-80 produce fairly sharp type, which I frequently use for correspondence. From starting to write to completing the printing, this letter took 16:02 (timed with the Valdocs timer, by the way).

**James L. Schefter**
**Playa del Rey, CA**

*I'm glad you like your QX-10.*

*Epson continues to improve the machine, and I'm told there will be a really wonderful new Valdocs Real Soon Now. I've always thought Valdocs was great in conception but too complex for a Z80; when 16-bit conversions for the QX-10 are available, maybe the execution will be up to the concept.*

*Meanwhile, it takes nearly a full minute simply to erase a single file under Valdocs, and if it took us 16 minutes to produce each letter, we'd be further behind than we are. . .* Jerry

### Detecting Errors

Dear Jerry,

In the January User's Column on page 68 you said, "Eagle tells me it did a lot of work on parity checking and found that it decreases the overall reliability by 15 percent." Did you really think about this before you committed it to print?

Some companies realize that memory chips have higher error rates than most other computer circuits and have designed appropriate error-detection schemes, such as parity, into their computers. For Eagle to produce a computer that will let these errors go undetected and tell us this is better upsets me.

Perhaps the problem is the definition of reliability. Apparently some people feel that a computer is reliable if it will always do something without regard for the validity of the result. I view reliability as being able to trust what the computer tells me. Detecting errors with parity and similar techniques increases reliability.

If you need your computer "right now," you might be upset when your machine stops running because of a small error. Alternately, undetected errors can result in misleading responses when you ask "What if. . ." What if you make an important business decision based on erroneous answers? Wouldn't you rather

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**Paul Crumley**
**Monroeville, PA**

*I didn't say I agreed with Eagle's position; I reported what its vice-president for development told me. Dr. Godbout tends to your view: he doesn't trust dynamic-memory chips operated at high speeds and wants parity checking.*

*On the other hand, present parity-checking software doesn't restore your data; it merely dumps your job if it finds an error—which could be caused by a genuine memory error or (about a 15 percent chance) by an error in the chip that stores the parity bits.*

*Eagle lets you test memory on start-up; if it detects a faulty memory chip, it gives you the choice of running the system or not. The IBM simply won't work if it finds a memory error, even if the error is in high memory you'll not use for most of your programs. I can certainly think of times when I want the machine, and don't care if there's a minor memory error. Other times, though, I'd completely agree with you.*

*I guess there ain't no justice. . . .*Jerry



## Televideo 950 and Palantir

Dear Jerry,

On your Televideo 950 (if you haven't gotten rid of it): it's easier to cut traces and disable keys than it is to insert the PROM, and you can always solder back over them if you have to. I've disabled 925 and 950 break keys more than once (they reset the OSM Zeus, among other machines, and are in a position that's even more dangerous than the Back Tab).

There is a program that enables you to use the arrow keys, the home keys, the Back Tab (it's used for decimal tab, I believe), and most of the function keys and special keys to do word processing in what appears to be a dedicated word-processing environment. It's Palantir Word Processing, and it's just the ticket for a lot of people. It's easy to use and conceptually easier to understand for a lot of people who are not computer literate. Unfortunately, Palantir supplies little labels (which come off and get lost) instead of key-caps, but its program is good, and its mail-merge-like utility is built in and included in the price (and more like a language than simply a "mail-merge"). It's a good product.

**Jeff Lasman**
**Simi Valley, CA**

*I've reviewed Palantir; it was written by the original author of Magic Wand (a.k.a. Peachtext), and it incorporates a fair number of features I like.*

*For the record: Jeff Lasman is the editor of the newsletter of the Valley Computer Club, 1409 Kuehner Dr. Suite S-80, Simi Valley, CA 93063; dues are $10 a year, and well worth it for anyone in that area interested in computers. One of its previous speakers was Tony Pietsch, and it has good meetings.*

*While I'm on that subject, I can also recommend the Connecticut Micro Decision Users Group, 773 Dixwell Ave., Box #5, New Haven, CT 06511. The current issue of its newsletter has a long piece on public-domain software. . . .*Jerry

## More on Superfile

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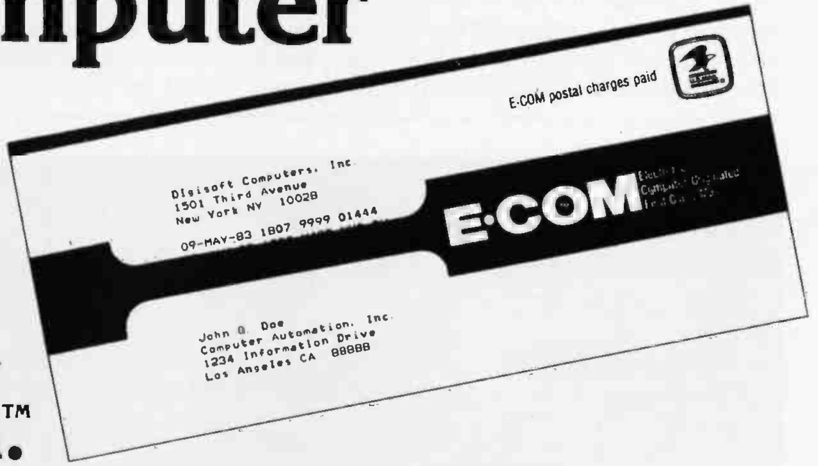


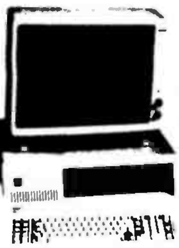

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Telephone(______)__________

printed in your December 1983 column from Alan Beagley in Australia ("For Your Information," page 508). Obviously, Mr. Beagley's friend is a novice user of the Superfile utility program since neither he nor Mr. Beagley realized that the power of the rename facility lies in its being able to rename any filename to any other filename, even ones that are illegal in CP/M. Therefore, the file he accidentally renamed to MAIL LIS could have easily been renamed again using the Superfile utility program. You don't need DU, Spat, or some other program to do this.

FYI Inc. (the maker of Superfile) gives the utility program away with Superfile. When I asked the company why it went to the trouble to write the utilities, FYI said that it wrote it for its own use and decided to include it with Superfile for customers who needed its capabilities.

It is also obvious from your comments last June and your comments after Mr. Beagley's letter that you have not taken the time to learn what Superfile really does. But I'll bet even you will be astounded by FYI's newest product called FYI 3000 (available on the IBM PC). I recently used one and could hardly believe my eyes. This program takes standard text files from my word processor and cross-indexes all the paragraphs in the files, using every word as a keyword. FYI says that it will handle 65,000 keywords and 65,000 paragraphs (with 500 words each) in a single filing system. One more amazing feature of FYI 3000: it gives me a count of each word in my text so I can analyze my word usage.

If you call FYI, I'll bet it will send you a review copy of FYI 3000 if you promise to give it a closer look than you did Superfile. Please try to reorient your thinking from the fixed-field approach to the more natural free-format approach used by Superfile and FYI 3000.

I read your column and appreciate your frank approach. However, I do wish you would be a little more careful in your research so that you don't give your readers erroneous advice.

**John Shine**

*You may recall that FYI's silly licensing agreement was so terrible that I couldn't legally run its software, since I have to use more than one machine. I understand it has changed that and made other changes as well. Apparently I had an early copy of the program; in any event, I haven't seen the updated version you describe.*

*Although I do sometimes solicit review software, for a while there was such a long queue of good stuff that I hesitated to add to it. Now that we've added to the permanent staff, things are a little better here at Chaos Manor. A little better. . . .*Jerry

*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.*

*Jerry Pournelle is a former aerospace engineer and current science-fiction writer who loves to play with computers.*

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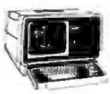

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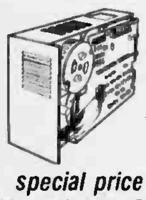

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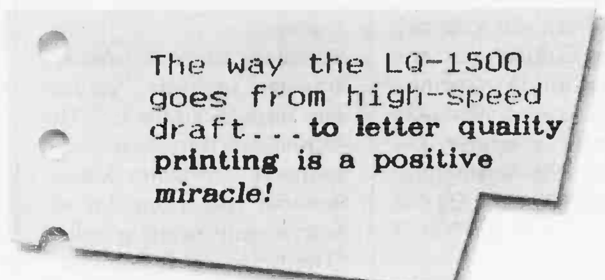


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# Event Queue

## May 1984

*May-June*
**Computer Showcase Expos,** various sites throughout the U.S. National and local vendors exhibit a broad range of small systems, peripherals, software, services, and supplies. For a show schedule, contact the Interface Group Inc., 300 First Ave., Needham, MA 02194, (800) 325-3330; in Massachusetts, (617) 449-6600.

*May-June*
**Courses from QED Information Sciences,** various sites throughout the U.S. and Canada. A few of the courses to be held are "Project Management," "Systems Design," and "Structured Programming." For a complete list of titles, contact Priscilla Goudreault, QED Information Sciences Inc., QED Plaza, 170 Linden St., POB 181, Wellesley, MA 02181, (800) 343-4848; in Massachusetts, (617) 237-5656.

*May-June*
**National Educational Computer Library Conferences,** various sites throughout the U.S. The National Educational Computer & Technology Conference and the Eastern and Southern Educational Computer Conferences are on the agenda this spring. For details, contact National Educational Computer Library, POB 792, Torrington, CT 06790, (203) 489-2728.

*May-June*
**Productivity '84,** various sites throughout the U.S. This series of two-day programs serves as a showcase of Hewlett-Packard products. Seminars are available, and more than 25 products are to be demonstrated, including the HP 150 personal computer and laser printers. Admission is free. For more information, contact Hewlett-Packard, Public Relations Department, 3000 Hanover St., Palo Alto, CA 94304, (800) 554-4466.

*May-June*
**Seminars from the Continuing Education Institute,** various sites throughout the U.S. Among the seminars offered are "Database Machines: An Overview," "Modern Techniques in Digital Signal Processing and Spectral Estimation," and "Peripheral Array Processors." For complete information, contact Continuing Education Institute, Oliver's Carriage House, 5410 Leaf Treader Way, Columbia, MD 21044, (301) 596-0111; in California, (213) 824-9545.

*May-June*
**Seminars from Datapro Research Corporation,** various sites throughout the U.S. Subject areas include data communications, microcomputers, and information systems. In-house presentations of technical programs can be arranged. For a 40-page catalog of seminars, contact Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 257-9406; in New Jersey, (609) 764-0100.

*May-June*
**Seminars from Technology Transfer Institute,** various sites throughout the U.S. The Technology Transfer Institute sponsors the James Martin Seminar and a one-day executive-only seminar called "The End-User Revolution." The programs explore such topics as evolving to electronic banking, relational database, and executive strategies for the information age. Full details on the seminars, registration, and meeting locations are available from the Technology Transfer Institute, 741 10th St., Santa Monica, CA 90402, (213) 394-8305.

*May-June*
**Understanding Microprocessor-based Equipment and Troubleshooting,** Chicago, IL, Detroit, MI, and Minneapolis, MN. This comprehensive four-day seminar provides a background in microprocessor fundamentals and troubleshooting techniques for technicians and engineers. Equipment familiarization and hands-on experimentation are emphasized. On-site presentations can be arranged. For information, contact the Registrar, Micro Systems Institute, Garnett, KS 66032, (913) 898-6152.

*May-July*
**Courses from Integrated Computer Systems,** various sites throughout the U.S. Among the courses to be presented are "Designing with 16-bit Micros," "Programming in C: A Hands-on Workshop," and "Hands-on Unix Workshop." The fee for each course is $895. Enrollment details are available from Ruth Dordick, Integrated Computer Systems, 6305 Arizona Place, POB 45405, Los Angeles, CA 90045, (213) 417-8888.

*May-July*
**Reliability and Maintainability Engineering Institutes and Short Courses,** various sites throughout the U.S. A couple of the programs to be offered are "Reliability Engineering, Testing, and Maintainability Engineering" and "Mechanical Reliability and Probabilistic Design for Reliability—The Stress/Strength Interference Approach to Designing a Desired Reliability into Components and Equipment." For a complete schedule, contact Dr. Dimitri Kececioglu, College of Engineering, Aerospace and Mechanical Engineering Department, University of Arizona, Tucson, AZ 85721, (602) 621-2495.

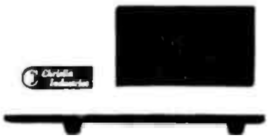
*May-August*
**Compuworkshops Computer Seminars for Educators,** various locations throughout California. Among the seminars offered are "Authoring Tools and Word Processing for Educators," "BASIC Programming for Educators," "Designing Educational Courseware," "Computer Literacy for Educators," and "How to Set up a Computer-based Education Program in Your School or District." The fee is $50 per course. For details, contact Compukids of Seal Beach, Rossmoor Shopping Center, 12385 Seal Beach Blvd., Seal Beach, CA 90740, (213) 430-7226; West Los Angeles, (213) 473-8002; Tarzana, (213) 343-4008; Rancho Bernardo/San Diego, (619) 451-1742.

*May-August*
**Conferences and Expositions from the Society of Manufacturing Engineers,** various sites throughout the U.S. and around the world. More than 25 conferences and expositions are scheduled. For a calendar, contact the Public Relations Department, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-0777.

*May-August*
**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." For complete details, contact Joan Hall, Plum Hall Inc., 1 Spruce Ave., Cardiff, NJ 08232, (609) 927-3770.

# IBM PC/XT COMPATIBLE

**10MB and 20MB WINCHESTER**



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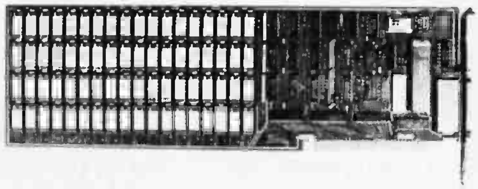

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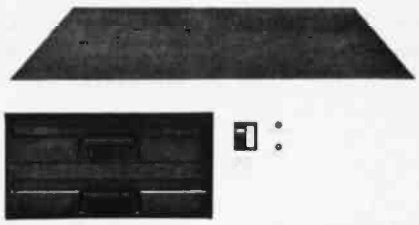

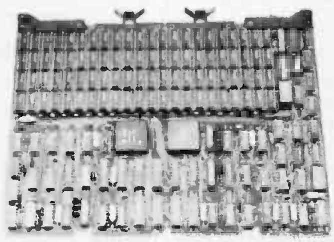

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*May-August*
**Digital Consulting Associates' Classes and Seminars,** various sites throughout the U.S. For descriptions of seminars and classes on dBASE II, Lotus 1-2-3, database administration, and other microcomputer-related topics, contact Digital Consulting Associates Inc., 339 Salem St., Wakefield, MA 01880, (617) 246-4850.

*May-August*
**Software Banc 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. For information and registration, contact Software Banc Inc., 661 Massachusetts Ave., Arlington, MA 02174, (800) 451-2502; in Massachusetts, (617) 641-1241.

*May-September*
**Computer Competence Seminars,** Boston University Metropolitan College, Boston, MA. This series of hands-on presentations is tailored for managers who know little or nothing about computers and for those who wish to sharpen their computing skills. Some of the seminars 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. For details, contact Joan Merrick, University Seminar Center, Suite 415, 850 Boylston St., Chestnut Hill, MA 02167, (617) 738-5020.

*May-September*
**Technical and Management Seminars for Professionals,** various sites throughout the U.S. Subject areas encompass system-performance management, networking, personal computing, applications design and programming, real-time applications design, management development, and other issues relating to computers. On-site seminars can be arranged. For a brochure, contact Digital Equipment Corp., Educational Services, Seminar Programs BUO/E58, 12 Crosby Dr., Bedford, MA 01730, (617) 276-4949.

*May-October*
**Tutorial Short Courses from Hellman Associates,** various sites throughout the U.S. Among the courses offered are "VLSI Design," "Digital Control," and "Error Correction." Fees are generally $895. For a descriptive brochure, contact Hellman Associates Inc., Suite 300, 299 California Ave., Palo Alto, CA 94306, (415) 328-4091.

*May-December*
**Seminars from the Institute for Professional Education,** various sites throughout the U.S. Programs in statistics, management, simulation and modeling, personal computers, and computer science are offered. For an explanatory pamphlet, contact the Institute for Professional Education, POB 756, Arlington, VA 22216, (703) 527-8700.

*May 10-12*
**BYTE Computer Show,** McCormick Place, Chicago, IL. Seminars, product displays, and conference sessions are some of the highlights of this show sponsored by BYTE and *Popular Computing* magazines. For complete details, contact the Interface Group, 300 First Ave., Needham, MA 02194, (800) 325-3330; in Massachusetts, (617) 449-6600.

*May 11*
**Writing Efficient Programs,** Mathematics and Science Building, Room W-117, Montclair State College, Upper Montclair, NJ. Dr. Jon Bentley from Bell Laboratories will speak on writing machine-independent code. He will present a general set of rules for using this tool and show how those rules can speed up a program. A subtheme will address the problem of converting programming tricks into engineering techniques. For information, contact Gideon Nettler, Department of Mathematics and Computer Science, Montclair State College, Upper Montclair, NJ 07043, (201) 893-4294.

*May 13-17*
**Computer Graphics '84,** Convention Center, Anaheim, CA. Panel discussions on specific standards, technical sessions exploring the application of standards in a working environment, and tutorials explaining standards will be complemented by an exposition. For details, contact the National Computer Graphics Association, Department ZF, Suite 601, 8401 Arlington Blvd., Fairfax, VA 22031, (703) 698-9600.

*May 14-17*
**The Twenty-fifth International Conference of the Association for the Development of Computer-based Instructional Systems,** Hyatt Regency Hotel, Columbus, OH. Guest speakers will focus on the problem of exchanging courseware between computer systems. The use of computers, education for the disabled, and computer-based instruction in home economics and music are other topics of interest. Hardware, software, and courseware will be demonstrated. Program particulars can be obtained from the Association for the Development of Computer-based Instructional Systems, 409

## Event Queue

Miller Hall, Western Washington University, Bellingham, WA 98225.

*May 14-18*
**Auditing in the Contemporary Computer Environment,** Honolulu, HI. Participants will learn a comprehensive audit approach for computer-based systems. Topics include how to evaluate controls, how to prepare an audit report, and how to design a program of tests using questionnaires, checklists, software tools, and flowcharts. Contact Beth Ann Musto, EDP Auditors Foundation, 373 South Schmale Rd., Carol Stream, IL 60187, (312) 682-1200.

*May 15*
**Breakthroughs in Artificial Intelligence,** Worcester Polytechnic Institute Campus, Worcester, MA. This executive briefing explores the impact of artificial intelligence on corporate strategy. Sessions are limited. To reserve a space, contact Kathy Shaw, Office of Continuing Education, Worcester Polytechnic Institute, Worcester, MA 01609, (617) 793-5517.

*May 15-16*
**Factory Systems Summit Conference,** Chicago, IL. Factory-automation experts will discuss total systems integration and how to implement them, new developments in technology, and how to plan for the future. For details, contact Lisa Caruso, the Yankee Group, 89 Broad St., Boston, MA 02110, (617) 542-0100.

*May 15-17*
**Criminal Justice Systems Conference,** Virginia Commonwealth University, Richmond, VA. Presentations and panel discussions on recent developments in criminal justice applications of computer technology are planned. Additional sessions will address the uses of microcomputers in law enforcement. The fee is $20. Information is available from Ben Wood, Department of Criminal Justice Services, 805 East Broad St., Richmond, VA 23219, (804) 786-4000.

*May 15-17*
**Electro/84 and Mini/Micro Northeast/84,** Boston, MA. Conference sessions will address a broad range of topics, including artificial intelligence, communications and networks, distributed systems, microprocessor technology, and robotics. For details, contact Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

*May 15-17*
**Micro City '84,** Exhibition Complex, Bristol, England. More than 100 companies will exhibit computers, business systems, and communications equipment. For complete details, contact Tomorrow's World Exhibitions Ltd., 9 Park Place, Clifton, Bristol BS8 1JP, UK; tel: (0272) 292156/7.

*May 15-18*
**Computacion '84,** U.S. Trade Center, Mexico City, Mexico. Computer equipment, peripherals, services, and software for business will be exhibited. For complete details, contact the United States Trade Center, Centro de Comercio Estadounidense, Liverpool 31, 06600 Mexico City, Mexico; tel: (905) 591-0155; Telex: 1773471 USTCME.

*May 16-18*
**Data Communications,** Cincinnati, OH. Eighteen major topics, including concepts and definitions, types of data-communications equipment, modems, satellite communications, and protocols, will be addressed. Registration is $695; multiple dis-

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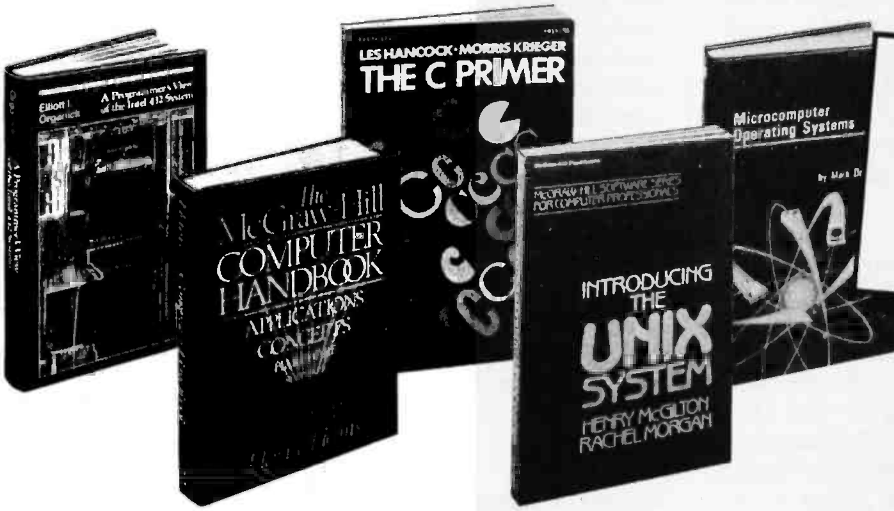


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counts are available. For complete details and registration forms, contact Data-Tech Institute, 386 Franklin Ave., POB 569, Nutley, NJ 07110, (201) 661-2300.

*May 16-18*
**Teaching Math with Microcomputers**, Marriott Hotel, Miami, FL. This program, sponsored by the National Council of Teachers of Mathematics (NCTM), is designed to inform elementary, intermediate, and secondary school mathematics teachers how to effectively use the microcomputer as a classroom tool. For further information, contact NCTM, 1906 Association Dr., Reston, VA 22091, (703) 620-9840.

*May 19*
**The Seventh Annual Show & Tell Microcomputer Conference**, University of Oklahoma Mathematics and Physical Science Complex, Norman. Computer hobbyists are invited to speak briefly, demonstrate an example of their presentation, and answer questions. For details, send a self-addressed, stamped envelope to Show & Tell, Dr. Richard Andree, University of Oklahoma, Mathematics Department, 601 Elm St., Norman, OK 73019.

*May 20-23*
**The Fourth Annual Conference of the Association of Human Resource Systems Professionals**, Hyatt Regency, Fort Worth, TX. Roundtable discussions will address topics related to the theme "People, Data, and Systems . . . Putting It All Together." Embracing cross-disciplinary concerns and emphasizing the practical requirements of successful human-resource information-system development, discussions will explore networking, vendor evaluation, and time management. For complete details, contact HRSP Inc., 3051 Adeline St., Berkeley, CA 94703, (415) 548-1364.

*May 20-23*
**Personnel Data Systems' 1984 Annual Users Conference**, Fairmont Hotel, Dallas, TX. On-line software demonstrations and sessions on Personnel Data Systems' products highlight this convocation. Contact Personnel Data Systems Inc., 15 East Ridge Pike, Conshohocken, PA 19428, (215) 828-4294.

*May 20-23*
**The Thirteenth Mid-Year Meeting of the American Society for Information Science**, Indiana University, Bloomington. The theme for this meeting is "The Micro Revolution: Implications for the Information Age." Joseph Weizenbaum, author of *Computer Power and Human Reason* and a professor of computer science at Massachusetts Institute of Technology, will speak. For more information, contact Stephen Harter, School of Library and Information Science, Indiana University, Bloomington, IN 47405, (812) 335-5113.

*May 20-25*
**The Fourth Jerusalem Conference on Information Technology—JCIT**, Jerusalem, Israel. Papers, panel discussions, workshops, and exhibits will emphasize software engineering and manufacturing related to the theme of this international event, the "Next Decade in Information Technology." The fee is $225. Isratech '84, the national exhibition of high technology, runs concurrently with JCIT. For information on Isratech '84, contact the Government of Israel Trade Center, 350 Fifth Ave., New York, NY 10118, (212) 560-0660. For details on JCIT, contact the Fourth Jerusalem Conference on Information Technology, POB 29313, 61292 Tel Aviv, Israel; tel: (03) 258-535.

*May 21-22*
**Evaluating Decision Support Software: Personal Computer, Mainframe, and Distributed Applications—A Managerial Perspective,** New York Hilton, Rockefeller Center, New York City. This conference will explore the influence of new developments in end-user computing, software design, distributed decision support, local-area networks, microcomputer technology, fourth-generation languages, and artificial intelligence. Further information is available from the DSS Conference, 215 First St., Cambridge, MA 02142, (617) 547-5061.

*May 21-23*
**AAMSI Congress 1984—The Third Spring Joint National Congress**, Hilton Hotel, San Francisco, CA. Invited and contributed papers, special sessions, tutorials, reviews, panel discussions, and demonstrations will focus on the applications of computers and information technology and systems to all fields of medicine. Program sponsors include a dozen professional organizations that have joined the American Association for Medical Systems and Informatics (AAMSI) in producing this three-day program. For particulars, contact AAMSI, Suite 402, 4405 East-West Highway, Bethesda, MD 20814, (301) 657-4142.

*May 21-23*
**Data Processing for the Non-Data Processing Executive, Part 2,** Miyako Hotel, San Francisco, CA. This is the second part of a program that addresses microprocessor and database technology, packaged software, and data communications. It's designed for people with a basic understanding of electronic data processing. Inhouse presentations are available. Register with the American Management Associations, POB 319, Saranac Lake, NY 12983, (518) 891-0065.

*May 22-24*
**Softwest '84**, Denver Merchandise Mart, Denver, CO. This conference and exhibition features educational seminars, lectures, and panel discussions on software, equipment, and peripherals for Apple and IBM computers. For information, contact the Colorado Conference Group, Suite C, 3312 Cripple Creek, Boulder, CO 80303, (303) 499-1034.

*May 22-25*
**COMDEX Spring,** Georgia World Congress Center, Atlanta. For details, contact the Interface Group, 300 First Ave., Needham, MA 02194, (800) 325-3330; in Massachusetts, (617) 449-6600.

*May 22-26*
**Micro Expo '84**, Palais des Congrès, Paris, France. Manufacturers and vendors of hardware, software, peripherals, and accessories for the microcomputer market will attend this conference and exposition. For details, contact Sybex France, Centre Paris Daumesnil, 4 Place Felix Eboue, 75583 Paris Cedex 12, France. In the U.S., contact the International Show Coordinator, Sybex Inc., 2344 Sixth St., Berkeley, CA 94710, (415) 848-8233.

*May 22-26*
**Oficomp Korea 84—The International Korean Office and Information Management Exhibition and Conference**, Korea Exhibition Center, Seoul, South Korea. Exhibits will include demonstrations of computers, communications equipment, and business machines. Contact Clapp & Poliak International,

POB 70007, Washington, DC 20088, (301) 657-3090.

*May 23*
**Breakthroughs in Artificial Intelligence,** Loew's Summit, New York City. For details, see May 15.

*May 23-24*
**Automach-Australia '84,** Royal Hall of Industries, Showground, Sydney. This trade show serves to update Australian manufacturing industries on automated, integrated factory systems incorporating numerically controlled machinery, CAD/CAM, and robotics. For details, contact Mr. Greco, Howard Rotavator Pty., POB 82, Parramatta 2150, New South Wales, Australia; tel: 630-1231; Telex: AA21328. In the U.S., contact SME World Headquarters, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1500.

*May 23-24*
**Distribution/Computer Expo '84,** Hyatt Regency, Chicago, IL. This is said to be the largest exhibit of computer systems and services for the transportation, distribution, logistics, and warehousing industries. Entrance fee per person is $35. Registration brochures are available from CS Report Inc., POB 453, Exton, PA 19341, (215) 363-7156.

*May 23-24*
**The 1984 Trends and Applications Conference,** National Bureau of Standards, Gaithersburg, MD. Presentations will address current systems and applications as well as research into advanced concepts relating to the theme, "Making Database Work." Information can be obtained from Trends and Applications 84, POB 639, Silver Spring, MD 20901, (301) 921-3491.

*May 23-25*
**Data Communications,** Fort Lauderdale, FL. For details, see May 16-18.

*May 23-25*
**The Eighth Conference on Computer Applications in Radiology,** Stouffer's Riverfront Towers, St. Louis, MO. Patient information systems, personal computers and computers for the private office, teleradiology, computer-assisted instruction, and artificial intelligence are a few of the topics to be covered. Exhibits are included. The fee is $350. For details, contact American College of Radiology, 20 North Wacker Dr., Chicago, IL 60606, (800) 227-5463; in Illinois, (312) 236-4963.

*May 23-25*
**The Third Annual European Semiconductor Industry Conference,** Hotel Kempinski, Berlin, West Germany. International industry leaders will discuss issues facing the semiconductor industry. Contact Barbara Chupp, Dataquest Inc., 1290 Ridder Park Dr., San Jose, CA 95131, (408) 971-9000.

*May 24*
**The Selection, Care, and Feeding of Consultants,** College of Management, Georgia Institute of Technology, Atlanta. This course teaches business people with limited time and resources how to define problems and how to locate the trained consultant for the job. Office automation and productivity are a few of the problem areas to be considered. The course fee is $175. Contact Elaine Hadden Nicholas, Department of Continuing Education, Georgia Institute of Technology, Atlanta, GA 30332-0385, (404) 894-2547.

## Event Queue

*May 26-27*
**The Third Annual Toronto PET User's Group (TPUG) Conference**, Constellation Hotel, Toronto, Ontario, Canada. This program consists of formal speeches, product exhibits, and a trader's corner for used computer equipment. For information, contact Chris Bennett, TPUG Business Office, 1912A Avenue Rd., Toronto, Ontario M5M 4A1, Canada, (416) 782-9252.

*May 29-31*
**Gulf Coast Computer and Office Show**, New Orleans, LA. Speakers, technical sessions, and product displays will highlight this exhibition. For full details, contact Gulf Coast Computer and Office Show, 119 Avant Garde Circle, Kenner, LA 70062, (504) 467-9949.

*May 29-June 1*
**The Technical Manager in a Dynamic Environment,** San Francisco, CA. The fee for this short course is $875. Advanced registration is required. For information, contact Continuing Education in Engineering, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

*May 31-June 2*
**Personal Computer and STD Computer Interfacing for Scientific Instrument Automation,** Blacksburg, VA. This workshop provides hands-on experience in wiring and testing interfaces. The fee is $395. For more information, contact Dr. Linda Leffel, C.E.C., Virginia Polytechnic Institute and State University, Blacksburg, VA 24061, (703) 961-4848.

### June 1984

*June*
**Continuing Engineering Education Courses from George Washington University,** Washington, DC. Courses include "Improved CAD/CAM Utilization," "Systems Analysis Techniques for Information Managers," and "Algorithm Design for Managers and Entry-level Programmers." Tuition ranges from $625 to $795. For complete course outlines, contact George Harrison, Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-6106.

*June-August*
**Engineering Summer Conferences,** Chrysler Center, North Campus, University of Michigan, Ann Arbor. Topics include aerospace, chemical, computer, information, control, electrical, nuclear, marine, metallurgical, mechanical/automotive, and industrial engineering. Courses will also be offered in written communications and optical technology. A continuing education unit is awarded for every ten hours of attendance and students are awarded certificates indicating the number of units earned. Lecture notes are provided. Fees range from $450 to $1000, depending upon course length. Room and board are additional. For more information, contact Engineering Summer Conferences, 200 Chrysler Center—North Campus, University of Michigan, Ann Arbor, MI 48109, (313) 764-8490.

*June 1-3*
**The First Annual Computer Country Fair & Exposition,** New Hampshire Voc-Tech College, Stratham. Demonstrations and displays of computer hardware and software for home, personal, and business uses will be featured. Adult admission is $2.50. For more information, contact Julianne Cooper,

Cooper/GK, 41 Front St., Exeter, NH 03833, (603) 778-0344.

*June 2-3*
**The Ninth NJ-NY-CT Microcomputer Show & Flea Market,** Meadowlands Hilton Hotel, Secaucus, NJ. More than 250 vendors will display computer equipment, parts, supplies, software, and accessories. Admission is $6. Contact Ken Gordon Productions, POB 13, Franklin Park, NJ 08823, (201) 297-2526.

*June 4-5*
**Electronic Motion Control Association Seminar,** Chicago, IL. This educational program combines tutorial sessions with technical paper presentations. Devices and systems will be displayed. For details, contact the Electronic Motion Control Association, Suite 1200, 230 North Michigan Ave., Chicago, IL 60601, (312) 372-9800.

*June 4-6*
**Advanced Project Management,** Berkeley, CA. The fee for this short course is $645. Advanced registration is required. Contact Continuing Education in Engineering, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

*June 4-7*
**Electronics in Oil and Gas/U.S.,** Convention Center, Dallas, TX. This exhibition will focus on electronics technology as it applies to processing, production, supervision, data control, communications, navigation, maintenance, testing, instrumentation, exploration, and safety. The conference program, held concurrently with the World Oil and Gas Show and Conference, will cover telemetry, sensing, computers, simulation, and automation. Complete particulars are available from Martin C. Dwyer International, 1350 East Touhy Ave., Des Plaines, IL 60018, (312) 299-9311.

*June 4-7*
**Robots 8,** Cobo Hall, Detroit, MI. More than 80 industry experts will expound upon the latest aspects of robot implementation, applications, and research. Nearly 250 builders and suppliers of industrial robots, related services, and components will exhibit their wares. For more information, contact RI/SME, POB 930, Dearborn, MI 48121, (313) 271-0023.

*June 4-8*
**The Thirteenth Annual Meeting of the MUMPS Users Group,** Adam's Mark Hotel, Philadelphia, PA. Introductory and advanced tutorials on MUMPS programming and applications, workshops, round-table discussions, site visits, and formal presentations will be offered. In addition, hardware, software, and systems will be demonstrated. Contact the MUMPS Users Group, Suite 308, 4321 Hartwick Rd., College Park, MD 20740, (301) 779-6555.

*June 6-8*
**Introduction to the Design of Fault-Tolerant Microcomputer Systems,** San Francisco, CA. This course serves as an introduction to such major topics in fault-tolerant computing as microprocessor testing, redundancy techniques, error correction and detection, and fault classification, detection, diagnosis, and recovery. The fee is $650. For information, contact William C. Dries, Engineering and Applied Science, University of Wisconsin—Extension, 432 North Lake St., Madison, WI 53706, (800) 362-3020; in Wisconsin, (608) 262-2061.

*June 6-8*
**ACM SIGCOMM '84 Symposium on Communications Architectures and Protocols,** Montreal, Quebec, Canada. Address inquiries to Rebecca Hutchings, Honeywell/FSD, 7900 Westpark Dr., McLean, VA 22102, (703) 827-3982.

*June 6-9*
**The 1984 Rochester FORTH Applications Conference,** University of Rochester, NY. An international conference now in its fourth year, this convocation is appropriate for both experienced users and newcomers to the FORTH language. Invited speakers will discuss real-time systems and FORTH applications and techniques. Contact Diane Ranocchia, Institute for Applied FORTH Research Inc., 70 Elmwood Ave., Rochester, NY 14611, (716) 235-0168.

*June 11-13*
**Data Processing for the Non-Data Processing Executive, Part 2,** New York City. For details, see May 21-23.

*June 11-15*
**Auditing in the Contemporary Computer Environment,** New York City. For details, see May 14-18.

*June 11-15*
**Fiber and Integrated Optics,** Teaneck, NJ. This short course explores such fiber-optic components as single- and multimode fiber cabling, photo detectors, receiver and repeater technology, and optical-fiber sensors. The fee is $875. For details, contact Continuing Engineering Education, George Washington University, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-6106.

*June 11-15*
**Managing the Audit Computer-based Bank Systems,** Chicago, IL. A course providing a comprehensive audit approach for evaluating and testing controls in computer-based bank systems. Information is available from Darlene Floading, Bank Administration Institute, 60 Gould Center, Rolling Meadows, IL 60008, (312) 228-6200.

*June 11-30*
**Faculty Development Institute: Retraining in Computer Science,** Wheaton College, Norton, MA. The Faculty Development Institute, made up of introductory and intermediate courses, is designed to increase educators' capacity to teach computer science at the college level. The tuition is approximately $1000, with additional expenses for room and board. For further information, contact Nercomp Inc., 439 Washington St., Braintree, MA 02184, (617) 848-6494.

*June 12-14*
**Advanced Manufacturing Systems Exposition & Conference—AMS 84,** McCormick Place, Chicago, IL. The theme for this event is "The Computer: Mind of the Factory of the Future." Demonstrations of information and automated production systems directed at the needs of manufacturing companies, more than 50 conference sessions, workshops, and short courses will be featured. Some topics of interest include planning for closed-loop systems, software selection and systems integration, systems implementation, artificial intelligence, and robotics. AMS runs concurrently with Info/Software (see below). For details on AMS 84, contact Clapp & Poliak, 708 Third Ave., New York, NY 10017, (212) 370-1100 or 661-8410.

*June 12-14*
**Info/Software,** McCormick Place, Chicago, IL. An exposition and conference de-

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## Event Queue

voted exclusively to demonstrations of applications and systems software. Mainframe, minicomputer, and microcomputer software will be featured. Info/Software runs concurrently with AMS 84 (see above). Further information is available from Clapp & Poliak, 708 Third Ave., New York, NY 10017, (212) 370-1100 and (212) 661-8410.

*June 12-14*
**Update '84**, Hyatt O'Hare Hotel, Chicago, IL. This forum is targeted at the information-management and micrographics industry. Trends in office automation technologies and their relevance to imaging and image-transmission capabilities will be considered along with the opportunities and competitive pressures that these technologies represent. For details, write to IMC Update '84, POB 34404, Bethesda, MD 20817.

*June 13-15*
**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*
**The Sixth Annual National Educational Computing Conference—NECC '84**, University of Dayton, OH. Papers, workshops, and exhibits are designed to promote a higher quality of classroom instruction in educational computing. Complete details on NECC '84 are available from Lawrence A. Jehn, Computer Science Department, University of Dayton, Dayton, OH 45469, (513) 229-3831.

*June 13-15*
**PC-World Exposition**, McCormick Place West, Chicago, IL. Further information can be obtained from Mitch Hall Associates, POB 860, Westwood, MA 02090, (617) 329-8090.

*June 14-17*
**BYTE Computer Show**, Convention Center, Los Angeles, CA. For details, see May 10-12.

*June 14-17*
**International Computer Show**, Cologne, West Germany. Seminars, workshops, and hardware and software exhibits will highlight this international event. The focus is on informing users on buying-decision criteria, how to scrutinize software, and how to solve user's needs such as customer service, advice, and spare parts. 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 16*
**Writing for the Computer Industry**, Plymouth State College, Plymouth, NH. Topics to be addressed include 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 17-20*
**The Seventeenth Annual Association for Small Computers Users in Education Conference**, Western Kentucky University, Bowling Green. This conference will focus on academic computing, robotics, computer applications in libraries, and the effective use and control of institutional word processing. Demonstrations and a

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*June 17-21*
**International Banking Conference on Computer Networks,** Hilton, Tel Aviv, Israel. This educational program for bankers, corporate executives, government representatives, and electronics manufacturers will center around the theme, "Bank Transfers Via Computer Networks." Security and fraud concerns will also be discussed. The program will be complemented by speakers and an exhibition of computer products that support networking. For details, contact Nancy Italia, UMB/PSI Conference Coordinator, Suite 350, 2700 Cumberland Parkway, Atlanta, GA 30339, (404) 432-2892; Telex: 80-4294.

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

*June 18-22*
**The Fourth Annual Notre Dame Short Course Series: Computers in Biology,** University of Nevada-Reno. Three concurrent short courses on Computers in Biology will be offered: "Computers in Bioeducation," "Microcomputers in Classroom and Laboratory," and "Computerized Data Analysis in Biological Research." A computer background is not required. Most days will include lectures and hands-on sessions. Tuition is $450. Contact Professor Theodore J. Crovello, Biocomputing Short Course Coordinator, Department of Biology, University of Notre Dame, Notre Dame, IN 46556, (219) 239-7496.

*June 18-22*
**Office Information System Software,** Massachusetts Institute of Technology, Cambridge, MA. This course provides a systematic treatment of the concepts behind the design of multifunction office workstations, including technologies, human factors, software, and applications generators. Further information is available from the Director of the Summer Session, Room E19-356, MIT, Cambridge, MA 02139.

*June 18-July 27*
**Experimental Music Studio,** Massachusetts Institute of Technology, Cambridge. Two complementary sessions, "Techniques of Digital Audio Processing" and "Workshop in Computer Music Composition," make up this program. The former, which runs from June 18-29, provides a technical background as well as practical 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. Both workshops involve lectures, tutoring, and hands-on experience. No special technical knowledge is required. Application information is available from the Director of the Summer Session, Room E19-356, Massachusetts Institute of Technology, Cambridge, MA 02139.

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

*June 19-22*
**Percom '84—The Second International Exhibition and Conference on Business and Personal Computers,** Jade Ballroom, Hotel Furama Intercontinental, Hong Kong. Exhibits at this show cover a wide spectrum of mini- and microcomputers, hardware, software, peripherals, accessories, components, and publications. The emphasis is on products for the commercial, manufacturing, and education industries. Contact Adsale Exhibition Services, 20/F., Tung Sun Commercial Centre, 194-200 Lockhart Rd., Wanchai, Hong Kong; Telex: 63109 ADSAP HX.

*June 20*
**How to Document a Computer System,** Sheraton Commander Hotel, Cambridge, MA. This seminar presents a series of procedures that covers the system-development process, including project initiation, study, design, programming, implementation, and maintenance. The fee is $155. Contact Technical Communications Associates, Suite 210, 1250 Oakmead Parkway, Sunnyvale, CA 94086, (800) 227-3800, ext. 977; in California, (408) 737-2665.

*June 20-22*

**The First International Conference on Computers and Applications**, Fragrant Hill Hotel, Peking, People's Republic of China. More than 100 technical papers on parallel processing, database systems, local-area networks, and distributed processing will be delivered at this joint technical program sponsored by the Chinese Institute of Electronics (CIE) and the IEEE Computer Society. Conference details can be obtained from the IEEE Computer Society, POB 639, Silver Spring, MD 20901, (301) 589-8142.

*June 21-23*

**The Great Southern Computer Show,** Veterans Memorial Coliseum, Jacksonville, FL. Hardware, software, peripherals, accessories, and word- and data-processing exhibits will be featured. Workshops and seminars complement the displays. For registration information, contact Great Southern Computer Shows, POB 655, Jacksonville, FL 32201, (904) 356-1044.

*June 22*

**How to Document a Computer System**, Empire Hotel, New York City. For details, see June 20.

*June 25*

**How to Document a Computer System**, University Inn, Pittsburgh, PA. For details, see June 20.

*June 26-28*

**PCExpo**, Coliseum, New York City. This show is dedicated to the IBM Personal Computer market. Exhibits by manufacturers, software producers, and vendors will be complemented by a daily seminar program. Contact PCExpo, 333 Sylvan Ave., Englewood Cliffs, NJ 07632, (201) 569-8542.

*June 26-29*

**Logo '84 Conference,** Massachusetts Institute of Technology, Cambridge. Four main themes, Logo Learning, Learning Environments, Technical Forecasts, and Images of Future Work, constitute the main program. Product exhibits will correspond with the discussions. Contact the Special Events Office, Room 7-111, Massachusetts Institute of Technology, Cambridge, MA 02139.

*June 26-29*

**Using FORTH Effectively,** Humboldt State University, Arcata, CA. This is a hands-on advanced course on the generation and internal operations of a FORTH system. A mastery of an introductory FORTH course or minimum of six months using FORTH, knowledge of assembly language, and operating-system principles are prerequisites. The fee is $150 or $200 with three quarter hours academic credit. Registration information is available from Claire Duffey, Office of Continuing Education, Humboldt State University, Arcata, CA 95521, (707) 826-3731.

*June 27-29*

**Introduction to the Design of Fault-Tolerant Microcomputer Systems,** Boston, MA. For details, see June 6-8.

## July 1984

*July 2-6*

**Contemporary Computer Auditing: Integrity Controls,** New York City. This program is designed to provide an

## THE AT&T INTERNATIONAL BUSINESS NETWORK:

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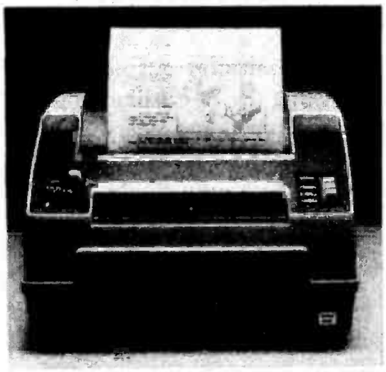

TOKYO

An exact copy of the original. That's fax. And fax is the only system that can transmit blueprints, legal documents, and signed contracts almost anywhere in the world.

This unique ability makes fax one of the most exciting electronic mail technologies available today.

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In fact, you can save as much as $8.00 per page with AT&T's lowest rates compared with sending the same page via telex. With some fax machines, you don't even have to be there.

They can be programmed to transmit during Discount and Economy periods. Telex has no daily reduced rate periods.

Since fax is a copy of the original, you don't need a typist. No special operators.

And since there's no retyping, no redoing of any kind, fax is free of transcription errors.

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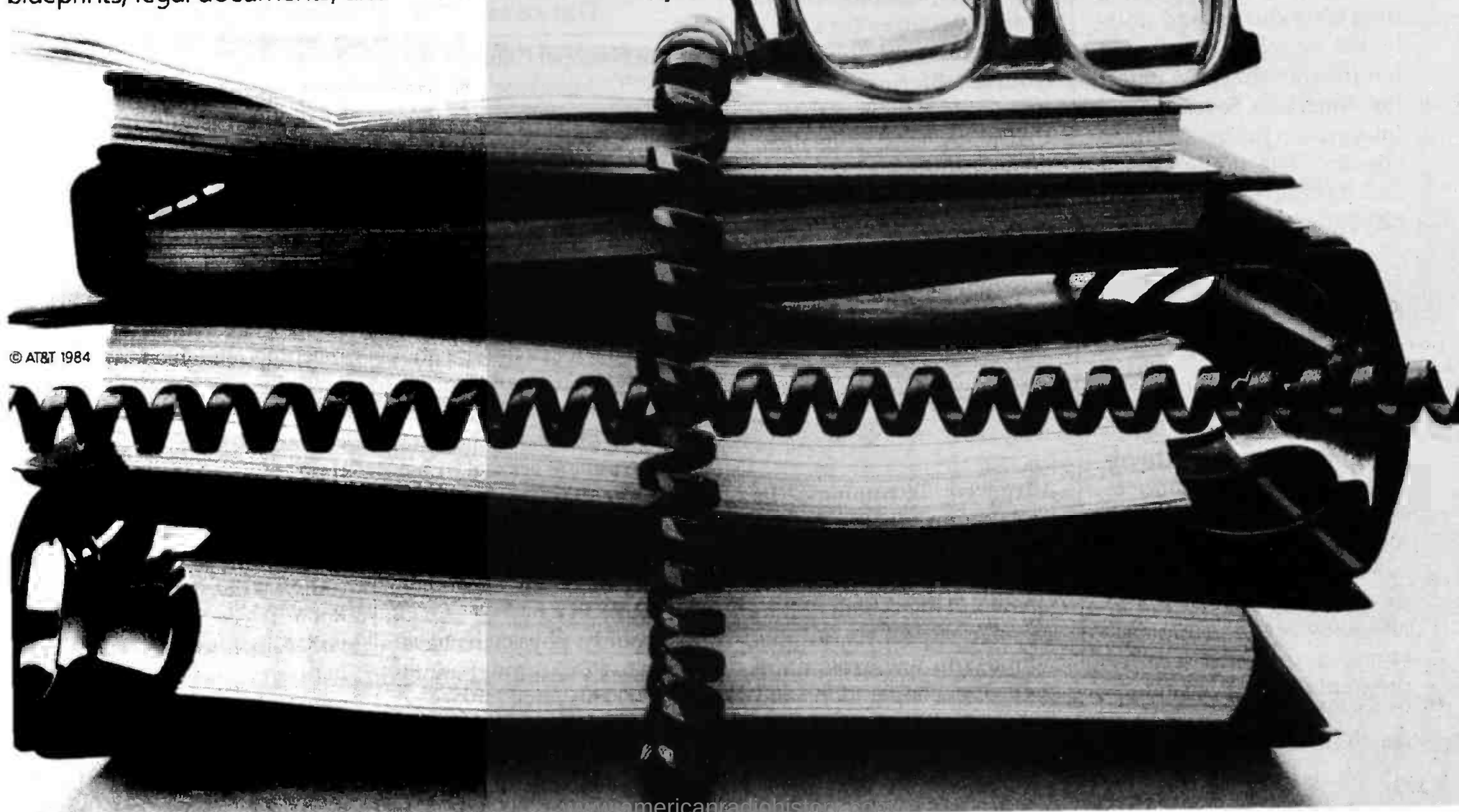


*overview* of the complete computer-auditing environment, its controls, and the interrelationships. Full details are available from Beth Ann Musto, EDP Auditors Foundation, 373 Schmale Rd., Carol Stream, IL 60187, (312) 682-1200.

*July 8*
**The Third Annual National Conference of the Association for Women in Computing,** Holiday Inn Center Strip, Las Vegas, NV. The conference theme, "Choice or Chance in Computing Careers," will be the starting point for sessions about women entrepreneurs, technologies in the forefront of the eighties, and career development. Registration and additional information can be obtained from Patricia Timpanaro, AWCC '84 Registration, 40 Main St. #206, Stoneham, MA 02180.

*July 9-12*
**The 1984 National Computer Conference—NCC,** Convention Center, Las Vegas, NV. One of the most prestigious computer shows, the NCC will provide professional-development seminars, more than 650 exhibits, and nearly 100 technical sessions in ten program tracks. Contact the American Federation of Information Processing Societies Inc., 1899 Preston White Dr., Reston, VA 22091, (703) 620-8926.

*July 9-13*
**Fiber and Integrated Optics,** San Diego, CA. For details, see June 11-15.

*July 10-12*
**Computer-Security Technology,** University of California, Berkeley. This short course looks into protective technologies in three general categories: procedural, hardware, and software. A module evaluating a computer-security program will be included. Registration costs $595, which includes all materials. For details, call or write Continuing Education in Engineering, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

*July 23-25*
**Summer Computer Simulation Conference—SCSC '84,** Copley Plaza Hotel, Boston, MA. Technical sessions made up of plenaries, papers, panel discussions, and a variety of tutorials will be featured. Highlights include displays of simulation computers, simulators, auxiliary devices, and software. Special sessions will also be held on artificial intelligence. Contact Charles Pratt, Simulation Councils Inc., POB 2228, La Jolla, CA 92038, (619) 459-3888.

*July 23-27*
**ACM SIGGRAPH '84,** Minneapolis, MN. This is the eleventh annual ACM conference on computer graphics and interactive techniques. Refereed technical paper presentations, panel discussions, a design show, film and video presentations, and nearly 30 courses are some of the features of this event. Course offerings will be divided into four categories: CAD/CAM/CAE, animation/image synthesis, graphics, and general topics. What is said to be the first totally computer-generated Omnimax film will be shown. For details, contact SIGGRAPH '84 Conference Office, 111 East Wacker Dr., Chicago, IL 60601, (312) 644-6610.

*July 23-27*
**Advanced Technology: Its Impact on International Business, Economics, Finance, and Trade,** Miramar Sheraton Hotel, Santa Monica, CA. Speakers at this symposium will explore the need for cooperation and competition with Pacific Rim countries in the building of supercomputers. Program details and registration information are available from Charles Partington, West Coast University, 440 Shatto Place, Los Angeles, CA 90020, (213) 487-4433.

*July 27-29*
**International Heath/Zenith Users' Group Conference,** Pheasant Run Resort, St. Charles, IL. For details, call or write the Heath Users' Group, Hilltop Rd., St. Joseph, MI 49085, (616) 982-3463.

*July 30-August 3*
**Robot Manipulators, Computer Vision, and Automated Assembly,** Massachusetts Institute of Technology, Cambridge. This short course will emphasize ways of developing strategies for solving problems in robotic sensing, spatial reasoning, and manipulation. Also covered is the use of existing industrial robots and binary vision systems. Contact the Director of the Summer Session, Room E19-356, MIT, Cambridge, MA 02139.■

In order to gain optimal coverage of your organization's computer conferences, seminars, workshops, courses, etc., notice should reach our office at least three months in advance of the date of the event. Entries should be sent to: Event Queue, BYTE Publications, POB 372, Hancock, NH 03449. Each month we publish the current contents of the queue for the month of the cover date and the two following calendar months. Thus a given event may appear as many as three times in this section if it is sent to us far enough in advance.

# BYTE's Bits

## Database Aids Cancer Treatment

The National Cancer Institute's PDQ database provides physicians with up-to-date information on the prognosis and accepted treatment options for specific cancers. PDQ, designed for use with office or personal computers, offers several files of information, such as treatment statements for each type and stage of cancer and data on active cancer-treatment research protocols that are open to patient accrual. A list of physicians who are members of organizations that have a special interest in cancer-patient care is another feature of PDQ.

Currently, physicians have access to PDQ through more than 2000 National Library of Medicine MEDLARS centers. During the course of this year, the Institute plans to make an expanded version of PDQ more widely available through the cooperation of commercial vendors. Those vendors willing to participate will receive monthly updates from the Institute in machine-readable form. The Institute will promote PDQ among physicians and encourage vendors to conduct their own promotional efforts. If you're willing to help bring this vital service to community-based physicians, write to NCI PDQ, Room 11A49, Building 31, National Institutes of Health, Bethesda, MD 20205, for more information.■

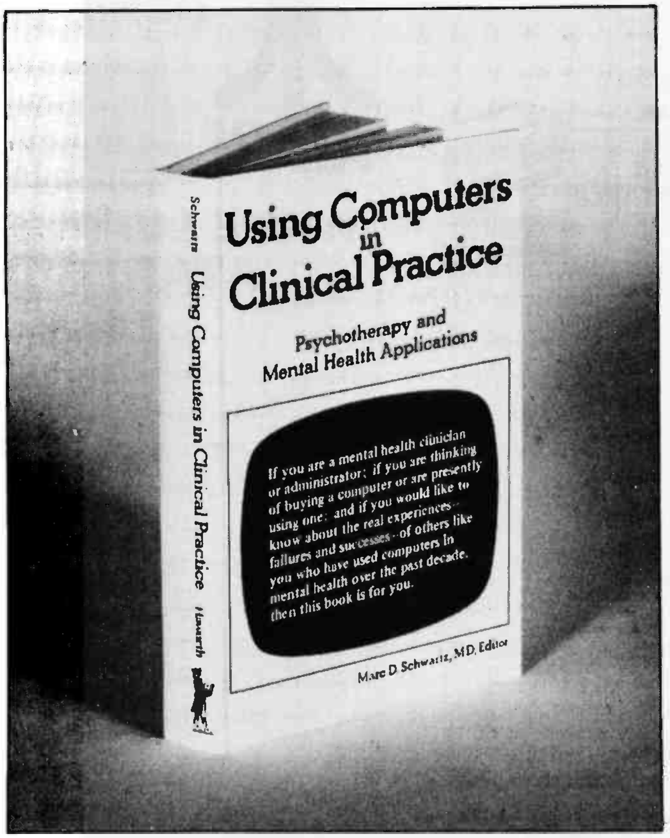


Circle 300 on inquiry card. ⟶

## Using Computers in Clinical Practice

Marc D. Schwartz, M.D., ed.
The Haworth Press, New York, 1984, 510 pages, hardcover, $34.95

Reviewed by
Evie Wilson




Are you a mental health professional unwilling to accept the thought of using computers to do the sensitive, sometimes intuitive, work of psychotherapy? At the same time, if your sense of futuristic mental health practices intrigues you, then you would be interested in reading *Using Computers in Clinical Practice*. Without resorting to a hard-sell approach, the 66 contributors will lead you objectively through various steps of getting acquainted with the possibilities computers offer. In what is a surprisingly readable format, even humorous at times, this book presents selected, relatively brief articles by experienced mental health professionals who use computers in varying degrees in their practices.

The articles in this book are grouped under 14 topics and, fortunately, they do not always agree with each other. The reader is thus exposed to various pro and con points of view. Nevertheless, the main goal of the editor, Dr. Marc D. Schwartz, is not to cause readers to choose an all-or-nothing stance, but to present in an unbiased manner the experiences, successes, and difficulties encountered by the pioneers currently introducing computers to the field of psychology. Because these people are mental health professionals first and computer specialists second, they tend to discuss the issues pertinent to clinical psychology using the language of the profession even though their prime focus, in this book, is on technology and computerization. This helps the more therapeutically oriented reader like myself become more involved, even absorbed, in the discussions.

Some of the articles listed in the table of contents that immediately piqued my interest were reviews on "A Probabilistic System for Identifying Suicide Attemptors," a "Computerized Analysis of Verbal Behavior in Schizophrenia," and on a "Direct Assessment of Depression by Microcomputer," the latter being one of several articles contributed by the editor of this volume.

This is actually a handbook that provides an overview of the multiple uses of computer hardware and software as they currently apply to mental health. For example, it includes discussions of the time-saving advantages of word processing and how to preprogram the routine phrases or diagnostic definitions necessary for repetitive report writing. It covers extensive considerations of the value, drawbacks, and unknowns related to computerized assessment, diagnosis, and testing procedures that have heretofore been tedious pencil-and-paper methods.

### Seeing the World

Not all is portrayed as rosy, however. The authors raise substantive legal, ethical, and humanistic questions. For instance, how will a depressed, depersonalized client react to being assessed by a machine rather than a caring human being? Will computer-using professionals begin to treat their microcomputers and software as authorities or become reluctant to introduce innovation into stable programs that have taken years to perfect? What happens to worker satisfaction when human interaction is exchanged for a full day of computer interaction?

On a more optimistic note, how about computerized fantasy games in child therapy? Or educational systems for cognitive rehabilitation in neuropsychology? Self-help via bulk mail? Or just plain old improvements in billing procedures and cash flow for the psychotherapist as a small-business owner?

### Keeping in Mind

Considerations are many in this relatively unexplored area; that is why this book is essential. It invites you to be aware of various options and warnings that you may not even have begun to imagine. In addition to words of caution, the contributors also include helpful suggestions. It seems that the editor wants to make certain that once you invest in a computer, you will be able to take full advantage of it and not relegate it, unused, to a dusty corner due to unanticipated frustrations. This is reason enough to read this book, since your investment can range from $2000 to $20,000.

What are some of those suggestions? Consider, for example, Parts I and II entitled "An Overview" and "Dealing With People," respectively. Once you have decided to go ahead and merge technology with the humanities, apparently the first roadblock is likely to come from other office personnel and colleagues who may feel professionally threatened. The authors offer insight into this fairly com-

# The Micromint Collection

*Micromint. Supporting the varied projects that appear in Steve Ciarcia's monthly article in BYTE Magazine, "Ciarcia's Circuit Cellar." Offering a wide range of computers and peripherals designed to meet the exacting demands of the hobbyist as well as worldwide corporate clients.*

## TERM-MITE ST SMART TERMINAL BOARD

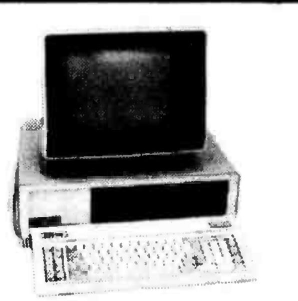
***As featured in Ciarcia's Circuit Cellar BYTE Magazine, January & February 1984***

All you need to build a Smart Video Terminal equivalent to the types advertised for $1,000.00 or more is a Term-Mite ST circuit board, scanned or parallel keyboard, video monitor and power supply.

- Uses brand new Nat'l Semi NS455A Terminal Processor.
- 24 lines by 80 characters, 25th reverse-video status.
- Upper & lowercase. Line (block) graphics.
- Selectable data rate, parity & display options.
- Reverse video, half intensity, double height & width, underlined, blinking and/or blank character.
- Separate sync or composite video output. Self Test.

**Term-Mite ST Video Display Terminal Board**
**BCC22 Assembled & Tested** .......... $284.
**BCC23 Complete Kit** .......... 244.

## MPX-16 MICROCOMPUTER IBM PC COMPATIBLE



***As featured on the cover of BYTE Magazine. Also featured in Ciarcia's Circuit Cellar November, December 1982 & January 1983***

The Computer With A Split Personality.
—Use it as an IBM PC look alike that directly boots PC DOS 1.1 and accepts all expansion boards designed for the IBM PC.
—Use it as a powerful 8088 single board computer for all your OEM applications. Just add serial terminal, disk drive and power supply. Directly boots CP/M-86.

Buy the MPX-16 in the form that best meets your needs or budget. As a bare board, as a wave soldered board that contains all components less ICs, as an assembled and tested circuit board or as a complete system.

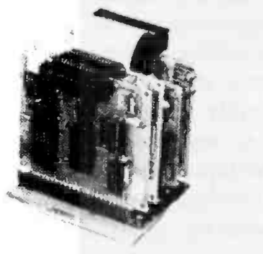
- Directly boots PC DOS 1.1 and CP/M-86.
- Most IBM PC software executes with no modifications.
- IBM PC bus compatible + 9 expansion slots.
- Intel 8088 16-bit microprocessor.
- Optional Intel 8087 math coprocessor.
- 256K bytes on board memory.
- Up to one megabyte of system memory.
- Up to 64K bytes of system ROM/EPROM.
- 2 RS-232C Serial & 3 Parallel I/O ports.
- Disk controller for 5¼" or 8" drives.
- Sixteen levels of vectored interrupts.

**MPX-16 Circuit Board Assembled w/64K RAM** .......... $1,200.
**OEM 100 quantity price** .......... 900.
**MPX-16 Circuit Board Asembled w/256K RAM** .......... 1,400.
**MPX-16 Semi-Kit (wave soldered circuit board w/all components) Less ICs** .......... 595.
**Complete Kit of ICs w/256K RAM** .......... 595.
**MPX-16 Unpopulated (bare) PC Board** .......... 300.
**CP/M-86 Operating System + Manuals** .......... 80.
**MPX-16 Switching Power Supply** .......... 300.
**MPX-16 Technical Reference Manual** .......... 50.
**MPX-16 Metal Enclosure with Fan** .......... 300.
**Tandon TM 100-2 Double Sided/Density Drive** .......... 300.
**IBM PC Keyboard Interface Adapter** .......... 100.
***Shipping & handling additional on all MPX-16 orders.***

IBM PC is a trademark of International Business Machines Inc.
CP/M-86 is a trademark of Digital Research Inc.
Z8 is a trademark of Zilog Inc.

**Circle 269 on inquiry card**

## Z8 BASIC SYSTEM CONTROLLER NEW!!!



***As featured in Ciarcia's Circuit Cellar. BYTE Magazine, July & August 1981***

The Z8 Basic System Controller is an updated version of our popular BCC01. The price has been reduced and features added. The entire computer is 4" by 4½" and includes a tiny BASIC interpreter, up to 6K bytes of RAM and EPROM, one RS-232C serial port with switchable baud rates and two parallel ports. BASIC or machine language programming is accomplished simply by connecting a CRT terminal. Programs can be transferred to 2732 EPROMs with an optional EPROM programmer for auto start applications. Additional Z8 peripheral boards include memory expansion, serial and parallel I/O, real time clock, an A/D Converter and an EPROM programmer.

- Uses Zilog Z8 single chip microprocessor.
- Data and address buses available for 124K memory.
- Can be battery operated.
- Cross assemblers for various computers.

**BCC11 Assembled & Tested** .......... $149.
**New Low Price**

## Z8 MEMORY, I/O EXPANSION, CASSETTE INTERFACE

- 8K bytes of additional RAM or EPROM.
- Three additional 8 bit parallel ports.
- Cassette interface—300 baud K.C. Standard.
- Software real time clock.

**BCC03 w/4K RAM Assembled & Tested** .......... $150.
**BCC04 w/8K RAM Assembled & Tested** .......... 180.

## Z8 EPROM PROGRAMMER

- Transfer BASIC or Assembly Language application programs from RAM to 2716 or 2732 EPROM.
- Comes with programming & utility routines on EPROM.
- Requires BCC03 Z8 Expansion Board for operation.

**BCC07 Assembled & Tested** .......... $145.

## Z8 ANALOG TO DIGITAL CONVERTER

- Uses Analog Devices 7581 IC, 8-channel 8-bit.
- Adds process control capability to the Z8 system.
- Over 1,000 conversions per channel per second.
- Monitors 8 analog signals in one of two 10v ranges.

**BCC13 Assembled & Tested** .......... $140.

## Z8 SERIAL EXPANSION BOARD

- Adds additional RS-232C and opto-isolated 20 ma. current loop serial port to the Z8 System.
- Runs at 75 to 19,200 baud in all protocols.
- Comes with listings of sample serial I/O routines.

**BCC08 Assembled & Tested** .......... $160.

## Z8 16K MEMORY EXPANSION BOARD

- Add up to 16K of additional memory, RAM or EPROM, to your Z8 System Controller in any multiple.
- Accepts 2016, 6116, 2716, or 2732 memory types.
- Four 16K cards may be installed on the Z8 System bringing the total memory to 64K.

**BCC14 Assembled & Tested w/8K RAM** .......... $120.
**BCC16 Assembled & Tested w/16K RAM** .......... 155.

## COMING SOON! FORTH LANGUAGE VERSION OF THE Z8

With the new Z8 with on board 4K FORTH you can program high speed control functions in a few simple high level language commands. Perfect for data reduction, process control and high speed control applications.

**BCC20 Z8F FORTH Microprocessor chip** .......... $150.
**BCC21 Z8F FORTH System Controller (This board is a BCC11 with a BCC20 installed) Assembled & Tested** .......... 280.

## Z8 CROSS ASSEMBLERS

*From Micro Resources*
IBM PC, APPLE, 6502 Systems 5¼", CP/M 2.2 8" .......... $ 75.
*From Allen Ashley*
TRS-80 Model I, III, Northstar 5¼" .......... 75.
CP/M 2.2 8" .......... 150.

## Z8 FIVE SLOT MOTHER BOARD

- Expand your Z8 BASIC System with minimum effort.
- Contains five slots complete w/44 pin connectors.

**MB02 Assembled & Tested** .......... $69.

## TRIPLE VOLTAGE POWER SUPPLIES

+5V @ 300 ma. +/−12V @ 25 ma.
**UPS01 Assembled & Tested** .......... $35.
**UPS02 Complete Kit** .......... 27.
+5V @ 1 Amp. +12V @ .5 Amp. −12V @ 50 ma.
**UPS03 Assembled & Tested** .......... 60.
**UPS04 Complete Kit** .......... 50.

## SPEECH SYNTHESIZERS

## MICROVOX TEXT-TO-SPEECH SYNTHESIZER

***As featured in Ciarcia's Circuit Cellar BYTE Magazine September, October 1982.***

Microvox is a second generation professional voice quality text-to-speech synthesizer that is easily interfaced to any computer, modem, RS-232C serial or parallel output device and provides speech of unbelievable clarity.

- Unlimited vocabulary.
- 64 programmable inflection levels.
- 6K text-to-speech algorithm.
- Full ASCII character set recognition and echo.
- RS232C and parallel output.
- 1000 character buffer, 3000 optional.
- Adjustable baud rates (75-9600).
- Spelling output mode.
- 7 octave music and sound effects.
- On board audio amplifier & power supply.
- X-On/X-Off handshaking.

**MV01 Assembled with 1K buffer** .......... $299.
**MV02 Complete Kit with 1K buffer** .......... 219.
Add $15.00 for 3K buffer option.

## VOTRAX SC-01A PHONETIC SPEECH SYNTHESIZER IC

The SC-01A Speech Synthesizer is a completely self-contained solid state device that phonetically synthesizes continuous speech of unlimited vocabulary. Used in our Microvox and Sweet-Talker.

*SC01A Quantity 1–99* .......... *$44. ea.*
*100+* .......... *32. ea.*
*1000+* .......... *24. ea.*

## MICRO D-CAM DIGITAL TV CAMERA

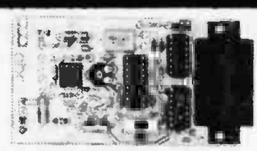
***As featured in Ciarcia's Circuit Cellar BYTE Magazine, September & October 1983***

GIVE YOUR COMPUTER THE DIMENSION OF SIGHT

- Interprets, enhances and stores images.
- 256 × 128 digital image sensor.
- Plug-in boards for the IBM-PC, APPLE II+ or e.
- Software includes utilities for auto exposure, multi-level greyscale, screen dump and image enhancement.
- Includes interface card, 4 foot extension cable, camera assembly, manual, and software on diskette.

**DC01 IBM PC Assembled & Tested** .......... $299.
**DC02 IBM PC Complete Kit** .......... 264.
**DC03 APPLE II Assembled & Tested** .......... 299.
**DC04 APPLE II Complete Kit** .......... 264.

## 300 BAUD ANSWER/ ORIGINATE MODEM KIT



***As featured in Ciarcia's Circuit Cellar BYTE Magazine, March 1983***

Micromint's latest 300 Baud Modem Kit is crystal controlled, uses the TI TMS99532 IC, contains just 25 parts and requires no calibration or adjustments. Use with acoustic coupler or in direct connect mode.

**MD04 Complete Kit as shown** .......... $60.
**MD05 Transformer for Direct Connect Mode** .......... 9.
**AC01 Acoustic Coupler Kit** .......... 20.

## E-Z COLOR GRAPHIC INTERFACE WITH SPRITES

*APPLE II E-Z Color plug-in board with Graphics Editor on 3.3 disk*
**EZ01 Assembled & Tested** .......... $150.
**EZ02 Complete Kit** .......... 125.

*APPLE II E-Z Color Plus*
- Allows the use of a single monitor or TV set.

**EZ11 Assembled & Tested w/Graphics Editor** . $200.

*KRELL LOGO for E-Z Color and E-Z Color Plus*
Supports Sprite Graphics.
**EZ21 Krell LOGO w/full documentation** .......... $89.

*Animation Software for E-Z Color Plus*
- Draw with Sprites using Joystick or Koala Pad.
- Animate Sprites from your own BASIC program.

**EZ21 Animation Software** .......... $49.

*S100 E-Z Color Graphics Board*
- With sound generator & joystick interface.
- MBASIC Graphics Editor on 8" diskette.

**EZ04 Assembled & Tested** .......... $289.

***MICROMINT INC.*** *561 Willow Avenue, Cedarhurst, NY 11516*
***To Order:*** *Call Toll Free 1-800-645-3479*
***For Information Call:*** *1-516-374-6793*
***Call: Monday-Friday, 9-5 PM***

MICRO MINT

mon reaction and suggest ways of introducing your new ideas in stages that are easier to accept.

In addition, precautions are raised in Parts I and II regarding facets of professional computerization that have apparently thwarted more than a few enthusiastic, though uninformed, potential computer users. First, although computers have the capacity to capitalize tremendously on the power of information, they can be subject to inconvenient programming limitations. Second, you may need to learn how to program your own software, because ready-made software is not always available or appropriate to specific needs. Finally, you are made aware that contracting a programmer to develop an operational program is very different financially from receiving a functional program. The former means simply that the program runs. The latter means the programmer stays on the job long enough to work out unforeseen bugs in the system. A misunderstanding of this contractual wording can result in a $40-per-hour charge for program modification costs until all the data is printing the way you want it.

For those readers who are employed by larger operations than private practice, such as hospitals, community-planning agencies, or mental health centers, this book contains valuable advice from those with previous experience. The authors emphasize that clinicians must be quite familiar with the computer systems in their agencies in order to adequately input their programming needs. Otherwise, programmers and administrators could set up programs that are not relevant to clinicians' information needs or are not sensitive to the human elements in therapeutic work. Then the result is potentially more, meaningless paperwork for the clinician, or you are stuck with a system that is woefully underused by the agency. The writers of the "Administrative and Clinical Information Management" chapters are both helping other professionals in the field to avoid the pitfalls they have experienced and expressing satisfaction with their accomplishments.

Selected articles in "Choosing a Computer" continue in the effort to offer guidance. Although the language in this article includes more technical terms than in any other portion of the book, it should not deter you. Yet this is the next to last of the 14 sections, so if you have read thus far and are ready to choose your computer, you need to know, in spite of technical terms, such considerations as how an Apple II compares with a Vector 2600.

**Contracting a programmer to develop an operational program can result in a misunderstanding that is largely financial.**

### Broadening Horizons

I recommend reading this book candy-box style. Pick out intriguing articles for the pure enjoyment of learning more about some fascinating applications of computers in mental health. Did you know, for instance, that computers can be programmed to respond as Rogerians, or Gestalt or Rational Emotive therapists? To date, these artificial-intelligence therapists are not the real thing, though. A set of repetitive Yes statements by a human tester elicits a series of hilarious, though empathic, reflective-listening statements from the computer. Did you know a Lithium Information Center exists? Or that computers are beginning to read minds by decoding brain-wave patterns that are produced by merely thinking of a word? You say, shades of 1984? Perhaps—but what about disabled people whose perfectly good minds are trapped in bodies that cannot move well enough to speak or write? A final chapter under "Other Issues" discusses tax tips for computer owners—another reason to invest in this book before computerizing your profession.

### Few Criticisms

As I read, I carefully watched for drawbacks in *Using Computers in Clinical Practice*, though, I must admit, I really couldn't find many. It seems to contain something for everyone ranging from the uninitiated to those with serious purchasing intentions. If anything could have been expanded, however, I would have liked to have read more about client reactions, e.g., case studies, articles by clients, and quotes. I found one of the most engaging articles to be "A Computer Assisted Therapy Game for Adolescents: Initial Development and Comments" because it did briefly cover clients' behaviors and attitudes. Other articles that brought in clients' reactions to some extent were those on self-help sex therapy and a review of "Talking to a Computer About Emotional Problems." I had hoped the chapter "Eliza and Her Offspring" might satisfy my desire to hear from clients, but as I read on I discovered Eliza is herself (itself?) an artificial-intelligence psychology program.

In sum, this book is outstanding and timely. It is a thorough overview that is both easy and enjoyable to read. It is well bound and clearly printed on nonglossy pages. It contains references at the end of many chapters as well as an extensive, categorized bibliography. Because of the overall writing style, the novice as well as an experienced user can learn a wealth of information almost effortlessly.

According to one article, it seems that during the 1970s panels designed to discuss computer use by the American Psychological Association were not very well attended. In 1980, however, these panels drew huge crowds of new computer owners who, having purchased the hardware, needed someone to show them what to do with it. Conclusion: computers are a growing facet of the mental health practice. If you are a clinician, it is time to find out what you may not already know, and *Using Computers in Clinical Practice* is an excellent first step.■

*Evie Wilson (POB 258, Gilsum, NH 03448) is a psychotherapist, a clinician at a mental health service, and a professor of psychology at Hawthorne College in Antrim, New Hampshire.*

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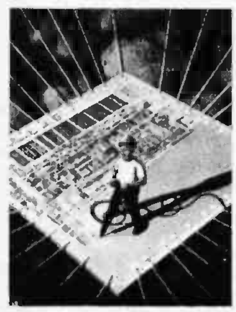
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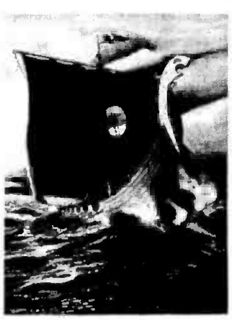
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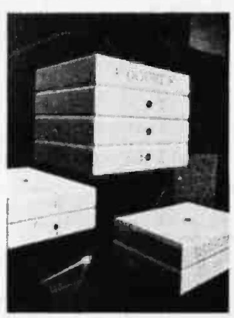
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## The Power Of: SuperCalc, 2nd ed.

Robert E. Williams and
Bruce J. Taylor
Management
Information Source Inc.
Portland, OR,
1983, 232 pages,
softcover, $14.95

Reviewed by
Jack Bishop

The idea of a book designed to teach you how to make user-friendly software work really boggles the mind. Philosophical questions aside, a book is an old, familiar, and reliable companion, whereas the computer sometimes requires two microcomputers, side by side, to present a computerized tutorial.

### Expectations

A user's manual is expected to focus on the commands of the program. In any handbook on computer software, I look to the author to either provide an introduction that explains the workings of the software in a unique way or to develop special and powerful insights (tricks of the trade) that go beyond the scope of the user's manual. *The Power Of: SuperCalc* seems to sit astride these two poles but leans toward the former, a beginner's manual. The introduction clearly states that the goal of this updated edition is to demonstrate Supercalc functions, rather than to illustrate specific problem-solving methods. And it uses a dozen exercises to do so.

### A Misnomer

*The Power Of: SuperCalc* is thus misnamed by my standards. Based on its contents, A Simple Tour of Supercalc would be a more accurate description. Such a simple tour is not intended to be derogatory, for simple tours are worth a great deal. But to earn its name, I expected this handbook to take me more deeply into applications of Supercalc (see table 1). When I see the word "power," I also expect to be led through an appreciation of the limitations of a program. I can imagine any user trying to expand any one of the exercises to a business use, only to find that limitations of the calc structure lead him or her into a dead end, and often when it is least convenient.

| Area | Supercalc | Power |
|---|---|---|
| Math Functions | 7 | 6 |
| Boolean Expressions | 4 | 3 |
| Trigonometric Functions | 9 | 3 |
| Miscellaneous Functions | 4 | 2 |
| Commands | 12 | 5 |
| Calculation | 4 | — |
| Display | 16 | 11 |

**Table 1:** *The coverage of* The Power Of: SuperCalc *is fairly complete but ignores a few key commands (such as NPV, LN, LOG).*

### Exercises

The Accounts Receivable Ageing Report is an exercise that develops a simple report with columns for several categories: Current Billing, Over 30 Days, Over 60 Days, Over 90 Days, and Total Due. The report is clean and fits on the 80-column screen or printer without a fuss. The use of the Execute file to update the report each month will pay for the cost of the book in one update session. The addition of titling and multipages could give you a no-frills report for about 150 customers.

Invoicing from Inventory uses a multiple-table look-up to find pricing for 16 products as well as volume discounts.

Cost Recovery for an equipment-rental company provides an example of recording "...a declining balance as entries accumulate against the fixed value." Rents received are used to offset the purchase price of each piece of equipment, the profit margin reflecting the difference between rents and initial cost. The use of the Execute command to update the worksheet is a good example of the power of Supercalc.

Production Scheduling extends the concept of comparing a value to a fixed base (as in the previous example) and to a variable base, in the scheduling of operations for a manufacturer of stained glass lamps. The Supercalc worksheet is set up to allow customer orders to be shifted from week to week to evaluate the effect on the schedule.

The Estimating exercise on machining and cost estimating for a small shop provides an example of using the calculation sequence in Supercalc. The example calculates values for a table, uses the table for reference, and finally selects values from the table for further calculations. The cleverness of the example is hidden in the excellence of the worksheet's layout.

Checkbook Ledger is a simple ledger, illustrating posting and maintaining a balance.

Engineering Formula uses a simple vector calculation to illustrate the ability to calculate mathematical formulas easily. While using only the cosine, square root, and exponentiation functions, engineers should have no trouble generalizing (if they needed the example in the first place!).

Payroll Reporting illustrates the updating, storage, retrieval, and use of multiple worksheets.

Monthly Sales Reporting is the vehicle to illustrate the development of multiple reports on one worksheet.

Daily Inventory extends the ability of Supercalc to develop a daily report, then update totals and clear the report for the next day. The use of a logic command (IF) provides the key for reordering the product.

Financial Forecasting and Accounts Payable exercises provide further examples of functions already illustrated.

### Insights

The most powerful feature of the examples is the experience with the Execute file to update, reorganize, and clear a worksheet. Beginning calc users will not appreciate the power of this ability for a while, but the multiple examples should give everyone a feeling of confidence in this capability of Supercalc.

*The Power Of: SuperCalc* provides three insights I believe will prove valuable to many readers. First, the look-up table is a very powerful and, I suspect, underused aspect of the various calc spreadsheets. The several illustrations of its applications should provide the background to increase its use. Putting a zero at the beginning and end of the table is the sort of trick of the trade I look for in a book of this sort.

Second, the calendar feature, while not a specific function of Supercalc, is a simple way to ensure that the end of-the-month change is handled smoothly and effortlessly. It is well described and laid out in this book.

Finally, the power of the example, discount taken versus the cost of borrowed money, is the simple idea of comparing the discount to the cost of borrowing the money, and using the Supercalc to lay out the results simply, easily, and clearly.

**Format**

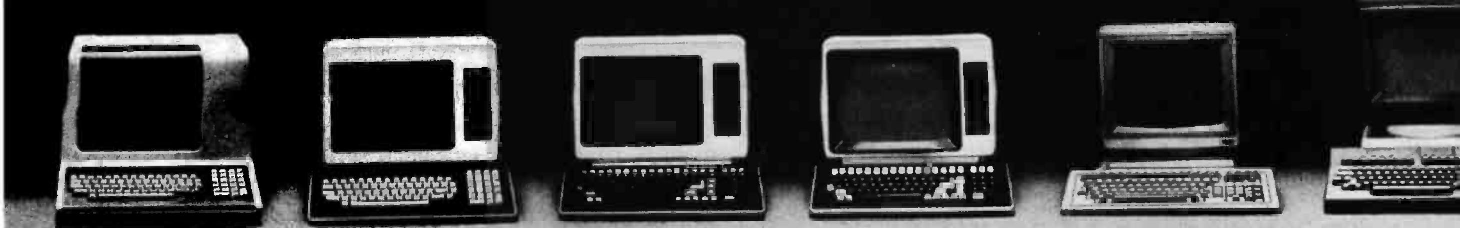
*The Power Of: SuperCalc* is laid out with commands on the left, explanations on the right. The commands are spelled out, as is the word Return.. More than one reader will issue oaths when discovering that typing the letters *r-e-t-u-r-n* is not what the author intended. (Ever wonder why we have carriage returns on the keyboard? That's another story!)

I would've gladly paid more for this book to cover the costs of highlighting the commands in color and for necessary typesetting improvements. The commas and colons tend to get lost unless your eyes are very young and the light is good and your arms are short and.... For example, the manual contains a Repeat Text command that appeared unworkable. Then I realized the squiggle at the other side of the page was an apostrophe, not a comma, and the mystery was solved.

**With some modification, these worksheets will provide greater individual productivity as well as the opportunity to learn several aspects of the language of Supercalc.**

All in all, the book is well worth the price. While *The Power Of: SuperCalc* provides a good short tour, the real power of Supercalc lies beyond the horizon for self-discovery. For a few, the payoff of *The Power Of: SuperCalc* will come in just having spent a few dollars to have a security blanket *on the shelf*. For others, the author's slightly different approach to the material in the Supercalc user's manual will be sufficient. Teachers will benefit from accompanying overhead-projection transparencies ($49.95) and a floppy disk ($64.95). A final group will find one or more of the 12 exercises applicable to their special needs. With some modification, these worksheets will provide greater individual productivity as well as the opportunity to learn several aspects of the language of Supercalc. For the price, you are getting honest examples carefully done.■

*Dr. Jack Bishop (Bishop Associates, 2000 Sherman Ave., POB 311, Evanston, IL 60201) is a management consultant specializing in corporate planning and economics.*



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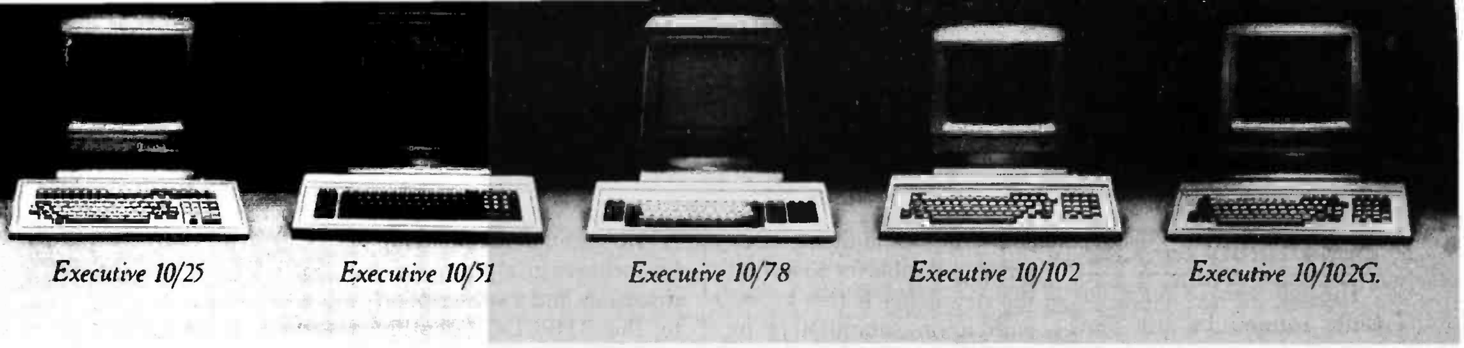


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# Clubs and Newsletters

## Opportunity for Kids

The San Pablo Computer Club, formed by the San Pablo Institute, a nonprofit public-service organization, is devoted to making computer education available to economically disadvantaged young people. The club offers programming instruction and an environment in which youngsters can meet and share ideas. Because it does not charge membership dues, the club relies on donated computer equipment, peripherals, and software. For information, write to the San Pablo Institute, 234 Mullen St., San Francisco, CA 94110.

## Tipping the TIP.C User

TIP.C, a group of Texas Instruments Professional Computer users, meets every month in Houston, Texas. Group members wish to contact TI PC users nationwide to share software and hardware information, develop a software library, and assist in the publication of a newsletter. For further details, contact Stephen Gay, TIP.C, 1608 Elmen, Houston, TX 77019, (713) 520-6990.

## Participate Locally

*Computer Users* is a quarterly newsletter produced in cooperation with the Computer Users Federation (CUF) of Southeast Wisconsin. Participation in local events is facilitated due to the newsletter's listings of a regional club and group directory and computer-related activities. An area calendar of classes, seminars, shows, and meetings is posted on a telecommunications system made up of two local bulletin boards. Subscriptions to the newsletter are available for $3 a year; the newsletter is free to any club upon submittal of its mailing list. To send or receive information, contact CUF, POB 23483, Milwaukee, WI 53223.

## Sooners Form Commodore Clubs

The Greater Oklahoma Commodore Club comprises three chapters: Oklahoma City, Midwest City, and Edmond. More chapters may be added later. A newsletter, *OKCommodore Connection*, is produced. For further information, contact Randy Hill, Greater Oklahoma Commodore Club, 1401 North Rockwell, Oklahoma City, OK 73127, (405) 789-3229.

## Serving the Victor

*SIVic-9000*, a newsletter for Victor-9000 users, has reports on new software and hardware releases, user critiques, a technical question-and-answer column, gameware, and personal-use software reviews. Interviews and feature articles of interest to Victor-9000 users are included. A charter subscription is $24 a year. For details, contact Michael McNeilley, *SIVic-9000*, Suite 456, 3277 Roswell Rd. NE, Atlanta, GA 30326.

## Hoosier Computerists Meet in High Land

The Terre Haute PC Users Group (THPCUG) is for users of the IBM PC and compatible computers and everyone else interested in small computers. Meetings are held at 7 p.m. on the first Monday of the month in the Terre Haute area of Indiana. A $10 annual membership fee includes group-purchase discounts and a subscription to the THPCUG monthly newsletter. A monthly disk produced by the club is available for a minimal copying charge. For further information, contact the Terre Haute PC Users Group, POB 3174, Terre Haute, IN 47803.

## Unir Project Is for Unix Users

Membership in the Unir Project, a user group for people interested in the Unix operating system and in the C programming language, is open to anyone fascinated by interactive computer systems. A $25 membership fee entitles you to receive a copy of the current quarterly newsletter and a certified UNID (a Unirversal Numeric Identifier) used to order reports and software from the Unir Project and to access the members' database. Subscriptions to the newsletter alone are $24. To become a member, send your name, address, and phone number plus a brief description of your interests to Unir Corp., Suite 106, 5987 East 71 St., Indianapolis, IN 46220, or call (317) 842-7014.

## Pick Ideas and Tools

*Logto Zircon*, a monthly newsletter for Pick users, provides a source for ideas and tools to improve the performances of operating systems. Each issue explores such themes as security, offers creative programs, or reports on design improvements. In addition, each issue contains programming tools. An annual subscription is $59.95. For further information, contact Catherine Hill, Zircon Co. Inc., 215 Salem St., Woburn, MA 01801, (617) 935-6901.

## Computerists Meet in the Granite State

The New Hampshire Atari Computer Club (NACC) meets on the first Tuesday of the month in Nashua, New Hampshire. For details, contact Scott Mitchell, NACC, 346 South Taylor St., Manchester, NH 03103, or call (603) 624-0089.

## Micro Library Up and Running

The Library Micro Clearinghouse is a national nonprofit endeavor to promote library management through the exchange of library-application templates for use with public-domain software. Librarians are encouraged to duplicate the templates they receive, adapt the programs to meet their needs, and share them with other libraries. Templates come in single- and double-disk versions for $5 and $7.50, respectively. To donate applications templates for public-domain distribution or for further information, contact Eric Anderson, Micro Computer Libraries, 145 Marcia Dr., Freeport, IL 61032.

## Stamp Out Sour Computer Experiences

The Lemon Byte Society assists personal computer users by combating some of the shortcomings of the computer industry. Aimed at users who are stymied by severe deficiencies encountered in using software or hardware, the professionals who comprise the Society act as go-betweens for the user and supplier. They document the problem, contact the parties responsible for the defect, and print their findings and results in a monthly bulletin available to all members. Annual membership is $32, which entitles you to all the Society's services. For further details, contact The Lemon Byte Society, POB 558250, Miami, FL 33155, (305) 386-3479.

### WUE Has Recipe for Success

The World Users Exchange (WUE) assists user groups in their efforts to promote computer knowledge. As a result of a recently conducted survey, WUE found that several user groups needed help in improving their programs and in planning services to members. One way WUE helps user groups is by offering possible solutions to organizational snafus in each issue of its newsletter, *The Exchange*. User groups are encouraged to share their solutions to problems so that they may be avoided by newer organizations. For details, write the World Users Exchange, POB 12132, Roanoke, VA 24022.

### Health-care Applications Supported

The *Micro MD Journal* is a monthly newsletter for novice and experienced computer users in the health-care field. It focuses on applications for clinical and diagnostic areas, office management, and personal-investment fields. A catalog listing medical and dental software, hardware, and accessories is provided and purchase discounts are offered. A charter subscription is $36 annually; $60 for two years. Send inquiries to Micro MD Publishers, POB 2500, Chesapeake, VA 23320.

### Users Converge in Toms River

The Computer Club of Ocean County (CCOC) New Jersey welcomes users of any personal computer to attend its meetings. Held at 7:30 p.m. on the first Friday of each month in the Ocean County Municipal Building in Toms River, CCOC meetings include speakers, presentations, and magazine swaps. The club produces a quarterly newsletter and an annual membership directory. An electronic bulletin board, (201) 244-2259, is open to the public from 4 p.m. to 7 a.m. weekdays and 24 hours a day on weekends. It supports 300- and 1200-bps (212A) operation and offers special privileges to club members. Downloading and uploading of text or programs and general-message storage/retrieval are supported and running on a Heath Z-89. For further details, contact Stuart MacDonald, CCOC, 6 Whitaker Dr., Toms River, NJ 08753, (201) 240-9323.

### Meet with Fellow HP 80 Users

All users of the Hewlett-Packard Series 80 personal computer in Orange County, California, are welcome to attend meetings offered by the HP Club 80. Members meet on the first Wednesday of the month in the Irvine area. There are no dues. For details or to get on the mailing list, contact Milt Beychok, 63 Oak Tree Lane, Irvine, CA 92715, (714) 786-0837.

## Volunteers Host 64 Users

The E T 64 Users Group is a club in Tennessee dedicated to learning about using the Commodore 64 computer. For further details, contact Walt Turner, E T 64 Users Group, POB 495, Knoxville, TN 37901, or call (615) 966-8478.

## Garden of Software Created for Adam

Sage Enterprises has created a public-domain software library and exchange for owners of Coleco's Adam personal computer. In addition, Sage Enterprises will offer a bimonthly newsletter of information about the public-domain software, user groups, and new products. For further information, contact Sage Enterprises, Route 2, Box 211, Russellville, MO 65074.

## Microcomputerists Gather in Memphis

The Memphis Area IBM PC Users Group meets on the fourth Wednesday of the month in room 233 of the Dunn Building on the campus of Memphis State University in Tennessee. Address further inquiries to Peter Vermilye, Memphis Area IBM PC Users Group, POB 241756, Memphis, TN 38124-1756, or call (901) 345-8760.

## Commodores at Golden Gate

The San Francisco Commodore Users Group provides beginners with an introduction to programming skills, hardware modifications, and software for the Commodore 64 and VIC-20. For details, contact Roger Tierce, San Francisco Commodore Users Group, 278 27th Ave. #103, San Francisco, CA 94121, or call (415) 387-0225.

## Sanyo Strong in Boston

The Sanyo Users Group/USA (SUG/USA), located in Boston, Massachusetts, gives support to Sanyo computer owners via a bimonthly newsletter and distribution of public-domain software. Sanyo products are reviewed, and software patches, articles from users about various applications, lists of public-domain software, and book reviews are included in the newsletter. Future plans call for access via Compuserve and a computerized bulletin-board service. SUG/USA will act as a referral service to help Sanyo users form local chapters. Contributions of articles and public-domain software are welcome. The membership fee is $15 annually. Write to the Sanyo Users Group/USA, POB 8069, Boston, MA 02114-8069.

## Sanyo Group Seeks Your Input

The Sanyo PC users group collects and welcomes information from business and personal users of the Sanyo 550 or 555 PC. A newsletter is planned. Send inquiries to Roger Wilcox, 425 Woodlawn Ave., Zanesville, OH 43701.

## MS-DOS Users Rally in Zürich

The PC-Club Zürich was started for users of IBM, Columbia, Corona, and other MS-DOS-based systems. For more information, contact Kurt Fürer, PC-Club Zürich, Kuenzlistrasse 38, CH-8057 Zürich, Switzerland.

## Texans Form TRS-80 Club

The TRS-80 Club meets at 7 p.m. once a month at the McLennan County Library in Waco, Texas. The *H.O.T. TRS-80 Club Monthly Newsletter* contains meeting dates, articles, editorials, and advertisements for purchase discounts available only to members. For further details, write to The TRS-80 Club, POB 1923, Waco, TX 76703. ■

If you would like BYTE readers to know about your club or newsletter send the details accompanied by no more than one newsletter to Clubs and Newsletters, BYTE Publications, POB 372, Hancock, NH 03449. Overseas groups are encouraged to participate. Please allow at least three months for your announcement to appear.

# Books Received

*The ABZ's of Word Processing for Executives and Professionals*, Robert M. Segal and Susan B. Kelley. New York: Stravon Educational Press, 1983; 64 pages, 21.5 by 28 cm, softcover, ISBN 0-87396-097-1, $10.95.

*Abstraction Mechanisms and Language Design*, Paul N. Hilfinger. Cambridge, MA: The MIT Press, 1983; 192 pages, 18 by 23.5 cm, hardcover, ISBN 0-262-08134-2, $27.50.

*Advanced Programming Techniques for Your Atari Including Graphics & Voice Programs*, Linda M. Schreiber. Blue Ridge Summit, PA: Tab Books, 1983; 224 pages, 19.5 by 23.5 cm, softcover, ISBN 0-8306-1545-8, $14.50.

*Adventures with the Atari*, Jack B. Hardy. Reston, VA: Reston Publishing Co., 1984; 368 pages, 17.5 by 23.5 cm, softcover, ISBN 0-8359-0172-6, $14.95.

*Affordable Word Processing*, Richard A. McGrath. Englewood Cliffs, NJ: Prentice-Hall, 1983; 160 pages, 15.3 by 22.8 cm, softcover, ISBN 0-13-018259-1, $10.95.

*Algorithmic Program Debugging*, Ehud Y. Shapiro. Cambridge, MA: The MIT Press, 1983; 248 pages, 18 by 23.7 cm, hardcover, ISBN 0-262-19218-7, $30.

*Apple Assembly Language*, W. Douglas Maurer. Rockville, MD: Computer Science Press, 1984; 432 pages, 15.3 by 23.8 cm, softcover, ISBN 0-914894-82-X, $17.95.

*Apple II Applications*, Marvin L. De Jong. Indianapolis, IN: Howard W. Sams & Co., 1983; 240 pages, 13.5 by 22.8 cm, softcover, ISBN 0-672-22035-0, $13.95.

*Apple II User's Guide*, 2nd ed., Lon Pool. Berkeley, CA: Osborne/McGraw-Hill, 1983; 496 pages, 16.3 by 23.5 cm, softcover, ISBN 0-88134-104-5, $17.95.

*Area-Efficient VLSI Computation*, Charles E. Leiserson. Cambridge, MA: The MIT Press, 1983; 152 pages, 18.3 by 23.8 cm, hardcover, ISBN 0-262-12102-6, $22.50.

*Assembly Language Programming for the IBM Personal Computer*, David J. Bradley. Englewood Cliffs, NJ: Prentice-Hall, 1984; 352 pages, 18.5 by 24 cm, hardcover, ISBN 0-13-049189-6, $19.95.

*Automating Your Financial Portfolio*, Donald Woodwell. Homewood, IL: Dow Jones—Irwin, 1983; 270 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-87094-399-5, $19.95.

*Basic Disk I/O Faster and Better & Other Mysteries*, Lewis Rosenfelder. Upland, CA: IJG Inc., 1983; 432 pages, 21.3 by 27.8 cm, softcover, ISBN 0-936200-25-1, $29.95.

*Basic Fun with Graphics the Apple Computer Way*, Margaret Ann Zuanich and Susan Drake Lipscomb. New York: Avon Camelot Books, 1983; 128 pages, 13 by 19 cm, softcover, ISBN 0-380-85043-5, $3.95.

*Basic Fun with Graphics the Atari Computer Way*, Margaret Ann Zuanich and Susan Drake Lipscomb. New York: Avon Camelot Books, 1983; 128 pages, 13 by 19 cm, softcover, ISBN 0-85050-8, $3.95.

*Basic Fun with Graphics the IBM/PC Computer Way*, Margaret Ann Zuanich and Susan Drake Lipscomb. New York: Avon Camelot Books, 1983; 160 pages, 13 by 19 cm, softcover, ISBN 0-380-85068-0, $3.95.

*BASIC II Advanced*, William C. Conley. New York: Petrocelli Books, 1983; 208 pages, 13.8 by 21 cm, softcover, ISBN 0-89433-202-3, $10.95.

*The Birds of Babel, Satellites for the Human World*, Hal Glatzer. Indianapolis, IN: Howard W. Sams & Co., 1983; 240 pages, 23 by 23.5 cm, softcover, ISBN 0-672-22033-4, $12.95.

*Bowker/Bantam 1984 Complete Sourcebook of Personal Computing*. New York: R. R. Bowker Co. and Bantam Books, 1983; 650 pages, 16 by 23.5 cm, hardcover, ISBN 0-8352-1767-1, $24.95.

*Business-Office Computers*, Gary Gagliardi. New York: Bantam Books, 1983; 64 pages, 13 by 19.5 cm, softcover, ISBN 0-553-34079-4, $2.95.

*Choose Your Own Computer*, Peter Rodwell, ed. Woodbury, NY: Barron's Educational Series Inc., 1983; 176 pages, 9.5 by 19 cm, softcover, ISBN 0-8120-2706-X, $4.95.

*Commodore 64 Computing*, Ian Sinclair. Englewood Cliffs, NJ: Prentice-Hall, 1983; 144 pages, 15.3 by 22.8 cm, softcover, ISBN 0-13-152306-6, $12.95.

*The Commodore 64 Music Book*, James Vogel and Nevin B. Scrimshaw. Cambridge, MA: Birkhäuser Boston Inc., 1983; 144 pages, 15.3 by 23.5 cm, softcover, ISBN 0-8176-3158-5, $14.95.

*The Complete Buyer's Guide to Personal Computers*, Tim Hartnell and Stan Veit. New York: Bantam Books, 1983; 400 pages, 10.5 by 17.5 cm, softcover, ISBN 0-553-23873-6, $4.95.

*Complexity Issues in VLSI*, Frank Thomson Leighton. Cambridge, MA: The MIT Press, 1983; 146 pages, 18 by 23.5 cm, hardcover, ISBN 0-262-12104-2, $19.95.

*Computational Aspects of VLSI*, Jeffrey D. Ullman. Rockville, MD: Computer Science Press, 1984; 514 pages, 23.5 by 15.5 cm, hardcover, ISBN 0-914894-95-1, $32.95.

*Computational Methods in Bifurcation Theory and Dissipative Structures*, M. Kubiček and M. Marek. New York: Springer-Verlag, 1983; 256 pages, 24.3 by 15.5 cm, hardcover, ISBN 0-387-12070-X, $42.

*Computer-Assisted Instruction*, Jack A. Chambers and Jerry W. Sprecher. Englewood Cliffs, NJ: Prentice-Hall, 1983; 240 pages, 17 by 23.5 cm, softcover, ISBN 0-13-164376-2, $12.95.

*Computer Confidence, A Woman's Guide*, Dorothy Heller and June Bower. Washington, DC: Acropolis Books Ltd., 1983; 264 pages, 21 by 24 cm, hardcover, ISBN 0-87491-555-4, $16.95.

*Computer Dictionary for Beginners*, Arthur Naiman. New York: Ballantine Books, 1983; 160 pages, 13.5 by 21 cm, softcover, ISBN 0-345-31223-6, $6.95.

*The Computer Phone Book*, Mike Cane. New York: New American Library, 1983; 480 pages, 13.5 by 20 cm, softcover, ISBN 0-452-25446-9, $9.95.

*Computer Wimp*, John Bear. Berkeley, CA: Ten Speed Press, 1983; 296 pages, 18.5 by 23.5 cm, softcover, ISBN 0-89815-101-5, $9.95.

*Contemporary Business Letters with WordStar*, Jane E. Robbins and Dennis P. Curtin. Somerville, MA: Curtin & London, 1983; 240 pages, 21.5 by 27.8 cm, softcover, ISBN 0-930764-63-3, $15.50.

*Cosmic Games for the Commodore VIC 20*, Hal Renko and Sam Edwards. Reading, MA: Addison-Wesley, 1983; 142 pages, 15.3 by 15.3 cm, softcover, ISBN 0-201-16476-0, $5.95.

*Creating Computer Programs for Learning*, Gary W. Orwig. Reston, VA: Reston Publishing Co., 1983; 192 pages, 17.3 by 23.3 cm, softcover, ISBN 0-8359-1168-3, $14.95.

*dBASE II Programmer's Notebook*, Steven G. Meyerson. Poquoson, VA: Computech, 1983; 50 pages, 21.5 by 28 cm, spiral-bound, ISBN-none, $12.95.

*Database Machines*, H. O. Leilich and M. Missikoff, eds. New York: Springer-Verlag, 1983; 356 pages, 16.5 by

24.5 cm, softcover, ISBN 0-387-12959-6, $23.

*The Design of Interpreters, Compilers, and Editors for Augmented Transition Networks*, Leonard Bolc, ed. New York: Springer-Verlag, 1983; 228 pages, 17 by 25 cm, hardcover, ISBN 0-387-12789-5, $29.

*The Directory of Software Publishers*, Eric Balkan, ed. New York: Van Nostrand Reinhold, 1983; 320 pages, 22 by 29 cm, hardcover, ISBN 0-442-21429-4, $25.50.

*Discover Your VIC-20*, Donald Kahn Jr. and Nevin B. Scrimshaw. Cambridge, MA: Birkhäuser Boston Inc., 1983; 112 pages, 16 by 23.5 cm, softcover, ISBN 0-8176-3160-7, $10.95.

*Discovering Apple Logo*, David D. Thornburg. Reading, MA: Addison-Wesley, 1983; 158 pages, 18.7 by 23.5 cm, softcover, ISBN 0-201-07769-8, $14.95.

*Discrete Optimization Algorithms with Pascal Programs*, Maciej M. Syslo, Narsingh Deo, and Janusz S. Kowalik. Englewood Cliffs, NJ: Prentice-Hall, 1983; 560 pages, 18.5 by 24.3 cm, hardcover, ISBN 0-13-215509-5, $37.50.

*Electronic Life*, Michael Crichton. New York: Alfred A. Knopf, 1983; 224 pages, 14.6 by 22 cm, hardcover, ISBN 394-53406-9, $12.95.

*Executive VisiCalc for the Apple Computer*, Roger E. Clark. Reading, MA: Addison-Wesley, 1983; 144 pages, 18.8 by 23.3 cm, softcover, ISBN 0-201-10242-0, $14.95.

*Executive VisiCalc for the IBM Personal Computer*, Roger E. Clark. Reading, MA: Addison-Wesley, 1983; 260 pages, 18.5 by 23.5 cm, softcover, ISBN 0-201-10243-9, $12.95.

*Experiments in Four Dimensions*, David L. Heiserman. Blue Ridge Summit, PA: Tab Books, 1983; 512 pages, 19.5 by 23.5 cm, softcover, ISBN 0-8306-1541-5, $17.50.

*54 SuperCalc Models*, Robert H. Flast. Berkeley, CA: Osborne/McGraw-Hill, 1983; 256 pages, 21 by 27.5 cm, softcover, ISBN 0-88134-118-5, $15.95.

*Formal Specification of Interactive Graphics Programming Languages*, William R. Mallgren. Cambridge, MA: The MIT Press, 1983; 290 pages, 18 by 23.8 cm, hardcover, ISBN 0-262-13191-9, $35.

*Fundamentals of Data Structures in Pascal*, Ellis Horowitz and Sartaj Sahni. Rockville, MD: Computer Science Press, 1984; 560 pages, 15.5 by 23.8 cm, hardcover, ISBN 0-914894-94-3, $26.95.

*Funny Things, Computers*, Trevor Hutchings. Toronto, Canada: James Lorimer & Company Publishers, 1983; 66 pages, 13.5 by 19.5 cm, softcover, ISBN 0-88862-678-9, $6.95.

*Games for Your Atari Computer*, Paul Bunn. New York: Dell Publishing Co., 1983; 128 pages, 14.5 by 25 cm, spiral-bound, ISBN 0-440-52800-3, $5.95.

*Games for Your Timex/Sinclair 1000*, Mark Charlton. New York: Dell Publishing Co., 1983; 128 pages, 14.5 by 25 cm, spiral-bound, ISBN 0-440-52785-6, $5.95.

*Games for Your Timex/Sinclair 2000*, Peter Shaw. New York: Dell Publishing Co., 1983; 128 pages, 14.5 by 25 cm, spiral-bound, ISBN 0-440-52794-5, $5.95.

*Games for Your VIC-20*, Alastair Gourlay. New York: Dell Publishing Co., 1983; 128 pages, 14.5 by 25 cm, spiral-bound, ISBN 0-440-52789-9, $5.95.

*Graphics Primer for the IBM PC*, Mitchell Waite and Christopher Morgan. Berkeley, CA: Osborne/McGraw-

Hill, 1983; 448 pages, 18 by 23.3 cm, softcover, ISBN 0-931988-99-3, $21.95.

*Graphics Programs for the IBM PC*, Robert J. Traister. Blue Ridge Summit, PA: Tab Books, 1983; 256 pages, 19.8 by 23.5 cm, softcover, ISBN 0-8306-1556-3, $15.50.

*Graphiques de Gestion*, Denis Charpentier. Paris, France: Masson, 1983; 176 pages, 16 by 24 cm, softcover, ISBN 2-225-80110-X, 150 francs.

*Home-Family Computers*, Gary Gagliardi. New York: Bantam Books, 1983; 64 pages, 13 by 19.5 cm, softcover, ISBN 0-533-34077-8, $2.95.

*How To Do It on the TRS-80*, William Barden Jr. Upland, CA: IJG Inc., 1983; 200 pages, 21 by 27.5 cm, softcover, ISBN 0-936200-08-1, $29.95.

*How to Find and Buy Good Software*, Jess W. Curry Jr. and David M. Bonner. Englewood Cliffs, NJ: Prentice-Hall, 1983; 176 pages, 17.5 by 23.3 cm, softcover, ISBN 0-13-406652-9, $8.95.

*How to Microcomputerize Your Business*, Jules A. Cohen with Catherine Scott McKinney and the staff of Orbis. Englewood Cliffs, NJ: Prentice-Hall, 1983; 192 pages, 17.3 by 23.3 cm, softcover, ISBN 0-13-423889-3, $9.95.

*IBM Personal Computer & XT*, Gerald VanDiver. Prior Lake, MN: Micro Information Publishing, 1983; 1024 pages, 21 by 27.8 cm, softcover, ISBN 0-912603-00-3, $24.95.

*Introducing LOGO for the Apple II Computer, Texas Instruments 99/4A, and Tandy Color Computer*, Peter Ross. Reading, MA: Addison-Wesley, 1983; 260 pages, 15.5 by 23.5 cm, softcover, ISBN 0-201-14652-5, $12.95.

*Introduction to Ada*, David Price. Englewood Cliffs, NJ: Prentice-Hall, 1984; 160 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-13-477653-4, $22.95.

*An Introduction to the Commodore 64*, Nevin B. Scrimshaw and James Vogel. Cambridge, MA: Birkhäuser Boston Inc., 1983; 144 pages, 16 by 23.5 cm, softcover, ISBN 0-8176-3161-5, $11.95.

*Introduction to DECSYSTEM-20 Assembly Programming*, Stephen A. Longo. Monterey, CA: Brooks/Cole Publishing Co., 1984; 208 pages, 18.5 by 23.5 cm, softcover, ISBN 0-534-02942-6, $17.95.

*An Introduction to Vu-Calc Spreadsheeting for the Timex/Sinclair 2000 and the Sinclair ZX Spectrum*, Harry Anbarlian. New York: McGraw-Hill, 1984; 448 pages, 23.5 by 17 cm, spiral-bound, ISBN 0-07-001698-4, $22.95.

*Instructional Computing with the TRS-80*, Herbert L. Nickles and George H. Culp. Monterey, CA: Brooks/Cole Publishing Co., 1984; 240 pages, 18.5 by 23.5 cm, softcover, ISBN 0-534-02966-3, $15.95.

*Invitation to COBOL for the TRS-80*, Lawrence L. McNitt. New York: Petrocelli Books, 1983; 304 pages, 15.5 by 23.5 cm, softcover, ISBN 0-89433-209-0, $15.

*Low-Cost Word Processing*, Laurence Press. Reading, MA: Addison-Wesley, 1983; 240 pages, 18 by 23.5 cm, softcover, ISBN 0-201-05735-2, $10.95.

*Management Information Systems*, 3rd ed., Jerome Kanter. Englewood Cliffs, NJ: Prentice-Hall, 1984; 464 pages, 18.3 by 24.3 cm, hardcover, ISBN 0-13-549543-1, $27.95.

*The McWilliams II Word Processor Instruction Manual*, Peter A. McWilliams. West Hollywood, CA: Prelude

Press, 1983; 144 pages, 13.3 by 21 cm, softcover, ISBN 0-671-50433-9, $3.95.

*Microcomputer Software Design*, Sally Campbell. Englewood Cliffs, NJ: Prentice-Hall, 1984; 240 pages, 17.5 by 23.3 cm, softcover, ISBN 0-13-580621-6, $12.95.

*The Minute Manual for Apple Writer IIe*, Jim Pirisino. Columbia, MD: Minuteware, 1983; 140 pages, 13.5 by 22.8 cm, softcover, ISBN 0-913131-01-6, $7.95.

*Multidimensional Digital Signal Processing*, Dan E. Dudgeon and Russell M. Mersereau. Englewood Cliffs, NJ: Prentice-Hall, 1984; 416 pages, 18 by 24.3 cm, hardcover, ISBN 0-13-604959-1, $36.95.

*The New American Computer Dictionary*, Kent Porter. New York: New American Library, 1983; 320 pages, 10.5 by 17.8 cm, softcover, ISBN 0-451-12578-9, $3.50.

*Office Automation & Word Processing Buyer's Guide*, Tony Webster. New York: McGraw-Hill, 1984; 352 pages, 28 by 21.5 cm, softcover, ISBN 0-07-068962-8, $19.95.

*PATCA Directory of Consultants, 1983-1984*, Professional & Technical Consultants Association. San Jose, CA: PATCA, 1983; 140 pages, 21 by 13.5 cm, softcover, ISBN 0-939840-02-2, $7.95.

*Pascal for BASIC Programmers*, Charles Seiter and Robert Weiss. Reading, MA: Addison-Wesley, 1983; 256 pages, 18.7 by 23.7 cm, softcover, ISBN 0-201-06577-0, $10.95.

*Pascal for FORTRAN Programmers*, Ronald H. Perrott and Donald C. S. Allison. Rockville, MD: Computer Science Press, 1984; 352 pages, 15 by 23 cm, softcover, ISBN 0-914894-09-9, $18.95.

*Pascal Programs for Games & Graphics*, Tom Swan. Rochelle Park, NJ: Hayden Book Co., 1983; 224 pages, 18 by 23.5 cm, softcover, ISBN 0-8104-6271-0, $15.95.

*Personal Computer Buyers Guide*, Dennis J. Grimes and Brian W. Kelly. Cambridge, MA: Ballinger Publishing Co., 1983; 300 pages, 22.8 by 27.8 cm, softcover, ISBN 0-88410-917-8, $16.95.

*The Personal Computer Handbook*, Peter Rodwell. Woodbury, NY: Barron's Educational Series Inc., 1983; 208 pages, 21.5 by 28 cm, softcover, ISBN 0-8120-2704-3, $14.95.

*Personal Computing: BASIC Programming on the TRS-80*, Robert R. Hare Jr. Monterey, CA: Brooks/Cole Publishing Co., 1984; 352 pages, 21.3 by 27.8 cm, softcover, ISBN 0-534-02768-7, $19.95.

*Practical WordStar Uses*, Julie Anne Arca. Berkeley, CA: Sybex, 1983; 336 pages, 17.8 by 23 cm, softcover, ISBN 0-89588-107-1, $16.95.

*Professional-Personal Computers*, Gary Gagliardi. New York: Bantam Books, 1983; 64 pages, 13 by 19.5 cm, softcover, ISBN 0-533-34078-6, $2.95.

*A Programmer's View of the Intel 432 System*, Elliot I. Organick. New York: McGraw-Hill, 1983; 432 pages, 16 by 23.5 cm, hardcover, ISBN 0-07-047719-1, $29.95.

*Programming the 8086/8088*, James W. Coffron. Berkeley, CA: Sybex, 1983; 336 pages, 14.8 by 23 cm, softcover, ISBN 0-89588-120-9, $15.95.

*Programming Projects for Your Timex/Sinclair 1000*, Frank Wattenberg. Englewood Cliffs, NJ: Prentice-Hall, 1983; 112 pages, 17.5 by 23.5 cm, softcover, ISBN 0-13-729673-8, $8.95.

*Programming the M68000*, Tim King and Brian Knight. Reading, MA: Addison-Wesley, 1983; 160 pages, 15.5 by





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## Books Received

23.5 cm, softcover, ISBN 0-201-11730-4, $12.95.

*Programs for the TI Home Computer*, Steve Davis. Englewood Cliffs, NJ: Prentice-Hall, 1983; 126 pages, 21.5 by 28 cm, softcover, ISBN 0-13-729534-0, $14.95.

*Real-Time Software*, Robert L. Glass. Englewood Cliffs, NJ: Prentice-Hall, 1983; 464 pages, 15.8 by 23.5 cm, hardcover, ISBN 0-13-767103-2, $24.95.

*Science and Engineering Programs for the IBM PC*, Cass Lewart. Englewood Cliffs, NJ: Prentice-Hall, 1983; 144 pages, 15 by 23 cm, softcover, ISBN 0-13-794934-0, $12.95.

*Semiconductor Memories*, Betty Prince and Gunnar Due-Gundersen. New York: John Wiley & Sons, 1983; 216 pages, 15.5 by 23.5 cm, hardcover, ISBN 0-471-90146-6, $21.95.

*Simple Interfacing Projects*, Owen Bishop. Englewood Cliffs, NJ: Prentice-Hall, 1983; 176 pages, 23 by 15.3 cm, softcover, ISBN 0-13-811083-2, $10.95.

*Spreadsheeting on the TRS-80 Color Computer*, Harry Anbarlian. New York: McGraw-Hill, 1983; 320 pages, 17 by 23.5 cm, spiral-bound, ISBN 0-07-001595-3, $39.95. Includes a cassette.

*The Software Sifter*, Philip Frankel and Ann Gras. New York: Macmillan Publishing Co., 1983; 271 pages, 21.3 by 28 cm, spiral-bound, ISBN 0-02-949330-7, $24.95.

*Survival on Planet X with the Atari Home Computer*, Michael Orkin and Ed Bogas. Reston, VA: Reston Publishing Co., 1984; 161 pages, 17.5 by 23.5 cm, softcover, ISBN 0-8359-7412-X, $12.95.

*Thrilling Games for the Tandy Color Computer*, Hal Renko and Sam Edwards. Reading, MA: Addison-Wesley, 1983; 156 pages, 15.3 by 15.3 cm, softcover, ISBN 0-201-16481-7, $5.95.

*Through the MicroMaze: A Visual Guide*, Wayne Creekmore. Culver City, CA: Ashton-Tate, 1983; 64 pages, 21.5 by 25.3 cm, softcover, ISBN 912677-02-3, $9.95.

*The Timex/Sinclair 1000 Basic Handbook*, Douglas Hergert. Berkeley, CA: Sybex, 1983; 192 pages, 14 by 21 cm, softcover, ISBN 0-89588-113-6, $7.95.

*20 Programs for the ZX Spectrum & 16K ZX81*, S. Daly. London, England: Bernard Babani Ltd., 1983; 128 pages, 11.3 by 18 cm, softcover, ISBN 0-85934-103-8, £1.95.

*Using the Commodore 64 in the Home*, Hank Librach and Bill L. Behrendt. Englewood Cliffs, NJ: Prentice-Hall, 1983; 110 pages, 14.8 by 23 cm, softcover, ISBN 0-13-940072-9, $10.95.

*VIC-20: The Affordable Learning Tool for the Mature Adult*, John A. Heil and Jack Martin. Wayne, PA: Banbury Books, 1983; 206 pages, 18 by 23.5 cm, spiral-bound, ISBN 0-88693-001-4, $14.95.

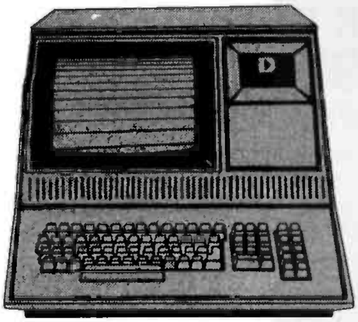
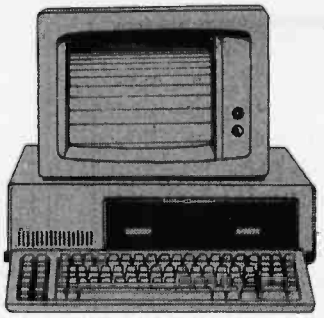
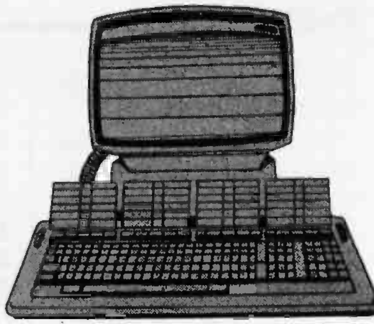
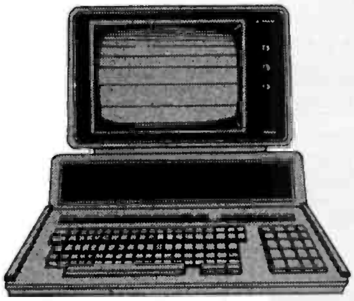
*Word Processing on the IBM*, Peter A. McWilliams. Los Angeles, CA: Prelude Press, 1983; 288 pages, 15 by 23 cm, softcover, ISBN 345-31530-8, $9.95.

*The WordStar Handbook*, Dennis P. Curtin. Somerville, MA: Curtin & London, 1983; 176 pages, 28 by 21.5 cm, softcover, ISBN 0-930764-64-1, $16.50.

*Xanadu*, Roy Mason with Lane Jennings and Robert Evans. Washington, DC: Acropolis Books Ltd., 1983; 262 pages, 21 by 23.5 cm, hardcover, ISBN 87491-701-8, $18.95.

*Your Commodore 64*, John Heilborn and Ran Talbott. Berkeley, CA: Osborne/McGraw-Hill, 1983; 464 pages, 16.8 by 23.5 cm, softcover, ISBN 0-88134-114-2, $14.95.

*Your First Microprocessor*, James W. Coffron. Englewood Cliffs, NJ: Prentice-Hall, 1984; 352 pages, 17.5 by 23.5 cm, softcover, ISBN 0-13-978446-2, $14.95. ■

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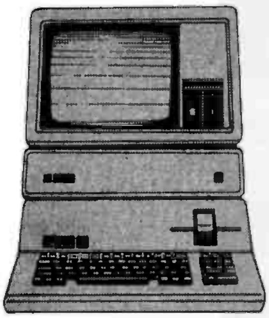

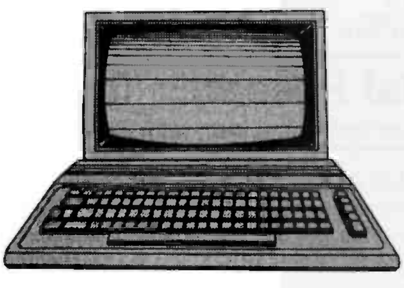
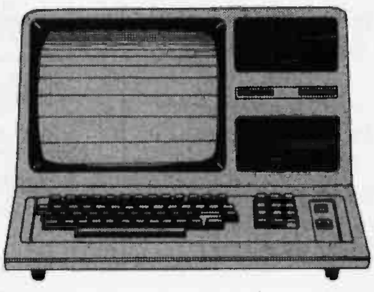
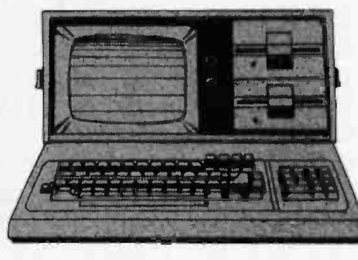

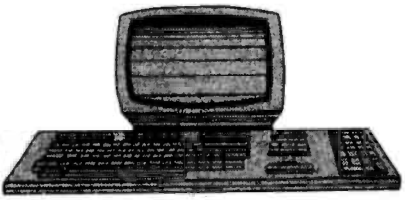

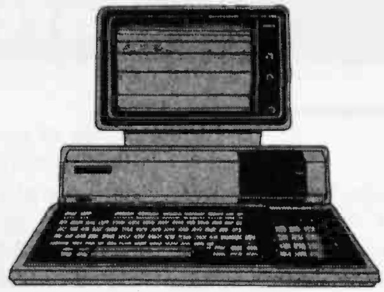

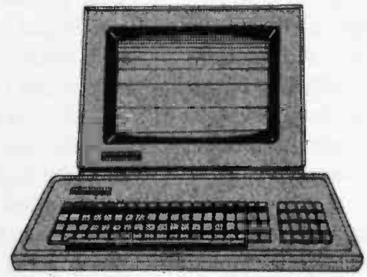

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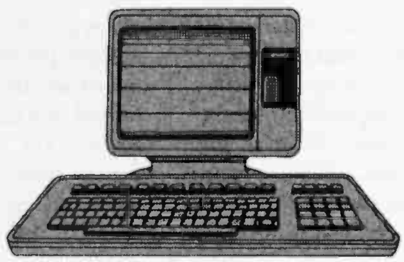

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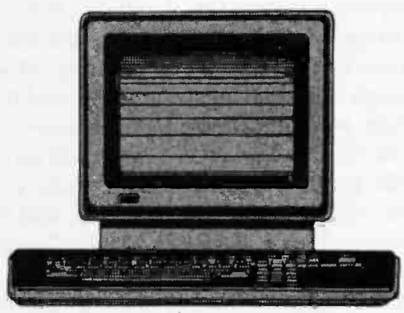

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# Software Received

## Apple

**Apple Logo,** an interactive computer language. This program is an introduction to programming using turtle graphics. When you see the shapes you create, you learn what steps are involved in programming technique. Suitable for children or adults. For II, II Plus, and IIe; floppy disk, $175. Logo Computer Systems Inc., 9960 Cote de Liesse, Lachine, Quebec H8T 1A1, Canada.

**Appleworks,** an integrated software package for use in business and at home. This program combines word processing, database managing, and financial modeling into a single program. You can write and edit letters and documents, make financial calculations on spreadsheets, and keep important information on disk. For the IIe; floppy disk, $250. Apple Computer Inc., 20525 Mariani Ave., Cupertino, CA 95014.

**Basic Accounting,** a financial-management system for use in business and at home. You can keep track of checkbooks, charge cards, savings books, cash accounts, and business accounts. Update, search, edit, print, and even secure your system using a secret password. For II, II Plus, and IIe; floppy disk, $89. Practical Software Inc., 31245 La Baya Dr., Westlake Village, CA 91362.

**Beat the Street,** a stock-market technical-analysis training simulator. Beginning or experienced investors can practice playing the market without real capital losses on poor investments. Learn point and figure charting and interpret the price pattern as it unfolds based on actual price histories of over 175 stocks on the big board. Simulation can take the place of years of experience in trading stocks. For II and IIe; floppy disk, $49.95. MEA Software Associates, POB 2385, Littleton, CO 80161.

**The Bilestoad,** a strategic adventure game. In a futuristic setting of 39 levels and 44 combat fields, your job is to help mankind survive in a violent world. Barbaric battles are fought man to man or man against robot. For the II; floppy disk, $39.95. Datamost, 8943 Fullbright Ave., Chatsworth, CA 91311-2750.

**Calculus,** an educational program for use in both schools and business to solve calculus problems. This second edition program contains 22 user-friendly and self-contained working programs in BASIC. For II Plus and IIe; floppy disk, $39.95. Sasoco, 5004 Glen Forest Dr., Raleigh, NC 27612.

**Caverns of Callisto,** an arcade-type game. Save your space station from aliens who are attacking you and running off with your ship's panels and the ion drive. Try to retrieve your ship parts and fight off the aliens so you can repair your ship. For II, II Plus, and IIe; floppy disk, $34.95. Origin Systems Inc., 1545 Osgood St. #7, POB 99, North Andover, MA 01845.

**Compu Ped,** a database program for dog breeders. You can keep track of three to five generations of pedigree dogs even if you are a computer novice. Log in the dog's name, birthdate, AKC number, sex, and the dog's parents' names. For II Plus and IIe; floppy disk, $37.50. B & L Mac, 132 Patton, Richland, WA 99352.

**Da Poma GB,** a gradebook-emulation program. A teacher's tool that keeps track of up to 50 students' grades and averages for the academic year. Each student's record has 42 individual scores that are divided into three categories that include test and exams, homework, and any other items you need to consider. For II Plus and IIe; floppy disk, $49. Da Poma Inc., POB 23192, Honolulu, HI 96822-0910.

**Exodus: Ultima III,** the third in a series of role-playing adventure games. You are sent out to conquer treacherous foes in the realm of Sosaria. With new powers, you must create characters from a variety of attributes, form and disband an adventure party, and restore peace. For II, II Plus, and IIe; floppy disk, $59.95. Origin Systems Inc. (see address above).

**Flight Simulator II,** a flying-simulation package. Once you've learned to maneuver a Piper during day or dusk, land in various cities, and perform aerobatics, you can test your skills in a World War I aerial-battle simulation. For II, II Plus, and IIe; floppy disk, $49.95. Sublogic Corp., 713 Edgebrook Dr., Champaign, IL 61820.

**Flow Charting,** a business package for use in diagramming an operation's work flow. Produce flowcharts in rapid succession for presentations or distribution by a trial-and-error method. For the II, II Plus, IIe, and III; floppy disk, $138. Patton & Patton, 340 Lassenpark Circle, San Jose, CA 95136.

**Forecaster-Buy II,** an inventory-control package for business use. This program lets you monitor inventory ordering to reduce overstocking for faster turnover and cash flow. Features include printout of data-entry worksheets, updating, and monthly forecast reports of parts or material that consider reorder lead time. For II, II Plus, and IIe; floppy disk, $800. Alessi Data Technology, POB 4, Needham Heights, MA 02194.

**Mastering the SAT,** a self-paced preparation course for the Scholastic Aptitude Tests in verbal, math, and standard written English skills. Endorsed by the National Association of Secondary School Principals (NASSP), this program analyzes students' answers and provides study and practice in skills covered on the SAT. For II Plus and IIe; floppy disks, $150. CBS Software, One Fawcett Place, Greenwich, CT 06836.

**Micro-Dynamo,** a system-dynamics modeling language. This program lets you build a mathematical model of a hypothetical situation and simulate its behavior on a computer. When the simulation is complete, the program outputs the results in tabular or graphic form on the screen or printer. For the II; floppy disk, $245. Addison-Wesley, 6 Jacob Way, Reading, MA 01867.

**One-on-One,** a basketball-simulation game. Choose from four levels of play: park and recreation, varsity, college, and professional basketball. Test your scoring skills against another player or against the computer. Action is sparked by comments from Julius Erving and Larry Bird from the game-development sessions. For II and IIe; floppy disk, $40. Electronic Arts, 2755 Campus Dr., San Mateo, CA 94403.

**Pasdos,** a utility program written in Pascal and assembly language to allow transfers of files between DOS 3.3 and UCSD Pascal. Features include automatic display of either directory, automatic text-file formatting, code-file generation, and high-resolution picture transfer between printer and computer. Built-in demonstrations and documentation enable smooth conversions. For the II; floppy disk, $39.95. Linnton Systems, POB 17612, Portland, OR 97217.

**Scientific Plotter,** Version II, a graphing program for plotting scientific, engineering, and business data. Superimpose more than one data set on the same graph easily with 20 plotting symbols. You control axis position, grid size, and scaling intervals. A stand-alone utility program prints labels on any high-resolution picture. For II, II Plus and IIe; floppy disk, $50. Interactive Microware Inc., POB 771, State College, PA 16801.

**Talking Blissapple,** a trimodal program written in a combination of machine language and FORTH that is designed for communicatively disabled children. It functions by interfacing with custom keyboards to act as a communication/writing aid. These children can write with Blissymbols and have their messages and stories displayed on a terminal, spoken, or printed on the printer. For II and II Plus; floppy disk, $35. Trace Research and Development Center, 314 Waisman Center, 1500 Highland Ave., Madison, WI 53706.

**Time is Money,** a personal accounting package that can double for a small-business financial-management system. You can balance your checkbook, calculate and monitor budgets, discern net worth, and record tax-deductible expenses without bookkeeping or accounting skills. You can track up to 240 income types, 240 income sources, 240 expenses, and 240 assets and liabilities. Full report generation and graphics capabilities are a few of the instructions that require a single keystroke. For II, II Plus, and IIe; floppy disk, $100. Turning Point Software, 11A Main St., Watertown, MA 02172.

**Tom Thumb,** a reading program for preschoolers and first graders. This adaptation of the fairy tale by the Brothers Grimm improves reading, vocabulary, and comprehension skills. Features include self-paced reading levels, multiple vocabulary levels, easy-to-use software, color graphics, and special character sets. For II Plus and IIe; floppy disk, $29.95. International Software Systems, POB 5427, Richmond, VA 23220.

**Trompers,** an arcade-type game. Due to a skip in Arnold Strump's shortwave radio, too many little creatures from the planet Tromp are falling from the sky into his domain. You have five levels in which to help old Arn catch them all and score the most points you can. For II, II Plus, and IIe; floppy disk, $29.95. Avant-Garde Creations Inc., POB 30160, Eugene, OR 97403.

**Unprintable Physics,** an educational program for science and engineering students. You can use up to 32 simulations, demonstrations, examples, and quizzes of mathematical methods, mechanics, thermodynamics, electromagnetism, and wave phenomena. Learn modern physics in ways it cannot be taught by books. For II, II Plus, and IIe; floppy disk, $29.95. Prentice-Hall, Rt. 9W, Englewood Cliffs, NJ 07632.

## Atari

**Gridrunner,** an arcade-type game. As a pilot of an air-battleship, you try to stop the droids from attacking the orbiting solar-power station. Destroy pods, droid segments or leaders, and avoid the releases of plasma and ever-increasing attack waves. Requires a joystick. For the 400/800; cartridge, $29.95. Human Engineered Software, 150 North Hill Dr., Brisbane, CA 94005.

**Omnitrend's Universe,** a three-dimensional tactical strategy game. You are a starship captain in search of the lost hyperspace booster. Save the civilization, become a hero, and win a fortune if you succeed. For 400/800 and 1200; floppy disks, $89.95. Omnitrend Software, 8 Huckleberry Lane, West Simsbury, CT 06092.

## CP/M

**Compas Pascal,** a Pascal compiler. This superset of standard Pascal is a one-pass compiler that generates machine code quickly. The interactive editor is command compatible with Wordstar. It includes such features as overlays, dynamic strings, random-access files, and more. Floppy disk, $440. K. J. Computer Services, POB 66, Mentone, Victoria 3194, Australia.

**FORTRAN Relabel,** a label-renumbering program. All the numeric labels in FORTRAN programs containing statements and line references can be renumbered using this program. Subroutines, function programs, and Microsoft EDIT80 line numbers, if present, are processed automatically. You specify the ASCII filename, the desired new label beginning, and increment. Floppy disk, $29.95. Cleydale Engineering, POB 784, Dahlgren, VA 22448. (This program's description was listed incorrectly in the March "Software Received," page 463. We regret any inconveniences this may have caused.)

**ICAMS,** an integrated condominium- and apartment-management system. You can perform property-management calculations with features that include semi-automatic billing and payment receipts, account updates, and 18 current reports. It can search for specific word clues and customization is an option. Floppy disk, $1195. Advanced Management Approach Inc., POB 8576, Calabasas, CA 91302.

**LeBug,** a Z80-based assembly-level debugging tool. With this program, breakpoints do not need to be removed to resume execution because they are already transparent. You can manipulate arithmetic and symbolic expressions, address expressions using register contents, and benefit from nondestructive memory tests, error codes, and built-in disk protection from overwriting. Floppy disk, $80. Lehey Microcomputer Systems, Postfach 145, 6365 Rosbach 1, Germany.

**Mailer,** Version 1.2, a mailing-list management package running on the CP/M 2.2 operating system. This program can read in address files created by word-processing and mailing programs to create new files. A screen form simplifies data entry and updating, delimiting the entry fields and catching common entry errors. Floppy disk, $150. Maurizi Associates, 1344 Fitch Way, Sacramento, CA 95825.

**Propstar,** a typeset-quality printing program. Print Wordstar document files via your proportional space printer to achieve true proportional spacing. This program supports boldface, doublestrike, strikeout, underscore, formatting, and subscripts and superscripts. Floppy disk, $49.95. Civil Computing Corp., Suite 1, 2111 Research Dr., Livermore, CA 94550.

**Tarbell Database System,** an interactive database system whose programs use a common file format. It includes ASCII files with fixed- and variable-length records. You can make changes in the way the files are accessed without changing the files. It is also possible to change the structure of a file without changing the way that your file is accessed. Floppy disk, $249. Tarbell Electronics, Suite B, 950 Dovlen Place, Carson, CA 90746.

## Commodore

**Attack of the Mutant Camels,** an arcade-type game. As the pilot of a combat ship, you must destroy enemy droids, deadly pods, and 20 attack waves of Cosmic Cameloids. You win an extra ship for every wave of challenges you encounter. Be prepared for the enemies' bizarre psychological disorientation tactics. Requires a joystick. For the VIC-20; cartridge, $29.95. Human Engineered Software, 150 North Hill Dr., Brisbane, CA 94005.

**Commodore 64 BASIC Programs,** an introductory programming package. Complemented by a seven-chapter book, this package includes 30 programs that demonstrate the intricacies of the computer. You are encouraged to make modifications to improve program development and learn its techniques. For the 64; cassette, $16.95. Howard W. Sams & Co., 4300 West 62nd St., Indianapolis, IN 46268.

**The Disk Librarian,** a utility program designed to keep track of disk directories. You can search easily for a given directory attribute, catalog up to 150 disks, and easily back up the disks with a trilogy program. You can choose from nine facilities on the menu, including read and catalog, edit, display, print, comment line, and print disk labels. For the 4000/8000 Series; floppy disk, $49.95. Computer Field Service, 660 Longview Lane, Palatine, IL 60067.

**Kindercomp,** a collection of six learning games to encourage computer skills in children between the ages of 3 and 8. As they create colorful pictures or find letters or numbers on the keyboard that match those on the screen, children are improving their reading readiness and counting skills. Pictures and sounds promptly reward each successfully matched shape or completed number sequence. For the VIC-20; cartridge, $34.95. Human Engineered Software (see address above).

**Lazer Zone,** an arcade-type game. You try to control two lasers against encroaching aliens. After you learn firing technique and movement, try to score as high as you can in 31 levels of increasing challenge. Requires a joystick. For the VIC-20; cartridge, $29.95. Human Engineered Software (see address above).

**MusiCalc 1 Synthesizer and Sequencer,** a music-creation program. With or without a musical background, you can learn, play, compose, and understand music, rhythms, and sound produced by a synthesizer. You can use this program as an instrument, a songwriting or compositional aid, a music-theory tool, a sound-effects generator, and more. For the 64; floppy disk, $74.95. Waveform Corp., 1912 Benita Ave., Berkeley, CA 94704.

**Synthesound 64,** a music-synthesizer program. Create music or special sound effects that include bagpipes, outer-space panic, footsteps, or chirping birds. You play keys on one of two keyboards: solo or accompaniment. Features include high-resolution piano-keyboard display, real-time clock, voices and filter modes, and storage of 256 patches. For the 64; floppy disk, $34.95. Human Engineered Software (see address above).

**Time Money Manager,** a dual financial- and time-management program. In Finance 64, you can make informed decisions on buy versus lease options, payback analysis, profit margin, and future of present values. In Schedule 64, plan days or years in advance, get daily or weekly scans, or zoom in for detailed views. For the 64; floppy disk, $69.95. Human Engineered Software (see address above).

**VIC-20: 50 Easy-to-Run Computer Games,** a collection of educational games. Each one of these 50 easily entered programs contains less than 30 statements and offers games that help you explore many facets of programming and debugging your computer. Choose from Hurray, Beethoven!, Bird Watching, and the Backward Test, to name a few. For the VIC-20; cassette, $12.95. Howard W. Sams & Co. (see address above).

## IBM Personal Computer

**Autosort 86M,** a sort/merge/select utility program that places no limit on file size. Designed for large files with fixed-length fields within fixed-length records, this program can be used as a stand-alone sort routine with options that include nine modes of sort/select. Multiusers can sort simultaneously as long as they use different identification numbers. Floppy disk, $150. Computer Control Systems Inc., 298 21st Terrace SE, Largo, FL 33541.

**Catalog-Master,** a disk-management system. You can create and maintain a master-file directory of your disks to locate a desired file when you need it. The directory can include file descriptions, sort alphabetically by filename, and you can select only certain groups of files to output by using a file-selection template. Floppy disk, $29.95. Generic Software, POB 790, Marquette, MI 49855.

**Certified Accounting Systems,** a group of five accounting packages for use in businesses. The packages consist of the Systems Guide to format the software for your requirements: Accounts Payable, Accounts Receivable, General Ledger, Inventory, and Payroll. Floppy disk, Systems Guide, $45; with automatic update, $295 each; without update, $195 each. Certified Software Inc., 9900 SW Wilshire St., POB 25585, Portland, OR 97225.

**Data Evaluation System,** a data-evaluation utility package. A series of three routines that plot and fit data into a variety of mathematical models by nonlinear least squares. The results can be printed in full color. The menu and special-function keys are combined to easily select designed routines and also various options within each routine. You can also manipulate data. Floppy disk, $250. R & L Software, 1299 Beacon St., Newton, MA 02168.

**Decision Maker,** a logical-analysis program. Make informed decisions by seeing graphs to help you determine the most logical choice. Input alternatives and factors, and the computer shows you the best decision in detail, summary, or graphic form. Floppy disk, $12.95. HCS, 3616 Dannys Lane, Alexandria, VA 22311.

**Encore,** a financial-modeling, spreadsheet-analysis, and decision-support system. Features include color graphics, plotting, printing, slide shows, and a graphics editor. Generate a formal report with one function key. The eight sections include an editor, spreadsheet, English modeling language, function library, an exec programming language, a report writer, a graphics system, and computation and analysis. Floppy disk, $695. Ferox Microsystems Inc., Suite 611, 1701 North Fort Myer Dr., Arlington, VA 22209.

**Exec-I,** a database-management system for professionals, executives, and people in business. Includes mailing list, check management, appointment keeper, stock security, personal inventory, personal finances, and memo writing. Compatible with a word-processing program and other office-integration software. Floppy disk, $198. Micro Architect Inc., 6 Great Pine Ave., Burlington, MA 01803.

**Executive Assistant,** an office-management record-keeping system. By accessing the flexibility of Lotus 1-2-3, this information-management system is ready for you to run without previous programming experience. It can store information on five files, including people, to do, calendar, events, and projects. Floppy disk, $100. Reston Publishing Co., 11480 Sunset Hills Rd., Reston, VA 22090.

**Exette,** a data-retrieval system. You can restore up to 18 sectors on single- or double-sided disks that have been lost due to media wear, scratching, or other errors. The three functions include encode, verify, and restore. Data recovery transfers all information to a new disk containing corrections. Floppy disk, $80. Errex Inc., 5 Research Dr., Ann Arbor, MI 48013.

**FABS/PC,** an assembly-language subroutine program. With Fast Access Btree Structure (FABS) you can access large data files containing up to 65K records in one second or less. The speed of execution is due to balanced key structure where keys do not need resequencing. A few of the commands include create, open, close, search, insert, delete, replace, build file, and more. Floppy disk, $150. Computer Control Systems (see address above).

**Frieze Graphics,** a printing and storing graphics-utility program. Without generating graphics, Frieze will produce a variety of screen dumps from an existing graphics display or save and retrieve pictures while a program is in progress. This program will work with nine assorted printers, producing up to 16 shading patterns on black-and-white printers and 256 colors on color printers. Floppy disk, $55. ZSoft Corporation, 370 Hermitage Court SW, Marietta, GA 30064.

**Frustration,** a learning game of memory and skill. Try to guess the secret alphabetical sequence as you practice typing letters in ascending order. Improves memory and typing skills simultaneously as you try to light up 25 *little* boxes. Floppy disk, $29.95. Asmara Productions, POB 1199, Noble, OK 73068.

**Incunabula,** a strategy game set in an ancient civilization. As your civilization advances and establishes arts and technologies, it develops from a tribe to a clan, a nation, and finally an empire. Disasters along the way reduce the population as you fend off enemies. In the struggle toward civilization, only the selection of wise laws will determine the success of your civilization. Floppy disk, $39. Expert Systems Inc., POB 9, Redmond, WA 98052.

**InteCalc,** an electronic-spreadsheet program. With three-dimensional, split-screen capability, you can custom-program or sort sample worksheets. Additional features include formula analysis by rows, columns, and pages; four numeric types; commas and floating dollar signs; and adjustable column widths for clarity. Floppy disk, $295. Schuchardt Software Systems, 515 Northgate Dr., San Rafael, CA 94903.

**MicroPlan,** a financial-forecasting package for business professionals. Plan cash flow, prepare budgets, report variances, and analyze product pricing in simple steps with on-screen prompts. Build a financial model cell by cell. Specialized what-if capabilities available by the touch of a few keys provide quick solutions to puzzling forecasting problems. Floppy disk, $495. Digital Research, 160 Central Ave., POB 579, Pacific Grove, CA 93950.

**Move-It,** a communications program for use in transferring data between computers. Move important documents between locations via modem regardless of hardware. The low error rate is due to error checking, auto-dial support, unattended operation, and on-line helps. The directory display ensures disk integrity. Combines with Speedstart, a load-and-go system. Floppy disk, $150. Digital Research (see address above).

**The Organizer,** a file-link utility system for use with Lotus 1-2-3. Create a branching-tree file-selection menu system to organize and instantly access files. An easy-to-edit menu board with handy commands. With push-button menu selections on a file-link master menu, you can access up to six files that provide access to an additional six files. Floppy disk, $89. The Whiterock Alternative, 8255 15th Ave. NE, Seattle, WA 98115.

**Oubliette,** a fantasy-adventure game. This role-playing game uses text and graphics in ten dungeon levels of increasing challenges. You control six adventurers in their quest for gold and glory. But when you enter the dungeon there is one escape and occasional encounters with monsters. Floppy disk, $39.95. Human Engineered Software (see address above).

**PlanStar,** a financial-planning and reporting package. Functioning like a visible calculator, this program stores data or arithmetic relationships at each spreadsheet position for financial modeling. It separates data from calculation rules allowing for sequential logic. You can specify calculations in English rather than matrix notation. Reports and graph formatting do not take up unnecessary spreadsheet space. Floppy disk, $595. Micropro International Corp., 33 San Pablo Ave., San Rafael, CA 94903.

**Reportmaker,** a business tool for use in writing and presenting reports. The main menu offers several commands: a pie-chart generation program that can be cancelled without destroying data, the graph generator that is for bar charts with various shading methods, and a heading generator that lets you format. You can also design logos on the grid. Floppy disk, $130. Krepec Software Inc., Suite 208, 5460 Royalmount, Montreal, Quebec H4P 1H8, Canada.

**RL-1 Relational Database Management System,** an integrated operational data-storage package. An interactive English-type language is used for the manipulation of data. A relational editor inputs and updates records into database. The report generator creates customized reports. And the program interface enables applications to be written in any high-level language. Floppy disk, $495. ABW Corp., POB M1047, Ann Arbor, MI 48106.

**RXSet,** a printer-interface program. You set format and printer-control codes through interactive screens. In turn, receive a status report and access help screens to print numerous text files requiring different printing parameters. This program does not include graphics capabilities. Floppy disk, $15.25. On-Disk Software, POB 382, Lincoln, MA 01773.

**The Sales Edge,** a business-strategy success program. You can evaluate the human factors affecting your sales performance by learning customer buying styles, being aware of your own behavioral techniques, and preparing customer-specific strategies for opening, presenting, and closing of sales negotiations. Floppy disk, $250. Human Edge Software Corp., 2445 Faber Place, Palo Alto, CA 94303.

**Silver Software Series,** four business-applications programs. Silverwriter is the word processor for editing, creating and merging a mailing list, and printing. Silverbudget is the accounting and budgeting program. Silvercalendar is a multidimensional scheduling section. And Silverfolio is the personal inventory section. The portfolio also offers financial functions such as net-worth statement, lists of property, and amortization schedules. Floppy disk, $399. Douthett Enterprises Inc., 200 West Douglas, Wichita, KS 67202.

**Softplot/BGL,** a graphics library for Microsoft BASIC. Enhance systems with graphics displays and add hard-copy graphics capability to any system with a dot-matrix printer or plotter. Improve technical, business, educational, or other applications with a set of high-level commands to build graphics programs. Floppy disk, $99. Graphic Software Inc., POB 367, Kenmore Station, Boston, MA 02215.

**SuperCalc 2,** an electronic-spreadsheet package. Without typing in commands, you can format and make backup copies of your disks, rename and erase data files you create and display them on the screen, and find out how much workspace is left. You can also set up what-if modeling spreadsheets. Floppy disk, $295. Digital Research (see address above).

**Target Financial Modeling with Speedstart,** an electronic spreadsheet for financial modeling in accounting, marketing, finance, and banking. Features include forward referencing, conditional logic, column referencing, communication, data and statement consolidation, a report generator, and prewritten financial models. Floppy disk, $325. Digital Research (see address above).

**Ten Key,** a concurrent calculator program. Integrated inside your computer, this calculating program lets you interrupt any application by pressing a command key. Press the key again, and the former application is restored. It also has the ability to transport final totals back to the original application. Floppy disk, $48.50. Photon Software, POB 1408, Bellevue, WA 98009.

**TMP/Free Form,** an information storage and retrieval system for management planning. Regardless of the drive you entered on the command line, you can specify what drive you want to access for storing, listing, and deleting files without losing your program. Because the program will use the drive you specify, you can use any number of drives. Floppy disk, $225. United Software Co., 2431 East Douglas, Wichita, KS 67211.

**TMP/Manager I,** a structured database-management system. Two master disks contain the following program tools or functions: dictionary, edit, select and sort, transfer, report maintenance, report writer, catalog and label writer, and a database directory. Using tags instead of index files, you can speed up the process by selecting and sorting only a portion of your database. Floppy disk, $595. United Software Co. (see address above).

**Under-Control,** a file-management system. Automatically generate data-entry screens, sort, write reports, select records, and total them up. Allows for customizing and defining new fields such as legal-time accounting and billing applications. Floppy disks, $125. A+ Software Inc., 16 Academy St., Skaneateles, NY 13152.

**Wordstar Professional,** a collection of three word-processing packages that integrate with Wordstar. Mailmerge lets you combine information from various sources to produce letters, documents, and files. With Spellstar, your spelling errors are located and checked against the 20,000-word *American Heritage Dictionaries.* With Starindex, you can create reference aids to help readers locate information in a report, contract, manual, or any document you prepare. Floppy disk, $345. Micropro International Corp. (see address above).

**Word-X,** a word-processing package. Features include full-screen editor, word wrap, print text formatter, merge facility, function keys, help command, global changes, and the ability to obtain multiple copies. This program is compatible with other office-integration systems such as the database manager and executive information systems. Floppy disk, $98. Micro Architect Inc. (see address above).

**WSSORT,** an interactive program. Select, merge, and sort sequential files, manage a database, or select up to 20 specifications and 20 levels of sorting simultaneously. The amount of information processed is disk based, and is thus not limited by memory. Floppy disk, $69.95. Nugget Software Inc., POB 440979, Aurora, CO 80044.

**μ-Series Assemblers, Linker, and Librarian,** cross-assembler programs for program development. Several relocating macroassemblers and a few compilers are supported by a single universal linker named XLINK. A special symbolic format exists that contains module names, globals, and locals to use with external emulators and debuggers. XLIB, a universal librarian, is included to create and maintain object-code libraries. Floppy disks, price not available. IAR Systems AB, POB 23051, S-750 23 Uppsala, Sweden.

## TRS-80

**Accounts Payable,** a business-accounting program. This can handle four standard general-ledger accounts plus an additional 14 expense accounts that you define. It can contain up to 1100 transactions on file, 75 vendors, and an unlimited number of invoices per check. It automatically calculates due dates, discount dates, and can print in several formats. For the Model 4; floppy disks, $199.95. Radio Shack, 1400 One Tandy Center, Fort Worth, TX 76102.

**AgDisk (Crop Management),** a financial agricultural program. Designed to be used with Visicalc spreadsheets, this program helps in informed decision making of business crops. A few of the 11 templates include grain marketing, corn yield, gross margin, growing days, field calculations, pivot application, and fertilizer needs and costs. Combined with a calculator program with a grid 63 columns by 254 rows, you can construct formulas that ensure success. For the Model III; floppy disk, $69.95. Radio Shack (see address above).

**AgDisk (Feedlot Cattle Management),** an agricultural management program. Templates on the feedlot cattle management disk include cattle feeder, steer marketing, carcass evaluation, protein supplement, and ration formulation. Combined with Visicalc spreadsheets, you can keep up with changes and evaluate data for future reference. For the Model III; floppy disk, $69.95. Radio Shack (see address above).

**Assembly Language Development System,** a tool for developing Z80 programs. The five systems this program contains are a text editor, an assembler that converts source programs to Z80 object code, a linker, a debugger, and a file-transfer system. Previous knowledge of assembly language suggested. For Models III and 4; floppy disks, $149. Radio Shack (see address above).

**Business Graphics Analysis Pak,** a colorful graphics package for business presentations. Enter data, select a chart type, format to your specifications, and print the screen. Choose from four types: line charts, bar charts, pie charts, and scatter charts. Select variations such as automatic scaling, formatting, labeling, chart width, straight or curved lines, solid or dotted lines, shading, frames, and numeric scale labels. You can also manipulate data. For Models II and 12; floppy disk, $249. Radio Shack (see address above).

**Executive Calendar,** a time-management program. Plan your daily and weekly schedules or display and print any month of the year. The dates of 17 holidays are programmed in the calendar section, and the calculation ability lets you figure the number of days needed to complete a specific project. For the Model 100; cassette, $19.95. Radio Shack (see address above).

**Graphicom,** a graphics-design program. You can create, edit, and transmit pictures and text. Written in FORTH and designed for the novice user, you let the graphics guide you through the program. This program can even facilitate communication between people of different languages. For the Color Computer; floppy disk, $24.95. Spectrum Projects, 93-15 86th Dr., Woodhaven, NY 11421.

**Payroll,** a payroll system for small businesses that tracks earnings, deductions, and taxes for each employee. You can customize your system to meet local, state, and federal tax laws. It keeps historical records by current period, quarter, and year for all employee earning and deductions, plus all employer liabilities. It lets you design reports or print reports for audit trails. For the Model 4; floppy disk, $199.95. Radio Shack (see address above).

**Spectaculator,** a calculator program. Your screen becomes a worksheet with rows and columns. You can budget and forecast, do statistics, and even do math homework. Prepare a table format with formulas for easy recalculation to avoid retyping. It can print any or all of a document. For Models I and III; cassette, $34.95. Radio Shack (see address above).

**Starblaze 100,** a space-arcade game. With one of your three ships, you must move from planet to planet. You can fire up to three missiles at a time with the space bar. Be certain not to move when you are in the transporter or your ship will be destroyed. For the Model 100; cassette, $19.95. Radio Shack (see address above).

**Videotex Plus,** a communications package. You can communicate with a variety of information services and host computer systems. The three modules include an interactive terminal and data communications program, a specialized program for use with store and forward information services, and a program to prepare auto-log-on/auto-dial procedures. You can print hard copies with a printer-control feature. For the Model 4; floppy disk, $49.95. Radio Shack (see address above).

## Other Computers

**Graphics Subroutine,** a graphics programming aid. Move small and large drawings smoothly around the screen one pixel at a time. Keep a drawing stationary to draw or color in your own animations or cartoons. For the Spectrum; cassette, £10. Fowler Software, Hendon Mill, Nelson, Lancashire BB9 8AD, England.

**MorseKey,** a Morse code to ASCII converter. Written for disabled children, this program is valuable for anyone wishing to use a computer as a communications device. For the Epson Notebook Computer; microcassette, $45. Blue Heron Software, POB 91927, West Vancouver, British Columbia V7V 4S4, Canada.

**Nest Egg II,** a strategic financial-planning program. Calculate retirement finances, your children's education, vacation plans, and trust funds. Test several assumptions and calculate alternative futures. For the Timex/Sinclair 1000/ZX81; cassette, $19.95. Computer Ware Publishing, 3rd Floor, 234 Fifth Ave., New York, NY 10001.

**PID.COM,** a program that provides graphic, programmable, programmed instruction with phased experiments in closed-loop control. No previous mathematics required. For the Heath/Zenith H-/Z-89; floppy disk, $26. Friendliware, POB 21206, Lansing, MI 48909.■

*This is the final "Software Received" section in BYTE. It will be replaced by expanded coverage of software in our "What's New?" section beginning in June. This expansion will include color pictures in "What's New?" and the relocation of the beginning of this section to the front of the magazine. Color transparencies (slides), 35mm or larger, stand a better chance of being used than color prints. Publishers who want their software to be considered for inclusion in "What's New?" should send information or products to New Products Editor, BYTE, 70 Main St., Peterborough, NH 03458. Of course, we will continue to do full reviews of software also. Publishers who want their programs to be considered for a full review should send a copy of their product to the Product Review Editor at the same address.*



# BYTE's Bits

### Used Equipment Repository

The Harvester is a nonprofit organization that places used computers in service with other nonprofit associations requiring computers but unable to afford them. Donations are tax deductible, and reimbursements for shipping fees are available.

The Harvester accepts pocket, mini-, and microcomputers as well as peripherals, software, and supplies. For information, call or write Ed Simpson, The Harvester, POB 931, Columbia, MD 21044, (301) 997-4992.■

# Ask BYTE

## Conducted by Steve Ciarcia

### Kaypro Composite Video

Dear Steve,

I would like to know how to connect a Kaypro II to a monitor that accepts 1-volt composite video. I have not been able to obtain schematics. Is there any way around this? Thanks.

**Henri J. Poché**
**New Orleans, LA**

*The Kaypro II video output cannot be sent directly to a composite-video monitor. You will have to combine the Kaypro's horizontal sync, vertical sync, and video signals into a composite-video signal first.*

*The separate video signals are available at the following pins of connector J1:*

*Pin 1 horizontal sync*
*Pin 2 (key)*
*Pin 3 video*
*Pin 4 vertical sync*

*An example of a good video-combiner circuit can be found in an Intel application note titled "A Low Cost CRT Terminal Using the 8275." The number of the application note is AP-62, and it can be obtained from Intel Corporation, 3065 Bowers Ave., Santa Clara, CA 95051.*

*Kaypro schematics and a manual on the theory of the Kaypro's operation can be obtained from Micro Cornucopia, POB 223, Bend, OR 97709. . . .* **Steve**

### 80 by 24 on an H-19A

Dear Steve,

After reading "Build the Micro D-Cam Solid-State Video Camera" in the September 1983 BYTE, I realized that my system was deficient because I had no high-resolution graphics. My system consists of a Heath H-19A terminal, Heath H-8 computer with 60K bytes of RAM, and a disk system. My terminal is connected to the computer via RS-232C.

What determines the 80-column by 24-line format in the display? And if I want high-resolution graphics, what modifications can I make to accomplish this? Will I be able to retain an 80 by 24 display with these modifications? Any help will be appreciated.

**John Loong**
**Oak Park, IL**

*Most computer terminals have a similar set of components that allows characters to be displayed on a video-display screen. The components generally consist of*

1. *A keyboard controller that converts key closures into ASCII (American National Standard Code for Information Interchange) code.*
2. *A memory system to store the input data.*
3. *A video-display controller to access the data and properly position it on the video display using timing circuitry.*
4. *A character generator that converts the data into readable characters on the video display.*
5. *A UART (universal asynchronous receiver/transmitter) to send the input data to the computer.*

*When a character is entered at the keyboard and converted to ASCII code, it is simultaneously sent through the UART to the computer and to the internal memory in the terminal. If the terminal displays 24 lines of 80 characters, the size of the memory system is usually 2K bytes (24×80=1920 bytes—it's rounded up to an integer power of 2). The video-display controller then continuously accesses data from the memory system and sends it to the character generator for display on the video display.*

*Each line of characters on the screen is composed of a number of "scan lines." Typically, several hundred scan lines are presented on the screen in a fraction of a second, which makes the display look like it is being presented all at once. These scan lines are composed of a number of dots that represent one slice of each character on the display line being presented. For example, depending on the character generator, the letter "T" might have five dots in the first scan line and a single dot in the next six scan lines, using a 5- by 7-dot character generator.*

*Terminals constructed in this manner cannot be used for high-resolution graphics unless significant modifications are made to the circuitry. One reason is that the amount of memory needed in a stand-alone terminal would have to be much larger than the 2K bytes built into the terminal. This doesn't mean it cannot be done. A good reference on the subject is a book written by Donald E. Lancaster,* Son of Cheap Video, *which can be obtained from Priority One Electronics or other advertisers in BYTE. An article in* Microcomputing *magazine shows how to use the TVT 6 5/8 terminal discussed in Don Lancaster's book with the Heath H-8 computer system (see "Cheap Video for Your Heathkit H-8,"* Microcomputing, *March 1979, page 24).*

*Also, Heathkit is now offering a color graphics board for the H-8 computer that has three color display modes and 256- by 192-pixel resolution. This board is for use with a video device that accepts NTSC (National Television System Committee) composite video. . . .* **Steve**

### A Faster Z-89

Dear Steve,

How much would it entail to upgrade a Z-89 to operate at 4 or 6 MHz using a new crystal and a Z80A or Z80B in place of the original Z80? What else would have to be done?

**Fred Ernst**
**Skokie, IL**

*Some care must be exercised whenever a piece of commercial equipment is modified to increase its speed. In some cases, it may be as easy as replacing the crystal and upgrading the processor. However, in most cases, the memory chips also must be replaced to be compatible with the new memory access times derived by the processor. Depending on the new processor clock rate, chips with access times of 150 to 200 nanoseconds will be needed. The existing chips should be checked to verify if their access time is compatible with the new clock rate. This also includes any ROM (read-only memory) chips in the circuit.*

*The schematics of the device also should be checked to verify that the new crystal is used only by the processor and not by other circuitry such as the video controller and disk drives. In many cases, all clock frequencies in a device are derived from the same master oscillator. . . .* **Steve**

### A 2716/2732 Programmer

Dear Steve,

I have finally realized that, for me, the era of the 2716 EPROM (erasable programmable read-only memory) is about over. Having stocked up on some 2732s and still having only a 2716 programmer, I'm looking for an easy method or an adapter that

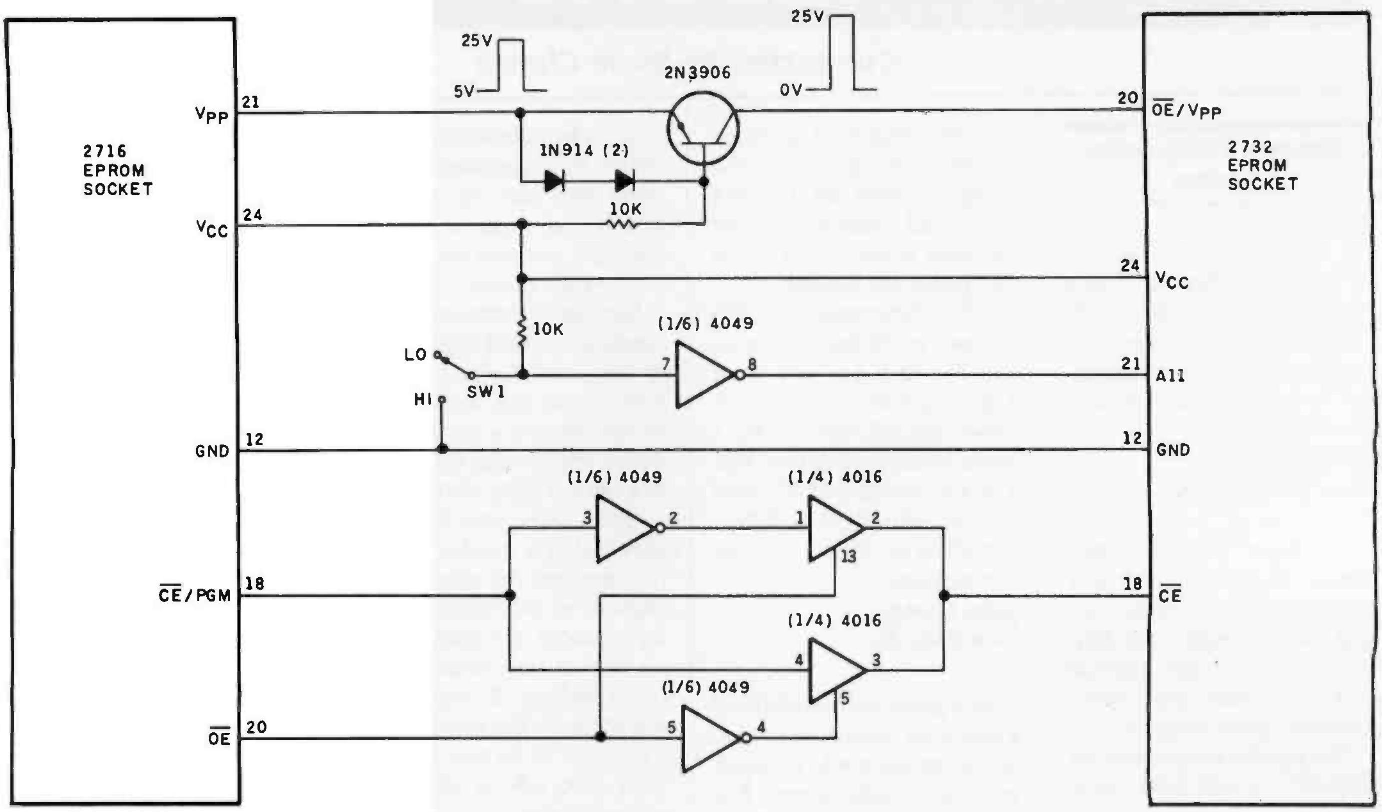



**Figure 1:** *Programming the 2732 as two separate 2K-byte segments.*

can be used to program 2732s on a 2716 programmer. What I have in mind is something that can plug into the existing socket on the 2716 programmer. Thank you.

**Michael Graham**
**Cameron Park, CA**

*There is no direct method of converting a 2716 EPROM programmer into a 2732 programmer by using the existing 2716 socket. Another address line, which does not appear on the 2716 socket, is needed for the 2732 (A11).*

*Figure 1 is a circuit diagram that shows how to get around this problem if you are willing to program the 2732 as two separate 2K-byte segments. The circuit assumes that you have a standard 2716 programmer and are going to convert it to program Intel-type 2732 EPROMs. To make the conversion, the functions of pins 18, 20, and 21 of the 2716 must be modified before they are sent to the 2732 programming socket. The following table shows the functions of these pins for the two EPROMs:*

| *Pin* | *2716* | *2732* |
|---|---|---|
| *18* | $\overline{CE}$*/PGM* | $\overline{CE}$ |
| *20* | $\overline{OE}$ | $\overline{OE}/V_{pp}$ |
| *21* | $V_{pp}$ | *A11* |

*As shown in figure 1, A11 is produced at the 2732 socket by a switch that selects either the upper 2K bytes or the lower 2K bytes of the 2732. This is not a terrible inconvenience because the 2716 programmer works with a maximum 2K-byte block of data.*

$V_{pp}$ *now must be routed from pin 21 on the 2716 socket to pin 20 on the 2732 socket. The problem is that the* $V_{pp}$ *pulse for the 2716 varies from +5 volts (V) to +25 V, and the voltage levels for* $\overline{OE}/V_{pp}$ *on the 2732 vary from 0 V to 25 V. The transistor shown in the circuit performs this voltage translation. If you intend to use 2732As in the circuit instead of the standard 2732, the maximum voltage must be reduced from +25 V to +21 V at pin 20 of the 2732 socket.*

*To produce a proper signal at the* $\overline{CE}$ *pin of the 2732, the truth table (see table 1) must be used.*

| | 2716 | | 2732 |
|---|---|---|---|
| Mode | $\overline{CE}$/PGM | $\overline{OE}$ | $\overline{CE}$ |
| Read | low | low | low |
| Standby | high | — | high |
| Program | pulse | high | low |
| Verify | low | low | low |
| Inhibit | low | low | high |

**Table 1:** *A truth table.*

*The 4016 CMOS (complementary metal-oxide semiconductor) transmission gates and the 4049 CMOS inverters shown in figure 1 perform this translation. CMOS chips were selected to keep the power consumption from the 2716 programmer low, but equivalent TTL (transistor-transistor logic) or LS (low-power Schottky) chips can be substituted.*

*All other lines from the 2716 socket should be routed directly to the 2732 socket. . . .* **Steve**

## Starting Points

Dear Steve,

I want to buy test equipment so that I can start building computer kits and learning about digital electronics, but I don't know which instruments I really need and how much performance they should have.

My main fears are that I will buy an instrument that I won't use a great deal and that I will buy an instrument that is not capable of the performance necessary for computer circuitry. I want to be able to work with processor clock speeds to 6 MHz.

I know I'll need a quality VOM (volt-ohm meter). Please help me choose other instruments that will get me started. Thanks.

**Tony L. Essman**
**Bartlesville, OK**

*As you start building and learning about digital and analog circuitry, you will find that your VOM will be the first piece of equipment you reach for when something doesn't work. It will be used to determine if your power-supply wiring is correct and if your voltage levels are proper. Your decision to obtain a quality VOM is thus an excellent one.*

*A logic probe will also be important when analyzing digital circuits. You can obtain a good logic probe and pulse catcher combination from Priority One Electronics (see its ad in BYTE). The model number of the probe is 07GSCLP1, and the price is around $45. This probe will respond to a pulse train of 10 MHz and to a single pulse as short as 50 nanoseconds. The probe has pulse- or transition-level storage capability.*

*A good oscilloscope is expensive, but if you are serious about learning more electronics it will be a valuable item. Priority One Electronics also has a scope that will fill your needs. The model number is 07BKP1522, and the price is about $595 for a 20-MHz dual-trace scope. If you are interested in building a scope kit, you should look at Heathkit's IO-4550 dual-trace 10-MHz scope, which is advertised for about $470 in its 1983 catalog. . . .* **Steve**

Dear Steve,

I am a fairly new subscriber to BYTE who has been intrigued by your Circuit Cellar projects. But while I have a good understanding of computers, I have virtually no knowledge of electronics. Can you suggest any books or materials that would help me get started? Also, which of your projects would you recommend for a beginner? I am interested in computer peripheral devices. Any information or advice would be truly appreciated.

**Jeffery S. Bond**
**Thousand Oaks, CA**

*Many good books are available to assist you in getting a better understanding of electronics. If you scan the advertising pages in BYTE, you will find just about everything you need, or you can obtain many of these books at a Radio Shack store.*

*If you have never worked with electronics, you could start with material that covers DC and AC circuit theory, then advance to books on digital electronics and linear circuits. However, a mix of reading and hands-on experience is probably the most enjoyable way to get started. A good book called* Getting Started in Electronics *by Forrest Mims uses this approach.*

*As you begin building circuits, you also may need technical data manuals that describe the functions of the devices you are using. Most chip manufacturers publish data manuals that cover TTL (transistor-transistor logic), CMOS (complementary metal-oxide semiconductor), and linear devices.*

*You also will need some tools of the trade when you actually start building and checking out your circuit. To get started, you should have at a minimum a good VOM, a soldering iron, some wire-wrap equipment, and a lot of patience.*

*As a first project, don't pick the MPX-16. Choose a simple circuit like the ECM-103 modem in the March 1983 BYTE or one of my other circuits with a low component count. You also can pick up a compilation of other Circuit Cellar projects in the volumes of* Ciarcia's Circuit Cellar *sold through the BYTE Book Club. . . .* **Steve**

Dear Steve,

I have three questions that I hope you will answer. First, what is virtual memory? Second, what is a memory cache? Finally, what are the pros and cons of the new 32-bit microprocessors? Thank you.

**Sanjoy Mahajan**
**Pittsburgh, PA**

*Virtual memory is a concept, as opposed to a physical entity. The concept allows running very large programs in a relatively small physical-memory space. It works by bringing small segments of a program into main memory from disk or drum storage and running those segments of the program. When these program segments have been run, new segments are brought into the same memory space and overlay those previously run. In this manner, virtually any size program can be run in a limited memory space.*

*Cache memory is a relatively small but fast RAM buffer physically located in the processor of a system. Portions of the relatively slow main RAM are brought into the cache memory where they are executed at high speeds. For example, a large main memory could consist of MOS (metal-oxide semiconductor) RAM chips with access times of 150-200 nanoseconds (ns), while the cache RAM could be ECL (emitter-coupled logic) chips operating with 45-ns access times. By running program segments in cache, a large increase in performance can be obtained.*

*The pros and cons of 32-bit microprocessors are numerous. I will touch on a few. The obvious advantage is that wider data buses offer an increase in speed because more bits can be manipulated with the same number of machine cycles. More powerful 32-bit instructions also make number crunching and string handling much more efficient. A disadvantage is that wider data buses and address buses mean carrying a lot more wires around the system. Another disadvantage, in the short term, is that software for the 32-bit microprocessors is not as available as it is for the smaller ones. . . .* **Steve**

## The ECM-103 Modem Revisited

Dear Steve,

I have your ECM-103 modem kit ("Build the ECM-103, an Originate/Answer Modem," March 1983 BYTE, page 26) and was wondering about the possibility of adding an auto-dial/auto-answer feature. Do you have any suggestions on how to accomplish this? I've seen inexpensive Touch-Tone chips advertised. How does the auto-answer mechanism work, and how could I go about integrating them? Thanks.

**Ian Cassell**
**Philadelphia, PA**

*Implementing auto-answer/auto-dial features in a modem can be quite complicated if the full power of these features is to be used. For example, a full-featured auto-dial modem resolves all the call-failure conditions that normally exist when making a call, such as busy signals and no-answer conditions.*

*Simplified versions of these features can, however, be implemented with some available chips. Radio Shack is offering a set of telephony chips that can be used in these applications. They are the TCM1512A Ring Detector and the TCM5089 Tone-Dialing Encoder.*

*The TMS99532 modem chip*

*used in the ECM-103 has a pin that can be used for Touch-Tone dialing purposes. An analog signal present on the EXI (external input, pin 17) pin of the modem is passed through to the telephone line. You can make a simplified version of an auto-dial function by using this pin and the tone encoder. The EXI input is enabled when ATE is high, ALB is low, and SQT is high. For the ECM-103, these conditions are met when the originate/answer switch is in the originate mode prior to a valid carrier-detect signal.*

*The ring detector can be used to connect the output of the ECM-103 to the phone lines when a ring signal is detected. The ECM-103 also should be switched to the answer mode by this signal if it is not already in this mode. Circuitry also can be introduced that causes the modem to automatically hang up if a valid carrier-detect signal is not received in a preset time period. . . .* **Steve**

Dear Steve,

Two of us bought your ECM-103 modem. My friend connected one to his Drake Theta 9000E terminal for amateur radio use, and I connected mine to my Kaypro II. We have had some success, but not in the normal manner. When I use the Term program from Kaypro that converts my computer into a dumb terminal, I can receive the signals originating from my friend but not my own ASCII characters.

I can send files through CP/M using PIP, transferring from the file in disk, to TTY: or PUN:, and using the echo feature I am able to see what I send. But I am able to do this only if I put the modem in the originate mode and connect the "mysterious jumper" between pins 5 and 6. Although we can communicate, we had not anticipated that the conversations would be only "one way."

Here are my questions: What does the jumper do? Must one of us stay in the answer mode? We are using only the acoustic enclosures. Should we change to transformer coupling? Thank you.

**Mario Handler**
**Caracas, Venezuela**

*First of all, let me clear up the question about the "mysterious jumper." When a modem and computer are linked together, they must have some method of telling each other what they are doing and what they want to do next. These signals that are passed back and forth are generally termed handshaking signals. Pins 4, 5, and 6 of the RS-232C cable are handshaking lines and are generally called RTS (request to send), CTS (clear to send), and DSR (data set ready).*

*DSR in the ECM-103 is always set to a high level, telling the computer that the data set is ready (the modem is connected in this case). Normally, the computer sends a signal back through the DTR (data terminal ready) line to tell the modem that it is there. Both devices now know that the other exists. Note that the ECM-103 does not look for the DTR signal on pin 20 because it is assumed that a terminal exists. When you want to send data from the computer to the modem, the computer sends out an RTS signal to the modem. If the modem is ready to accept the data, it sends back a CTS signal, and the computer or terminal then sends the data to the modem.*

*If the RTS and CTS lines in the ECM-103 are jumpered together, as soon as the computer asks permission to send data by setting RTS, it gets an immediate "yes you can" signal from the CTS line. This should satisfy most applications. The other way this can be handled is to set the CTS line to a state where it is always telling the computer that it is ready. This is done by placing the jumper between pins 5 and 6. One of these two configurations will handle most cases where the terminal software needs a handshaking signal.*

*The ECM-103 was designed to be used in either the answer or originate mode depending on how the modem on the other end of the line was set. Both modems cannot be set to the same mode or you will not be able to communicate properly. In general, the caller is set in the originate mode and the modem that is called is set to the answer mode.*

*You should not have to go to transformer coupling to get proper response from the ECM-103. However, if the room noise is high on either end, direct connections would be helpful. . . .* **Steve**

## Cable Computing

Dear Steve,

I have been wondering if anyone has invented a modem for cable TV. Because the idea of tying up the phone for local communications or paying for my own phone line doesn't excite me, I would welcome the development of such a device. I also would be interested to know if a device like this could have channels, not only so that you could switch to an empty channel, but so that different makes of computers could have designated channels.

Currently, our local cable company is letting a corporation and a community college use its cable as a high-speed link. I think it would make sense to make use of these frequencies.

**Joel Stevey**
**Nyack, NY**

*Taking advantage of the cable TV frequencies for computer communication is going to be one of the next big areas in home-computer technology. In fact, it has already begun, as you mentioned, with cable stations being used for high-speed links. Teletext services also are being offered by networks and independent stations that send information in the vertical interval of regular TV broadcasts. However, decoders for this information are still very expensive, with prices ranging around $2000.*

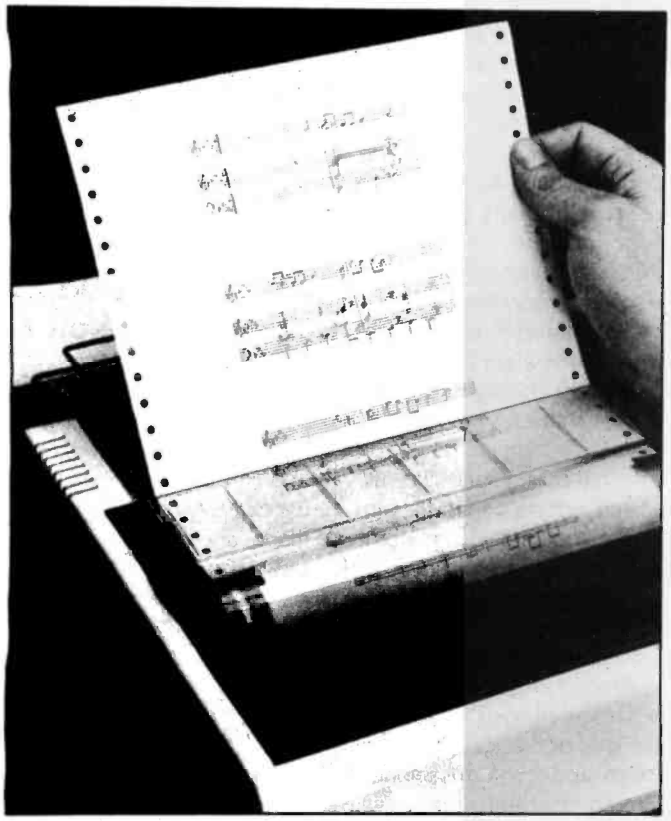
*The home computerist may soon see systems from Matsushita Electric that will include a combination teletext decoder and personal computer for communication over cable TV stations. This equipment would be rented by the cable company for use on its channels carrying this type of information service. Standards for this type of service are still being worked out, and the system may use the full TV channel rather than the vertical interval.*

*Full communication between computer users over cable networks will probably be next with all this activity in the area. A good source for keeping up with this type of technology is the Video Electronics column of* Radio-Electronics *magazine, where new developments in this area are periodically discussed. . . .* **Steve**■

In "Ask BYTE," Steve Ciarcia answers questions on any area of microcomputing. The most representative questions received each month will be answered and published. Do you have a nagging problem? Send your inquiry to:
Ask BYTE
c/o Steve Ciarcia
POB 582
Glastonbury, CT
06033

Due to the high volume of inquiries, personal replies cannot be given. All letters and photographs become the property of Steve Ciarcia and cannot be returned. Be sure to include "Ask BYTE" in the address.

## SOFTWARE



### Music-Writer Scores with Apples

Passport Designs is marketing Polywriter, a music-writing program for Apple II series computers. Polywriter generates and outputs to a printer musical scores of whatever is played on a Soundchaser keyboard. Diverse score formats can be printed: single treble line, single bass line, piano score, choral score, treble clef with piano, bass clef with piano, and full orchestral score.

Polywriter prints standard music notation. It handles note divisions, seconds, accidentals, ties, up or down octave adjustments, flags and beams, split stemming, triplet brackets, rests, any key signature, transposition up or down nine half-steps, and up to 15 time signatures, including complex and asymmetrical. Its full-scale editor can manage lyric and chord symbols.

Minimum system elements are a Soundchaser Basic System, a floppy-disk drive, monitor, Grappler printer interface card, a dot-matrix printer with graphics capabilities, and an Apple II, II+, or IIe or equivalent compatible. The suggested list price is $595. Passport Designs Inc. is located at Suite 103, 625 Miramontes St., Half Moon Bay, CA 94019, (415) 726-0280.

Circle 554 on inquiry card.

### File Sort for Visicalc

A machine-language Visicalc file-sorting utility is available from Keene Computing Services Company. XVCSort lets you sort any block of data made up of either strings or numeric constants. Sorts can be performed in ascending or descending rows or columns and with any number of columns or rows setting the sort-comparison order. This utility's only requirement is that the model's data be saved in a /DIF file.

XVCSort is compatible with systems running LDOS 5.1.x or TRSDOS/LDOS version 6. The suggested price is $25.00. When ordering, specify DOS and computer. Contact Keene Computing Services Co., Suite 43, 407 Nagle St., College Station, TX 77840, (409) 846-4426.

Circle 562 on inquiry card.

### Church Management Programs Available

ACTS church financial and information management packages are available from Burr Computer Consultants. The financial programs are designed to handle all general and special income and expenses. They include provisions for checkbook accounts, payroll, and donation accounting. They also include five monthly financial statements.

ACTS information management programs provide utilities to maintain member profiles, directory listings, visitor follow-up, attendance tracking, and shepherding programs. They offer profile-search functions as well as the ability to generate mailing lists and interface with word-processing programs.

Distributed in dBASE II source code, ACTS' minimum requirements are two double-sided, double-density 48-tpi disk drives. Programs are available in most CP/M, MS-DOS, and PC-DOS formats. Churches with memberships in excess of 500 require larger disk capacities. The programs are $300 each, or both can be purchased for $500. Manuals alone are $30. Contact Burr Computer Consultants, 6402 Thoreau's Way, San Antonio, TX 78239, (512) 650-4342.

Circle 569 on inquiry card.

### Program Orders Disk Files

Catalog-Master organizes and maintains a master file directory of your floppy disks. It composes directory reports sorted in alphabetic order by filename. Individual file descriptions can be merged with master directory reports.

Catalog-Master will index any disk volume supported by CP/M-80 version II. An 80-column by 24-line display and 48K bytes of memory are needed. Disk formats are available for Epson QX-10, Heath/Zenith Z90, Kaypro II/4, and other CP/M-80-based computers. Catalog-Master is $29.95. For full particulars, contact Generic Software, Department 14P, 190 Timber, Marquette, MI 49855, (906) 249-9801.

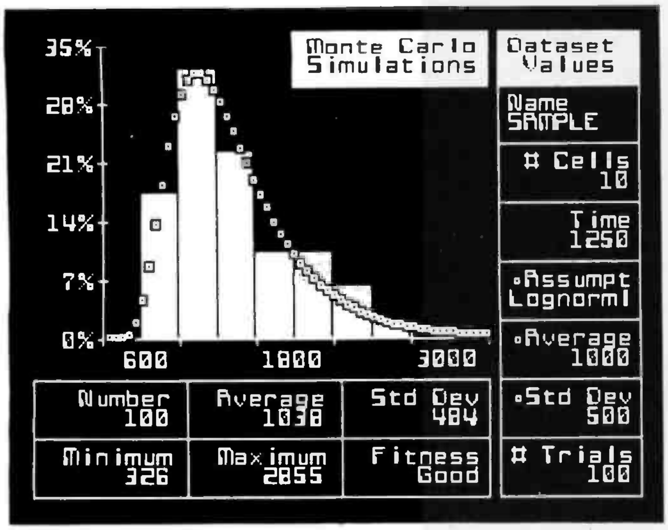
Circle 557 on inquiry card.

### Peachpak 4 for 16-Bit Computers

Peachtree Software is distributing an updated version of its Peachpak 4 accounting package that's fashioned to run on 16-bit microcomputers. Comprising general ledger, accounts receivable, and accounts payable modules, Peachpak has been enhanced with expand and compress abilities that let you adjust your work for 80-column printing without exiting to DOS. In addition, the operators manual has been rewritten.

Peachpak 4 will run on the following 16-bit microcomputers: Compaq, Eagle PC, IBM PC, Texas Instruments Professional Computer, and Zenith Z-100. It lists for $395. For more information, contact Peachtree Software Inc., 8th Floor, 3445 Peachtree Rd. NE, Atlanta, GA 30326, (800) 247-3224; in Georgia, (404) 239-3000.

Circle 550 on inquiry card.




## Statistical Simulators Released

Actuarial Micro Software has released two general-purpose statistical simulators for Apple II and IBM PC computers: Gass and Monte Carlo Simulations. Gass simulates as many as 10 variables simultaneously and combines them into a single user-defined algorithm. Variables can be either random, Boolean, functional, or compound. Random variables can be any of 13 different probability distributions, including empirical tables. Gass also features on-line documentation and the ability to produce reports that summarize final results, display intermediate values, and present histograms.

Monte Carlo Simulations can perform statistical analyses and construct models. It employs the chi-square goodness-of-fit test to match a set of raw data to a standard probability distribution. It features high-resolution graphics, color, and audio enhancements. Results of individual simulations can be incorporated into a spreadsheet to produce complex models.

Gass lists for $450. Monte Carlo Simulations is $60. For more information, contact Actuarial Micro Software, 3915 A Valley Court, Winston-Salem, NC 27106, (919) 765-5588.

Circle 573 on inquiry card.

## Rainbow Graphs Suitable for Presentation

Infograph 100 is a presentation-quality graphics system for novice and knowledgeable DEC Rainbow 100/100+ users. This menu-driven package has integral decision rules that help you make consistent and accurate graphs. Data may be entered directly from a spreadsheet program or manually by responding to a series of prompts.

Infograph 100 uses Digital Research's GSX graphics extension of CP/M, which provides access to most standard graphics printers and plotters. It requires CP/M. This system costs $395, including GSX. For the name of the Infograph dealer nearest you, contact GMS Software, 113 East Savarona Way, Carson, CA 90746, (213) 217-0161.

Circle 553 on inquiry card.

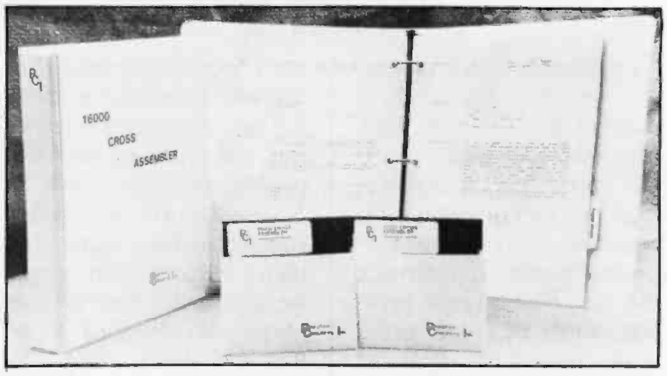
## HP/IBM PC Link

PCCOM from DWJ Associates provides the IBM PC with Hewlett-Packard terminal emulation and communications capabilities. Operating modes and terminal- and printer-control functions are selected through a 13-menu function-key hierarchy. PCCOM generates a 48-line display memory with a 23-line by 80-character screen window. Terminal configuration is performed through keyboard entries that can be saved to disk for automatic power-on terminal configuration. Its full-screen editing capabilities include line and page insert, delete, and clear. Video attributes such as inverse video, blinking, high intensity, and underline are supplied.

Among its print features are adjustable margins and character, line, or block operation in forms and nonforms modes. Fifteen transmission rates, ranging from 50 to 9600 bps, and even, odd, zero, mark, or no parity transmissions are provided. Eight user-programmable function keys with up to 16 character labels and 80 character-string definitions are available. Also offered are serial-port capture into or transmission from user-specified data files, and carriage return/line feed, ENQ-ACK, and XON/XOFF pacing.

PCCOM is compatible with PC-DOS versions 1.0, 1.1, 2.0, and 2.1. It will emulate HP2622 and HP2624B terminals with the exception of their graphics modes and alternate character sets. It costs $450. The manual alone is $20. *For more information, contact* DWJ Associates Inc., One Robinson Lane, Ridgewood, NJ 07450, (800) 922-0090; in New Jersey, (201) 445-1711.

Circle 567 on inquiry card.




## Cross-Assembler for NS16000 Announced

Program Concepts has announced a cross-assembler development system for National Semiconductor's 32-bit NS16000 microprocessor. Designed for use with the IBM Personal Computer, this package comprises four utility programs: cross-assembler, cross-link, debugger, and librarian. Program features include macro instructions, floating-point mathematics, a memory-management unit, and MMU support.

Basic requirements are PC-DOS 2.0, 192K bytes of RAM, and dual 320K-byte floppy-disk drives. It costs $595. A manual is supplied. A C language source and a multitasking operating system for the NS16000 will be available soon. Contact Program Concepts Inc., POB 8164, Charlottesville, VA 22901, (804) 978-1850.

Circle 559 on inquiry card.

# What's New?

## Tektronix Compatibility for Lisa

A Tektronix-compatible applications program, Mesa Graphics' Tekalike operates on the Apple Lisa. Tekalike is a graphics terminal communications package that supports communications to remote computers as an ASCII terminal. It maintains the Tektronix 4010 family's graphics protocols for graphics terminal I/O and is said to be compatible with most mainframe graphics software that works with the 4010 terminals, including Issco, Megatek, and SPSS/Graph. Tekalike also provides local facilities for zooming and plotting pictures. No modifications to the Lisa are required.

Tekalike is tailored for the Lisa, Lisa 2/5, and 2/10 with a hard-disk drive and 1 megabyte of RAM. It costs $350 and is available from Mesa Graphics, POB 506, Los Alamos, NM 87544, (505) 672-1998.

Circle 555 on inquiry card.

## Background Processing for IBM PC

The DoubleDOS operating system enhancer from Softlogic Solutions lets the IBM PC or PC XT run two tasks simultaneously. Acting as an extension to PC-DOS 1.1 or 2.0, DoubleDOS divides the PC's memory into two areas, one for each program running. Programs can be loaded into either memory area, where they are allowed to operate without requiring keyboard interaction. Program displays are trapped by DoubleDOS. When the background program screen is called up, any processing that occurred during operation is reflected.

DoubleDOS supports either monochrome or color display monitors. On PCs with both displays, it provides the option of using either one for background or normal applications. DoubleDOS also provides two 80-character type-ahead buffers.

DoubleDOS does not require software modifications or additional hardware. It can work with 128K-byte systems, but 192K bytes of RAM are recommended. The suggested price is $299. For more information, contact Softlogic Solutions, 530 Chestnut St., Manchester, NH 03101, (800) 272-9900; in New Hampshire, (603) 627-9900.

Circle 568 on inquiry card.

## Scribe Works with Notebook Computers

The Scribe word processor works with the NEC PC-8201 notebook computer's built-in Text program. Scribe features menu control, message prompting with defaults, automatic paging and numbering, text indentation, headers, insert, double-width characters, margin resets, right justification on/off, and the ability to stamp each page with filename, date, and time. Print attributes such as user-selectable tractor-feed or single-sheet paper and the ability to print documents of any length from a combination of RAM or tape files are standard. A typical unjustified text can be printed at about 25 to 50 cps.

Scribe uses only 2.3K bytes of memory. It requires approximately 3.5K bytes to load and run. Scribe cannot underline or create superscripts or subscripts. It costs $29.50, plus $2 for shipping and handling. A version for the Radio Shack Model 100 can be ordered. Contact Chattanooga Systems Associates, POB 22261, Chattanooga, TN 37422, (615) 892-2339.

Circle 566 on inquiry card.


## Turtle Logo Paks In Two Sizes

The Krell Turtle Logo Pak for the Apple II is available in two sizes: 20 and 40 disks. Each Turtle Pak contains "Alice in Logoland" disks and primer and utility disks with a host of MIT's Logo programs: Dynatrack, Shape Editor, Music Editor, and Sprite Drivers. In addition, the Pak has Logo command wallcharts, Dan Watt's Learning with Logo, and the MIT technical manual, Logo for the Apple II.

The 20-disk version of Turtle Pak lists for $499.95. The 40-disk version is $899.95. For details, contact Krell Software Corp., 1320 Stony Brook Rd., Stony Brook, NY 11790, (516) 751-5139.

Circle 564 on inquiry card.

## Doodle with Graphics on Your Z-100

The Doodler Graphics Package for Heath/Zenith Z-100 computers works with color or monochrome displays. Doodler draws lines, boxes, circles, ovals, and mirror images and lets you move, copy, or erase portions of the screen. Text can be of variable width and proportionally spaced or scaled. Characters can be displayed in italics or with a back-slant, and Doodler's font editor lets you build custom characters. The two-dimensional drawings created with Doodler can be saved to disk for later playback, editing, or merging with other programs.

Doodler is menu-driven, using single-keystroke commands. It comes with drivers for Gemini, Epson, C. Itoh, and similar dot-matrix printers. It costs $79.95. Contact Paul F. Herman, Data Systems Consultant, POB 535, St. James City, FL 33956, (813) 283-2227.

## Passive and Active Circuit Analyzer

ACNAP is a general-purpose electronic circuit analysis program from BV Engineering. It analyzes passive and active circuits consisting of resistors, capacitors, inductors, controlled current sources, operational amplifiers, transistors, FETs, and so forth. It will analyze the response of any linear network consisting of up to 21 nodes and 60 components.

ACNAP works with component tolerances to provide worst-case and Monte Carlo analysis. It can calculate minimum, maximum, mean, and three sigma points of a circuit's gain/phase response to any frequency input. Linear and logarithmic frequency sweeps can be specified. Additional calculations include the sensitivity of the gain/response to components at a frequency or range of frequencies. Calculation of any circuit's noise equivalent bandwidth is automatic.

Every ACNAP command is either menu-driven or program-prompted. Circuit data is stored to disk; both ASCII and binary file structures are supported. Calculating the response of a typical five-node circuit takes approximately 0.4 second.

This program is available in 5¼- and 8-inch CP/M formats for such systems as the Apple II Plus, IBM PC, Victor 9000, and Radio Shack TRS-80 Models I, III, and 4. It costs $49.95, plus $3 handling. For $59.95 and shipping, 8087 coprocessor versions for the IBM PC and Victor 9000 can be obtained. Contact BV Engineering, POB 3351, Riverside, CA 92519, (714) 781-0252.

Circle 572 on inquiry card.

### Rainbow and TI Professional Business Software

State of the Art's FM Series of small-business accounting and word-processing programs are available for the Texas Instruments Professional Computer and the DEC Rainbow and Rainbow Plus. The FM Series is made up of general ledger (with bar-chart graphics), budget and financial reporting, accounts payable, accounts receivable, sales invoicing, inventory control, payroll, word processing, and professional time and billing modules.

These programs can serve as stand-alone modules or, for a complete accounting system, they can be integrated with each other. They can be customized to meet your organization's specific needs. Program highlights include information windows and on-screen prompts. For future expansion, all modules are designed to be easily expandable from a floppy-disk- to a hard-disk-based MS-DOS system.

Individual FM Series packages range in price from $495 to $795. A hard-disk installation kit is $95. Versions of FM Series are also available for the IBM PC, PC XT, Corona, Compaq, and Columbia. For further information, contact State of the Art Inc., 3183-A Airway Ave., Costa Mesa, CA 92626-4618, (714) 850-0111.

Circle 565 on inquiry card.

### Function Key Program for Kaypro

Xtrakey from Xpert Software lets you redefine any key on your Kaypro's keyboard with character strings. It has a built-in screen dump that lets you produce hard-copy outputs of the current screen display while running another program. Xtrakey also provides variable-length strings (i.e., pausing), as well as clear-screen and two additional screen-dump functions. It comes with predefined key-string sets for a variety of programs and an editor for devising custom key strings. Xtrakey can also redefine cursor and numeric keypad keys.

With documentation, Xtrakey costs $39.95. Add $2 postage and handling when ordering factory-direct from Xpert Software, 8865 Polland Ave., San Diego, CA 92123, (619) 268-0112.

Circle 560 on inquiry card.

### Generate Fonts with Plotters

Centerpoint's Sign-Plot program lets you produce six different typeset-quality letter fonts for use with pen plotters from such manufacturers as Hewlett-Packard, Houston Instrument, and Enter. Uppercase, lowercase, punctuation, and numbers are part of this menu-driven program. Any character can be slanted for an italic effect, and letter sizes are variable. Characters may be positioned vertically and horizontally in fractional inch increments. Additional fonts and symbols can be created.

Sign-Plot works with 128K-byte IBM Personal Computers with two disk drives and CP/M-80-compatible systems. It also works with Amdek, Apple, Calcomp, Mannesmann Tally, and Strobe plotters. Sign-Plot costs $149. For more information, contact Centerpoint Computer Applications, 500 North Michigan Ave., Chicago, IL 60611, (312) 467-0333.

Circle 570 on inquiry card.

### Protact Processing and Control for DEC

Protact, a transaction processing and control system for DEC Professional computers, gives you terminal, file, and network management capabilities and lets one or two users access applications on a remote or local Professional, PDP-11, or VAX. Its terminal management presents a form to be completed by the user and verifies user-specified primary edit checks as each field is entered. Form definition is kept separate from the program. A dispatching system provides a hierarchical menu structure. Protact can route items to another computer for processing. This is said to be transparent to the user and applications programmer. Security is definable at both the local and remote level.

Protact's file manager uses DEC's Record Management Services as its file-access method. Transparent remote file access is supported, and file definition is maintained outside the referencing program. A restart/recovery system with start- and commit-transaction logic is supplied.

Protact comes in three versions. The Developer's Kit, priced at $2500, has the necessary components to write and carry out applications on the Professional. (Applications are written in any language that supports CALL statements.) The Protact run-time system is made up of components used while an application is executing. A license is $395. The Terminal Server, intended for Professional computers linked into an Ethernet network, has terminal- and network-management facilities. It costs $595.

P/OS V1.5 and V1.7 are required. Multiple processor and educational institution discounts are available. Contact Advanced Systems Concepts Inc., 22 Hudson St., Hoboken, NJ 07030, (201) 798-6400.

Circle 558 on inquiry card.

### Spreadsheet Link for IBM PCs

Spreadsheet Link lets you download data from the Dow Jones News/Retrieval database into Lotus 1-2-3, Visicalc, Multiplan, and other spreadsheet programs running on an IBM PC. This program works with the IBM PC, PC XT, and 3270 PC. Minimum memory requirements are 128K bytes; your spreadsheet may require more memory. With Visicalc, Spreadsheet Link only needs a single double-sided drive; Multiplan and Lotus require two. A monitor, acoustic coupler or 300/1200-bps modem, and a parallel or serial printer with an asynchronous communications adapter are requisite. The following modems are supported: Radio Shack TRS-80 Modem II, Hayes Smartmodem, and the Novation 103/212 Smart-Cat. The suggested retail price is $249. For further information, contact Dow Jones & Co. Inc., POB 300, Princeton, NJ 08540, (800) 257-5114; in New Jersey, (609) 452-1511.

Circle 563 on inquiry card.

# What's New?

## MASS STORAGE

### 60K RAM for Portable Computers

Portapac 100 from Cryptronics expands a portable computer's memory by serving as a RAM disk. It comes with its own operating system and communicates with CP/M- and MS-DOS-based computers through its RS-232C serial port. It can access up to 32 separate files in a 60K-byte RAM, which is expandable to 252K. It can operate continuously for three hours and store data for two days before recharging the battery.

Portapac 100 is $395. It's available from Cryptronics Inc., Suite 7, 11711 Coley River Circle, Fountain Valley, CA 92708, (714) 540-1174.

Circle 574 on inquiry card.

### Apple Disk Drive and Controller Card Marketed

Concorde Peripheral Systems markets a single-sided 163K-byte floppy-disk drive and a disk controller card for Apple computers. The Concorde Model C-111 disk drive has the following technical specifications: 35- or 40-track capabilities; track density: 48 tpi; data transfer rate: 250K bits per second; rotation speed: 300 rpm; recording frequency: 250 kHz. This single-head drive measures 6 by 3⅝ by 9 inches and weighs 4 pounds. It plugs directly into the Apple II Controller Card.

The C-130 Disk Controller Card can accommodate four single- or double-sided Concorde or Apple-compatible drives. Its supplied software allows Apple DOS 3.3 to function with Concorde's line of double-sided disk drives. The C-130 operates with DOS 3.3, DOS 3.2, CP/M 2.2, and Pascal 1.1. One Apple slot is used.

The C-111 lists for $249. The C-130 is $89. Concorde Peripheral Systems Inc. is located at 23152 Verdugo Dr., Laguna Hills, CA 92653, (714) 859-2850.

Circle 575 on inquiry card.

### 33-Megabyte Winchester for PC

Interface Inc's Disksystem provides the IBM PC with 33.3 megabytes of formatted disk storage. This 5¼-inch Winchester hard-disk drive records at 640 tpi and offers an average access time of 40 milliseconds. System features include a 512-byte buffer, an architecture built around a microprocessor, a double shock isolation system, and error checking and corrections of 32 bits. Its physical dimensions are 5¾ by 8¼ by 15¼ inches.

Disksystem requires PC-DOS 2.0. It comes with its own power supply, cable, connector, and I/O adapter. The suggested list price is $2795. For more information, contact Interface Inc, 7630 Alabama Ave., Canoga Park, CA 91304, (818) 341-7914.

Circle 577 on inquiry card.

### Line of Hard Disks Can Be Daisy-Chained

Diskitjr from Systems Peripherals Consultants is a low-profile line of hard-disk drives for IBM PCjrs, Sanyo 550s, and PC-compatible portables. Diskitjr's interconnect cables can be removed or daisy-chained up to four drives. The basic system chassis measures 2¼ by 6 by 12 inches.

Diskitjr's formatted storage capacities are 10.8, 22.2, and 34 megabytes of fixed storage and 5 or 10 megabytes of removable-cartridge storage. With the addition of an 8-bit controller, Diskitjrs will work with such Z80-based systems as the Kaypro, North Star, and Televideo.

The 10-megabyte drive costs $1495. The 22.2- and 34-megabyte units are $2695 and $3495, respectively. The 5-megabyte removable-cartridge Diskitjr is $1695; pricing for the 10-megabyte version, which will be available later this month, was not established at the time this was written. When drives are daisy-chained, additional controllers are not required, reducing the per-unit price. For details, contact Systems Peripherals Consultants, 9747 Business Park Ave., San Diego, CA 92131, (619) 693-8611.

Circle 576 on inquiry card.

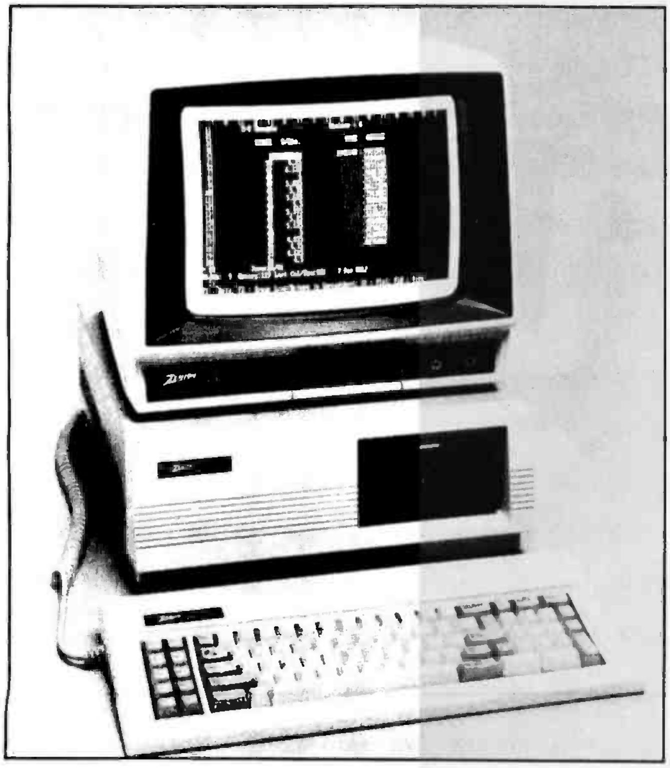
## SYSTEMS

### Transportable PC-Compatible

The Colby PC-3 stand-alone portable computer is compatible with the IBM Personal Computer. A 26-pound unit, the PC-3 measures 8½ by 16 by 16½ inches. Its 9-inch amber monitor has an 80-column by 25-line display format and IBM PC graphics capabilities. Standard are 128K bytes of RAM, a real-time clock, serial and parallel ports, and a SASI hard-disk interface. Dual 360K-byte double-sided, double-density floppy-disk drives provide mass storage. A carrying handle eases transportation and serves as a tilt stand. Up to 1 megabyte of RAM and 3½ internal slots constitute this computer's expansion possibilities.

The Colby PC-3 lists for $2795. For complete information, contact Colby Computer, 849 Independence Ave., Mountain View, CA 94043, (415) 968-1410.

Circle 584 on inquiry card.



## Z-100 PC Series

Zenith Data Systems' Z-100 PC series microcomputers are compatible with IBM Personal Computer expansion boards and software. The Z-100 PC line consists of three desktop computers and two portables. All are based on the 8088 microprocessor and contain 128K bytes of RAM, dual RS-232C serial ports, a single Centronics-type parallel interface port, RGB color output, an IBM expansion bus, and a detached keyboard. The Z-100 PCs come with power-up diagnostics, three scrolling modes, and high-speed text and graphics displays. System software includes MS-DOS and a ROM-based BIOS. Mass-storage capacities range from 320K to 360K bytes per drive, depending on recording format. RAM is expandable to 640K bytes. When fully configured, the Z-100s have four expansion slots remaining for future accessories.

The desktop Z-100 PCs are available with a single 5¼-inch floppy-disk drive, dual floppy-disk drives, or with a floppy-disk and 10.6-megabyte Winchester hard-disk drive. Prices are $2699, $3099, and $4799, respectively. Each desktop unit provides gray-scale monochrome output. Monitors are extra.

The portable systems are equipped with 9-inch amber monitors. They measure 19.5 by 8.38 by 19.13 inches and weigh approximately 33 pounds. They're offered in single and dual floppy-disk drive configurations. The prices are $2799 for the former and $3199 for the latter. For full details on these products, contact Zenith Data Systems, 1000 Milwaukee Ave., Glenview, IL 60025, (312) 391-8744.

Circle 585 on inquiry card.

## AKA PC Offers IBM Compatibility

The AKA Personal Computer is a 16-bit, 8088-based microcomputer that's compatible with IBM PC hardware and software. Equipped with 128K bytes of RAM, the AKA carries a pair of half-height, double-sided, double-density floppy-disk drives; five expansion slots; one parallel and two serial ports; and a low-profile detachable keyboard. A choice of monochrome or color-graphics display boards is offered. Its cabinet has room for four additional expansion slots and two disk drives. User memory can be increased to 256K bytes.

The AKA Personal Computer runs under MS-DOS. The AKA Plus, a version outfitted with a 10-megabyte hard-disk drive, is available. The AKA PC lists for $3295. The AKA Plus has a suggested retail price of $4795. For further information, contact AKA Computers Inc., POB 36247, Charlotte, NC 28236, (704) 334-2504.

Circle 579 on inquiry card.

## Portable PC and PC Cluster Unveiled

IBM recently unveiled a portable computer and a PC Cluster program for connecting up to 64 IBM PCs, PC XTs, Portable PCs, and PCjrs. The Portable PC uses the 16-bit 8088 microprocessor and comes with 256K bytes of RAM, color/graphics monitor adapter, a single 360K-byte slimline floppy-disk drive, and a universal power supply. It sports a built-in, 9-inch amber monitor; the display format is 80 characters by 25 lines. An optional slimline floppy-disk drive can use one of the Portable PC's five slots. IBM DOS 2.1 provides compatibility with most of the software available for the full-sized IBM PC. This 30-pound unit measures 20 by 17 by 8 inches. It lists for $2797, including a carrying bag.

The IBM Personal Computer Cluster program lets you send, exchange, and share messages and information among IBM PC workstations. Workstations can share information and storage space on a fixed-disk drive at one machine in the Cluster. An interconnecting cable is required. A number of support options for connecting different IBM PCs are available: an adapter board, a PCjr Cluster attachment, and a Computer Cluster Cable Kit, which contains the cables and connectors for hooking together a pair of PCs.

A program license, priced at $92, is required for each system in the Cluster. The Cluster adapter is $340, and the Cluster Cable Kit lists for $110. The

PCjr Cluster attachment costs $400. Contact your local IBM Products dealer, or write to IBM Entry Systems Division, POB 2989, Delray Beach, FL 33444.
Circle 578 on inquiry card.

### Havac Is an Apple Work-alike

Microsci Corporation recently introduced an Apple II work-alike computer called Havac. This transportable computer, constructed around the 6502 microprocessor and a 164K-byte 5¼-inch floppy-disk drive, offers 64K bytes of RAM, 8K bytes of ROM, a 62-key detached keyboard supporting uppercase and lowercase characters, four cursor keys, high-resolution color graphics, video connections, and printer, serial, and game ports. Among the supplied software are DOS, a card filer, calculator, BASIC, and a variety of utilities. The manufacturer asserts that more than 1000 Apple II programs have been successfully run on the Havac.

A stand-alone floppy-disk drive is offered as an option. The suggested list price is $850 and includes all the features outlined above. For further details, contact Microsci Corp., 2158 South Hathaway St., Santa Ana, CA 92705, (714) 241-5600.
Circle 583 on inquiry card.

### CP/M Computer Is Apple-Compatible

The Intertek System IV is a dual-processor, CP/M-based computer offering compatibility with Apple hardware and software. The System IV runs Microsoft CP/M 2.20B on its Z80A microprocessor while in the Apple mode; operations are handled by a 6502 chip. The system features 64K bytes of RAM, high- and low-resolution graphics capabilities, a built-in RF modulator, six free peripheral connectors, speaker, game paddle/joystick ports, uppercase and lowercase characters, cassette interface, and diagnostics. It offers 16 colors and Integer BASIC. A QWERTY keyboard is augmented with a numeric pad, function keys, and automatic repeat.

A variety of peripherals are available: 12-inch green or amber monochrome monitors, 13-inch RGB or composite-video monitors, 5¼-inch half- and full-sized floppy-disk drives and controllers, serial or parallel 13-cps letter-quality printers, and joysticks. The suggested retail price of the base System IV is $849. For details, contact Intertek Systems Inc., 1210 West Collins Ave., Orange, CA 92667, (714) 633-3591.
Circle 582 on inquiry card.

### S-100 Bus Systems for Industry

Industrial-grade mainframe computers engineered around 8- or 16-slot IEEE-696 S-100 motherboards are marketed by Futech International Corporation. The Futech 2000 Series provides up to 25 rear-panel DB25 connectors, front bezels to accommodate up to six floppy- or Winchester-disk drives, and switchable heavy-duty 100, 120, 220, and 240 V AC 50/60 Hz power supplies.

The 2000 Series' multiuser, multiprocessor CP/M-compatible operating system supports concurrent hard disk and 8- and 5¼-inch floppy disks. Batch processing, record and file locking, multilevel security, and automatic log are provided. It supports high-performance spooling of up to 16 concurrent printers and 16 print queues.

The 2000 Series can handle both 8- and 16-bit slave processors in the same enclosure. Each slave has a dedicated microprocessor, RAM memory, and I/O ports. Other standard features include on-board LED warning indicators, gold-plated 100-pin edge connectors, built-in EMI/RFI filter, line surge/spike suppression, and two filtered fans.

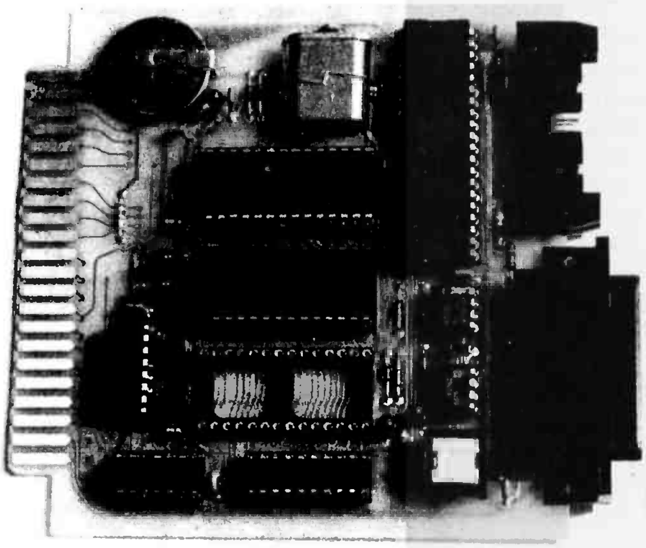
The 2000 Series can incorporate a front-panel LED that displays time, date, and internal and ambient temperatures. Additional options include auxiliary connectors for floppy- and hard-disk drives, a synthesized warning voice, and backup power supply. A variety of applications packages and operating systems are available. The base price is $730, quantity one. For complete specifications, contact Futech International Corp., Suite 1807, 2100 North Highway 360, Grand Prairie, TX 75050, (214) 660-1955.
Circle 581 on inquiry card.

### ET Desktop with Software

The ET-2010 desktop computer comes with a software bundle comprising an enhanced DOS that's compatible with CP/M 2.2, Business BASIC, and word processing, spreadsheet, general ledger, accounts receivable, accounts payable, and payroll with job costing packages. The ET-2010, a 64K-byte machine assembled around a 4-MHz Z80A microprocessor, has parallel Centronics and serial interface ports and a 76-key QWERTY keyboard plus a numeric pad. Its built-in 9-inch high-resolution green screen has an 80-character by 24-line display and strike-through, blink, blank, reverse, and underline attributes.

Optional system hardware includes 9511 and 9512 arithmetic coprocessors, DMA controller, the 6-MHz Z80B, and a 10-megabyte hard-disk unit. A multiuser, multitasking operating system and networking capabilities are also offered. A two-disk system costs $1349, including software, monitor, and keyboard. With a single disk drive, it's $1225. Options range from $25 to $1100. Contact ET Computer Systems, 8161 Broadway, Lemon Grove, CA 92045, (619) 466-1671.
Circle 580 on inquiry card.

## PERIPHERALS



### Dedicated Control Boards

Adaptive Micro Systems' AMS-1000 series of single-board computers is intended for dedicated control applications in which the board serves as the development and target application system. Standard are an RS-232C port, dual 8-bit parallel TTL I/O ports, a pair of 16-bit counter/timers with interrupt, 2K or 8K bytes of battery-backed CMOS RAM, and a 44-pin expansion bus. An extra socket is available for 2K- or 8K-byte EPROMs or EEPROMs. Programs can be automatically booted on power-up, and a wake-up feature for multidistributed process-control applications is provided. The fully socketed board measures 4½ by 4½ inches.

The basic board comes with a 6502 microprocessor and an extended version of fig-FORTH and a 6502 assembler in firmware. The 2K-byte AMS-1000 is $299. The 8K-byte version is $399. Documentation and FORTH tutorials are supplied. Further details can be obtained by contacting Adaptive Micro Systems, POB 965, Sandy, UT 84091.

Circle 595 on inquiry card.

### Apple Given Gold Card

Digital Research has announced the CP/M Gold Card for Apple II series microcomputers. The Gold Card combines a 6-MHz Z80B microprocessor, up to 192K bytes of memory, disk cache, and CP/M Plus on a single plug-in card. Standard are CBASIC, menu-driven utilities, 80-column display capacity, hash directory, time and date stamp facility, automatic loading, and console I/O redirection.

It comes with 64K bytes of memory, software application-development tools, and assembly-language utilities. The price is $495. An add-on disk cache advances the Gold Card's memory to 128K bytes. It's $325. A complete Gold Card package with cache is available for $775. For a full account, contact Digital Research Inc., POB 579, Pacific Grove, CA 93950.

Circle 588 on inquiry card.

### 8-MHz 80186 Heart of SBC

The Super 186, a high-speed, 16-bit single-board S-100 computer, is built around Intel's 8-MHz 80186 microprocessor. Manufactured by Advanced Digital Corporation, Super 186 is cable of addressing up to 1 megabyte of RAM without requiring banking techniques. It is supplied with 256K bytes of on-board RAM with parity, four serial RS-232C ports, two parallel ports, a two-channel DMA controller, three uncommitted counter/timers, and a floppy-disk controller that lets you operate 5¼- and 8-inch drives simultaneously. It can be equipped with 64K bytes of monitor EPROM. Bus master or slave/temporary master capability and compatibility with CP/M-86, TurboDOS, and MS-DOS are standard.

Optional hardware available includes a clock/calendar, battery backup, dual-ported memory, and mathematics coprocessors. Super 186 is $1995. For more information, contact Advanced Digital Corp., 5432 Production Dr., Huntington Beach, CA 92649, (714) 891-4004.

Circle 589 on inquiry card.

### Versatile Graphics Board for PC

Profit Systems' Multigraph single-board graphics adapter for the IBM Personal Computer lets you select either color or monochrome monitors. The basic board offers high-resolution 720- by 350-pixel monochrome graphics and the ability to run standard software for the IBM color board. In either color or monochrome, Multigraph gives you 32K bytes of on-board memory, flicker-free scrolling, and 32-bit internal architecture for increased operating speed. The basic color resolution is 160 by 100, 320 by 200, or 640 by 200, using sixteen, four, or two colors, respectively. Alphanumeric displays of 80 by 40 can be achieved in the monochrome mode.

Expansion options include a parallel printer port, soft scrolling, and a 128K-byte display buffer. In color, resolution can be upgraded to 640 by 200 or 400 pixels with 16 colors. In monochrome, graphics can be upgraded to 720 by 700 resolution with 132 columns. The base price is $499, complete with documentation. Dealer and OEM inquiries are invited. Full details can be requested from Profit Systems Inc., POB 1039, Berkley, MI 48072, (313) 559-0444.

Circle 608 on inquiry card.

### Abort Printing Without Reloads

The Passport Printer Emulator lets you quickly abort an ongoing print operation, preventing potential time and data losses. Passport has two operating modes: Print Pass-Through and Print Bypass. If you wish to cease printing or if you inadvertently invoke a printer operation, such as print screen, Passport's Print Bypass mode lets you terminate the printing without locking your keyboard or requiring a reload. Print Pass-Through permits normal operations.

Passport functions as a standard printer device. It emulates most parallel printers that connect with an IBM PC or PC-compatible cable. Passport costs $29.95, plus $2 handling. It's available from Micro Computer Components, 8660-D Miramar Rd., POB 195, San Diego, CA 92126, (619) 453-3367.

Circle 597 on inquiry card.

## 24 by 80 Terminal

The LCT-100 terminal from Data Terminal Service produces 24-line by 80-character screen displays in a 9- by 12-dot grid. It generates 129 uppercase and lowercase ASCII characters and offers 12 video attributes, including blink, half-intensity, reverse, and underline. Miscellaneous features consist of a 58-key typewriter-format keyboard, 80 graphics characters, the ability to display control characters on screen, status displays of configuration switches and RS-232C interface settings, switchable automatic line feed upon receipt of a carriage return, and an RS-170-like composite-video interface. The RS-232C interface has 16 switch-selectable transmission rates and 7 data bits/words with 1 or 2 stop formats. Full-duplex or local-echo protocols are provided.

The LCT-100 costs less than $400. With an optional monitor, it's less than $500. For complete details, contact Data Terminal Service Inc., 715 Rankin Rd., Albuquerque, NM 87192, (505) 345-1611.

Circle 602 on inquiry card.

## 16-Bit CPU Board for S-100 Systems

Seattle Computer's 8086 CPU board is purported to deliver true 16-bit high-speed performance to S-100 bus-based computers. It comes in 8- and 10-MHz versions. As a result of its 16-bit architecture and increased clock speeds, the CPU board can be used for enhancing the throughput capabilities of 8088-based systems, such as the IBM PC. It can operate with older 8- or 16-bit peripherals, including disk controllers and video units. The memory address range of the CPU board can be expanded up to 16 megabytes. The board can be used as a stand-alone unit or as part of a three-card support/MMU set.

Software support includes MS-DOS and Xenix. The 8-MHz board is designed for use with the 8087 numeric processor. The 10-MHz board is $795, and the 8-MHz board costs $695. Both prices include a support board. Dealer and OEM inquiries are invited. For complete specifications, contact Seattle Computer Products Inc., 1114 Industry Dr., Seattle, WA 98188, (800) 426-8936; in Washington, (206) 575-1830.

Circle 607 on inquiry card.

## New Life for Older PCs

A memory upgrade for older IBM PCs carrying the 16K- by 64K-byte CPU is obtainable from Add-Mem. With this upgrade, the PC's memory can be jacked up to 256K bytes without using an expansion slot. Upgrades of 128K, 192K, or 256K bytes are offered.

Add-Mem can install 256K bytes of RAM in your PC for $335, or you can order a do-it-yourself kit. The kit, made up of DIP sockets, capacitors, wires, documentation, and instructions, involves assembling and installing a small printed-circuit board and the soldering of nine jump wires. The basic kit is $69.95. With an assembled board, it's $99.95. For $5.85 each, you can order RAM chips. A protective, antistatic carton with board removal and shipping instructions costs $5. Call or write Add-Mem, 22151 Redwood Rd., Castro Valley, CA 94546, (415) 886-5443, for more information.

Circle 593 on inquiry card.

## Legacy Created for PCjr

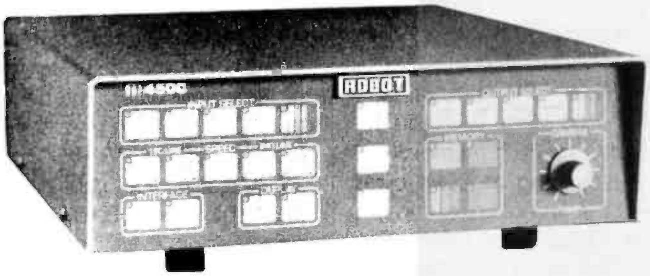
Legacy Technologies is shipping an expansion box for the IBM PCjr called the Legacy. This modular unit is engineered around a power supply capable of accommodating either a floppy- or hard-disk drive, up to 512K bytes of RAM, and a four-slot, 80-pin bus for a variety of add-ons. Sixty of the bus pins are identical to the PCjr's; the rest are prepared to provide hookups for interrupt capabilities, control and synchronization signals for coprocessors, or specialized I/O functions.

The basic Legacy, priced at $395, comprises the power supply, an LED status panel, the expansion bus, and a cabinet. Options offered are a half-height disk drive, a 64K-byte RAM card that's expandable to 256K bytes in 64K-byte increments, a 10-megabyte hard-disk subsystem, and printer spooler board with a clock/calendar and parallel port. For hobbyists, a $199 L-Bus Developer's Kit with power supply, two wire-wrap cards, and manual are available.

With a half-height 320K-byte floppy-disk drive and controller (required), Legacy is $795. The 10-megabyte hard-disk version is $1595. The disk controller, floppy-disk drive, and the half-height hard-disk drive may be purchased separately for $189, $279, and $995, respectively. The RAM card is $299, with the 64K increments going for approximately $100. The clock/calendar card costs $159. Order directly from Legacy Technologies Ltd., Suite 100, 1414 O St., Lincoln, NE 68508, (800) 288-7257; in Nebraska, (402) 475-7257.

Circle 591 on inquiry card.

# What's New?




## Image Converter Serves as Camera/Computer Interface

The Model 450C image-processing scan converter serves as an interface between a video camera and a computer. The Model 450C has three video memories, any one of which can accept black-and-white images; all three are employed for a single color image. A total of 4096 separate hues can be simultaneously displayed in the color mode.

Computer access is accomplished through a bidirectional interface using a pair of independent 8-bit parallel ports. Individual pixels can be randomly accessed for image enhancement, graphics generation, storage, and recall. Control over system operations is via a command set. An internal slow-scan video modem will transmit video images over voice-grade communications links.

The Model 450C has a suggested retail price of $895. For technical specifications and ordering procedures, contact Robot Research Inc., 7591 Convoy Court, San Diego, CA 92111, (619) 279-9430.

Circle 596 on inquiry card.

## 68000 SBC Compatible with S-100

PSCE's X-tended 68000 single-board computer is compatible with the S-100 bus. The X-tended 68000 comes with an 8-MHz 68000 microprocessor, 16 megabytes of memory address space, 64K bytes of I/O address space, and 4K bytes of EPROM. Suitable for multiuser systems, X-tended's I/O controls include two RS-232C synchronous/asynchronous ports, both of which offer programmable data rates up to 9600 bps. One RS-232C port provides full modem controls. A Centronics-type parallel interface is standard.

For mass storage, X-tended's floppy-disk controller can handle a mix of four 8-, 5¼-, or 3½-inch single- or double-sided, single- or double-density drives. Its software-programmable floppy-disk write precompensation can select one of six values for drive compatibility, and it can be optimized for the track being accessed. Also furnished are a DMA controller and two general-purpose undedicated 16-bit timers. Nonmaskable interrupts and three types of vectored interrupts are supported.

X-tended 68000 can work with a mix of 8- and 16-bit memory boards. A jumper option for generating the S-100 Mwrite signal and CP/M-68K with optimized BIOS, an editor, assembler, debugger, linker, librarian, and a C compiler with a full library are available. RAM is additional. The base price is $850. For more information, contact PSCE Inc., POB 8, Port Jefferson, NY 11777.

Circle 603 on inquiry card.

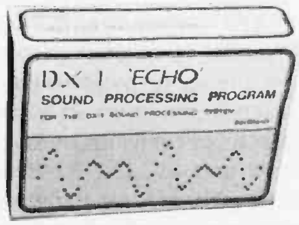

## Inforite Recognizes Handwritten Characters

Inforite is a handwritten-character-recognition terminal. Incorporating dynamic character recognition, mark/sense recognition, and graphics capabilities, Inforite is suitable for applications that require direct computer entry of data from handwritten forms. It's based on the 4-MHz Z80A microprocessor and contains 64K bytes of RAM, 56K of ROM, and 48K bytes of battery-backed CMOS RAM.

Inforite can store almost 50 pages of data for more than three days. It transmits data to a local or remote computer through an RS-232C serial interface. Switch-selectable data rates range from 110 to 19,200 bps. DSR/DTR and XON/XOFF controls are supported. Standard features include a 2-line by 32-character LCD display that identifies the field and the data, error messages, and a programmable calculator function that computes extensions, subtotals, totals, tax calculations, and percentages as a form is being completed. It operates with a ballpoint pen and accommodates three-part forms.

A forms-definition package that lets you create forms tailored to your business is available as a $450 option. Inforite is $2000. OEM prices quoted on request. Contact Inforite Corp., Suite 201, 1670 South Amphlett Blvd., San Mateo, CA 94402, (415) 571-8766.

Circle 605 on inquiry card.




## Sound Processing System Polishes Apples

Decillionix's DX-1 lets you record, process, and play back ordinary sounds with Apple II series computers. Sounds can be entered through a microphone or other source and saved, manipulated, sequenced, and modified in any way you choose. Pitch, volume, direction, and sequence are software-programmable, and real-time sound can be played through the Apple's keyboard.

Major system components are a printed-circuit board, a high-fidelity pre-amp circuit, a connecting cable, and software. Key features include 8-bit sample record/playback techniques, variable sound rates ranging from 0.78 kHz to 30 kHz, variable play times from 0.8 to 10 seconds, the ability to play continuous sound sequences, and independently variable record and playback rates. The system software disk comes with 22 prerecorded sounds.

Echo, an optional software package with more than 40 key-selectable routines, adds echoing, reverb, and real-time sound processing. Direct control of all parameters by joystick is provided. Echo costs $149. A four-volume set of prerecorded sounds can be purchased for $79.

DX-1 requires a 48K-byte Apple II or IIe with DOS 3.3 and Applesoft BASIC. List price is $239. For further information, contact Decillionix, POB 70985, Sunnyvale, CA 94086, (408) 732-7758.
Circle 592 on inquiry card.

## FOREIGN

### Gang-of-Eight Programs EPROMs

The Gang-of-Eight EPROM Programmer from Dataman Designs can simultaneously program eight devices using manufacturers' recommended fast-programming algorithms. The programming time for a batch of 2764s reportedly averages 1.5 minutes. No special modules are required. The Gang-of-Eight has a simple switch setting that handles single-rail 24- or 28-pin devices, including the 27256. Programming voltage has fixed levels of 21 and 25 volts, a user-settable level, and a factory preset level of 12.5 volts, which is required by the newer, larger EPROMs.

For normal operations, the Gang-of-Eight has a single operating key. This device has a built-in intelligence feature that traps operator errors and an emergency Reset key for escaping those situations. Other features include an audible alarm and blank-check, pretest, and verify functions.

The Gang-of-Eight EPROM Programmer costs £395, including VAT (value-added tax). It's available from Dataman Designs, Lombard House, Cornwall Rd., Dorchester, DT1 1RX, England; tel: Dorchester (0305) 68066.
Circle 613 on inquiry card.

### RAM Disk Emulator for CDOS Systems

Tesco's TDrive RAM disk I/O emulator works with Cromemco computers. It serves as a single logical CDOS disk drive, providing access to up to 224K bytes of memory. Memory is partitioned into seven banks of 32K bytes (2K bytes are reserved for directory entries). It's compatible with 5¼-inch floppy-disk drives, and all CDOS software reportedly can be used on TDrive, including KSAM files under SBASIC.

TDrive works with systems that use bank-switched memory boards. It comes as a .COM object file on either 5¼- or 8-inch CDOS floppy disks. TDrive installs directly under CDOS and makes all required patches within CDOS. All boards with a bank-switch feature, such as the Cromemco 64 KZ, are supported.

Tesco's TDrive RAM disk I/O emulator is available in the United States for $98 from Albion Industries, POB 7, Millersville, MD 21108. It's produced and manufactured by Tesco, POB 10, 8714 Wiesentheid, West Germany; tel: 09383/1237.
Circle 609 on inquiry card.

### Structure-Analysis Program Aids Civil Engineers

AMP80-REV8340 is a structure-analysis program for civil engineers. When given the general configuration of a structure, the geometrical properties of its proposed sections, and its loads, this FORTRAN program produces such design stresses and forces as shearing, compression, and bending moments, each in two or more elements. It lets you enter shearing walls and several kinds of materials in the same frame, and it will accept load groups, sinking supports, earthquake forces, tilted loads, and so forth. Combinations of loads can be requested in the same run, and AMP80-RVC8340 can give you analyses of trusses. For producing direct design values, it lets you introduce load factors into a run. Results provide displacements and turns in every joint of the structure or at any intermediate point.

AMP80-REV8340 works with any 64K-byte machine with a FORTRAN compiler, such as the Apple *II Plus and* the Franklin. It comes on two floppy disks and with instructions and examples. The price is $1000. Order from Antoniano, Gonzalez Davila, Medina Mora, S.A. de C.V., Nuevo León 209-601, México 11, D.F., Mexico; tel: 516-0293.

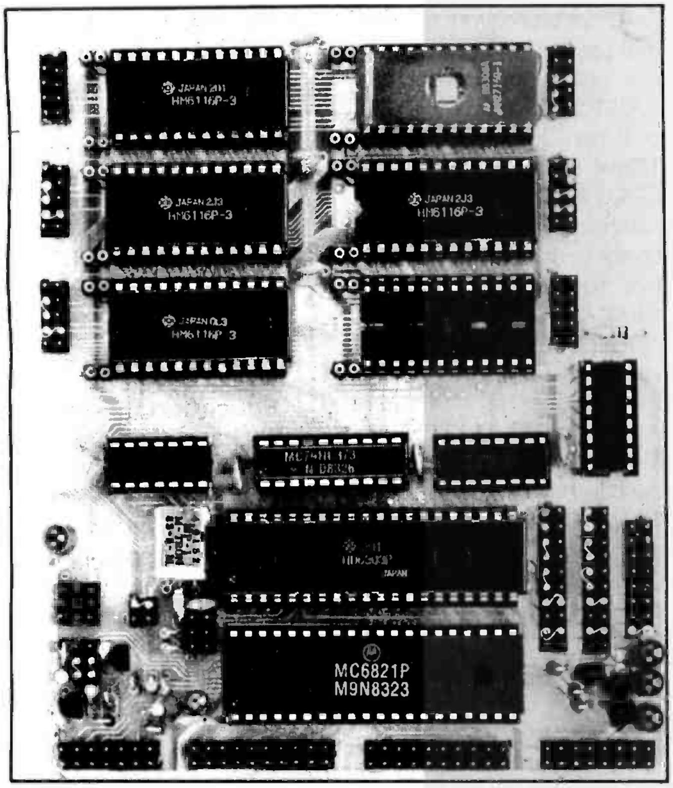
### Educational Robot Package for School and Industry

The Scorbot-ER III robot from Eshed Robotec Ltd. comes with a package of educational materials intended for technical schools, research laboratories, and industry. The complete system comprises the robot, textbooks, laboratory experiments, software, videotapes, slides, and overhead transparencies. The educational modules, which provide practical experiments, guide students from the principles of robotics through to state-of-the-art concepts.

Scorbot features an open-arm construction that lets students observe the operation mechanism. Its DC servomotors with closed-loop control are under the direction of an eight-axis controller that's capable of exercising simultaneous control on all eight axes. The controller has provisions for eight inputs and eight outputs. Scorbot connects to a host computer through an RS-232C serial interface. The rotation specifications for the working envelope are as follows: 360°, body joint; ±150°, elbow joint; ±90°, pitch joint; 360°, roll joint.

Software to run Scorbot is available for a variety of microcomputers. For full details, contact Eshed Robotec Ltd., POB 28346, Tel Aviv 61 282, Israel; tel: (03) 340860; Telex: 361131 ESHED IL.
Circle 610 on inquiry card.

# What's New?




## SBC Handles Mix of Chips

Brick from Dysys Inc. is a single-board computer suitable for sophisticated applications. Its 48K-byte memory space handles a mix of 2K-, 4K-, and 8K-byte RAMs, EPROMs, and EEPROMs. The Hitachi 6303 microprocessor, 33 I/O lines, a 16-bit timer/counter, an on-board UART for normal and multidrop communications, an asynchronous serial I/O line with selectable data rates, three LED indicators, and a power indicator are all standard.

Brick is marketed in four versions. Brick-1 is a development system offering a bus interface, voltage regulator, and a wire-wrap area for twenty 16-pin integrated circuits. Brick-2 is a plug-in board for OEM production. STD bus-compatible, Brick-3 is suitable for development and production of large systems. Brick-4 can be integrated into an OEM's circuit board at the drafting stage. Board dimensions vary.

A choice of Pascal or FORTH is available. Pascal provides an editor, interpreter, compiler, and run-time support. FORTH offers a screen editor, interpreter, and compiler directories. BASIC is optional.

Contact the manufacturer for pricing information on Brick-4. In lots of 10, prices for the other versions begin at $560. Further information is available from Dysys Inc., Suite 206, 961 South Bland St., Halifax, Nova Scotia B3H 2S6, Canada, (902) 423-5308.

Circle 612 on inquiry card.

## 8088 Processor Card Incorporates 80130 RMX

DY-4 Systems Inc. has announced the availability of the DSTD-187 processor card to its line of products for the STD bus. The DSTD-187, an 8088-based card, incorporates the 80130 RMX processor and two RS-232C serial channels. A single 28-pin byte-wide socket for a RAM, EPROM, or ROM is provided. Its on-board memory can be disabled under software control. The contents of dynamic RAM will be preserved during reset. Full 1-megabyte memory addressing is supported, and the DSTD-187 provides transparent dynamic RAM refresh, which permits the use of high-density quarter-megabyte memory cards. Other features include Z80 and 8088 bus architecture support and compatibility with other DY-4 DSTD series cards.

An 8087 mathematics coprocessor is optional, and 8-MHz versions of the card can be obtained. The single-unit price is $584. Contact DY-4 Systems Inc., Marketing Department, 888 Lady Ellen Place, Ottawa, Ontario K1Z 5M1, Canada, (613) 728-3711.

Circle 615 on inquiry card.

## Easy-to-Use Mailing System

Orion Systems of Concord, Ontario, markets a computerized mailing system for users of the IBM Personal Computer. With Oscims, your client file can be added to, deleted from, and modified easily. This program has flexible facilities that let you print addresses on any type or size of label or flyer. Menu-driven, Oscims has the ability to print customer information and lets you select different customer types. A name-search option is included.

With user manual and distribution disk, Oscims costs $59.95. Write to Orion Systems, 110 Riviera Dr., Concord, Ontario L4K 1A9, Canada.

Circle 611 on inquiry card.

## PUBLICATIONS

### Products for Disabled Outlined in Catalog

A catalog of technical aids and systems for disabled individuals is available from Tash Inc. This 37-page brochure outlines ability switches, computer aids, environmental controls, communications and educational aids, and mobility and living aids. A price list is provided. For a copy, contact Tash Inc., Unit 1, 70 Gibson Dr., Markham, Ontario L3R 2Z3, Canada, (416) 475-2212.

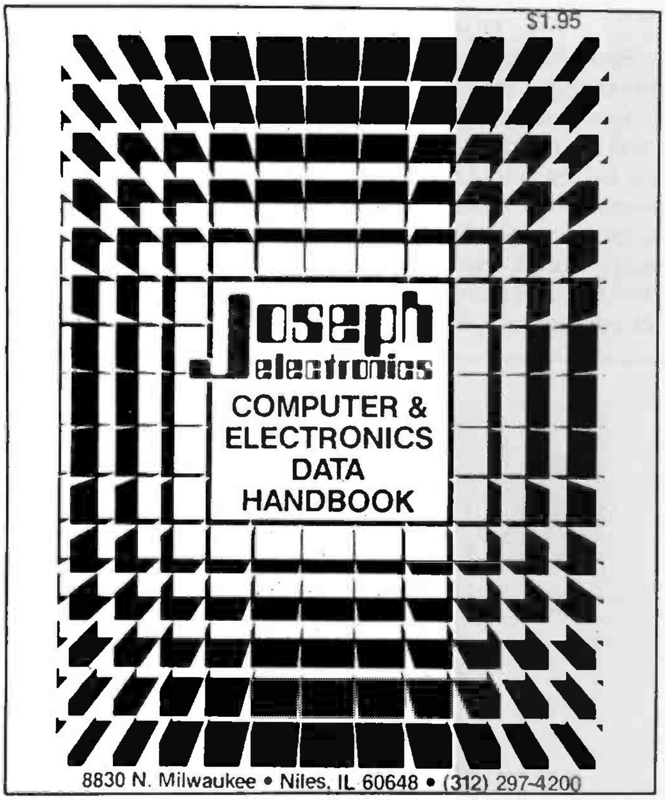
Circle 628 on inquiry card.

### Guide Probes Micropro Software

Jane Davis's Prostar Training Guide explains how to use a wide spectrum of Micropro office software. Programs covered are Wordstar, Spellstar, Datastar, Calcstar, Supersort, and Mailmerge. This 248-page book begins with an introduction to the computer, covering such topics as operating systems, floppy disks, and keyboards. Using step-by-step examples, Ms. Davis shows you how to type a letter in Wordstar, design a form and enter names and addresses in Datastar, alphabetically sort names and addresses with Supersort, and merge the letter and data file to produce form letters and envelopes using Mailmerge. Individual programs are then explored in greater detail, and advanced programming techniques are elucidated. Readers are also shown how to link the packages together.

The Prostar Training Guide is available for $45, postage paid, from Jane Davis Publications, POB 717, Richboro, PA 18954.

Circle 618 on inquiry card.




## Computer and Electronics Data Handbook

Joseph Electronics has released the second edition of its Computer and Electronics Data Handbook. This 32-page booklet contains glossaries of computer, electronic, fiber optic, and cable terminology. In addition, the most commonly referred to electronic tables, formulas, and symbols are provided. Individual copies are $1.95. Contact Joseph Electronics, 8830 North Milwaukee, Niles, IL 60648, (312) 297-4200.
Circle 623 on inquiry card.

## Guide to Micro Periodicals

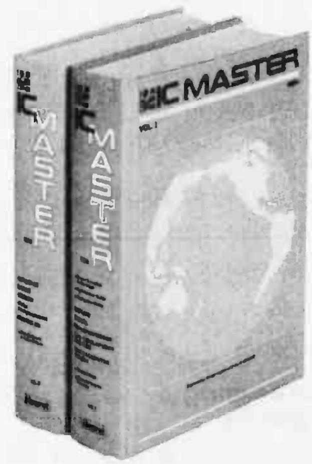
A 16-page guide with information on more than 100 microcomputer periodicals has been published. Fifty of the periodicals are profiled, while the remainder are organized according to the hardware, software, or topic they serve. Subscription prices and pertinent information are given for all the periodicals.

The guide is $2.50. Order it from Microguide, POB 4363, Chicago, IL 60680, (312) 986-1536.
Circle 624 on inquiry card.

## Catalog Outlines Mail-Order Software

A catalog outlining brand-name software available through mail order can be obtained from 800-Software. This company markets packages from nearly 30 major software houses, including Ashton-Tate, Continental Software, Digital Research, Fox & Geller, Micropro, Microstuf, Pickles & Trout, and Visicorp. Computers from such manufacturers as Apple, Cromemco, Dynabyte, Heath/Zenith, Intertec, Micropolis, North Star, Televideo, Xerox, and others are supported. Both 5¼- and 8-inch formats are offered, and most programs are sold at less than list price. The catalog also contains comparison charts of database, spreadsheet, and word-processing programs.

Customer backing includes a support department that answers technical questions and a customer service department to handle program updates, exchanges, and returns. Both telephone and mail orders are accepted. For your catalog, contact 800-Software Inc., Suite 14, 940 Dwight Way, Berkeley, CA 94710, (800) 227-4587; in California, (800) 622-0678 or (415) 644-3611.
Circle 617 on inquiry card.




## IC Master Lists 38,000 ICs

The 1984 edition of IC Master has been released by Hearst Business Communications. This two-volume, 3300-page reference book lists key specifications for more than 38,000 integrated circuits, microcomputer boards, microprocessor development systems, PROM programmers, and custom and semicustom integrated circuits from over 200 manufacturers. Only products currently offered are described in the data tables; however, an alternate-source directory covers both new and discontinued devices, provides information on replacement parts, and lists approximately 60,000 IC substitutes.

IC Master is divided into 20 sections, such as microprocessors, memories, and linear integrated circuits, and each product group is organized by key specifications. Eleven technical-data sections, including military, digital, and interface, are arranged by function and parameters. An advertisers' product index, part-number index, and a manufacturer and distributor directory are among this set's eight supporting sections.

IC Master costs $95. It can be ordered directly from IC Master, Hearst Business Communications Inc., 645 Stewart Ave., Garden City, NY 11530.
Circle 619 on inquiry card.

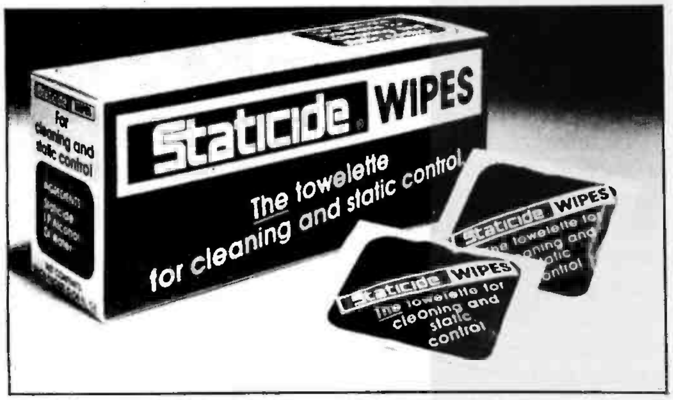
## Information Resource

The Whole Computer Catalog, an illustrated guide to professional consultants, manufacturers, and associations, assists people seeking information on computers. Among the topics covered in this book are hardware in an evolving marketplace, available software, on-line information sources, computer careers, computer stores, the sociological impact of computers, magazines and newsletters, government publications, books, schools that specialize in computer science, and user groups. Each section begins with a discussion clarifying the scope of the topic presented.

The Whole Computer Catalog, edited by Narda Lacey Schwartz, is more than 400 pages long. It's available in softcover for $35 from Designs III Publishers, 515 West Commonwealth Ave., Fullerton, CA 92632, (714) 871-9100.
Circle 620 on inquiry card.

# What's New?

## MISCELLANEOUS




### Antistatic Wipes

Staticide Wipes are individually wrapped towelettes saturated with an antistatic solution that can reduce static buildup on terminal screens, computer housings, and peripheral cabinets. These low-lint, disposable towelettes can be used on any surface not adversely affected by water or alcohol. Static protection is provided at humidities as low as 15 percent. The saturating fluid contains a topical antistat concentrate, deionized water, and isopropyl alcohol.

Each 5½- by 8-inch Staticide towelette is packed in a small foil package. The suggested price for a box of 24 is $4.98. For a sample and more information, contact ACL Inc., 1960 East Devon Ave., Elk Grove Village, IL 60007, (312) 981-9212.

Circle 632 on inquiry card.

### Solderless Prototyping Board for Micros

The EZ Board from Sabadia Export Corporation is a solderless breadboard system for building experimental add-ons for microcomputers. EZ Board's breadboarding area consists of 1460 tie points capable of holding sixteen 14-pin DIPs. Components with lead diameters of up to 0.032 inch can be plugged in and connected with ordinary hookup wire.

This glass/epoxy printed-circuit board has four distribution buses, each with 50 tie points. The distribution buses can be used for power, ground, clock lines, and reset commands. A four-position DIP switch is mounted onboard, and each DIP position corresponds to a set of tie-point-block sockets. For rapid identification, EZ Board has an easily accessible array of tie-point blocks from which each pin of the computer's I/O channels is labeled.

EZ Board is available for Apple, Commodore, and IBM PC systems, and their respective compatibles. Models for other computers are in the works. Including cable and connectors, EZ Board is $174.95. Add $5 shipping when ordering from Sabadia Export Corp., POB 1132, Yorba Linda, CA 92686, (714) 630-9335.

Circle 633 on inquiry card.

### Disks Meet ANSI Standards

Beck Manufacturing offers a line of single- and double-sided 5¼-inch floppy disks. Beck disks meet ANSI standards and are backed with a seven-year warranty. A 25-pack of single-sided disks costs $54.75 ($2.19 each); double-sided disks are $69.75 ($2.79 each). The Beck 25-packs come with hub-reinforcing rings, envelopes, color-coded labels, and nonmetallic protect tabs. To order, call (800) 232-5634 or write to Beck Manufacturing, Box 111, Main St., West Peterborough, NH 03468; in New Hampshire, call (603) 924-3821.

Circle 629 on inquiry card.

### Keyboard Replacement Has 90 Preset Functions

A detached extension 87-key keyboard, the Data Spec comes with 90 preprogrammed Apple II/II Plus functions and commands. By depressing the function key and a preprogrammed key, operating commands, programming key words, and operating-system commands are automatically entered into the Apple. Among the operating commands are BOOT, CATALOG, and INIT.; programming keywords include FOR, NEXT, PRINT. Some of the operating-system commands are DIR, PIP, TYPE, and STAT. Dat Spec has a 10-key numeric pad, and a full ASCII character set with uppercase and lowercase. Overall dimensions are 7½ by 17¾ by 1½ inches.

The Data Spec Keyboard is supplied with a 10-foot coiled cable and a three-position tilt. The suggested price is $299.95. It's available from Alliance Research Corp., 18215 Parthenia St., Northridge, CA 91325, (818) 701-5848.

Circle 634 on inquiry card.

### QX-10 Support Packages Unveiled

Micronova recently unveiled two software packages for the Epson QX-10 microcomputer: MicroRAM and QXKeys. MicroRAM gives CP/M users access to 167K bytes of unused QX-10 memory by providing RAM disk emulation. QXKeys lets you reconfigure the QX-10 keyboard to your liking. MicroRAM is $80. QXKeys is $25, including source code. Add $2 postage to each order. You can purchase both packages factory-direct from Micronova, RR 5, Canning, Nova Scotia B0P 1H0, Canada, (902) 582-7016.

Circle 614 on inquiry card.

# What's New?

## Financial Analysis for Professionals

CRT Associates' MIFPADS (Microcomputer Interactive Financial Planning and Development System) is a financial-analysis package for professional users of Radio Shack's TRS-80 Models II, 12, 16, and 16B. It's suitable for such functions as amortization, trade credit decisions, economic order quantity, capital budgeting, time value of money, current portion of long-term debt, and interest rate calculations. MIFPADS can perform the following analyses: risk, statistics, ratios, and bonds. Hard copy can be generated. Previous programming experience is not required.

MIFPADS is available in both single- and multiuser versions. Apple IIe and IBM PC configurations are in the works. The price is $595. Contact CRT Associates, POB 372, Dollar Bay, MI 49922, (906) 482-1339.

Circle 556 on inquiry card.

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## PCjr Word Processor Has Full-Screen Editing

Full-screen editing on the IBM PCjr is possible with CMA Micro Computer's Docuwriter jr word processor. Some of its editing commands are block move, deletion, insertion, copy, and search and replace. Docuwriter jr lets you create reports as large as 130 columns. Wordwrap and justification are also available.

Standard PC-DOS spelling checkers can work with Docuwriter jr files. In addition, Docuwriter jr disk-file outputs are compatible with such word processors as Wordstar. All the PCjr's keyboard editing-key operations, including cursor control, are retained. IBM graphics and thermal printers are also supported, although they are not mandatory.

Docuwriter jr requires 128K bytes of RAM and a single disk drive. The retail price is $79.95. More information can be obtained from CMA Micro Computer, 55722 Santa Fe Trail, Yucca Valley, CA 92284, (619) 365-9718.

Circle 551 on inquiry card.

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## Display and Print Scientific Graphs

GraphiC from Scientific Endeavors displays and prints scientific graphs calculated on the Corona or IBM PC. Written in C and assembly language, GraphiC provides 40 graphics routines that can be called upon to plot data or make text slides. Plots are created and stored in a 4096- by 3120-pixel Tektronix format. It has a zoom mode that can replay, shrink, enlarge, or shift a picture. Magnifications from 0.25 to 4.0 are available. Other features include five line types, eight curve markers, two fonts, and linear, logarithmic, and contour plots.

Tektronix-formatted plots from other computers can be replayed by GraphiC under certain conditions, and GraphiC files are compatible with mainframes that support Tektronix terminals. It operates with such dot-matrix printers as Epson FX/RX, C. Itoh Prowriter, and Okidata 91 and 93.

Presently, GraphiC works with the C-Ware DeSmet C compiler. It requires a minimum of 192K bytes of memory. Although it can function on a single disk drive system, two double-sided, double-density disk drives are preferred. GraphiC costs $150 and is available directly from Scientific Endeavors, Route 4, Box 79, Kingston, TN 37763.

Circle 571 on inquiry card.

## Apple ROMdisk Card

ROMdisk lets Apple II users store a full floppy disk of program files in EPROM. It can be used in on-line systems and permits Apple II computers to be used as workstations. ROMdisk comes with a menu-builder program that lets you select program files to be loaded and has the ability to automatically boot the menu or a desired program. Up to four ROMdisks can be used in a single Apple. Power is derived from the computer.

ROMdisk works with Apple-DOS 3.3 or the ProDOS operating system. It costs $499. Further details are available from Curtis Inc., 22 Red Fox Rd., St. Paul, MN 55110, (612) 484-9183.

Circle 604 on inquiry card.

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## Statistical Package for Mainframes Ported to PC

SPSS/PC is a menu-format IBM PC version of SPSS-X, a mainframe statistical-analysis and data-management package. SPSS/PC gives you univariate statistics, cross tabulations, correlations, multiple regressions, nonparametric tests, log linear, and contour and scatter plot procedures. You can analyze factors and variance and generate tables and graphs, which can then be reformatted for display or presentation-quality hard copy. SPSS/PC can handle missing values, sort cases, and compute new variables. Up to 150 variables can be drawn upon. Cases are limited only by disk space. Help commands, an integrated report-writing facility, and an on-line tutorial are supplied.

An IBM PC or PC XT with 320K bytes of RAM, a hard-disk drive, 8087 coprocessor, and PC-DOS are necessary. (Note that SPSS/PC will use approximately 1 megabyte of hard-disk storage.) With documentation and demonstration disk, SPSS/PC costs $795. A version for DEC Professional Series computers is available. For more information, contact SPSS Inc., Marketing Department, Suite 3000, 444 North Michigan Ave., Chicago, IL 60611, (312) 329-2400.

Circle 552 on inquiry card.

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## CP/M Computer Mounts on Floppy Drive

The Little Board, a single-board CP/M computer from Ampro, can be screwed directly onto the mounting holes of a 5¼-inch floppy-disk drive. Outfitted with a 4-MHz Z80A central processor, 64K bytes of RAM, a boot EPROM, floppy-disk controller, terminal and modem ports, and a Centronics-type parallel port, Little Board can support four single- or double-density, single- or double-sided, 48- or 96-tpi disk drives. Through software, one of its serial RS-232C ports can put forth data at 75 to 38,400 bps, while the other administers rates ranging from 75 to 9600 bps.

The Little Board runs under CP/M 2.2. A set of utility programs for formatting and copying data is furnished. A disk-translation utility lets Little Board read, write, and execute programs and data from Kaypro, Morrow Designs, IBM PC, and other computers.

Power requirements are +5 V DC at 750 mA and +12 V DC at 50 mA. Little Board lists for $349. CP/M BIOS source code is $49. Contact Ampro, 67 East Evelyn Ave., POB 390427, Mountain View, CA 94039, (415) 962-0230.

Circle 594 on inquiry card.

# What's New?

## 68000 Coprocessor Speeds Apple Programs

Saybrook II, a 16-/32-bit 68000 coprocessor board, is said to execute Apple Pascal, FORTRAN, and BASIC programs 10 to 30 times faster than normal. The base system comprises 128K bytes of RAM, UCSD p-System Run-time Unit version IV.13, Applesoft-compatible 68000 BASIC, turtle graphics, a 24-hour time-of-day clock, and five programmable timers. It's available in 8-, 12.5-, and 14-MHz versions for $895, $1195, and $1395, respectively.

An advanced model of Saybrook II is also available. This system has all the features of the base unit plus a screen editor, graphics package, cross-assembler, and either a FORTRAN-77, Pascal, or BASIC compiler. Depending on the clock rate, the Saybrook II advanced model costs $995, $1295, or $1495.

Options include compilers, CP/M-68K, Unix with C, and a 128K-byte RAM card that's expandable to 2 megabytes. The additional compilers cost $95 each. Inquire about RAM card pricing. Produced and manufactured by Analytical Engines Inc., Suite 305, 3415 Greystone, Austin, TX 78731, (512) 346-8430.

Circle 599 on inquiry card.

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## 68008 STD Board

Peopleware Systems has brought out a 68008-based STD bus microprocessor board. The 68008, a 16-/32-bit processor running at 8 MHz, has approximately 60 percent of the throughput of an equivalent 68000 microprocessor. This board has buffered data and control signals for expansion and three 28-pin JEDEC sockets for 32K bytes of memory; one of the sockets is configured for 2764- or 27128-type EPROMs. Off-board memory access is facilitated by a one-of-eight decoder/driver that selects memory cards via a front connector; up to 1 megabyte of memory can be addressed. Two RS-232C ports with RTS and CTS signals are supported; the transmit and receive data rates can be individually set. All address, data, and control signals are TTL-compatible.

Prices begin at $595. For a complete description, contact Peopleware Systems Inc., 5190 West 76th St., Minneapolis, MN 55435, (612) 831-0827.

Circle 590 on inquiry card.

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## Terminal Plug-Compatible with VT100

Tandberg Data's Series TDV 2200S editing/display terminal is plug-compatible with DEC VT100, Data General 6053, and other terminals. The basic TDV features an 8.75-MHz 8085/2 processor, a 70-Hz refresh rate, 8K bytes of dedicated RAM, 512 bytes of nonvolatile memory, 16 soft switches under user or software control, tilt-and-swivel pedestal, height adjustment, 121-key (maximum) detachable keyboard, and a 15-inch screen. Characters are green-on-green; black-on-white is optional. The set-up menu is written in plain English.

The TDV can be equipped with up to 56K bytes of memory; some versions can store up to eight pages of data. An add-on controller enables the TDV to communicate through packet-switched networks using X.25 protocols. The TDV can transmit by character, page, block, or line/field. An optional plug-in card produces bit-mapped raster-screen displays with a resolution of 684 by 384 pixels. In addition, this arrangement emulates Tektronix 4010/4014 vector drawing, point plotting, and graphics-input modes. The TDV character generator can handle 1024 characters. Latin, Cyrillic, and Greek alphabets are available, and mathematics and semigraphics symbols can be obtained. Characters can be double height and width.

Other options include a 2K-byte print buffer and communications protocols. The Series TDV 2200S begins at $1875. For full specifications, contact Tandberg Data Inc., POB 99, Labriola Court, Armonk, NY 10504, (914) 273-6400.

Circle 587 on inquiry card.

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## Development System for Adams

Frobco is marketing a software-development system for formatting 32K-byte Adam/Colecovision cartridges. This package contains a 32K-byte interface unit that plugs into the Coleco's expansion slot, an interface board for Apple slot number two, and a EPROM cartridge adapter board that connects with the Coleco's cartridge slot. Any program in the interface unit can be read, modified, and run through the Adam. Programs in the interface RAM can be stored on an Apple disk.

Frobco's system development software lets you transfer programs from the Apple disk or Coleco cartridge to the interface unit, access the Adam/Colecovision's memory space and I/O channels, set breakpoints in code for initiating or halting graphics motion in real time, and observe and modify a cartridge's contents. A built-in Z80 disassembler lets you review a cartridge's object code.

With the EPROM cartridge adapter, you can create and run a prototype program. It has four 8K-byte 2764-type EPROM sockets. Detailed information on the Adam's operating system, memory map, display processor, and sound generator are supplied.

Minimum hardware requirements consist of an Apple II Plus or IIe, a floppy-disk drive, Microsoft-compatible Z80 card, monitor, and an Adam/Colecovision console. The list price is $1995. For more information, contact Frobco, Tri-Comp Polytechnical Inc., 603 Mission St., Santa Cruz, CA 95060, (408) 429-1551.

Circle 600 on inquiry card.

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### Where Do New Products Items Come From?

The information printed in the new products pages of BYTE is obtained from "new product" or "press release" copy sent by the promoters of new products. If in our judgment the information might be of interest to the personal computing experimenters and homebrewers who read BYTE, we print it in some form. We openly solicit releases and photos from manufacturers and suppliers to this marketplace. The information is printed more or less as a first-in first-out queue, subject to occasional priority modifications. While we would not knowingly print untrue or inaccurate data, or data from unreliable companies, our capacity to evaluate the products and companies appearing in the "What's New?" feature is necessarily limited. We therefore cannot be responsible for product quality or company performance.

# "More Computer for Your Calculating Dollar"

## Try the New

# XPC-XT by XOR

## Introductory Offer

*(Offer expires May 31,1984)*

# $1995.00

SYS-8100-00

**"Need a 16-bit IBM-PC™ to process your data?"**

The first IBM™ compatible that **IS** compatible! A complete system including the PC-DOS™ operating system from IBM™. Two thinline double-sided 5¼" Disk Drives hold 360K of formatted storage each, the other drive opening is fitted with a close-out plate. Removal of the plate will allow room for a Winchester Hard Disk. The Power Supply is like that of an IBM-PC XT™..Hard Disk ready! How compatible is the **XPC-XT**? It will run 1-2-3™, Flight Simulator™, dBASE II™, WordStar™, SuperCalc™, VisiCalc® and hundreds of others, The system will also support MS-DOS™ 1.1 and 2.1, PC-DOS™ 2.2, CP/M-86™ and Unix Operating Systems. Add-on an additional 192K of RAM for a full 256K of on-board Memory for only **$195.00**. This computer comes standard with 2 Serial and 1 parallel ports (IBM™ COM1 and COM2). No need to purchase Add-On cards.

## Standard Features:

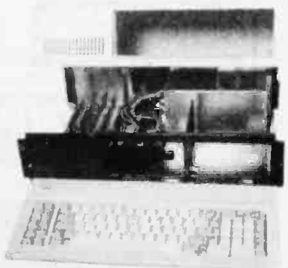
- PC-DOS™ Operating System Vers. 2.1
- 64K of parity checked RAM, expandable on-board to 256K
- 8088 16-bit CPU
- 5 IBM compatible expansion slots
- 4 DMA and 3 Timer channels
- Up to 32K of EPROM (supplied with full 8K)
- DOS BIOS on EPROM
- Full size capacitance touch keyboard with 10 function keys and calculator type numeric keypad
- 8087 Math Co-Processor ready
- 110-220 VAC, 50-60 Hz
- High resolution, 12" Monitor with Green Screen and 18MHz bandwidth.
- Two Slimline 5¼" DS/DD 48 TPI Floppys @ 360K storage each.
- Floppy Disk Controller expansion card, runs up to four SS or DD Floppys
- *ALSO* supports MS-DOS™ and CP/M-86® Operating Systems
- Power Supply is Hard Disk ready, no need to add-on additional power
- Full One Year Parts and Labor Warranty on all **XDS Manufacturing** products!

## BASIC XPC SYSTEM

If that incredibly *LOW* Total System price doesn't suit you, try this ***"Do It Yourself System"*** and take your pick of the wide range of options listed below.

**The Features:** •64K RAM •Expandable to 256K •4 DMA channels •5 Expansion Slots •Runs MS/DOS™ and CP/M-86™ (not included) •Multi-function Keyboard and Cable •Hard Disk Ready Power Supply •2 Serial and one Parallel Port •and MORE! •SYS-8000-00

**Only $895**



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### FLOPPY INTERFACE

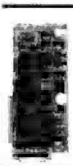
*This* is the standard Floppy Interface Card supplied in all systems not using Tape Back-up. It can access up to four drives in 48 or 96 TPI formats. The same high quality data separator as used in IBM™ counterparts, insures data integrity. BOA-6001-00 ................ $255.00

### EXPANSION MEMORY

This super reliable, four layer design Memory Card can be expanded from 64K to 576K in 64K increments (at $75.00 ea.). We've tested them all and can recommend this one with confidence. The price below is with 64K and includes Spooler and RAMDISK software. BOA-8650-00 ................ $255.00

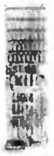
### CALENDAR CLOCK

This simple but effective Card should be ordered with every system. Battery Back-up (naturally) keeps your Disk Log right up to date. Saves typing in the date everytime you "boot up" the system. BOA-8700-00 .. $149.00



### 300/1200 BAUD MODEM

If this is your first computer, you will soon want it to Communicate. Compuserve and The Source are on your screen minutes after you plug-in this Custom Made Unit. Supplied with cable to plug into any wall outlet. Auto-Dial Software "remembers" phone numbers and log-in sequences to ease operation. Software included for each operating system. BOA-8725-00 ................ $295.00



### SUPER 12 PAK MULTI-FUNCTION

Now we need a full page to describe this fantastic Card! Since we only have a little room, here are the features: IBM™ compatible Joystick Port (2), Real-Time Chronograph (Battery Back-up), Parallel Port, Serial Port, 64K to 384K of Parity Memory, Print Spooler and RAM-DISK software, and supplied with 0K of Memory. BOA-8680-00 ................ $345.00

**XDS MANUFACTURING**

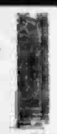
## HARD DISK ADD-ON

### *Complete Packages*

Includes BIOS Software, 5¼" Winchester Hard Disk, mounting hardware, Interface P.C.B. for expansion slot, and all the necessary power and data cables (the Power Supply in the **XPC-XT** is Hard Disk ready).

| | |
|---|---|
| **10 Megabyte $995** | **65 Megabyte $2495** |
| **20 Megabyte $1295** | **105 Megabyte $3295** |
| **40 Megabyte $1795** | **140 Megabyte $4195** |

**Archive Tape Back-up** unit shown above is of 20 and 40 megabyte capacity. **Memtek** unit will soon be available at 10 megabyte capacity at approximately **One-Half the cost!** Circle 410 on inquiry card.



### MONOCHROME ADAPTOR

If you are impressed with all the rave reviews that the Hercules Graphics Card gets, you will love ours! Made expressly for the **XPC-XT** by Hercules themselves, it runs everything the Hercules Card does (1-2-3™, dBase II, etc.). BOA-8500-00 .... $395.00

### COLOR ADAPTOR

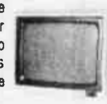
Color and monochrome combinations, can be run *simultaneously*. Flight Simulator™, 1-2-3™ all perform without modifications. *NO FLICKER!* Besides performing perfectly, included are: Light Pen Interface, Print Spooler, and RAM Disk options! BOA-8400-00 ...... $495.00

### COLOR

MON-1500-00 $345.00

### MONOCHROME

MON-1000-00 $125.00



Three models of Color to choose from, each with higher and higher resolution. Price from $345.00 to $750.00. Monochrome Unit is outstandingly clear and easy on the eyes. In Green or Amber screens.

### HARD DISK ONLY INTERFACE

A simple, quick solution to adding a Hard Disk to your **XPC**. All you need is this card, a Cable, and the Drive. Handles from 5 to 140 megabytes with minimum software configuration. Order with your System now or order later. Compatible with all the operating systems. BOA-8050-00 ........................ $375.00

### H.D./TAPE CONTROLLER

This package consists of a combination Interface Adaptor having SCSI H.D./TAPE Connector as well as the Floppy Controller. Two additional 5" form factor Boards are included and mount over the Tape Drive and Hard Disk. 10, 20, & 40 megabytes of Back-up is added to your Hard Disk. BOA-8675-00 ................ $750.00

**XDS Manufacturing ■ 5791 Machine Drive ■ Huntington Beach, CA 92649 ■ 714/898-0336**

Circle 365 on inquiry card.

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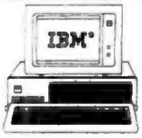
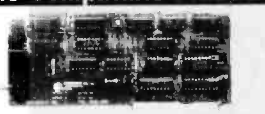
Calif. orders and all info Call 213-644-1149

## IBM Compatible Products




QUADRAM-2 (2) Ser. Ports w/64K..$355.00
QUADBOARD (1 ea)Par/Ser. w/64K..355.00
QUAD 512+ w/64K ................305.00
QUAD 512+ w/512K ...............665.00
CLOCK/CALENDAR BOARD ..........105.00
MODEM Signalman Mark 5..........215.00
ADD-ON Hard Disk Drive System
6Mb w/Power Supply & Cabinet .1799.00
Controller for above Hard Drive...279.00
PC 1600-1 .......................... Call
COLUMBIA VP (Portable)............. Call
EAGLE COMPUTER PC-2 .............. Call
AST SIXPACK CARD Six-function card with 64K-348K RAM Memory, Parallel Port, Serial Port, Clock Calendar, Super Drive and Super Spool ............ only 291.00
MSI DUAL I/O (2 ea) Ser/Par. & Clk . 175.00
MSI 256K RAM Board
256K RAM Board with 64K.........199.00
256K RAM Board with 256K......... Call
MSI 256K w/Parallel or Serial Port
256K w/Parallel Port and 64K .....259.00
256K w/Parallel Port and 256K ...... Call
256K w/Serial Port and 64K ........259.00
256K w/Serial Port and 256K......... Call
VISTA DISKMASTER DMA
Diskmaster interfaces Sub 4", 5¼", 8" & V1200 6Mb Hard Disk ............225.00
IBM TEAC Disk Drive DSDD, 40 Track Slimline.................215.00
APPRATE IBM PROM Blaster .......129.00
CABLE Parallel for IBM, Eagle & Columbia ...................29.95
IBM Prototype Board-SUN-208 double sided glass with gold plated terminals ... 29.50

## Apple Compatible Products



AFDC-1 Floppy Disk Drive Controller .................. $55.95
Runs DOS 3.3 with any standard Shugart compatible 5¼" disk drive. (2 drives each card). Does not read ½ track.

Apprate PROM Blaster ..............119.00
"ALS" 80 Column Card...............159.00
"ALS" Z-CARD (Z80 CPU) ............149.00
API Apple Parallel Printer Interface card. Centronics Compatible ............$39.00
Apple Compatible Drives (40 Track, 163K) .....................195.00
SUN-Z-80 CARD (Softcard Compatible) ........................55.00
SUN-80 COLUMN CARD...............97.00
POWER SUPPLY (5 amp)..............59.95
COOLING FAN .........................42.00

## Software

Formats for Following Software Include: IBM, MS DOS, Apple CPM, 8" CPM 2.2
WORD PROCESSOR (Benchmark)..$299.00
MAILING LIST (Benchmark) ........140.00
SPELLING CHECKER (Benchmark) ...105.00
TELECOM (Benchmark) ...............85.00
CDEX IBM Training ...................52.00
PEARL Data Manager. See reviews ... Easy-To-Use ... Powerful...........199.00

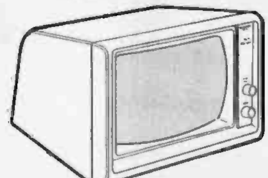
## General Products

| 5¼" Diskettes | 10 up | 100 up |
|---|---|---|
| SS/DD (100% certified) | 1.75 | 1.55 |
| DS/DD (100% certified) | 2.50 | 2.30 |

MODEM Novation 103 Smart-Cat ..$210.00
MODEM Signalman Mark 7 (RS232). 115.00

## General Products- cont.

NEW MODEL SAMWOO DISPLAY HI-RESOLUTION VIDEO MONITORS



Features: • Anti glare screen • Attractive case • Std composite video input, also output for second monitor • 22 MHz video bandwidth • High resolution; 1,000 lines or 132 characters across • Adjustable contrast, brightness, V/H-hold, V-size, H-center • Input impedance: high or 75 ohm • Passes FCC test for computer equipment • UL approved

Compatible With: IBM, IBM PCjr, Apple II, Apple IIe, Commodore, Columbia MPC, Eagle, Radio Shack, Sinclair/Timex, and more.

| | Each | 3-up |
|---|---|---|
| DM-216 12" Green........ | $135.00 | Call |
| DM-216 12" Orange........ | $139.00 | Call |

DEALER INQUIRY INVITED

MX COMPATIBLE BMC PRINTER
BX-80 dot matrix printer 259.00

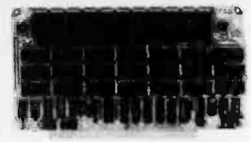
RAM & ROM IN STOCK .... Call

Mother Boards & Card Cages

| SLOTS | Bare Bd | KIT | A & T | w/CAGE |
|---|---|---|---|---|
| 6 | $19.00 | $44.00 | $59.00 | $84.00 |
| 8 | 24.00 | 56.00 | 81.00 | 116.00 |
| 12 | 29.00 | 75.00 | 110.00 | 150.00 |

10MHz. No termination. Includes power indicator and wiring for muffin fan. Uses OK connector for solderless installation and removal of power & reset lines.

## S-100 Products



64KSM A&T without RAM... $155.00
64KSM A&T w/64k RAM (32-6116's). 339.00
S-100 Board Uses 6MHz 6116's. ½ Amp max. power, Bank Select plus Extended Addressing allows for multi-memory board set-up. 4 independant 16K Blocks make easy use with multi-user systems. Any 2K RAM may be replaced by a 2716 EPROM.

SBC-880 Z80A CPU, A&T..........$149.00
SBC-880 Z80A CPU, Kit.............129.00
4MHz Z80A CPU boards with RAM, ROM & Serial/Parallel Ports.

UFDC-1 Floppy Controller, A&T.....245.00
UFDC-1 Floppy Controller, Kit ......225.00
The UFDC-1 Floppy Controller uses the WD1795 chip which runs either and/or 8"/5¼" Disk Drives.

CLOCK CALENDAR A&T.............115.00
CLOCK CALENDAR Kit ...............95.00
This S-100 Clock Calendar Board has 4 interrupts, Time, Day of Week and Battery Backup.
Call for S-100 Quantity Discounts

## Special Sale Items

SUN-721 S-100 Prototype Board.....9.95
SUN-722 Apple Prototype Board.....5.95
See our January 1984 BYTE Ad for above item descriptions. Quantities are limited.

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Mail Order—Min. Order $10. Visa or MasterCard (please include expiration date). Add $2.00 (shipping and handling) for first 3 pounds plus .50 for each additional pound to your order. CA residents add Calif. sales tax.

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Ace 1200 w/drive ............... 1399
1200 OMS straight from the factory .. 1689
Ace 1000 Pro Pak, drive, 80 col., sftwr. 1169

**KAYPRO**
Kaypro II w/software ........... $1445

**APPLE**
Apple IIE Starter System ......... $1395

**IBM**
IBMPC 64K, 1 Drive ............. $1995
IBMPC 64K, 2 Drives ............. 2245

**SANYO**
MBC 550 ........................ $ 795
MBC 555 ........................ 1179

## DISK DRIVES

**SIEMENS**
FD 100-8 ....................... $ 154

**TANDON**
TM100-2 for IBMPC .............. $ 219

**TEAC**
Double Sided 320K for Sanyo ...... $ 189

**Drives For Apple & Franklin**

**MICRO-SCI**
A2 ............................. $ 209

**QUENTIN RESEARCH**
Apple Mate ...................... $ 199

**RANA SYSTEMS**
Elite I .......................... $ 229
Elite II ......................... 349
Elite III ........................ 429

## PRINTERS

**C. ITOH**
Prowriter 8510 AP, 120 cps ....... $ 339
Prowriter II 1550 AP, 15" 120 cps ... 545
Starwriter F10-40PU, 40 cps ....... 989
Printmaster F10-55PU, 55 cps ..... 1345

**EPSON**
RX80FT, 120 cps ................ $ 409
FX80, 10" 160 cps ............... 520
FX100, 15" 160 cps .............. 729

**OKIDATA**
ML82A, 10" carriage ............. $ 299
ML83A, 15" carriage ............. 559
ML92P, 160 cps .................. 429
ML93P, 160 cps .................. 709

**STAR MICRONICS**
Gemini 10X, 10", 120 cps ........ $ 278
Gemini 15X, 15", 120 cps ......... 409
Delta 10, 10", 160 cps ........... 469

**JUKI**
6100 LQ 15", 18 cps w/propor. spac.. $ 469

**TOSHIBA**
P1350 (1) Dot Matrix, L.Q., graphics . $1695

## DISPLAY MONITORS

**USI**
PI 2 (12" Green) ................ $ 129
PI 3 (12" Amber) ................ 135

**GORILLA**
Hi-Res. 12" Green .............. $ 85
Hi-Res. 12" Amber ............... 95

**AMDEK**
V300G .......................... $ 135
V300A ........................... 145
V310A for IBMPC .................. 165
Color I, 13" Color Composite ....... 289
Color II, RGB ..................... 409

**BMC**
12 UW (12" Green) ............... $ 89
9191 Color Composite .............. 229
12 EUN 20MHz (Hi-Res) ............. 125

**NEC**
JB 1260, 12" Green .............. $ 109
JB 1201M, 80 col. ................. 155
JB 1205M(A) w/audio ............... 165
JC 1203 Hi-Res Color IBM comp. ..... 465

**TAXAN**
12N (12" Green) ................. $ 129
12NUY (12" Amber) ................ 139

## IBM/APPLE ACCESS.

**AST RESEARCH**
Six Pak Plus .................... $ 279
Mega Plus II ..................... 279
Combo Plus ....................... 269
Io Plus II ....................... 129

**64K MEMORY UPGRADE**
64K, 9 chips .................... $ 55

**MICROMAX**
Viewmax 80E, 128K 80 col. card for Apple IIE .......... $ 129
for Apple II & II+ ................ 139

## MODEMS

**HAYES MICRO**
300 Baud Smart Modem ............ $ 205
1200 Baud Smart Modem ............ 499
1200 B for IBMPC .................. 409
Micro Modem IIE w/Term. pkg. ....... 259

**NOVATION**
J Cat 300 Baud .................. $ 119
Apple Cat II ...................... 269

## PRINTER ACCESSORIES

**ORANGE MICRO**
Grappler + ...................... $ 119
Buffered Grappler +, 16K exp. 64K . 179

**WESPER**
Wizard Personal Card & Cable ..... $ 89

**FOURTH DIMENSION**
Par. Card & Cable for Apple ....... $ 49

**TRACTORS**
Okidata for 82A & 92 ............ $ 49
Juki Bi-Directional ............... 129
Toshiba Bi-Directional ............ 199

**MICROTEK**
Dumpling GX Graphic Interface ... $ 99
Dumpling GX w/16K ................ 149
Dumpling GX w/32K ................ 165
Additional Buffering, 16K .......... 16

**CABLES**
Any Computer to Parallel Printer ... $ 29

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Circle 96 on inquiry card.

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## IBM ADD-ONS

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| **AST Research** | |
| *All AST Boards come with SuperDrive, SuperSpool, and one year warranty* | |
| SixPakPlus 64K upgradable to 384K, with clock calendar, serial and parallel ports *(game port optional)* | 265 |
| MegaPlus II 64K upgradable to 256K *(or more with MegaPak)* with clock calendar and serial port *(parallel, game, or second serial port optional)* | 265 |
| MegaPak 128K *(not upgradable)* | 225 |
| MegaPak 256K | 275 |
| I/O Plus II with clock calendar and serial port *(parallel, game, or second serial port optional)* | 115 |
| Parallel, Game, or second Serial Port for any AST board *(specify board)* | 40ea |
| 64K Memory upgrade increments for any AST board *(that is upgradable)* | 60ea |
| Connectall connector bracket | 15 |
| **Amdek** | |
| MAI Board | 459 |
| **Hercules Computer** | |
| Hercules Graphics Card *(with parallel port)* | 339 |
| Graph-X Software | 45 |
| **Keytronics** | |
| Typewriter style keyboard (KB5150) | call |
| Deluxe keyboard | call |
| **Koala Touch Tablet w/software** *(Connects to game port)* | 95 |
| **Maynard Electronics** | |
| Floppy Disk Controller | 175 |
| Floppy Disk Controller *(with parallel port)* | 229 |
| **Paradise Systems** | |
| MultiDisplay Card *(color & mono)* | 389 |
| **Persyst** | |
| Color Graphics Board | 229 |
| SB64 64K Multifunction Card | 339 |
| **Plantronics/Frederick** | |
| COLORPLUS *(with Color Magic)* | 389 |
| **Quadram** | |
| *We are a full line Quadram Dealer* | |
| New Expanded Quadboard 64K expandable to 384K, with clock calendar, parallel, serial & game port, I/O bracket, and Quadmaster software | 259 |
| 64K Memory upgrade increments for Quadram boards and buffers | 60ea |
| Microfazer Printer Buffer (par.) w/copy MP 64 (64K) upgradable to 512K | 229 |
| Quadcolor I color graphics card | 210 |
| Quadcolor II (add-on to Quadcolor 1) | 205 |
| Quadlink—Newest Version *(allows your IBM-PC to run most Apple II programs)* | 489 |
| Quadisk *(various size to 72 meg)* | call |
| **STB** | |
| RIOPlus 64K *(upgradable to 384K)* with PC accelerator, clock calendar, serial and parallel port, and "Connectall" type bracket *(game cable optional)* | 259 |
| Graphix Plus *(color & monochrome)* | 349 |
| *Call for prices on other STB products* | |
| **Tecmar** | |
| Graphics Master | 539 |

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## SURGE PROTECTORS

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|---|---|
| **Lemon** wall unit with 6 receptacles | 45 |
| **Lime** power cord with 6 receptacles | 59 |
| **Peach** wall unit, line filter & 6 receptacles | 69 |
| **Orange** power cord, line filter & 6 receptacles | 99 |

## PRINTERS

Unless otherwise noted, all of the printers listed have parallel interfaces.

### Dot Matrix

| | |
|---|---|
| **C. Itoh** | |
| 8510P 120 cps 10" crg | 369 |
| 1550P 120 cps 15" crg | 639 |
| **Epson** | |
| All Epson printers include GRAFTRAX-PLUS | |
| RX-80 100 cps 10" crg | call |
| RX-80 F/T 100 cps 10" crg | call |
| FX-80 160 cps 10" crg | call |
| FX-100 160 cps 15" crg | call |
| Tractor for FX-80 | 30 |
| Epson to IBM Parallel Cable | 30 |
| **Okidata** | |
| Microline 82A 120 cps 10" crg | call |
| Microline 92 160 cps 10" crg | call |
| Microline 83A 120 cps 15" crg | call |
| Microline 93 160 cps 15" crg | call |
| Microline 84AP 200 cps 15" crg | call |
| **Quadram** | |
| Quadjet 40 cps 8.5" crg color | 699 |
| **Star Micronics** | |
| Gemini 10X 120 cps 10" crg | 299 |
| Gemini 15X 120 cps 15" crg | 399 |
| Delta 10 160 cps 10" crg | 449 |
| Delta 15 160 cps 15" crg | 629 |
| **Toshiba** | |
| 1340P 160 cps 10" crg | 769 |
| 1350P 160 cps 15" crg | 1529 |
| **Transtar** | |
| 315 50 cps 10" crg color SPECIAL | 429 |
| *We also carry Mannesman Tally and NEC.* | |

### Letter Quality

| | |
|---|---|
| **C. Itoh** | |
| Starwriter 40 cps 15" crg | 999 |
| Printmaster 55 cps 15" crg | 1245 |
| Daisywriter 2000 40 cps 16" crg | 995 |
| **Dynax** | |
| HR-15 13 cps 13" crg | 459 |
| HR-25 23 cps 16" crg | 725 |
| Juki 6100 18 cps 13" crg | 455 |
| **Silver Reed** | |
| EXP 500 16 cps 10" crg | 439 |
| EXP 550 20 cps 17" crg | 569 |
| **Transtar** | |
| 120P 14 cps 12" crg | call |
| 130P 18 cps 17" crg | call |
| *We also carry NEC & Diablo.* | |

## MONITORS

Notations suggesting monitors for IBM are compatible with IBM PC compatible systems

| | |
|---|---|
| **Amdek** | |
| 300G 12" Green monochrome | 149 |
| 300A 12" Amber monochrome | 159 |
| 310A 12" Amber or green mono. (IBM) | 169 |
| Color I Plus 12" composite color | 299 |
| Color II Plus 12" RGB | 419 |
| **Comrex** | |
| 5600 12" Amber or green mono. (IBM) | 149 |
| **Princeton Graphics** | |
| HX-12 12" RGB *(690 x 240)* | 469 |
| SR-12 12" RGB *(690 x 480)* | call |
| MAX-12 12" Amber monochrome *(for IBM)* | 189 |
| **Quadram** Quadchrome RGB *(690 x 240)* | call |
| **USI** | |
| PI-3 12" Amber or green mono. (IBM) | 155 |
| **Taxan** | |
| 12" Amber or green monochrome | 145 |
| Vision III 12" hi-res RGB | 449 |
| RGB 420 Super hi-resolution RGB | 479 |
| We also carry NEC, BMC, and ZENITH. | |

## COMPUTERS

| | |
|---|---|
| **IBM** | |
| PC with 256K or XT | call |
| **Columbia** | |
| 1600-1 or 1600-4 10mb *w/software* | call |
| Columbia VP *complete portable* | call |
| **Compaq** or Compaq plus portable | call |
| **Eagle** | |
| PC-2, PC+, & PC+ w/10mb | call |
| **Franklin** Apple compatible systems | call |
| **NEC** | |
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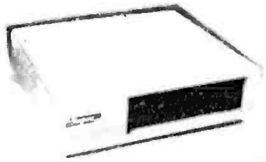

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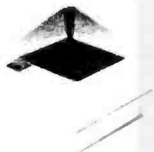

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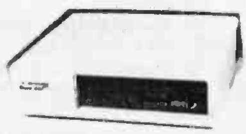

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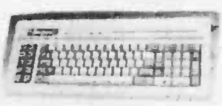

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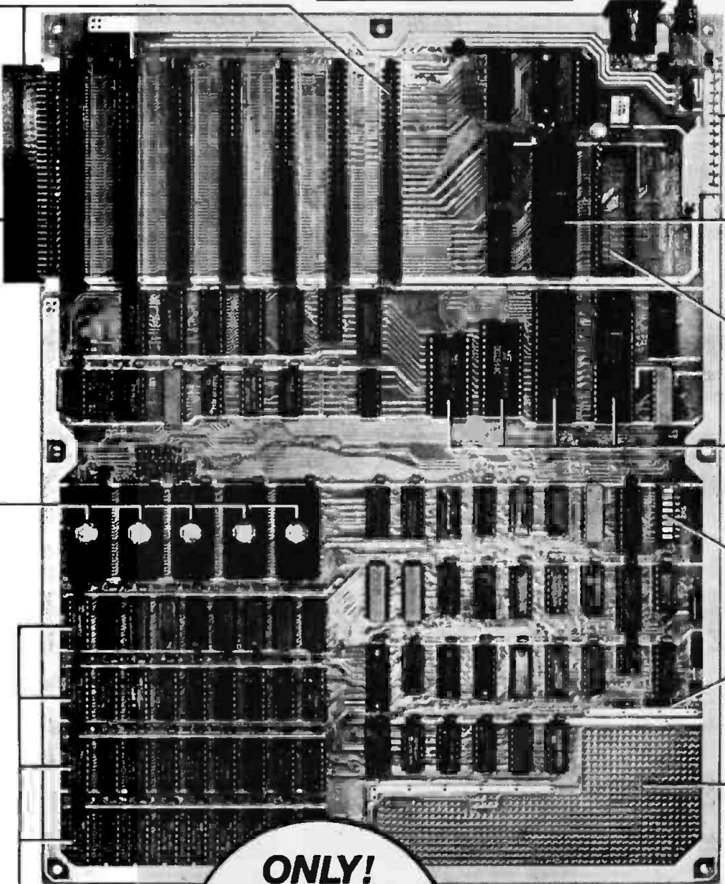

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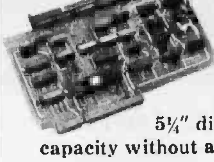

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| 74LS114 | .95 | 74LS347 | 2.55 |
| 74LS122 | 1.05 | 74LS348 | 2.55 |
| 74LS123 | 1.35 | 74LS352 | 1.65 |
| 74LS124 | 1.35 | 74LS353 | 1.95 |
| 74LS125 | .95 | 74LS363 | 1.95 |
| 74LS126 | .95 | 74LS365 | 1.25 |
| 74LS132 | 1.35 | 74LS366 | 1.25 |
| 74LS133 | .95 | 74LS367 | .95 |
| 74LS136 | .95 | 74LS368 | .95 |
| 74LS138 | 1.10 | 74LS373 | 2.50 |
| 74LS139 | 1.10 | 74LS374 | 4.95 |
| 74LS145 | 1.75 | 74LS375 | 1.25 |
| 74LS148 | 1.75 | 74LS377 | 1.95 |
| 74LS151 | 1.25 | 74LS378 | 2.55 |
| 74LS153 | 1.25 | 74LS385 | 1.95 |
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| 74LS156 | 1.35 | 74LS381 | 3.95 |
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| 74LS158 | 1.25 | 74LS393 | 2.55 |
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| 74LS161 | 1.25 | 74LS424 | 3.95 |
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|---|---|
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| 74S02 | .75 |
| 74S03 | .75 |
| 74S04 | .75 |
| 74S05 | .75 |
| 74S08 | .95 |
| 74S09 | .95 |
| 74S10 | .95 |
| 74S11 | .95 |
| 74S15 | .95 |
| 74S20 | .95 |
| 74S22 | .95 |
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| 74S32 | .95 |
| 74S38 | 1.95 |
| 74S40 | .95 |
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| 74S64 | .95 |
| 74S65 | .95 |
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| 74S113 | 1.25 |
| 74S114 | 1.25 |
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| 74S134 | 1.25 |
| 74S135 | 1.65 |
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| 74S174 | 2.25 |
| 74S175 | 2.25 |
| 74S188 | 3.55 |
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| 2114-200 | 2.15 |
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| 4.0 | 2.95 |
| 5.0 | 2.95 |
| 5.0688 | 2.95 |
| 5.185 | 2.95 |
| 5.7143 | 2.95 |
| 6.0 | 2.95 |
| 6.144 | 2.95 |
| 6.5536 | 2.95 |
| 8.0 | 2.95 |
| 10.0 | 2.95 |
| 10.738635 | 2.95 |
| 12.00 | 2.95 |
| 14.31818 | 2.95 |
| 15.0 | 2.95 |
| 16.0 | 2.95 |
| 17.430 | 2.95 |
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| 18.432 | 2.95 |
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| 22.1184 | 2.95 |
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|---|---|---|---|---|---|---|
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| 14 PIN WW | .65 | .55 |
| 16 PIN WW | .65 | .55 |
| 18 PIN WW | .89 | .79 |
| 20 PIN WW | 1.00 | .90 |
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| 28 PIN WW | 1.45 | 1.35 |
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| 16 PIN LP | .16 | .14 |
| 18 PIN LP | .18 | .16 |
| 20 PIN LP | .28 | .26 |
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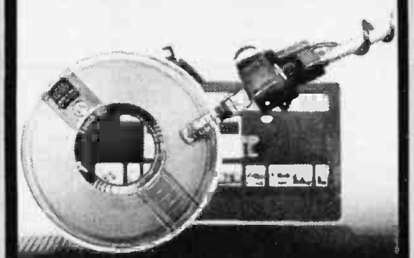

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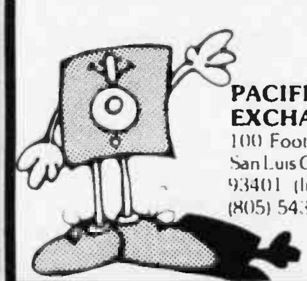

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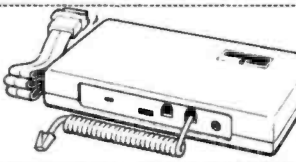

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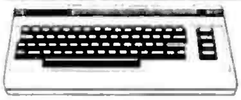

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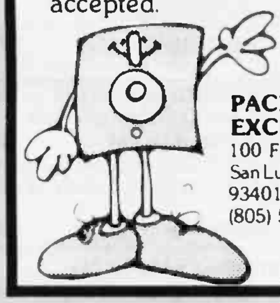

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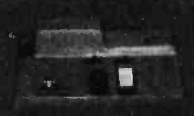

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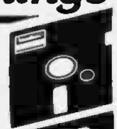

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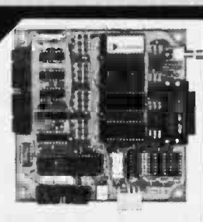

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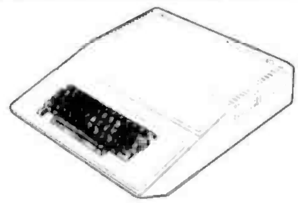

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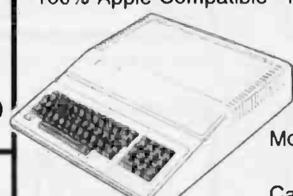

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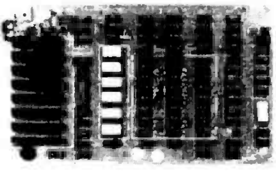

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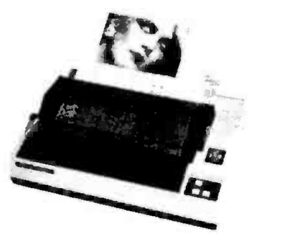

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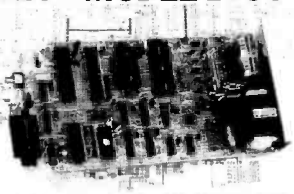

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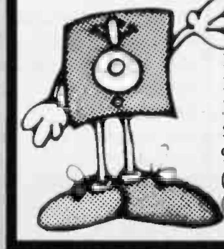

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LIBERAL DEALER PRICING ON ALL CCT PRODUCTS.

CCT®

CompuPro

### THE CCT EXCLUSIVE WARRANTY

With any system we build, we provide, in writing, an unconditional 12 month **direct** warranty on the entire system, including mainframe, boards, drives, power supplies, cabling and peripherals! We offer guaranteed 24-hour in-house repair and/or replacement with just a tech-line phone call. We can offer this, since we are so sure of our level of quality and reliability. It's great to know that in the event of a problem, you're not out of business waiting on service turnaround. We deliver!

Our various OEM contracts with all the manufacturers of the components we integrate, allow us this unprecedented flexibility. No factory O.K.'s necessary — just get it running - **NOW!**

### • 8" CP/M SOFTWARE SPECIALS •

| | |
|---|---|
| dBASE II - Latest Version 2.4 | $349 |
| Supercalc 86 - for CP/M 86 & MP/M | $ 99 |
| Wordstar $299 Pro-Pak | $429 |
| Microsoft BASIC $299 Compiler | $339 |
| Supersoft FORTRAN IV $339 C Comp | $399 |
| Peachtree Series 8 Modules | each $599 |

### • TOP SELLING PERIPHERALS •

| | |
|---|---|
| CCT-90K Parallel S-100 Amber Screen - 90K Baud | $749 |
| Wyse 100-14" Green | $699 |
| Wordstar Prom Option | $ 75 |
| Wyse 50 $529 75 | $609 |
| 200/300 | $1069 |
| Visual 50 ... $599 Televideo 925 | $749 |
| 950 ...... $950 970 | $1099 |
| Liberty Freedom 100 — $479 200 | $679 |
| Okidata 82 — $349 83 — $619 84 | $1029 |
| 92 ........ $459 93 | $779 |
| NEC 7710 ..... $2150 7730 | $2150 |
| Diablo 620 ..... $969 630 | $1899 |

INDUSTRIAL GRADE SUPERIOR QUALITY

## CCT DISK DRIVE SYSTEMS

ROLLS ROYCES OF THE INDUSTRY

### S-100 HARD DISK SUBSYSTEMS

Professionally engineered ST-506 type systems for the business market S-100 Computer user. Includes industry top quality drives, CompuPro Disk 3 DMA controller, all cabling, A&T, formatted, burned-in. Provisions for up to two hard disks in each system. We include operating system update. CP/M 80, CP/M 86, CP/M 8-16, MP/M 8-16, CP/M 68K. Soon to be supported - MS-DOS. (/1 Systems are CCT innovated hard/floppy combinations, with Mitsubishi DSDD 8" drive.)

| | | | |
|---|---|---|---|
| CCT-10 (11 + MEG) | $2349 | CCT-10/1 | $2849 |
| CCT-20 (22 + MEG) | $2749 | CCT-20/1 | $3249 |
| CCT-40 (36 + MEG) | $3349 | CCT-40/1 | $3849 |

Drive capacities shown are **after** formatting! We are working on tape cartridge back-up units.

### FLOPPY SYSTEMS

**CCT-2.4 • Dual 8" DSDD**

Mitusbishi 2.4 Megabyte in Extra Heavy horizontal enclosure, removeable filter air system, all cabling, A&T, Burned in. The fastest system available: $1199
with (2) half-height - CCT-2.4S $1229
Special configurations available — Call!

**CCT-5 • 5¼" DSDD**

IBM Compatible Tandon 320K. Extra Heavy Cabinet accommodates two drives, hard or floppy. All cabling, A&T, Burned-in. Perfect for our MS-DOS Package .... $369
with Hard Disk Power Supply $389
Two Drive Unit (720K) CCT-5/2 $649

## ★ SUPER PRICES ★ COMPUPRO COMPONENTS ★ IN STOCK ★

**SYSTEM SPECIAL—ALL CCT A&T, BURNED IN: 816A - $4299 816B - $4999 816C - $6499**

CCT-2 - **$6799** • CCT-3 - **$6699** • Disk 1 w/CP/M - **$469** • CPU 8086/87 - **$819** • M-Drive/H - **$1099**
CPU 8085/88 - **$329** • CPU 8086 - **$559**/10Mhz - **$599** • **CPU 68K - $519**/10Mhz - **$639**
CPU-Z - **$249** • Disk 1 - **$369** • Disk 2 - **$579** • Disk 3 - **$539** • RAM 16 (12Mhz) - **$369** • RAM 21 (128K) - **$779**
RAM 22 (256K) - **$1359** • Interfacer 3 - **$459** • Interfacer 4 - **$349** • System Support 1 - **$329**
Enclosure 2 Desk - **$599**/Rack - **$649** • CP/M 80 (CCTHMX) - **$125** • CP/M 86 (CCTTMX) - **$175**
CP/M 8-16 (CCTTMX) - **$199** • MP/M 8-16 (CCTSX) - **$499** • CP/M 68K (CCTCX) - **$279**
CP/M 86 Upgrade Kit: CP/M 86, RAM 16, Sys. Supt. 1, Cable - **$829**
**Call for CSC Boards — New Releases — CCT Mods Updates - $30/O.S.**

### CCT-1 — ENTRY LEVEL S-100 BUSINESS SYSTEM

- Enclosure 2-Desk-20 Slot Mainframe •
- CPU 8085/88 - 6Mhz 8085/8Mhz 8088 •
- Disk 1 - DMA Floppy Disk Controller •
- RAM 16 - 64K Static RAM - 12Mhz •
- Interfacer 4 - 3 Serial/2 Parallel I/O •
- CCT-2.4-Dual 8" Mitsubishi DSDD Drive System - 2.4 Megabytes •
- CP/M 80 - 2.2 HMX - CCT Modified •
- All Cabling, Complete CCT Assembly, Testing, and Minimum 20 Hour Burn-in •

**SPECIAL PRICE $3,449**

**RUNS ALL STANDARD 8" CP/M SOFTWARE - INCLUDES OUR EXCLUSIVE 12 MONTH DIRECT WARRANTY**

**OPERATING SYSTEM NOTE:** Latest CP/M, CP/M 86, MP/M 8-16, CP/M 68K, have each been restructured and optimized by CCT, for utmost flexibility, power and speed.

### MS-DOS FOR COMPUPRO - IBM COMPATIBLE CCT MODIFIED SYSTEM

For any CP/M 86 CompuPro System — Includes MS-DOS Version 2.0 and 5¼" DMA Disk Controller, All Manuals - **$699**

Prices & availability subject to change. All products new, and carry full manufacturer's warranties. Call for catalog. Free technical help to anyone. All products we well are CCT individually tested and set up for your system - Plug-In & Go! Arizona residents add sales tax **CCT**© Trademark — Custom Computer Technology; **MS-DOS**© Trademark — Microsoft; **IBM**© Trademark — International Business Machines; CompuPro© Trademark — W.J. Godbout; **CP/M**© **MP/M**© Trademarks — Digital Research

Circle 119 on inquiry card.

*U.S. MANUFACTURER*
*ONE YEAR WARRANTY!*

# 10 MEGABYTE HARD DISK FOR IBM PC! $995.00

**JADE Computer Products**

## 10 MEGABYTE HARD DISK FOR IBM PC

Plug-n-Run, ready to go • complete with controller card, data cable, and mounting hardware • totally PC/XT compatible • 3 times faster than XT • handles 4 different operating systems • streamer tape back-up available

| | | YOUR PRICE |
|---|---|---|
| 10 mbyte internal | *$1795* | $995.00 |
| 10 mbyte external | *$2095* | $1195.00 |
| 15 mbyte internal | *$1995* | $1395.00 |
| 15 mbyte external | *$2295* | $1595.00 |
| 26 mbyte internal | *$2495* | $1995.00 |
| 26 mbyte external | *$2795* | $2249.00 |
| Tape Back-up option | *$995* | $795.00 |

## HI-RES MONITORS

| | | YOUR PRICE |
|---|---|---|
| AMDEK 310A | *$230* | $169.95 |
| AMDEK 300G | *$179* | $129.95 |
| AMDEK 300A | *$199* | $149.95 |
| AMDEK COLOR I | *$379* | $259.95 |
| AMDEK COLOR II | *$559* | $419.95 |
| AMDEK COLOR IV | *$995* | $774.95 |
| PGS • MAX-12 | *$269* | $199.95 |
| PGS • HX-12 | *$699* | $469.95 |
| PGS SR-12 | *$799* | $649.95 |
| QUADCHROME | *$795* | $499.95 |
| COMREX CR6800 | *$649* | $499.95 |

## KEYTRONICS KEYBOARDS

| | | YOUR PRICE |
|---|---|---|
| 5150 | *$269* | $189.95 |
| 5151 | *$299* | $239.95 |

## STB BOARDS FOR IBM PC

| | | YOUR PRICE |
|---|---|---|
| GRAPHICS PLUS | *$495* | $379.95 |
| RIO PLUS 128K | *$495* | $349.95 |
| RIO PLUS 256K | *$595* | $449.95 |
| RIO PLUS 384K | *$795* | $549.95 |
| SUPER RIO 64K | *$419* | $329.95 |
| SUPER RIO 128K | *$519* | $379.95 |
| SUPER RIO 256K | *$619* | $479.95 |
| SUPER 10 | *$229* | $179.95 |

## SOFTWARE FOR IBM PC

| | | YOUR PRICE |
|---|---|---|
| LOTUS 1 2 3 | *$495* | $329.95 |
| SYMPHONY | *$695* | $549.95 |
| dBASE II | *$700* | $429.95 |
| R:BASE 4000 | *$495* | $319.95 |
| SMART KEY | *$89* | $69.95 |
| MOVE-IT | *$125* | $89.95 |
| MULTIPLAN | *$250* | $169.95 |
| ACCOUNTING PARTNER | *$395* | $249.95 |
| CROSSTALK | *$195* | $129.95 |
| PROKEY | *$75* | $54.95 |
| MULTIMATE | *$495* | $299.95 |
| SUPERCALC III | *$395* | $249.95 |
| TRANSEND PC | *$189* | $139.95 |

## MICROSOFT FOR IBM PC

| | | YOUR PRICE |
|---|---|---|
| MOUSE | *$199* | $129.95 |
| SYSTEM CARD 64K | *$395* | $279.95 |
| SYSTEM CARD 256K | *$625* | $429.95 |

## 320K DISK DRIVES

DOUBLE-SIDED, DOUBLE-DENSITY FOR IBM PC

**$199.95**

**CHOICE OF**

**Tandon** **Tec**
**Teac** **Epson**
**Panasonic** **Shugart**

## DISKETTES For IBM PC

High quality double-sided, double-density diskettes, certified to be absolutely error free. Box of ten, warranteed for one year

Box of 10 w/FREE plastic case _ *$39* $19.95

## HIGH SPEED 8087 APU

Math co-processor chip

*List Price $295* ________ SALE PRICE $99.95

## QUADRAM FOR IBM PC

| | | YOUR PRICE |
|---|---|---|
| QUADBOARD *No RAM* | *$295* | $214.95 |
| QUADBOARD 64K | *$395* | $275.95 |
| QUADBOARD 128K | *$495* | $339.95 |
| QUADBOARD 256K | *$595* | $399.95 |
| QUADBOARD 384K | *$795* | $595.95 |
| QUADLINK | *$680* | $449.95 |
| QUAD 512 PLUS 64K | *$325* | $219.95 |
| QUAD 512 PLUS 256K | *$550* | $389.95 |
| QUAD 512 PLUS 512K | *$895* | $549.95 |
| QUAD COLOR I | *$295* | $209.95 |
| QUAD COLOR II | *$275* | $199.95 |

## IBM VIDEO BOARDS

| | | YOUR PRICE |
|---|---|---|
| HERCULES GRAPHIC | *$499* | $339.95 |
| PLANTRONICS COLOR+ | *$549* | $379.95 |
| STB GRAPHICS+ | *$495* | $379.95 |
| QUADCOLOR I | *$295* | $209.95 |
| AMDEK MAI | *$649* | $495.95 |

## 64K RAM UPGRADE FOR IBM PC

High speed RAM upgrade kit with FREE! parity (error detection) and one year warranty

| | | YOUR PRICE |
|---|---|---|
| 64K KIT For IBM PC | *$90* | $49.95 |
| 128K KIT For IBM PC | *$180* | $95.95 |
| 192K KIT For IBM PC | *$270* | $143.95 |
| 256K KIT For IBM PC | *$360* | $199.95 |
| 384K KIT For IBM PC | *$540* | $289.95 |

## AST FOR IBM PC

| | | YOUR PRICE |
|---|---|---|
| SIX PAK PLUS 64K | *$395* | $269.95 |
| SIX PAK PLUS 256K | *$695* | $489.95 |
| SIX PAK PLUS 384K | *$945* | $569.95 |
| MEGA PLUS 64K | *$395* | $269.95 |
| MEGA PLUS 256K | *$665* | $429.95 |
| MEGA PLUS 512K | *$1095* | $799.95 |
| I/O PLUS | *$165* | $119.95 |
| MP 64K | *$295* | $199.95 |
| MP 128K | *$395* | $249.95 |
| MP 192K | *$495* | $299.95 |
| MP 256K | *$595* | $349.95 |

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**JADE**
*Computer Products*

# APPLE ACCESSORIES ON SALE!

## SMARTMODEM Hayes

Sophisticated direct-connect auto-answer/auto dial modem, touch tone or pulse dialing, RS232C interface programmable

| | | YOUR PRICE |
|---|---|---|
| Smartmodem 1200 | $699 | $475.00 |
| 1200B for IBM PC | $599 | $399.95 |
| Smartmodem 300 | $289 | $199.00 |
| Hayes Cronograph | $249 | $199.95 |
| Micromodem 100 | $399 | $299.95 |
| Micromodem IIe | $299 | $239.95 |

## 1200 Baud SMART CAT—Novation

103/212 Smart Cat and 103 Smart Cat, 1200 and 300 baud, built-in dialer, auto re-dial if busy, auto answer/disconnect, direct connect, LED readout displays mode analog/digital loopback self tests, usable with multi-line phones

| | | YOUR PRICE |
|---|---|---|
| 300 Baud 103 Smart Cat | $249 | $199.95 |
| 1200 Baud 212/103 Smart Cat | $595 | $449.95 |

## J-CAT MODEM

1/5 the size of ordinary modems, Bell 103, manual or, auto-answer. Automatic answer/originate, direct connect, built-in self-test, two LEDs and audio beeps provide status information

| | | YOUR PRICE |
|---|---|---|
| Novation J-Cat | $149 | $114.95 |

## THE BUS PROBE

Best selling inexpensive S-100 diagnostic analyzer

| | | YOUR PRICE |
|---|---|---|
| Bare board | $89 | $59.95 |
| Kit | $249 | $179.95 |
| A & T | $299 | $199.95 |

## VERSAFLOPPY II SD Systems

Double density disk controller for 5¼" and 8"

| | | YOUR PRICE |
|---|---|---|
| Versafloppy II with PROM | $400 | $344.95 |
| Versafloppy II/696 A & T | $400 | $349.95 |
| CP/M 3.0 with VF-II | $200 | $80.00 |

## 64 STATIC RAM—Jade

Uses new 2K x 8 static RAMs, fully supports IEEE 696

| | | YOUR PRICE |
|---|---|---|
| Bare board | $69 | $49.95 |
| Kit less RAM | $149 | $89.95 |
| 32K kit | $229 | $169.95 |
| 56K kit | $299 | $225.95 |
| 64K kit | $399 | $265.95 |
| Assembled & Tested | $50 | add $30.00 |

## EXPANDORAM III

High density memory board, 64K, 128K, or 256K

| | | YOUR PRICE |
|---|---|---|
| 64K | $475 | $398.95 |
| 128K | $595 | $464.95 |
| 192K | $709 | $524.95 |
| 256K | $825 | $589.95 |

## ULTRA-VIOLET EPROM ERASERS

Inexpensive erasers for industry or home

| | | YOUR PRICE |
|---|---|---|
| Spectronics w/o timer | $99 | $69.95 |
| Spectronics with timer | $139 | $94.95 |
| Logical Devices | $89 | $49.95 |

## ISOBAR

The ISOBAR looks like a standard multi outlet power strip but contains surge suppression circuitry and built-in noise filters, plus 15amp circuit breaker

| | | YOUR PRICE |
|---|---|---|
| 4 receptacle | $89 | $59.95 |
| 8 receptacle | $99 | $69.95 |

## APPLE ACCESSORIES

| | | |
|---|---|---|
| Full Height Disk Drive | $299 | $189.95 |
| Half-Height Disk Drive | $249 | $184.95 |
| Controller | $100 | $59.95 |
| 8 inch 2 Meg. system | $2495 | $1395.00 |
| 20 Megbyte Hard disk | $2495 | $1999.95 |
| CP/M 3.0 Card | $399 | $259.95 |
| Z-Card with CP/M | $169 | $139.95 |
| 16K RAM Card | $99 | $39.95 |
| Best 80 Column Card | $219 | $139.95 |
| 64K IIe 80 Column | $199 | $129.95 |
| Fan w/surge protect | $99 | $59.95 |
| Koala Pad | $125 | $89.95 |
| Grappler Plus | $175 | $119.95 |
| 64K Grappler w/16K | $245 | $175.95 |
| 64K Grappler w/64K | $345 | $239.95 |

## SUPER DISKETTE SPECIAL!

We bought out a major manufacturer's over-stock and we are passing the savings on to you! Single-sided, double-density package of ten with FREE! plastic case

| | | |
|---|---|---|
| Box of 10 w/FREE! case | $34 | $18.95 |

## 5¼ inch DISK DRIVES

| | | |
|---|---|---|
| **TANDON TM 100-1** SS/DD 48 TPI | | |
| *List $349* | $225.00 ea | 2 for $195.00 ea |
| **SHUGART SA 400L** SS/DD 48 TPI | | |
| *List $299* | $209.00 ea | 2 for $199.95 ea |
| **TANDON TM 100-2** DS/DD 48 TPI | | |
| *List $399* | $229.00 ea | 2 for $225.00 ea |

**5¼" Cabinets/Power Supply**

| | | |
|---|---|---|
| Single cab w/power supply | $99 | $69.95 |
| Dual cab w/power supply | $129 | $85.00 |

## 8 inch DISK DRIVES

| | | |
|---|---|---|
| **SIEMENS FDD 100-8** SS/DD | | |
| *List $399* | $179.00 ea | 2 for $175.00 ea |
| **SHUGART SA 801R** SS/DD | | |
| *List $502* | $355.00 ea | 2 for $349.00 ea |
| **SHUGART SA-851R** DS/DD | | |
| *List $605* | $459.00 ea | 2 for $455.00 ea |
| **QUME DT-8** DS/DD | | |
| *List $599* | $479.00 ea | 2 for $459.00 ea |
| **TANDON TM 848-1** SS/DD thin-line | | |
| *List $499* | $369.00 ea | 2 for $359.00 ea |
| **TANDON TM 848-2** DS/DD thin-line | | |
| *List $599* | $439.00 ea | 2 for $435.00 ea |
| **NEC FD1165** DS DD thin-line | | |
| *List $599* | $450.00 ea | 2 for $440.00 ea |
| **NEC FD1164** SS/DD thin-line | | |
| *List $499* | $360.00 ea | 2 for $350.00 ea |

## DISK SUB-SYSTEMS

Handsome metal cabinet with proportionally balanced air flow system, rugged dual drive power supply, cble kit, power switch, line cord, fuse holder, cooling fan, nevermar rubber feet. All necessary hardware to mount two 8" disk drives, power supply, and fan. Does not include signal cable

*Dual 8" Sub-Assembly Cabinet*

| | | |
|---|---|---|
| Bare cabinet | $75 | $49.95 |
| Cabinet kit | $299 | $199.95 |
| A & T | $349 | $249.95 |

*8" Sub-System—Single sided, Double density*

| | | |
|---|---|---|
| Kit w/2 Siemens FD100-8Ds | $950 | $579.00 |
| A & T w/2 Siemens FD100-8Ds | $995 | $595.00 |
| Kit w/2 Shugart SA-801Rs | $1195 | $939.00 |
| A & T w/2 Shugart SA-801Rs | $1295 | $969.00 |

*8" Sub-Systems—Double sided, Double density*

| | | |
|---|---|---|
| Kit w/2 Qume DT-8s | $1495 | $1229.00 |
| A & T w/2 Qume DT-8s | $1595 | $1249.00 |
| Kit w/2 Shugart SA-851Rs | $1495 | $1199.00 |
| A & T w/2 Shugart SA-851Rs | $1595 | $1219.00 |

## DUAL SLIMLINE SUB-SYSTEMS

*Dual 8" Slimline Cabinet*

| | | |
|---|---|---|
| Bare cabinet | $75 | $59.95 |
| A & T w/o drives | $249 | $164.95 |

*Dual 8" Slimline Sub-Systems*

| | | |
|---|---|---|
| Kit w/2 SS/DD drives | $1295 | $879.00 |
| Kit w/2 DS/DD drives | $1395 | $1060.00 |
| A & T w/2 DS/DD drives | $1495 | $1099.00 |

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# SUPER PRICES ON PRINTERS!

## High Performance, New Lower Price! DTC-380Z

True letter quality Daisywheel printer up to 32 CPS, with a built-in **48K buffer.** The 380Z comes with RS232 serial, parallel centronics, and IEEE-488 interfaces built-in

| Full one-year factory warranty! | | YOUR PRICE |
|---|---|---|
| DTC-380Z | *$1495* | $999.95 |
| Sheet feeder | *$895* | $579.95 |
| Forms Tractor | *$195* | $129.95 |
| Cable (specify) | *$85* | $49.95 |

## CALL US FOR OUR BEST PRICE!

**EPSON RX-80** 100 CPS w/tractor, graphics
**CALL FOR OUR BEST PRICE**
**EPSON RX-80FT** 100 CPS w/FREE! graphics
*Friction & tractor feed* — **SAVE $150.00**
**EPSON MX-80FT** 80 CPS w/FREE graphics
*Friction & tractor feed* — **SAVE $150.00**
**EPSON FX-80** 160 CPS w/FREE graphics
*Friction & tractor feed* — **SAVE $50.00**
**EPSON FX-100** 160 CPS 15" platten
*Friction & tractor feed* — **SAVE $150.00**

## PRICES TOO LOW TO PUBLISH! OKIDATA 92 & 93

160 CPS, true correspondence quality printing, full graphics, IBM PC compatible (optional), handles single sheet as well as fan-fold paper, professional design construction and quality

| | | |
|---|---|---|
| Oki 92 parallel | *$599* | $429.95 |
| Oki 93 parallel | *$995* | $699.95 |
| 2K serial board | *$150* | $120.00 |
| IBM PC ROMs for 92 | *$59* | $49.95 |
| IBM PC ROMs for 93 | *$59* | $59.95 |
| Extra Ribbon (2) | *$19* | $9.95 |
| Tractor for Oki 92 | *$89* | $54.95 |

## MICROLINE 82, 83, 84

120 CPS (82, 83) 200 CPS (84), industry standard printers, serial and parallel interfaces, true lower case descenders, handles single-sheet as well as fan fold

| | | |
|---|---|---|
| Oki 82 | *$499* | Now on SALE for $349.95 |
| Oki 83 w/FREE tractor | *$775* | $569.95 |
| Oki 84 parallel | *$1395* | $1095.00 |
| Oki 84 serial | *$1495* | $1195.00 |
| 2K serial board | *$120* | $99.95 |
| Extra Ribbons 82/92, 83/93 | *$19* | $9.95 |
| Tractor for Oki 82 | *$89* | $54.95 |
| Ribbons for 84 | *$19* | $9.95 |
| IBM PC ROMs for 82 or 83 | | $39.95 |
| IBM PC for 84 | | $89.95 |
| Commodore Interface & Cable | | $59.95 |

## MANNESMAN-TALLY

| | | |
|---|---|---|
| Spirit, 80 CPS 10 inch parallel | *$399* | $329.00 |
| 160L, 160 CPS 10 inch | *$798* | $588.00 |
| 180L, 160 CPS 15 inch | *$1098* | $828.00 |

**OPEN SATURDAYS 10:00am—4:00pm PST**

## OKIDATA PRINTER

(One hundred ninty-nine dollars and ninty-five cents)

**THIS IS NOT A MISPRINT!**

**$199.95**

- 80 CPS
- Friction & pin feed
- Standard centronics parallel
- 80 or 132 columns
- Full ASCII character set
- Block mode graphics

We bought several truck loads of these printers at a one time special price. Hurry and place your order. We've got lots now but the demand will far exceed the limited supply. Includes full manufacturer warranty

## GEMINI 10X & 15X

120 CPS, full graphics, friction & tractor, Epson FX-80 compatible

| | | |
|---|---|---|
| Gemini 10X | | CALL FOR OUR BEST PRICE! |
| Gemini 15X | | CALL FOR OUR BEST PRICE! |
| Serial I/O Card | *$69* | $54.95 |
| Serial I/O Card w/4K buffer | | $99.95 |
| Commodore Interface & Cable | | $59.95 |

## DELTA 10 & 15

160 CPS, full graphics, 8K buffer, serial & parallel, Epson FX-80 compatible

| | |
|---|---|
| Delta 10 | SAVE AT LEAST $150.00 |
| Delta 15 | SAVE AT LEAST $150.00 |

## RADIX 10 & 15

200 CPS, full graphics, 16K buffer, serial & parallel, semi-auto sheet feeder

| | |
|---|---|
| RADIX 10 | SAVE AT LEAST $200.00 |
| RADIX 15 | SAVE AT LEAST $200.00 |

## COMREX CR-II

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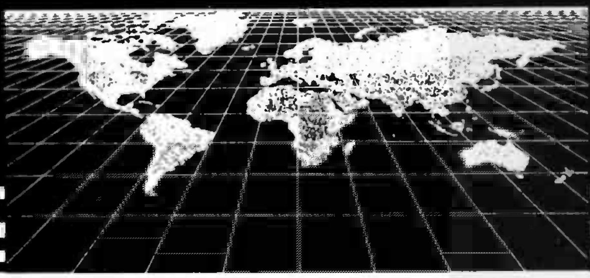

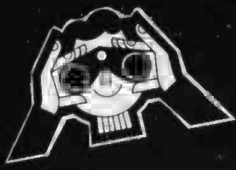

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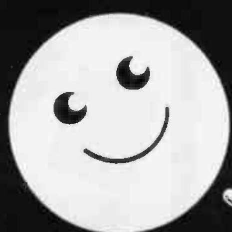

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| Apple Mate | $195 | $185 | $175 |
| Controller | 65 | 55 | 45 |
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| Elite II, Dbl. Head | 35 | 345 | 335 |
| Elite III, Quad Density | 455 | 445 | 435 |
| Controller Controls 4 Drives | 90 | 80 | 75 |
| **Half Height** | | | |
| FD525A Fully Apple com. | $150 | $140 | $130 |

## 5¼" Disk Drives All Applications

| QUANTITY | 1 | 2 | 10 |
|---|---|---|---|
| **Teac** | | | |
| FD55A, 160K | $160 | $150 | $140 |
| FD55B, 360K | 180 | 170 | 160 |
| FD55F, Quad Density | 200 | 190 | 180 |
| All Teac's are Half Heights | | | |
| **Tandon** | | | |
| TM100-1, 160K | $200 | $190 | $180 |
| TM100-2, 360K | 220 | 210 | 200 |
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| QUANTITY | 1 | 2 | 10 |
|---|---|---|---|
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| FDD-100-8 | $150 | $140 | $130 |
| FDD-200-8 | 300 | 290 | 280 |
| **Shugart** | | | |
| 801R, Sgl./Dbl. | $360 | $350 | $340 |
| 851R, Dbl./Dbl. | 470 | 460 | 450 |
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| TM848-1, Sgl./Dbl. ½ Ht. | $350 | $340 | $330 |
| TM848-2, Dbl./Dbl. ½ Ht. | 400 | 390 | 380 |
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| M2894-63, Dbl./Dbl. | $420 | $410 | $400 |
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| **Qume** | | | |
| DT8, Datatrak 8 | $450 | $440 | $430 |

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| QUANTITY | 1 | 2 | 10 |
|---|---|---|---|
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| Dual w/pwr & fan | 270 | 260 | 250 |

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| 300A, 12" Amber | 149 |
| 310A, Monochrome Amber | 179 |

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| | |
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| 12 AUW, 80 column | $ 79 |
| 12 EUN Hi-Res Green | 109 |
| 9191 Color New Version | 239 |

**IBM**

| | |
|---|---|
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| RGB Color | 699 |

**Princton Graphics**

| | |
|---|---|
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| DX25 | 729 |

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| RX-80FT (120 cps) Friction & Tractor | 419 |
| FX-80 (160 cps) | 519 |
| FX-100 (160 cps) 15" Carriage | 729 |

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| 8025 (15" Carriage) | 699 |

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| MD2 Dbl/Dbl | 38 |
| | 100 for 360 |

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| | |
|---|---|
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| Dbl/Dbl | 35 |
| | 100 for 320 |

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| | |
|---|---|
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| Dbl/Dbl | 36 |
| | 100 for 340 |

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| | |
|---|---|
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| Dbl/Dbl | 29 |
| | 100 for 270 |

## 8" DISKETTES

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| | |
|---|---|
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| | 100 for 320 |
| Dbl/Dbl | 53 |
| | 100 for 480 |

**Maxell**

| | |
|---|---|
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| | 100 for 380 |
| Dbl/Dbl | 50 |
| | 100 for 469 |

**Memorex**

| | |
|---|---|
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| | 100 for 250 |
| Dbl/Dbl | 38 |
| | 100 for 350 |

**Verbatim**

| | |
|---|---|
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**Wabash**

| | |
|---|---|
| Sgl/Sgl | $24 |
| | 100 for 220 |
| Dbl/Dbl | 34 |
| | 100 for 320 |

## DISK ACCESSORIES

**Verbatim**

| | |
|---|---|
| 8" or 5¼" Head Cleaning Kit | $ 9 |

**Flip Tub**

| | |
|---|---|
| 5¼" Holds 50 disks, plexiglass | 17 |
| 5¼" Holds 70 disks, plexiglass | 21 |

## APPLE DRIVES

**Apple**

| | |
|---|---|
| Disk 2 | $ 299 |
| Disk 2 controller w/DOS 3.3 | 89 |

**Micro Sci**

| | |
|---|---|
| A-2 Fully compatible | $ 200 |
| Controller w/diagnostics | 80 |

**Quentin Research**

| | |
|---|---|
| Applemate | $ 195 |
| Controller | 65 |

**Rana Systems**

| | |
|---|---|
| Elite I | $ 240 |
| Elite II Dbl Sided | 355 |
| Elite III Quad Density | 455 |
| Controller, controls 4 | 90 |

**Super 5**

| | |
|---|---|
| Slimline | $ 189 |
| Controller | 75 |

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## DISK DRIVE CABINETS

### 5¼" Cabinets

| | |
|---|---|
| Single Cab. w/power supply | $ 70 |
| Dual Cab. w/power supply | 80 |
| Dual Thinline Cab. w/pwr. sup. | 80 |

### 8" Cabinets

| | |
|---|---|
| Single Cab. w/fan & power supply | $ 220 |
| Dual Cab. w/fan & power supply | 270 |

LOOK!

## 5¼" DISK DRIVES

### CDC

| | |
|---|---|
| 9409 dbl/dbl | $ 230 |
| 9409T Quad Density | 300 |

### Panasonic

| | |
|---|---|
| Slimline 320K PC comp. | $ 200 |

### Tandon

| | |
|---|---|
| TM100-1, 160K | $ 200 |
| TM100-2, 320K | 220 |
| TM101-4 Quad Density | 220 |

## 8" DISK DRIVES

### Mitsubishi

| | |
|---|---|
| 2894 Dbl/Dbl | $ 420 |

### Qume

| | |
|---|---|
| DT8 Dbl/Dbl | $ 450 |

### Shugart

| | |
|---|---|
| 801R Sgl/Dbl | $ 360 |
| 851R Dbl/Dbl | 470 |

### Siemans

| | |
|---|---|
| FDD 100-8 Sgl/Dbl | $ 150 |

### Tandon

| | |
|---|---|
| TM848-1 Sgl/Dbl Thinline | $ 350 |
| TM848-2 Dbl/Dbl Thinline | 400 |

## PRINTER INTERFACES

### Cables

| | |
|---|---|
| IBM to Printer | $ 29 |
| Kaypro to Printer | 29 |
| RS232 Cables | 29 |

### Fourth Dimension

| | |
|---|---|
| Card & Cable | $ 49 |

### Microtek

| | |
|---|---|
| Dumpling GX (Grappler Compatible) | $ 89 |
| Dumpling GX exp to64K | 149 |
| Dumpling GX 16K w/16K exp to 64K | 169 |
| for each additional 16K | 15 |

### Okidata Options

| | |
|---|---|
| Tractor for 82 & 92 | $ 59 |
| Serial Interface | 99 |

### Orange Micro

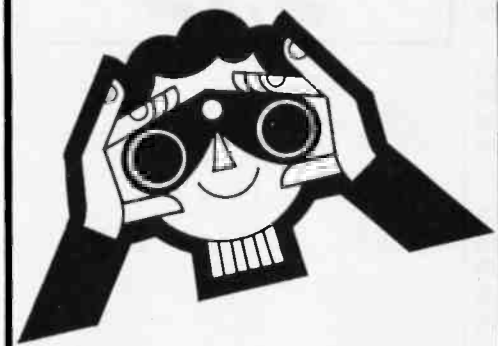
| | |
|---|---|
| Grappler + | $ 114 |
| Grappler + w/16K | 169 |

### Star or Epson

| | |
|---|---|
| Epson Serial Interface | $ 119 |
| Star Serial Interface | 59 |

### Wesper Micro

| | |
|---|---|
| Wizard Full Graphics Interface | $ 89 |



## MODEMS

### Anchor

| | |
|---|---|
| Mark VII 300 Baud | $ 119 |
| Mark XII, 1200 Baud | 279 |

### Hayes Micro Computer

| | |
|---|---|
| Smart Modem 300 Baud | $ 199 |
| Smart Modem 1200 Baud | 489 |
| Smart Modem 1200B for PC | 389 |
| Micro Modem IIE | 239 |

### Novation

| | |
|---|---|
| J-Cat | $ 119 |
| Apple Cat II | 259 |

## APPLE ADD ON'S

### ALS

| | |
|---|---|
| Z Card | $ 119 |
| CPM 3.0 Card | 269 |

### Apple

| | |
|---|---|
| Disk II | $ 299 |
| Monitor II | 99 |

### Astar

| | |
|---|---|
| RF Modulator | $ 15 |
| Fan w/Surge | 29 |

### Kensington

| | |
|---|---|
| System Saver | $ 69 |

### Koala

| | |
|---|---|
| Graphics Tablet | $ 89 |

### Kraft

| | |
|---|---|
| Joystick | $ 49 |

### Micro Max

| | |
|---|---|
| Viewmax 80, 80 col. card | $ 139 |
| Viewmax 80E (F for IIE) 64K | 129 |

### Micro Soft

| | |
|---|---|
| 16K Card | $ 69 |
| Premium Soft Card IIE | 369 |
| Multiplan | 189 |
| Soft Card (Z80) | 239 |

### Micro Tek

| | |
|---|---|
| Bam 16, 16K Memory | $ 59 |
| Serial Interface | 89 |

### TG

| | |
|---|---|
| Joystick | $ 44 |
| Select-A-Port | 31 |
| Paddles | 34 |

## IBM ADD ON'S

### Ast Research

| | |
|---|---|
| Six Pack + | $ 269 |
| Mega + | 269 |

### IBM

| | |
|---|---|
| Monochrome Adapter | $ 319 |
| Color Card | 275 |

### Plantronics

| | |
|---|---|
| PC + w/Software | $ 389 |

### Quadram

| | |
|---|---|
| Quad Color Card | $ 219 |
| Quad Link | 479 |

### 64K Upgrade

| | |
|---|---|
| 64K of Memory | $ 49 |

### USI Research

| | |
|---|---|
| Paradise Systems multi-display card | $ 399 |

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### FIVE INCH SINGLE SIDED DOUBLE DENSITY

| | Soft Sector / Ten Sector / Sixteen | Each box | 10 Boxes | 100 Boxes |
|---|---|---|---|---|
| CAL DIGITAL | CAL-501 / CAL-510 / CAL-516 | 19.95 | 18.50 | 16.50 |
| SCOTCH | MMM-744/0 / MMM-744/10 / MMM-744/16 | 26.50 | 24.50 | 21.75 |
| VERBATIM | VRB-525/01 / VRB-525/10 / VRB-525/16 | 26.50 | 25.25 | 23.50 |
| MEMOREX | MRX-3481 / MRX-3483 / MRX-3485 | 26.50 | 22.25 | 18.75 |
| MAXELL | MXL-MD1 / MXL-MH1/10 / MXL-MH1/16 | 26.50 | 24.50 | 23.25 |
| DYSAN | DYS-104/1D / DYS-107/1D / DYS-105/1D | 35.00 | 33.00 | 30.50 |

### FIVE INCH DOUBLE SIDED DOUBLE DENSITY

| | | | | |
|---|---|---|---|---|
| CAL DIGITAL | CAL-551 / CAL-561 / N/A | 24.95 | 22.75 | 20.50 |
| SCOTCH | MMM-745/0 / MMM-745/10 / MMM-745/16 | 39.95 | 37.95 | 31.25 |
| VERBATIM | VRB-550/01 / VRB-550/10 / VRB-550/16 | 39.95 | 37.95 | 32.75 |
| MEMOREX | MRX-3491 / MRX-3493 / MRX-3495 | 35.00 | 31.25 | 26.25 |
| MAXELL | MXL-MD2 / MXL-MD2/10 / MXL-MD2/16 | 39.95 | 37.95 | 34.75 |
| MAXELL / 96 | MXL-MD2/96 / N/A / N/A | 45.00 | 43.00 | 41.25 |
| DYSAN | DYS-104/2D / DYS-107/2D / DYS-105/2D | 42.50 | 40.50 | 35.50 |
| DYSAN / 96 | DYS-204/2D / N/A / N/A | 49.95 | 47.95 | 45.75 |

### EIGHT INCH SINGLE SIDED SINGLE DENSITY

| | | | | |
|---|---|---|---|---|
| SCOTCH | MMM-740/0 | 29.50 | 27.50 | 23.80 |
| MEMOREX | MRX-3062 | 27.75 | 26.60 | 22.25 |
| VERBATIM | VRB-34/9000 | 31.50 | 29.50 | 25.60 |
| DYSAN | DYS-3740/1 | 35.75 | 32.75 | 29.75 |

### EIGHT INCH SINGLE SIDED DOUBLE DENSITY

| | | | | |
|---|---|---|---|---|
| SCOTCH | MMM-741/0 | 37.75 | 35.15 | 29.15 |
| MEMOREX | MRX-3090 | 35.50 | 33.50 | 27.15 |
| VERBATIM | VRB-34/8000 | 35.25 | 33.25 | 28.75 |
| DYSAN | DYS-3740/1D | 40.75 | 38.75 | 32.25 |
| MAXELL | MXL-FD1 | 45.50 | 39.75 | 35.15 |

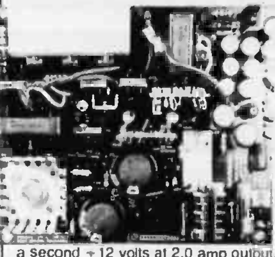
### EIGHT INCH DOUBLE SIDED DOUBLE DENSITY

| | | | | |
|---|---|---|---|---|
| SCOTCH | MMM-743/0 | 47.50 | 44.25 | 37.50 |
| MEMOREX | MRX-3102 | 39.25 | 36.75 | 31.50 |
| VERBATIM | VRB-34/4001 | 41.75 | 37.50 | 32.25 |
| DYSAN | DYS-3740/2D | 54.65 | 49.75 | 40.50 |
| MAXELL | MXL-FD2 | 52.50 | 48.75 | 40.45 |

## New Location


California Digital has just purchased a new distribution center six times the size of our existing facility. The new warehouse and retail store is in the city of Carson at 17700 Figueroa Street. We are located just off the San Diego Freeway near the Goodyear Blimp. Please stop by and visit our retail store when in the Los Angeles area. Store hours are 10 AM to 5 PM Monday through Saturday.

## Switching Supply



## $49

Power your single board system with one supply! This Kepro switcher power supply outputs +5 volts at 5 amps, +12 volts at 1.8 amps, 2.8 amps surge, −12 volts at 0.5 amps, and a second +12 volts at 2.0 amp output. It is jumper selectable for both 120 volt and 220 volt operation. Units measures approximately 6" by 8". This board is capable of supplying power for two 5¼" Winchesters, a single board computer along with a hard disk controller. Also suitable for use with all IBM look-a-likes. Priced at only $49.95 this power supply offers excellent value along with high reliability. Please phone for volume pricing. KPT-512

## MEMORY

| 16K DYNAMIC | 2732 EPROM |
|---|---|
| 1.95 | 4.95 |
| 4116 150ns. | 450ns. |
| **2764 EPROM** | **16K STATIC** |
| 6.95 | 4.95 |
| 350ns. | 6116 200ns. |


### 4164 DYNAMIC MEMORY 150ns $5.95

#### DYNAMIC MEMORY

| | | 1-31 | 32 + | 100 + |
|---|---|---|---|---|
| 4027 4K dynamic 250ns. | ICM-4027250 | 1.99 | 1.85 | 1.75 |
| 4116 150ns. 16K | ICM-4116150 | 1.75 | 1.65 | 1.45 |
| 4116 200ns. 16K | ICM-4116200 | 1.75 | 1.65 | 1.45 |
| 4164 150ns. 64K 128 refresh | ICM-4164150 | 5.95 | 5.85 | 5.55 |
| 41256 150ns. 256K | ICM-41256150 | | Available | |
| DP8409 dynamic controller | ICT-8409 | 39.00 | 35.00 | 29.00 |

#### EPROMS

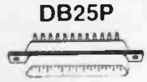
| | | | | |
|---|---|---|---|---|
| 2708 450ns. 1K x 8 | ICE-2708 | 4.95 | 4.75 | 4.55 |
| 2716 450ns. 2K x 8 | ICE-2716 | 4.50 | 4.25 | 3.97 |
| 2716TMS 450ns. Tri-voltage | ICE-2716TMS | 7.95 | 7.65 | 7.25 |
| 2732 450ns. 4K x 8 | ICE-2732 | 4.50 | 3.75 | 3.55 |
| 2732 350ns. 4K x 8 | ICE-2732350 | 8.50 | 8.00 | 7.60 |
| 2532 450ns. 4K x 8 | ICE-2532 | 10.50 | 9.90 | 9.50 |
| 2764 350ns. 8K x 8 | ICE-2764 | 6.95 | 6.95 | 6.95 |
| 27128 350ns. 16K x 8 | ICE-27128 | 18.95 | | |

#### STATIC MEMORY

| | | | | |
|---|---|---|---|---|
| 21L02 200ns. 1K static | ICM-21L02200 | 1.49 | 1.29 | 1.15 |
| 21L02 450ns. 1K static | ICM-21L02450 | 1.29 | 1.15 | .99 |
| 2112 450ns. 2K static | ICM-2112450 | 2.99 | 2.85 | 2.75 |
| 2114 300ns. 1K x 4 | ICM-2114300 | 1.95 | 1.85 | 1.75 |
| 4044TMS 450ns. 4K x 1 | ICM-4044450 | 3.49 | 3.25 | 2.99 |
| 5257 300ns. 4K x 1 | ICM-5257300 | 2.50 | 2.25 | 1.99 |
| 6116 P4 200ns. 2K x 8 | ICM-6116200 | 4.85 | 4.65 | 4.50 |
| 6116 P3 150ns. 2K x 8 | ICM-6116150 | 5.25 | 4.05 | 4.85 |
| 6167/2167 100ns. 16K x 1 (20 pin) | ICM-6167100 | 9.95 | 9.50 | |

## CONNECTORS

S-100 Gold



DB25P

#### GOLD S-100 EDGE CARD CONNECTORS

| | catalog | each | 10-99 | 100+ |
|---|---|---|---|---|
| Imsai s/t 250 | CNE-IMS | 2.95 | 2.50 | 2.19 |
| Sullins Hi/Rel | CNE-H100 | 4.10 | 3.85 | 3.47 |
| S-100 Wire W | CNE-W10 | 3.95 | 3.50 | 3.19 |
| Altair 140 s/t | CNE-100A | 4.95 | 4.50 | 4.19 |

#### .156" CENTER EDGE CARD CONNECTORS

| | | | | |
|---|---|---|---|---|
| 22/44 Eyelet | CNE-44E | 2.50 | 2.15 | 1.95 |
| 43/72 Moto s/t | CNE-72S | 6.60 | 6.15 | 5.75 |
| 36/72 D/G s/t | CNE-72S | 5.95 | 5.50 | 5.19 |

Other connectors available upon request

#### RIBBON CONNECTORS

| | | | | |
|---|---|---|---|---|
| DB25P male | CND-r25P | 5.65 | 5.25 | 4.15 |
| DB25S female | CND-r25S | 5.95 | 5.59 | 4.50 |
| 57-30360 male | CNC-r36P | 7.95 | 6.75 | 5.90 |
| 57-30360f male | CNC-r36S | 7.95 | 6.75 | 5.90 |
| 20 pin edge | CNI-DE20 | 4.35 | 3.30 | 2.50 |
| 20 pin socket | CNI-DS20 | 2.75 | 1.85 | 1.60 |
| 26 pin edge | CNI-DE26 | 4.95 | 3.50 | 2.70 |
| 26 pin socket | CNI-DS26 | 3.50 | 2.40 | 2.15 |
| 34 pin edge | CNI-DE34 | 4.95 | 4.50 | 3.50 |
| 34 pin socket | CNI-DS34 | 4.50 | 3.95 | 3.15 |
| 50 pin edge | CNI-DE50 | 5.95 | 5.60 | 4.90 |
| 50 pin socket | CNI-DS50 | 4.95 | 4.60 | 3.80 |

#### "D" TYPE

| "D" TYPE | catalog | each | 10-99 | 100+ |
|---|---|---|---|---|
| DE9P male | CND-9P | 1.60 | 1.40 | 1.30 |
| DE9S female | CND-9S | 2.25 | 2.00 | 1.30 |
| DE hood | CND-9H | 1.50 | 1.35 | 1.20 |
| DA15P male | CND-15P | 2.35 | 2.10 | 1.90 |
| DA15S female | CND-15S | 3.25 | 3.10 | 2.90 |
| DA15 hood | CND-15H | 1.60 | 1.35 | 1.30 |
| DB25P male | CND-25P | 1.95 | 1.75 | 1.35 |
| DB25S female | CND-25S | 2.95 | 2.55 | 1.65 |
| DB25 hood | CND25H | 1.35 | 1.15 | .77 |
| DC37P male | CND-37P | 4.20 | 3.95 | 3.65 |
| DC37S female | CND-37S | 5.95 | 5.75 | 5.50 |
| DC37 hood | CND-37H | 2.25 | 1.95 | 1.65 |
| DD50P male | CND-50P | 5.50 | 5.10 | 4.75 |
| DD50 hood | CND-50H | 2.60 | 2.40 | 2.10 |
| Hardware 2/set | CND-2HS | .89 | .69 | .42 |

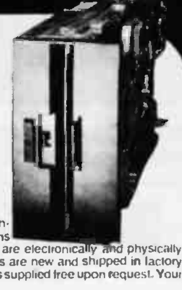
#### AMPHENOL / CENTRONICS TYPE

| | | | | |
|---|---|---|---|---|
| 57-30360 36-P | CNC-36P | 7.95 | 6.35 | 3.97 |
| IEEE488 C dor | CND-24P | 7.95 | 6.35 | 5.35 |

#### DISK DRIVE POWER CONNECTORS

| | | | | |
|---|---|---|---|---|
| 8" 6 pin D C | CNP-6DC | 1.95 | 1.29 | .89 |
| 8" 3 AC Sgl/S | CNP-3SS | 1.69 | 1.09 | .69 |
| 8" 3 AC Dbl/S | CNP-3DS | 1.69 | 1.09 | .69 |
| 5¼" 4 pin D C | CNP-4DC | 1.79 | 1.19 | .99 |
| 3 pin DIN recpl | CNP-D3P | 2.59 | 1.99 | 1.59 |

## BLOWOUT SALE $169



California Digital has recently participated in the purchase of several thousand Siemens FDD 100-8 floppy disk drives. These units are electronically and physically similar to that of the Shugart 801R. All units are new and shipped in factory sealed boxes. Manual and power connectors supplied free upon request. Your choice 115 Volt, 60 Hz, or 230 Volt, 50Hz.

**NOTE!** European customers, we have a large quantity of 230 volt 50 Hz units warehoused in Frankfort Germany. Arrangements can be made to will call these drives in quantities of 50 or more in Frankfort reducing import duty and freight charges.

## REMEX DOUBLE SIDED $219

California Digital has just purchased a large quantity of Remex RFD-4000 **Eight inch double sided disk drives**. Remex is the only double sided disk drive that has an double gimbal mounted head assembly that guaranties lower head tracking. This drive is mechanically solid. Remex has always been known for producing premiere products for the floppy disk market. The Remex company is a subsidiary of the Ex-cell-o Corporation, a Fortune 500 Company.

#### Eight Inch Single Sided Drives

| | One | Two | Ten |
|---|---|---|---|
| SHUGART 801R | 385 | 375 | 365 |
| SIEMENS FDD 100-8 | 169 | 169 | 159 |
| TANDON 848E-1 Half Height | 369 | 359 | 349 |

#### Eight Inch Double Sided Drives

| | | | |
|---|---|---|---|
| SHUGART SA851R | 495 | 485 | 475 |
| QUME 842 "QUME TRACK 8" | 459 | 459 | 449 |
| TANDON 848E-2 Half Height | 459 | 447 | 435 |
| REMEX RFD-4000 | 219 | 219 | 209 |
| MITSUBISHI M2894-63 | 447 | 439 | 433 |
| MITSUBISHI M2896-63 Half Ht. | 459 | 449 | 409 |

#### Five Inch Single Sided Drives

| | | | |
|---|---|---|---|
| TEAC FD-55A half height | 179 | 169 | 165 |
| SHUGART SA400L | 235 | 229 | 225 |
| SHUGART SA410 96TPI/80 Trk. | 129 | 129 | 119 |
| SHUGART SA200 ⅔ Height | 159 | 149 | 139 |
| TANDON TM100-1 | 189 | 179 | 175 |

#### Five Inch Double Sided Drives

| | | | |
|---|---|---|---|
| TEAC FD55B half height | 219 | 209 | 199 |
| CONTROL DATA 9409 IBM/PC | 259 | 249 | 239 |
| REMEX RFD480 IBM/PC | 199 | 189 | 175 |
| SHUGART SA450 | 319 | 309 | 299 |
| SHUGART SA455 Half Height | 259 | 249 | 239 |
| SHUGART SA465 Half Ht. 96TPI | 289 | 279 | 269 |
| TANDON TM50-2 Half Height | 215 | 209 | 199 |
| TANDON TM55-4 half Ht. 96TPI | 329 | 319 | 309 |
| TANDON 100-2 | 279 | 269 | 259 |
| TANDON 101-4 96TPI 80 Track | 369 | 355 | 350 |
| MITSUBISHI 4851 Half Height | 259 | 249 | 245 |
| MITSUBISHI 4853 ½ Ht. 96TPI | 339 | 329 | 319 |
| MITSUBISHI 4854 ½ Ht., 8" elec. | 465 | 449 | 439 |
| QUME 142 Half Height | 239 | 229 | 219 |

#### Three Inch Disk Drives

| | | | |
|---|---|---|---|
| SHUGART SA300 with diskette | 229 | 219 | 209 |

#### Five Inch Winchester Hard Disk Drives

| | | | |
|---|---|---|---|
| SHUGART 612 13 M/Bytes | 895 | 865 | 825 |
| SHUGART 706 6 M/Byte, Half Ht | 795 | 775 | 755 |
| SHUGART 712 13 M/Byte, ½ Ht. | 895 | 865 | 825 |
| TANDON 503 19 M/Byte | 895 | 875 | 855 |

**Upon request, all drives are supplied with power connectors and manual**

## ENCLOSURES

California Digital manufactures an asortment of stock and custom disk drive enclosures. If the volume is justified we will custom design an enclosure for your application. The following stock disk drive enclosures are available. All include power supplies the 8" enclosures are supplied with exhaust fans.

Horizontal mount two 8" full height drives. $279.00

Vertical mount two full height 8" disk drives. $299.00

Horizontal mount one full height or two half height 8" disk drives. $239.00

Vertical mount two full height 5¼" disk drives. $139.00

Telex 753607

VISA

master charge

Shipping: First five pounds $3.00, each additional pound $.50.
Foreign orders: 10% shipping, excess will be refunded.
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# California Digital

**Post Office Box 3097 B • Torrance, California 90503**

# DRAGON $139

The world famous Dragon computer is now available in the United States. Manufactured by the Tano Corporation under license of the British Broadcasting Company. The Dragon comes complete with 64K Byte of memory, serial modem port along with a Centronics printer interface. This unique microcomputer features Motorola's advanced 6809E microprocessor and comes standard with Microsoft Color Basic, data base manager, spread sheet, and a complete word processing package. The computer outputs color composite video along with R.F. video that allows the unit to be used in conjunction with any color television.

This is the ideal low cost computer to be used with any dial up information system such as the Source. Western Union's EasyLink or any other time share service.

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.

# FREE

Your Choice
Second Drive or Monitor

# SANYO
## IBM COMPATIBLE
# $995

Sanyo Electronics has just released the long awaited IBM/PC look-a-like, the MBC-550. This is a complete microcomputer that includes 128K/byte of memory, a 5¼" 160K/byte disk drive upgradeable to 320K/byte drives. Also includes both color composite and RGB graphics interface, low profile keyboard, and parallel printer port. Extensive software such as Sanyo Basic, disk utilities, Wordstar word processing software, Calcstar spread sheet & Easy Writer I. MS-DOS is supplied with the Sanyo computer. Most programs written for the IBM/PC will operate on the MBC-550.

Along with all this California Digital offers "FREE" your choice of either a second disk drive, or a high resolution green or amber screen monitor. All at the super low price of only $995.

We are currently experiencing an initial shortage of this computer. Please place your orders early. The MBC-550 will be shipped on a first ordered basis

# PRINTERS

## $289 Star Gemini

### MATRIX PRINTERS

| | | |
|---|---|---|
| Star Gemini 10X 120 char/sec | STR-G10X | 289.00 |
| Star Gemini 15X 160 char/sec 15" paper | STR-G15X | 419.00 |
| Star Gemini Delta 10 160 Char/sec | STR-D10 | 495.00 |
| Star Com 80FT friction & tractor | VST-C80FT | 229.00 |
| Toshiba P1350 192 char/sec letter quality | TOS-1350 | 1495.00 |
| Okidata 82A serial & parallel 9" paper | OKI-82A | 379.00 |
| Okidata 92A parallel interface 160 char/sec | OKI-92A | 479.00 |
| Okidata 83A & parallel 15" paper | OKI-83A | 619.00 |
| Okidata 84A & parallel 15" paper | OKI-84A | 1019.00 |
| Okidata 2350 linear 350 char/sec | OKI-2350 | 1995.00 |
| Epson FX80 10" 160 char/sec with graphics | EPS-FX80 | 529.00 |
| Epson MX100 with graphics 15" paper | EPS-MX100 | 589.00 |
| NEC8023A parallel 9" paper graphics | NEC-8023A | 389.00 |
| Anadex 9501A high speed with graphics | ADX-9501A | 1099.00 |
| Anadex 9620A 200 char/sec par & serial | ADX-9620A | 1199.00 |
| Quantex 7030 correspondence quality 180 char/sec | QTX-7030 | 1595.00 |
| Prowriter low cost dot matrix printer | PRO-7500 | 189.00 |
| Prowriter 8510 parallel 9" paper | PRO-8510P | 359.00 |
| Prowriter II parallel 15" paper graphics | PRO-2P | 689.00 |
| Dataproducts B-600 band printer 600 LPM | DPS-B600 | 6985.00 |
| Printronix P300 band printer 300 lines per minute | PTX-P300 | 4250.00 |
| Printronix P600 ultra high speed 600 lines per minute | PTX-P600 | 5795.00 |
| Transtar 130P par IBM PC compatible | TNS-130P | 629.00 |

### WORD PROCESSING PRINTERS

| | | |
|---|---|---|
| NEC7710 55 char/second serial interface | NEC-7710 | 1979.00 |
| NEC7730 55 char/sec par 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 | NEC-2050 | 995.00 |
| Silver Reed EXP500 14 char/sec par interface | SRD-EXP500 | 459.00 |
| Silver Reed EXP550 17 Char/sec par interface | SRD-EXP550 | 669.00 |
| Diablo 630 40 char/sec serial | DBL-630 | 1795.00 |
| Diablo 620 proportional spacing, hard & soft tab, 20 cps | DBL-620 | 879.00 |
| Juki 6100 18 char/sec graphic mode | JUK-6100 | 539.00 |
| Brother HR1A daisy wheel parallel interface | BTH-HR1P | 695.00 |
| Brother HR1A serial interface | BTH-HR1S | 779.00 |
| Starwriter F10 serial 40 char/sec | PRO-F10S | 1125.00 |
| Starwriter F10 parallel 40 char/sec | PRO-F10P | 1125.00 |
| Comrex CR1 word processing printer serial intf | CRX-CR1S | 729.00 |
| Comrex CR1 parallel proportional spacing par | CRX-CR1P | 495.00 |

# MONITORS

| | | |
|---|---|---|
| BMC 12A green phosphor 15 MHz composite video | BMC-12A | 79.00 |
| BMC 12" hi-resolution 20 MHz | BMC-12EN | 134.00 |
| Zenith ZVM122 Amber Phosphor 12" 40-80 column switch | ZTH-122 | 119.00 |
| Zenith ZVM123 green phosphor 12" 40-80 column switch | ZTH-2123 | 105.00 |
| NEC JB1201 green phosphor 18 MHz composite video | NEC-JB1201 | 169.00 |
| NEC JB1260 commercial grade composite | NEC-JB1260 | 129.00 |
| USI Amber screen 12" composite monitor | USI-12A | 169.00 |
| Motorola 23" open frame black/white composite 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 AU-1310 Color composite video with sound | BMC-9191 | 319.00 |
| BMC 9191M RGB designed for use with the IBM computer | BMC-9191M | 499.00 |
| NEC JC1203 RGB color monitor | NEC-1203 | 499.00 |
| NEC JC1201 color composite | NEC-JC1201 | 339.00 |
| Zenith ZVM134 RGB color suitable for IBM/PC | ZTH-2134 | 379.00 |
| Comrex color composite with sound | COM-6500 | 329.00 |
| Amdek Color I composite 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, 100 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 |
| Penril 300/1200 auto dial autolog | PEN-12AD | 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, accustic connect | NOV-CAT | 159.00 |
| Novation SmartCat 103, auto answer, auto dial | NOV-SC103 | 219.00 |
| Novation SmartCat 103/212, 1200 baud duplex, auto dial | NOV-SC212 | 529.00 |
| Signalman Mark I direct connect with terminal cable | SGL-MK1 | 75.00 |

# TERMINALS

## Perkin Elmer 550S

California Digital has recently purchased an OEM liquidation, of new Perkin-Elmer Bantam 550S terminals. These units feature direct cursor addressing, numeric cluster, conversational or block mode transmission and RS-232 printer port. Self diagnostics and function keys make this terminal an excellent value at only $339.00. PRK-550S

## $339

| | | |
|---|---|---|
| Perkin-Elmer Model 550S Bantam Terminal | PRK-550S | 339.00 |
| 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 Busness 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 |
| TEAC 5¼" disk drive for Apple II | TEA-A2 | 269 |
| Vista Vision 80, 80 column card for std Apple II | VSA-VIS80 | 289 |
| Vista 8" disk controller double side D/D. | VSA-A800 | 389 |

# ASCII KEYBOARD $49

California Digital has purchased over 3000 of these Microswitch keyboards from the General Dynamics Corporation. 93 ASCII encoded Hall effect switches includes 8 function keys and 14 key numeric cluster make this keyboard an excellect value at only $49 MIC-93GD 5 lbs.

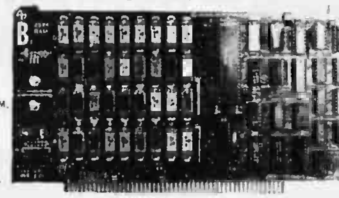
We also have available a matching General Dynamics steel trim panel $10

Non-encoded Hytek 58 key metal contact keyboard HIK-58 $24.95 Matching 15 key numeric cluster $9.95 HIK-15 Both for only $29.95 HIK-5815

Not pictured 49 key eight bit modified Hollerith coded Microswitch Hall effect keyboard REMOVED from punch card equipment $14.95 DIT-KB49 ASCII encoder available

# 256 KILOBYTE MEMORY BOARD

## $495



- 256 kilobytes of memory using 64K dynamic RAM.
- Over one megabyte of memory using the new 256K dynamic RAM chips
- Error detection-trap capability.
- Individual 16K block can be relocated to any boundry within a megabyte of RAM
- 24 bit addressing and phantom mode capability.

The California Digital 256K RAM board represents an outstanding value in S-100 memory technology. Priced slightly above earlier generation 64K dynamic ram boards it gives you these additional features: 256K of memory with parity. Parity error feature can be jumpered to any of the interrupt lines, a status port ERROR LED or IEEE-696 "ERROR signal". 24 or 16 bit addressing with memory management.

Proper operation with front panel equipped systems, DMA disk controllers, and IEEE-696 Temporary Buss Masters assured with an on the board M1 generator for memory refresh timing. CAS and RAS timing is controlled with tapped digital delay lines for proper operation over the entire operating temperature range.

The board is very recent in design using the National Semiconductor DP 8409 RAM Controller chip. Split termination networks are used on all address lines, CAS line, and RAS lines eliminating the last traces of ringing. The board uses two separate voltage regulators. One for the DRAMs and one for the interface logic increasing the noise immunity of the ram array. Typical power dissipation is 8 watts.

Documentation includes theory of operation, configuration guide, a schematic, and application notes on the use of the memory management options. CAL-256K 2 Lbs

# S-100 BOARDS

### 16 BIT MICROPROCESSORS

| | | |
|---|---|---|
| Octagon dual CPU 8088 Z80 & controller | OCT-88Z80 | 795.00 |
| Godbout 8086 8087 microcomp 16 bit | GBT-8687 | 495.00 |
| Godbout dual processor 8085 8088 8-16 | GBT-8588 | 369.00 |

### SINGLE BOARD COMPUTERS

| | | |
|---|---|---|
| Insight EQ-4 128K 4 serial not S-100 | INS-EQ4 | [illegible] |
| Advanced Digital Floppy & 64K | AMD-Z80 | 750.00 |
| Teletek System master 765 floppy 64K | TEL-SM1 | 895.00 |
| Teletek FDC-I single board no memory | TEL-FDC1 | 675.00 |

### 8 BIT MICROPROCESSORS

| | | |
|---|---|---|
| Godbout Z80 24 bit extended add | GBT-Z80 | 250.00 |
| California Computer Z80 microprocessor | CCS-2810 | 275.00 |
| Tarbell Z80 with two RS232 ports | TAR-Z80 | 339.00 |

### FLOPPY DISK CONTROLLERS

| | | |
|---|---|---|
| Godbout Disk 1, double density | GBT-DSK1 | 395.00 |
| California Computer 2422A with CPM | CCS-2422 | 339.00 |
| Morrow Disk Jockey II with CPM 2.2 | MDS-DJ2 | 350.00 |
| Morrow Disk Jockey I with CPM, sgl. Den | MDS-DJ1 | 225.00 |
| Tarbell Electronics double density | TAR-DDC | 419.00 |
| Tarbell Electronics single density | TAR-SDC | 279.00 |
| Fulcrum DMA OmniDisk, I/O to hard disk | FCM-OD1 | 389.00 |

### CPM OPERATING SYSTEM

| | | |
|---|---|---|
| Digital Research CP/M 3.0, 8" sgl. den | DRC-CpM30 | 249.00 |
| Godbout CPM 2.2 for Disk 1 | GBT-CpM22 | 159.00 |
| Godbout CPM86 for 8088 and 8086 | GBT-CpM85 | 265.00 |
| Tarbell Electronics CPM 2.2 | TAR-CpM22 | 159.00 |

### HARD DISK CONTROLLERS

| | | |
|---|---|---|
| Octagon hard disk controller with E.C. | OCT-HD1 | 475.00 |
| Godbout Disk 2, 8" & 14" hard disk | GBT-DSK2 | 569.00 |
| Godbout Disk 3, for 5¼" Winchesters | GBT-DSK3 | |
| Morrow Designs controller for 5¼" Win | MDS-W506 | 495.00 |
| Western Digital new WD-1001 (not S-100) | WDI-1001 | 495.00 |

### EPROM BOARDS

| | | |
|---|---|---|
| Inner Access EPROM Ifd, programs 27128 | IAC-P100 | 465.00 |
| Digital Research PROM board 32K | DGR-P32 | 119.00 |

### STATIC MEMORY BOARDS

| | | |
|---|---|---|
| Godbout Ram 16 64K 16 bit data trans | GBT-R16 | 459.00 |
| Godbout Ram 17 64K 8 bit 24 bit address | GBT-R17 | 359.00 |
| Godbout Ram 21 128K byte 16 transfer | GBT-R21 | 859.00 |
| Fulcrum OmniRam 8-16 transfer bank | FCM-R816 | 395.00 |
| California Computer 2116 8 bit only | CCS-2116 | 249.00 |

### DYNAMIC MEMORY BOARDS

| | | |
|---|---|---|
| California Digital 256K expand to 1 Meg | CAL-D256 | 495.00 |
| California Comp. 2066 64K bank select | CCS-2066 | 295.00 |

### INTERFACE BOARDS

| | | |
|---|---|---|
| Godbout Interfacer 1 2 serial ports | GBT-133A | 239.00 |
| Godbout Interfacer II 1 serial 3 par I ports | GBT-150A | 269.00 |
| Godbout Interfacer III with 5 serial ports | GBT-135A | 495.00 |
| Godbout Interfacer III with 8 serial ports | GBT-138A | 585.00 |
| Godbut Interfacer IV 3 serial 2 parallel | GBT-187A | 329.00 |
| California Computer 2710 4 serial ports | CCS-2710 | 279.00 |
| California Computer 2719 2 serial 2 par I | CCS-2719 | 295.00 |
| California Computer 2720 4 port par | CCS-2720 | 219.00 |
| California Computer 2830 6 port serial | CCS-2830 | 329.00 |
| Morrow Designs Multboard 3 S 2P | MDS-MTL1 | 319.00 |

### SPECIAL FUNCTION BOARDS

| | | |
|---|---|---|
| Hayes S-100 Micromodem 300 baud | HYS-M100 | 325.00 |
| QT Computer clock calendar battery | QTC-CC100 | 139.00 |
| Godbout System support board 4K EPROM | GBT-SYS1 | 359.00 |
| Godbout System support board 9511 math | GBT-S9511 | 539.00 |
| Dual Systems, 4 channel 12 bit D/A conv | DSC-AOM12 | 619.00 |
| Dual System 12 bit resolution 32 ch A/D | DSC-AIM12 | 624.00 |
| Mullins Opto-Isolator controls 8 ch | MUL-ICB10 | 179.00 |
| Mullins extender board with logic & probe | MUL-184 | 79.00 |
| I/O Technology wire wrap prototype | IOT-W100 | 49.00 |
| Artec Electronics wire wrap prototype | ART-WW100 | 25.00 |
| Artec Electronics general purpose solder | ART-GP100 | 25.00 |

### MAINFRAMES & MOTHER BOARDS

| | | |
|---|---|---|
| Eclipse Data stainless 22 slot | EDP-100 | 695.00 |
| Godbout Enclosure 2 20 slots | GBT-MF20 | 675.00 |
| California Computer 2200 12 slot | CCS-2200 | 479.00 |
| California Digital 18 slot mother board | CAL-MB18 | 35.00 |
| Godbout 12 slot mother board assembled | GBT-MB12 | 149.00 |

# CP/M SOFTWARE

| | | |
|---|---|---|
| AdaSoft CP/M | ADA-445C | 395.00 |
| D-Base II | ASH-015C | 429.00 |
| Wordstar | MPR-187C | 309.00 |
| Mailmerge | MPR-392C | 169.00 |
| Spellstar | MPR-429C | 169.00 |
| Multiplan | MSF-483C | 189.00 |
| Macro 80 | MSF-187C | 139.00 |
| Supersoft | MPR-309C | 149.00 |
| MAC | DGR-401C | 85.00 |
| CP/M 3.0 | DGR-410C | 249.00 |
| Despool | DGR-367C | 45.00 |
| Pascal Plus | DGR-004C | 429.00 |
| CP/M 86 | DGR-186C | 239.00 |
| MP/M II | DGR-208C | 379.00 |

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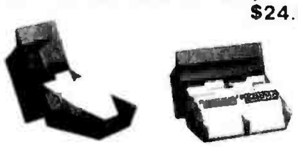
The Flip Sort Plus™ adds new dimensions to storage. Designed with similar elegant lines as the original Flip Sort™, in a transparent smoked acrylic. Holds over 100 diskettes and has all the outstanding features you have come to expect from the Flip Sort Family.

**$24.95**



## The FLIP SORT™

The new Flip Sort™ has all the fine qualities of the original Flip Sort™, with some added benefits. Along with a new design, capacity has been increased 50% to hold 75 diskettes and the price is more reasonable than ever – **$19.95**

### Z-80

#### 2.5 MHZ

| | |
|---|---|
| Z80-CPU | 3.90 |
| Z80-CTC | 3.95 |
| Z80-DART | 10.95 |
| Z80-DMA | 13.95 |
| 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 | 4.29 |
| Z80A-CTC | 4.90 |
| Z80A-DART | 9.95 |
| Z80A-DMA | 12.95 |
| Z80A-PIO | 4.29 |
| 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 |
| Z80B-DART | 12.95 |

### ZILOG

| | |
|---|---|
| Z6132 | 33.95 |
| Z8671 | 38.95 |

### DISC CONTROLLERS

| | |
|---|---|
| 1771 | 15.95 |
| 1791 | 23.95 |
| 1793 | 25.95 |
| 1795 | 48.95 |
| 1797 | 48.95 |
| 2791 | 53.95 |
| 2793 | 53.95 |
| 2795 | 58.95 |
| 2797 | 58.95 |
| 6843 | 33.95 |
| 8272 | 38.95 |
| UPD765 | 38.95 |
| MB8876 | 28.95 |
| MB8877 | 33.95 |
| 1691 | 16.95 |
| 2143 | 17.95 |

### UARTS

| | |
|---|---|
| AY3-1014 | 6.90 |
| AY5-1013 | 3.90 |
| AY3-1015 | 6.90 |
| PT-1472 | 9.90 |
| TR1602 | 3.90 |
| 2350 | 9.90 |
| 2651 | 8.90 |
| TMS6011 | 5.90 |
| IM6402 | 7.90 |
| IM6403 | 8.90 |
| INS8250 | 9.95 |

### INTERFACE

| | |
|---|---|
| 8T26 | 1.54 |
| 8T28 | 1.84 |
| 8T95 | .88 |
| 8T96 | .88 |
| 8T97 | .88 |
| 8T98 | .88 |
| DM8131 | 2.90 |
| DP8304 | 2.24 |
| DS8835 | 1.94 |
| DS8836 | .98 |

### VOLTAGE REGULATORS

| | | | |
|---|---|---|---|
| 7805T | .74 | 7905T | .84 |
| 78MO5C | .34 | 7908T | .84 |
| 7808T | .74 | 7912T | .84 |
| 7812T | .74 | 7915T | .84 |
| 7815T | .74 | 7924T | .84 |
| 7824T | .74 | | |
| 7805K | 1.34 | 7905K | 1.44 |
| 7812K | 1.34 | 7912K | 1.44 |
| 7815K | 1.34 | 7915K | 1.44 |
| 7824K | 1.34 | 7924K | 1.44 |
| 78L05 | .68 | 79L05 | .78 |
| 78L12 | .68 | 79L12 | .78 |
| 78L15 | .68 | 79L15 | .78 |
| 78H05K | 9.90 | LM323K | 4.90 |
| 78H12K | 9.90 | UA78S40 | 1.90 |

C.T = TO-220 K = TO-3 L = TO-92

### DIP SWITCHES

| | |
|---|---|
| 4 POSITION | .84 |
| 5 POSITION | .89 |
| 6 POSITION | .89 |
| 7 POSITION | .94 |
| 8 POSITION | .94 |

### IC SOCKETS

| | 1-99 | 100 |
|---|---|---|
| 8 pin ST | .12 | .10 |
| 14 pin ST | .14 | .11 |
| 16 pin ST | .16 | .12 |
| 18 pin ST | .19 | .17 |
| 20 pin ST | .28 | .26 |
| 22 pin ST | .29 | .26 |
| 24 pin ST | .29 | .26 |
| 28 pin ST | .39 | .31 |
| 40 pin ST | .48 | .38 |
| 64 pin ST | 4.20 | call |

ST = SOLDERTAIL

| | | |
|---|---|---|
| 8 pin WW | .58 | .48 |
| 14 pin WW | .68 | .51 |
| 16 pin WW | .68 | .57 |
| 18 pin WW | .98 | .89 |
| 20 pin WW | 1.04 | .97 |
| 22 pin WW | 1.34 | 1.23 |
| 24 pin WW | 1.44 | 1.30 |
| 28 pin WW | 1.64 | 1.44 |
| 40 pin WW | 1.94 | 1.75 |

WW = WIREWRAP

| | |
|---|---|
| 16 pin ZIF | 5.90 |
| 24 pin ZIF | 7.90 |
| 28 pin ZIF | 8.90 |

ZIF = TEXTOOL (Zero Insertion Force)

### CRYSTALS

| | |
|---|---|
| 32.768khz | 1.69 |
| 1.0 mhz | 3.69 |
| 1.8432 | 3.69 |
| 2.0 | 2.69 |
| 2.097152 | 2.69 |
| 2.4576 | 2.69 |
| 3.2768 | 2.69 |
| 3.579535 | 2.69 |
| 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 |
| 14.31818 | 2.69 |
| 15.0 | 2.69 |
| 16.0 | 2.69 |
| 17.430 | 2.69 |
| 18.0 | 2.69 |
| 18.432 | 2.69 |
| 20.0 | 2.69 |
| 22.1184 | 2.69 |
| 32.0 | 2.69 |

### RESISTORS

*¼ WATT 5% CARBON FILM, ALL STANDARD VALUES FROM 1 OHM TO 10 MEG OHM*

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| 50 pcs | 1.25 |
| 100 pcs | 2.00 |
| 1000 pcs | 15.00 |

### 5¼" DISKETTES
### ATHANA

| | |
|---|---|
| SSSD | 18.95 |
| SSDD | 22.95 |
| DSDD | 27.95 |

### BULK DISKETTES
### 5¼" DISKETTES
### NO LABEL

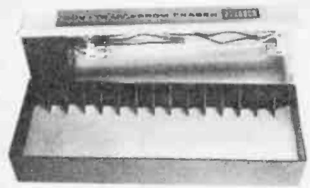
SINGLE SIDED DOUBLE DENSITY (WITH JACKETS AND HUB RING)

| | |
|---|---|
| Pack of Ten | $ 16.95 |
| Pack of 100 | $149.00 |

# SPRING SPECIALS

| | | |
|---|---|---|
| 4116 | 250ns | 49¢/ea |
| 4116 | 200ns | 89¢/ea |
| 2708 | 8K EPROMS | 2.49 |
| 2716 | 16K EPROMS | 2.95 |
| 2732 | 32K EPROMS | 3.95 |
| 2764 | 64K EPROMS | 5.95 |
| 27128 | 128K EPROMS | 19.95 |
| 4164 | 64K DYNAMIC 250ns | 4.45 |
| 4164 | 64K DYNAMIC 200ns | 5.45 |
| 4164 | 64K DYNAMIC 150ns | 6.45 |
| 2114 | 450ns | 8/7.95 |

## QUV-T8/1 EPROM Eraser



**$57.95**

**QUV-T8/1 Economy Model:** This is a low cost EPROM Eraser housed in a plastic enclosure. The UV element and components are installed in the top lid and you place the EPROMS in the bottom half. No timer or switch option is included.

- Erases up to 8 EPROMS in 15 to 20 minutes.
- 12,000 u Watts at 1" distance.
- 90-Day Warranty

DoKay

2100 De La Cruz Blvd.
Santa Clara, CA 95050

Circle 142 on inquiry card.

# SYSTEMS

## CUSTOMER SERVICE AND RETURNS

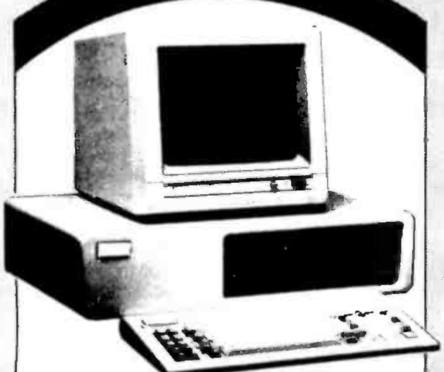
CALL DAVID 1-801-972-2739

Prices subject to change without notice

# The Great Salt Lake Computer Company, Inc.

Larger PS for IBS can be purchased to run 4 drives 10A or 12A PS.

## COLUMBIA



**COLUMBIA (1600-1)** 16 bit, 128K RAM 2 ea. 320K Disk Drive-2 SER, 1 PAR, Key Bd. 8 slots Display Cd., bundled software .......... CALL
**COLUMBIA** 1600-4 Same as 1600-1 except has 12MB Hard Disk & only 1 F.D. .......... CALL
**COLUMBIA MPC-VP** Portable 16/BIT 128K RAM 2 each 320K. drives SER & PAR Port. 9" monitor. bundled software .......... CALL

Service —
Bell & Howell Co. Nationwide

## NEC PORTABLE

**PC8201A**-Portable 2.4 MHZ CPU 16K Ram/ Expands to 64K-32K RAM LCD Display—Keybd (67 key-5 function) Modem, Serial and Par Port-FD and Cassette Interface—Uses 4AA Batt—bundled software .......... 660.00
**8201-06** Ram Chip - (8k) modl .......... 105.00
**8206-A** 32k Ram Cartridge - modl .......... 329.00
**8221-A** Thermal Printer - prnt .......... 149.00
**8271-02** AC Adapt/Print & Rec. - accs .......... 15.00
**8271-A** AC Adaptor - accs .......... 17.00
**8281-A** Cassette Recorder - accs .......... 105.00
**8201A-90** Nicad Battery Pak - accs .......... 16.00
Modem Communication Cable - accs .......... 25.00
Thermal paper for 8221-A - accs (5 rolls per pack) .......... 13.00

## SANYO PORTABLE

MBC-550 — 128K, 1 FD w/Word Star, Easywriter, Calcstar .......... 849.00
MBC-555 — 128K, 2 FD. w/Word Star, Easywriter, Calcstar, Mailmerge, Spellstar, Infostar .......... 1,149.00

Circle 186 on inquiry card.

## IBM

**IBM PC-1**—Includes 64K RAM, 1 ea. 320K Disk Drive .......... 1,995.00
**IBM PC-2**—Includes 64 RAM, 2 ea. 320K Disk Drive .......... 2,250.00
**IBM PC-3**—Includes 256K RAM, 2 ea. 320K Disk Drive, IBM Mono Adapter, IBM Mono Display .......... 2,999.00
**IBM PC-4**—Includes 256K RAM, 2 ea. 320K Disk Drive, Peacock Color Card, Princeton HX 12 Display .......... 3,395.00

*IBM-XT*

• 128K RAM • 1 ea 320K F.D. • 1 ea. 10MG Hard Disk .......... 4,695.00
8087 CPU .......... 198.00

## EAGLE

**PC-2** —"The ORIGINAL Version"
*Features* 128K RAM • 2 ea. 320K F.D. • Serial • Parallel • MS/DOS • 12" Grn Monitor • Bundled Software .......... 2,595.00

**PC+2** — "The NEW Version"
• Same as PC-2 except has no Monitor or Mono Adapter • Software consists of GW Basic, MS/DOS & CPM 86 .......... 2,295.00

## IBM SOFTWARE

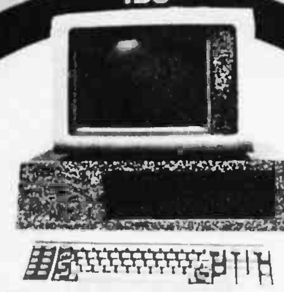
**ASTON-TATE** — D-Base II .......... 389.00
**CONTINENTAL** — Home Accountant .......... 89.00
**MICRO-PRO** — Mail Merge .......... 129.00
**MICRO-PRO** — Spell Star .......... 129.00
**MICRO-PRO** — Word Star .......... 279.00
**MICRO-PRO** — Calc Star .......... 119.00
**MICROSOFT** — Word with Mouse .......... 329.00
Multi-Plan .......... 175.00
Multi-Plan Financial .......... 69.00
**T-MAKER** — T-Maker 3 .......... 169.00
**S.S.I.** — Word Perfect .......... 349.00

**TELECOMMUNICATIONS FOR MODEM SOFTWARE**

**UNITED SOFTWARE** — ASC II Express .......... 99.00
**MICRO-STUFF** — Cross-Talk .......... 139.00

**LOTUS 1-2-3** .......... 339.00

## IBS



**IBM "LOOK-A-LIKE"**

**PC-2000** — Basic Mainframe .......... 995.00
***FEATURES***
- 5 Slot Mother Bd w/64K (Expands to 256K)
- Power Supply w/Fan
- Lo-Profile Keybd - 96 Key
- 2 ea Serial • 1 ea PAR
- Space for 4 ea. ½ HGT Drives or 2 Full Size.
- Will run PC/DOS or MS/DOS
- Will run all MS/DOS Compatible Software

**PC-2001** — Includes 64K RAM, 1 ea. 320K F.D. .......... 1,395.00
**PC-2002** — Includes 64K RAM, 2 ea. 320K F.D. .......... 1,650.00
**PC-2003** — Includes 256K RAM, 2 ea. 320K F.D., Video CD, 12" 310A Mono Display .......... 1,995.00
**PC-2004** — Includes 256K RAM, 2 ea. 320K F.D., Color Cd. Princeton Color Monitor .......... 2,499.00

## APPLE FRANKLIN

**APPLE** IIE Starter—Includes CPU 1 F.D. Monitor and Stand .......... 1,325.00
**FRANKLIN ACE** 1000 w/color .......... 799.00
**FRANKLIN ACE** 1200 OMS Includes CPU-2 F.D. and bundled software .......... 1,699.00

## APPLE SOFTWARE

**APPLE** — Apple Writer 2 .......... 79.00
**ASHTON-TATE** — D-Base II .......... 409.00
**MICRO PRO** — Word Star .......... 249.00
**MICROSOFT** — Macintosh Basic .......... 125.00
**MICROSOFT** — Multi-Plan (Specify) .......... 175.00
**MICROSOFT** — Multi-Tool Financial .......... 75.00
**MICROSOFT** — Typing Tutor II .......... 17.95
**SILICON VALLEY** — "The Handlers" (3 pkg) 39.00
**SILICON VALLEY** — List Handler .......... 35.00
**SILICON VALLEY** — Spell Handler .......... 50.00
**SILICON VALLEY** — Word Handler .......... 39.00
**SILICON VALLEY** — Easy Learner .......... 11.95
**SILICON VALLEY** — Rapid Reader .......... 11.95
**SILICON VALLEY** — Toddler's Tutor .......... 11.95
**SILICON VALLEY** — Turbo Charger .......... 11.95
**SILICON VALLEY** — The Collector .......... 11.95
**SILICON VALLEY** — Lancaster (Shoot Game) 9.95
**T-MAKER** (Needs CPM Card) .......... 149.95

**VISICORP**

Visicalc (Specify 2 or E) .......... 179.95
Visidex (Specify 2 or E) .......... 179.95
Visitrend/Plot (Specify 2 or E) .......... 229.00

1780 West 2300 South Salt Lake City, Utah 84119

TOLL FREE 1-800-545-2633

CUSTOMER SERVICE AND RETURNS

CALL DAVID 1-801-972-2739

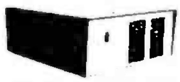
Prices subject to change without notice

# The Great Salt Lake Computer Company, Inc.

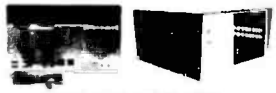
## QT PRODUCTS

S-100

**QT 8" THINLINE MAINFRAME**
•Provisions for 2 ea 8" thinline drives• 6 ea DB 25 cutout•2 ea 50 pin•2 ea 34 pin•1 ea Centronic •EMI filter (fused)•2 AC outlets•Power supply (+8V16A/-5V/+24V6A+5V6A)
QTC-IMF +DD6F (6 slot MB) ............ 350.00



**QT 5¼" MAINFRAME**
•Provisions for any 2-5¼" drives
QTC-MF + MD12 (12 slot MB) .......... 560.00



**QT 8" MAINFRAME**
•Provision for any 2-8" drives (hard or floppy)
**Desk Top Version**
QTC-MF + DD6 (6 Slot MB) ............ 575.00
QTC-MF + DD8 (8 Slot MB) ............ 625.00
QTC-MF + DD12 (12 Slot MB) .......... 675.00
All mainframes have EMI filter, 2 AC outlets, 15 ea. DB25, 2ea. 50 pin, 2 ea. 34 pin, 1 ea. Centronic cutouts, power supply for 8" MF (-5V1A/+5V5A/+8V14A/+16V3A/+24V5A)

**QT STANDARD MAINFRAME**
•Provisions for any 2-5¼" drives•15 ea DB 25 cutout •2 ea 50 pin•2 ea 34 pin•1 ea Centronic•EMI filter (fused)•2 AC outlets•Avbl with 6-8-12-18 or 22 slot MB•Power supply (+8V16A-16V3A)
**Desk Top Version**
7014/QTC-MF + 12 ........................ 499.00
7016/QTC-MF + 18 ........................ 525.00
7015/QTC-MF + 22 ........................ 550.00

### CARD CAGES/MOTHERBOARDS

*IEEE-696-No termination required*

| Slots | Bare Bd | A + T | w/card cage | bare card cage |
|---|---|---|---|---|
| 4 | 20.00 | 45.00 | 65.00 | 20.00 |
| 6 | 25.00 | 53.00 | 75.00 | 22.00 |
| 8 | 30.00 | 74.00 | 105.00 | 31.00 |
| 12 | 35.00 | 104.00 | 145.00 | 41.00 |
| 18 | 50.00 | 155.00 | 205.00 | 50.00 |
| 22 | 65.00 | 190.00 | — | 75.00 |

All card cages will acommodate a 4" fan
Add $20.00 for 1 fan-Add $30.00 for 2 fans

### CLOCK/CALENDAR

S-100•Time in hrs. min. sec.•AM/PM or Military Format•Date in Mo., Day, Yr., Day of Week & Leap Year recognition•4 hard interrupts (1024 Hz. 1 Hz 1 min. 1 hr)•On board battery (will last 14 mos. w/no power on)
QTC-CCS-BB (S-100) ........................ 45.00
QTC-CCS-A (A+T) for S-100 ............. 105.00

### QT/COMPUTIME BOARD SET

**Best Bare Board Set Available**
QTC-SBC 2/4 CPU (SBC 880)
QTC-EXP + III 256K (CT256) Memory bd./ Expandable to 1 MG
QTC-FDC 5/8 Floppy disk controller
**Bare Board Set** ............................ 165.00
1) Includes manuals & assembly instructions
2) Parts available 3) Monitor & B10S available

### CPU MEMORY BOARDS

QTC-SBC 2/4 BB (SBC880) ............... 50.00
QTC-SBC 2/4 A A+T (SBC880) .......... 265.00
**DYNAMIC** (64K/256K or 1 MEG)
QTC-EXP + III Bare Bd. (CT256) .......... 75.00
QTC-EXP + III 64K A + T (CT256) ....... 375.00

**Minimum Shipping $3.00 in the Continental U.S.A.**

## COMPUPRO PRODUCTS

S-100

**SYSTEMS**
System 816A ........................ 4,395.00
System 816A with RAM 21 .......... 4,569.00
System 816A - H40 .................. 7,169.00
System 816B ........................ 5,595.00
System 816B - H40 .................. 8,349.00
System 816C ........................ 7,150.00
System 816C - H40 .................. 9,999.00
System 816D ........................ 11,099.00
System 816D - H40 .................. 13,995.00
System 816E (68K) .................. 7,150.00
System 816E - H40 .................. 9,999.00
System 816Z ........................ 3,999.00
System 816Z - H40 .................. 6,725.00

**CPU BOARDS**
CPU Z 6 MHz ........................ 245.00
CPU 8085/88 - 6/8 MHz .............. 369.00
CPU 8086 - 8 MHz ................... 650.00
CPU 8086 - 10 MHz .................. 750.00
CPU 68K - 8 MHz .................... 575.00
SPUZ (March '84) ................... 575.00

**MEMORY BOARDS**
RAM 16 ............................. 475.00
RAM 17-64 .......................... 369.00
RAM 21 ............................. 839.00
RAM 22 ............................. 1,475.00
M-DRIVE H .......................... 1,199.00

**INTERFACE BOARDS**
Interfacer 1 ....................... 220.00
Interfacer 2 ....................... 245.00
Interfacer 3 ....................... 575.00
Interfacer 4 ....................... 349.00

**DISK CONTROLLERS**
Disk 1 ............................. 399.00
Disk 1A ............................ 575.00
Disk 2 (In 1. CP/M 80) ............. 750.00
Disk 3 ............................. 750.00

**DISK DRIVE SUBSYSTEMS**
8" Floppy/H-40 ..................... 4,595.00
8" Dual H-40 w/encl. ............... 6,000.00
Dual Floppy Subsystem .............. 2,695.00

**MOTHERBOARDS AND COMPUTER ENCLOSURES**
6 Slot Motherboard ................. 129.00
12 Slot Motherboard ................ 149.00
20 Slot Motherboard ................ 220.00
Enclosure 2-D ...................... 739.00
Enclosure 2-R ...................... 795.00

**MISCELLANEOUS BOARDS/CONTROLLERS**
Memory Manager ..................... 75.00
System Support 1 ................... 349.00
MPX 1 .............................. 495.00
Active Terminator .................. 60.00
8087 Support Board for 8085/88 ..... 379.00
WARRANTY: 1 year from date of purchase by end user.

**OPERATING SYSTEMS**
CP/M 2.2 (Disk 1) .................. 150.00
CP/M 86 (Disk 1 8085/88) ........... 199.00
MP/M 8-16 (For 8085/88) ............ 495.00
MAP FORTH OS ....................... 169.00
CP/M 68K ........................... 269.00

## SIERRA DATA

**SIERRA DATA S-100 BOARDS**
SDS-SBC-100-Z80 (4mhz) master 2 serial 2 par/floppy controller/64k ram ........ 655.00
SDS-SBC-100S4mhs slave/2 serial 2 par/64k ram ........................ 565.00
SDS-ZSIO/4-4 serial port I/O bd ....... 250.00
SDS-MUX-RS232 multiplexer bd .......... 235.00
SDS-HDI-M-Hard disk bd for micropolis . 129.00
SDS-CPM/B105-cp/m for SBC 100 w/BIOS ........................ 150.00
SDS-Turbodos-Multi-user for master & slaves ........................ 645.00

## E-PROM ERASERS

**E-PROM ERASERS**
QUV-T8/1H (hobby) .................. 49.95
QUV-T8/2 I (industrial version) .... 68.95
QUV-T8/2P (w/timer & safety switch) .... 97.50

## MODEMS

Anchor Volkmodem — 300 Baud Orig/Answer
Direct Connect ......................... 69.00
Cable for Above ........................ 9.95
Hayes 300 .............................. 219.00
Hayes 1200 ............................. 499.00
Novation D-CAT ......................... 159.00
Novation J-CAT ......................... 109.00
U.S. Robotics "Password" — 300/1200 . 375.00

### OUR BEST BUY

**ANCHOR MARK XII**
300/1200 Band Auto Answer/Auto Dial Direct Connect Intelligent Modem w/RS 232 Cable Included 2 Telephone Jacks, Low Power (60 MA) Dial Tone Detect .................... 279.00

## DISPLAY MONITORS

**GREEN**
BMC 12AU (15MHZ) 80 Col/12" ......... 80.00
USI PI-1 (20 MHZ) Hi-Res/9" .......... 119.00
USI PI-2 (20 MHZ) Hi-Res/12" ......... 129.00

**AMBER**
USI PI-4 (20 MHZ) Hi-Res/80-Col/9" ... 125.00
USI PI-3 (20 MHZ) Hi-Res/80 Col/12" .. 119.00

**COLOR**
Amdek I-12" Composite (For Apple) ..... 259.00
Amdek I + Composite w/audio ......... 275.00
Amdek II-12"-RGB (For IBM-PC) w/audio 419.00

### OUR BEST BUY

***OUR BEST BUY FOR APPLE***
SAKATA SC-100 Best Composite Video for Apple According to Creative Computing Analysis 275.00
***OUR BEST BUY FOR IBM***
Princeton HX-12-RGB (For IBM-PC) .... 469.00

## TERMINALS

**ADDS**
Viewpoint-A1 (White) ................ 509.00
Viewpoint-A2 (Green) ................ 539.00
Viewpoint-3A + (Green) .............. 509.00
Viewpoint 60-Same as Televideo 925 ... 715.00

**QUME**
QVT-102 80 Col. Green (910 comp) ..... 549.00
QVT-102 80 Col. Amber ................ 560.00
QVT-103 80/132 Col. Green ............ 865.00
QVT-103 80/132 Col. Amber ............ 895.00
QVT-108 80/132 Col. Amber (925 comp) 715.00

**TELEVIDEO**
TV910 ................................ 529.00
TV910+ ............................... 565.00
TV925 ................................ 715.00
TV950 ................................ 925.00
TV970 ................................ 1,019.00
2nd Page Memory ................... ADD 25.00
RG 1000/TV60 Graphics Upgrade for 925/950 .......................... 1,100.00

### AC SURGE ELIMINATORS

Lemon (6AC outlets-3 prong) .......... 44.00
Lime (5'-3 prong pwr cord w/on-off switch) 69.00
Orange-AC surge + EMI filter (6 outlets) .. 95.00
Peach (3 outlets) AC surge/EMI filter ..... 69.00
Grizzly (200W) uninterruptible power system + surge protection ...................... 799.00
Grizzly (500W) uninterruptible power system + surge protection ...................... 1850.00

**RELAX TECHNOLOGY**
**Both in Metal Enclosures**
**POWER CONTROL 1** ..................... 59.95
• Master Control. Switch, 3 PWR Switch, AC Surge Protect. 6 ft. cord. 4 PWR Outlets Metal Enc.
**POWER CONTROL 2** ............ 79.95
Same except has RFI Noise Suppressor

Circle 187 on inquiry card.

*1780 West 2300 South Salt Lake City, Utah 84119*

# PRIORITY ONE ELECTRONICS

# LOWER PRICES-BETTER SERVICE

CompuPro®


## 20 Slot IEEE 696/S-100 Mainframe with Constant Voltage Transformer

During their recent move, CompuPro discovered a few pallets of their 1983 model mainframes. They do not include most of the current cosmetic features such as shrouded/protected reset switch, or multiple rectangular cutouts on the rear panel for hard disks. As last year's model, we can offer these mainframes at tremendous savings!

- Power supply: 8V @ 25A, ±16V @ 3A
- Forced Air Cooled with Filter
- AC Line Filter and Convenience Outlets
- Rear Panel Punched for Multiple "D" Connectors
- Lighted Reset Switch
- 90 Day Warranty

| Desk Top | Rack Mount |
|---|---|
| List Price: $925.00 | List Price: $975.00 |
| **$595** | **$649** |
| BESPP04 | BESPP04RM |
| (Sh. Wt. 55 lbs.) | (Sh. Wt. 55 lbs) |

## Dual QUME 8" Floppy Drive Subsystem With S100 DMA Controller and CP/M 816™!!!

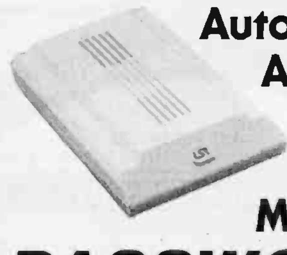
***2.4 Mbytes of On Line Storage!***

**Sale Price $1495.**

***SAVE OVER $1500.***

BESPP02 (shipping weight: 55lbs.)

U.S. ROBOTICS INC



## Auto Dial/ Answer 1200 Baud Modem

# PASSWORD

BEUSRPASSWORD List Price: $449.00

**SALE PRICE $295**

(Sh. Wt. 3 lbs.)

## BUY From The WORLDS LARGEST SUPPLIER of S-100 Boards!!

CompuPro®

### CPU BOARDS

| | | List Price | Sale Price |
|---|---|---|---|
| BEGBT51068 | CPU 68K A&T 8MHz | $ 695.00 | $ 488.95 |
| BEGBT51568 | CPU 68K CSC 10MHz | $ 850.00 | $ 765.00 |
| BEGBT51086 | Co-Processor w/8086 only A&T | $ 750.00 | $ 494.95 |
| BEGBT51586 | Co-Processor w/8086 only CSC | $ 850.00 | $ 696.95 |
| BEGBT51087 | CPU 8086/8087 A&T | $1050.00 | $ 939.00 |
| BEGBT51587 | CPU 8086/8087 CSC | $1150.00 | $1085.00 |
| BEGBT51080 | CPU 8085/88 A&T | $ 495.00 | $ 348.95 |
| BEGBT51580 | CPU 8085/88 CSC | $ 595.00 | $ 497.67 |
| BEGBT51060 | 3/6MHz CPU-Z A&T | $ 325.00 | $ 226.95 |
| BEGBT51560 | 3/6MHz CPU-Z CSC | $ 425.00 | $ 347.87 |

### DISK CONTROLLER BOARDS

| | | | |
|---|---|---|---|
| BAPDB171ACPM | DISK 1 (A&T) w/CP/M® 2.2 | $670.00 | $489.00 |
| | ***When purchased with two 8" disk drives:*** | | $450.00 |
| BEGBT54018 | DISK 1 Floppy controller (A&T) | $495.00 | $425.00 |
| BEGBT41000 | CP/M® 2.2 for Z80/8085 w/manuals & BIOS, 8" S/D Disk | | $146.95 |
| BEGBT41050 | CP/M-86® for CPU 8085/88 & CPU 8086/87 CPUs w/manuals, BIOS 8" S/D Disk | | $249.00 |
| BEGBT54025 | DISK 2 8" hard disk controller w/CP/M® 2.2 (A&T) | $795.00 | $556.95 |
| BEGBT54030 | DISK 3 ST-506 type 5¼" hard disk controller w/CP/M-80® & CP/M-86® (A&T) | $795.00 | $558.95 |

### I/O BOARDS

| | | | |
|---|---|---|---|
| BEGBT56010 | System Support 1 Multifunction I/O (A&T) | $450.00 | $318.95 |
| BEGBT56010/56531 | SS1 w/8231 Math Chip A&T | $645.00 | $570.00 |
| BEGBT56010/56320 | SS1 w/8232 Math Chip A&T | $645.00 | $570.00 |
| BEGBT53030 | Interfacer 3 - 8 port serial (A&T) | $699.00 | $488.95 |
| BEGBT53040 | Interfacer 4 - 3 Serial, 1 Centronics Parallel, 1 Parallel (A&T) | $450.00 | $318.95 |

### 8/16 BIT MEMORY BOARDS

| | | | |
|---|---|---|---|
| BEGBT52016 | RAM 16 12MHz 32K Static A&T | $ 550.00 | $ 458.95 |
| BEGBT52021 | RAM 21 12 MHz 128K Static A&T | $ 995.00 | $ 805.00 |
| BEGBT52022 | RAM 22 12MHz 256K Static A&T | $1750.00 | $1226.95 |
| BEGBT52012 | M-Drive/H® 512K RAM Disk A&T | $1475.00 | $ 884.25 |

### MAINFRAMES

| | | | |
|---|---|---|---|
| BEGBT51200 | 20 Slot Desk Top (A&T) | $925.00 | $674.95 |
| BEGBT51250 | 20 Slot Rack Mount (A&T) | $975.00 | $794.95 |

**For more CompuPro Specifications see pages 2 - 33 of our New Catalog** Vector

***Manufactured by Vector Electronic Co. under license from CompuPro***

| | | | |
|---|---|---|---|
| BEVCT8800GFB | Interfacer 1, 2-Serial (A&T) | $295.00 | $219.00 |
| BEVCT8800GF2B | Interfacer 2, 3-Par., 1-Ser. (A&T) | $325.00 | $239.00 |
| BEVCT8800GR17B | RAM 17 64K 10MHz Static RAM (A&T) | $450.00 | $369.00 |

CompuPro is a registered trademark of CompuPro

SDSystems
A SYNTECH COMPANY

| | | List Price | SALE Price |
|---|---|---|---|
| BESDS38095 | SBD-300 4MHz Z80A CPU A&T | $ 741.00 | $ 619.00 |
| BESDS38092 | SBD-300 6MHz Z80B CPU A&T | $ 825.00 | $ 669.00 |
| BESDS38007 | Z80 Starter System A&T | $ 450.00 | $ 399.00 |
| BESDS38086 | ExpandoRAM IV 256K A&T | $1145.00 | $ 975.00 |
| BESDS38089 | ExpandoRAM IV 256K w/EDC A&T | $1990.00 | $1675.00 |
| BESDS38097 | ExpandoRAM III/696 256K | $ 825.00 | $ 749.00 |
| BESDS38076 | PROM-100 w/software A&T | $ 285.00 | $ 219.00 |
| BESDS38082 | RAM Disk 256K A&T | $ 875.00 | $ 775.00 |
| BESDS38061 | ROM Disc 128K A&T | $ 350.00 | $ 319.00 |
| BESDS38096 | I/O-8 4-Port Async Ser. A&T | $ 600.00 | $ 549.00 |
| BESDS38093 | I/O-8 8-Port Async Ser. A&T | $ 695.00 | $ 589.00 |
| BESDS38094 | I/O-8 4 Sync, 4 Async, 8-Port Serial I/O A&T | $ 795.00 | $ 699.00 |
| BESDS38099 | Versafloppy III Floppy & ST-506 Hard Disk Controller | $ 895.00 | $ 759.00 |
| BEPOBVF339145* | w/5¼" unbanked CP/M® 3.0 | $1083.00 | $ 886.00 |
| BEPOBVF339146* | w/8" unbanked CP/M® 3.0 | $1083.00 | $ 886.00 |
| BEPOBVF339147* | w/5¼" banked CP/M® 3.0 | $1083.00 | $ 866.00 |
| BEPOBVF339148* | w/8" banked CP/M® 3.0 | $1083.00 | $ 888.00 |
| BESDS38098 | Versafloppy II/696 (A&T) | $ 400.00 | $ 344.00 |
| BEPOBVF239141* | w/5¼" unbanked CP/M® 3.0 | $ 588.00 | $ 424.00 |
| BEPOBVF239142* | w/8" unbanked CP/M® 3.0 | $ 588.00 | $ 424.00 |
| BEPOBVF239143* | w/5¼" banked CP/M® 3.0 | $ 588.00 | $ 424.00 |
| BEPOBVF239144* | w/8" banked CP/M® 3.0 | $ 588.00 | $ 424.00 |

*CP/M-Plus™ (3.0) configured for the SBC-300

***See Complete Specifications on Pages 12-25 Of Our '83/'84 Engineering Selection Guide***

octagon

### BOARD LEVEL PRODUCT

| | | | |
|---|---|---|---|
| BEOCT8087NDP | 8087 for CPU 8/16 | | $ 300.00 |
| BEOCTCPM86 | CP/M-86® | | $ 150.00 |
| BEOCTCONCPM86 | Concurrent CP/M-86® | | $ 195.00 |
| BEOCTMPM86 | MP/M-86® | | $ 495.00 |
| BEOCTHDC | ST-506 Hard Disc Controller | $ 595.00 | $ 474.95 |
| BEOCTHDSUB19 | 19.2Mb Hard Disc Subsystem | $2295.00 | $1995.00 |
| BEOCTS256T00 | 256K Static RAM (A&T) | $1850.00 | $1719.00 |
| BEOCTD512K | 512K Dynamic RAM (A&T) | $1450.00 | $1345.00 |

***See Specifications on Pages 12-27 Of Our '83/'84 Engineering Selection Guide***

### COMPLETE OCTAGON 8/16™ SYSTEMS

| | | |
|---|---|---|
| BEOCT816SMPM | w/256K Static RAM & MP/M-86™ | $7350.00 |
| BEOCT816SCCPM | w/256K Static RAM & Concurrent CP/M-86 | $7350.00 |
| BEOCT816DMPM | w/512K Dynamic RAM & MP/M-86 | $7350.00 |
| BEOCT816DCCPM | w/512K Dynamic RAM & Concurrent CP/M-86 | $7350.00 |

***See Complete Specifications on Page 5 Of Our New '83/'84 Engineering Selection Guide***

ADVANCED DIGITAL CORPORATION

### Z80 SINGLE BOARD COMPUTERS

| Part Number | Description | List Price | SALE Price |
|---|---|---|---|
| BEADCSUP6128 | Super Six 6MHz 128K Master w/1 ADC PS1 RS232 Serial Adapter | $995.00 | $849.00 |
| BEADCSPRSLV6128 | Super Slave 6MHz 128K | $695.00 | $595.00 |
| BEADCSBC15 | Super Quad for 5¼" drives | $750.00 | $695.00 |
| BEADCSBC18 | Super Quad for 8" drives | $750.00 | $695.00 |

### SOFTWARE & I/O PORT ADAPTERS

| | | |
|---|---|---|
| BEADCPS1 | PS/Net1 RS232 Serial Adapter | $ 35.00 |
| BEADCCPSP | Centronics Parallel Port Adapter | $ 35.00 |
| BEADCCPM22*† | Advanced Digital CP/M® 2.2 | $150.00 |
| BEADCCPM30*† | Advanced Digital CP/M Plus™ (3.0) | $350.00 |
| BEADCTDOS4U*† | 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.

### ST506/SA1000 HARD DISK CONTROLLER

| | | | |
|---|---|---|---|
| BEADCHDC10015 | ST506 5¼" Winchester Cont. | $500.00 | $395.00 |
| BEADCHDC10018 | 8" Winchester Cont. | $500.00 | $395.00 |
| BEADCHDCINSTL | Install program for use with non-ADC CPU board (Supplied on 8" CP/M® compatible disk) | | $ 10.00 |

***See Complete Specifications on Pages 14 - 27 of our '83/'84 Engineering Selection Guide***

MACROTECH International Corp.

### MAX: 1 S-100 SLOT 1 MEGABYTE

The MACROTECH MAX is a 256K to 1 Megabyte S-100 IEEE/696 dynamic memory board. That's right, up to 1 Megabyte on a single standard size S-100 board. The first 384K is on the Host card that plugs into your motherboard. The remaining 640K is located on a unique "piggy-back" card that attaches to the host. The MAX family is ideally suited to applications where density, speed, and software flexibility are essential. See Page 16 Of Our New '83/'84 Engineering Selection Guide for Complete Specifications

**Ordering Information:** The 256K and 384K versions include the fully socketed Host card. The 512K and larger versions also include the fully socketed "piggy-back" card.

| | | List Price | SALE Price |
|---|---|---|---|
| BEMACMAX256 | 256K Dynamic RAM (A&T) | $1125.00 | $1165.00 |
| BEMACMAX384 | 384 Dynamic RAM (A&T) | $1467.00 | $1395.00 |
| BEMACMAX512 | 512K Dynamic RAM (A&T) | $1880.00 | $1795.00 |
| BEMACMAXM | 1 MEG Dynamic RAM (A&T) | $2449.00 | $2325.00 |
| BEMACM3 | Memory Mapping Option | | $ 91.00 |

**Attention CompuPro CPU 8085/88 Users:** You must order the CPU modification hardware to insure complete compatibility.

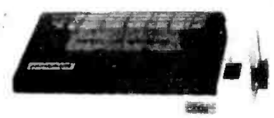
| | | |
|---|---|---|
| BEMACGBTM00 | Hardware modification for CompuPro CPU 8085/88 | $ 10.00 |

## ORDER TOLL FREE (800) 423-5922 - CA, AK, HI CALL (818) 709-5111

# PRIORITY ONE ELECTRONICS

## PRINTERS

star



**$289**

| Part Number | Description | List Price | Our Price |
|---|---|---|---|
| BESTRGEMIOX | 120 cps, 80 col. (20 lbs.) | $399.00 | $369.00 |
| BESTRGEMI5X | 120 cps, 132 col. (26 lbs.) | $649.00 | $399.00 |
| BESTRSERINTX | Serial Interlace for 10X and 15X | | $ 59.00 |
| BESTRSERINTX4K | Same as above with 4K Buffer | | $119.00 |
| BESTRDELTA10 | 160 cps, 80 col. (20 lbs.) | $649.00 | $489.00 |
| BESTRDELTA15 | 160 cps, 132 col. (20 lbs.) | $799.00 | $699.00 |
| BESTRPOWERTYPE | 18 cps Letter Quality (25 lbs.) | | $449.00 |

### MANNESMAN-TALLY
### Letter Quality Dot Matrix Printers

| | | |
|---|---|---|
| BETALMT160L | 160 cps, 80 col. (21 lbs.) | **$579** |
| BETALMT180L | 160 cps, 132 col (28 lbs.) | **$799** |
| BETALMTRIB160 | Replacement Ribbon for MT160L | $15.75 |
| BETALMTRIB180 | Replacement Ribbon for MT180L | $17.60 |

### PRINTER CABLES

| | | |
|---|---|---|
| BEPGC36CP72CP | Centronics Male to Male 6' | $24.95 |
| BEPGC250P72CP | IBM PC™ to Centronics Parallel 6' | $34.95 |
| BEPGC251PGP | 6' 9 conductor shielded RS-232 | $19.95 |

### PRACTICAL PERIPHERALS PRINTER BUFFERS

### MICROBUFFER - Stand Alone Buffer

| | | | |
|---|---|---|---|
| BEPRPMB1S64 | 64K Serial | $349.00 | $269.00 |
| BEPRPMB1P64 | 64K Parallel | $349.00 | $269.00 |
| BEPRPMEM64 | 64K Expansion Module | $179.00 | $145.00 |

### MICROBUFFER II+ For Apple II/IIe
**16K, Expandable to 64K. Extensive Graphics. Serial & Parallel Ports.**

| | | | |
|---|---|---|---|
| BEPRPMB2PLUS16S | w/Serial Calbe | $259.00 | $189.00 |
| BEPRPMB2PLUS16P | w/Parallel Cable | $259.00 | $189.00 |
| BEPRPGRAPHICARD | Graphics Only Card | $ 99.00 | $ 85.00 |
| BEPRPPRINTERFACE | Centronics Paralle I/O Card | $ 75.00 | $ 59.00 |

### BUFFERS FOR EPSON PRINTERS
**Compatible with EPSON MX, FX, RX Series' and IBM Printers**

| | | | |
|---|---|---|---|
| BEPRPM8S8 | Serial 8K buffer | $159.00 | $129.00 |
| BEPRPMBP16 | Parallel 16K buffer | $159.00 | $129.00 |

## VIDEO MONITORS

### SANYO
### 12" 80 x 24 18MHz

| Part Number | Description | List Price | Sale Price |
|---|---|---|---|
| BESYODM8012CX | Black & White Display | $240.00 | $149.00 |
| BESYODM9012CX | B&W w/Audio | $260.00 | $165.00 |
| BESYODM8112CX | Green P31 Display | $240.00 | $149.00 |
| BESYODM9112CX | Green P31 w/Audio | $260.00 | $165.00 |
| BESYODM8212CX | Amber Display | $240.00 | $149.00 |
| BESYODM9212CX | Amber w/Audio | $260.00 | $165.00 |

### 13" RGB COLOR w/AUDIO

| | | | |
|---|---|---|---|
| BESYODM6500 | Medium Res. 350 x 350 lines | $495.00 | $349.00 |
| BESYODM7500 | High Res. H480 x U240 dots | $725.00 | $499.00 |
| BESYODM8500 | Ultra High H690 x V240 dots | $1085.00 | $799.00 |

(Shipping Weights on above monitors: 12": 24 lbs. ea / 13" color: 30 lbs. ea.)

### TAXAN
### 12" 80 x 24 18MHz

| | | | |
|---|---|---|---|
| BETAXKG12NUY | Amber Display | $189.00 | $129.00 |
| BETAXKG12N | Green Display | $179.00 | $119.00 |

### 12" RGB COLOR

| | | | |
|---|---|---|---|
| BETAXRGB1 | Medium Res. 310 lines | $399.00 | $349.00 |
| BETAXRGB3 | Super High Res. 630 lines | $699.00 | $449.00 |
| BETAXRGB420 | IBM Look-Alike, 630 lines | $699.00 | $495.00 |

## 15M Byte Hard Disk For IBM PC™
## 50% More Capacity Than The XT™!

International Instrumentation Incorporated

- Plug and Run — ready to go right out of the box!
- Complete with controller card, data cable, & internal mounting hardware
- Total PC/XT compatible — will boot directly from the hard disk under DOS 2.0™
- No special software needed
- 8K BIOS emulates XT command set
- Controller will support any 2 hard drives (ST506 Compatible
- Hard disk can be partitioned into 4 operating systems
- 2:1 interleaving (data transfer rate 3 times faster than XT™)

### INTERNAL 10M Byte Hard Disk With Controller
**$995**
BEIIIHDPCI10 (Sh. Wt. 22 lbs.)

### INTERNAL 15M Byte Hard Disk With Controller
**$1395**
BEIIIHDPCI15 (Sh. Wt. 11 lbs.)

### EXTERNAL 15M Byte Hard Disk With Controller
The 15Mbyte drive is mounted in a IIIHD5001 cabinet with power supply. All hardware specifications are the same.

**$1595**
BEPDBIIIHDPCX15 (Sh. Wt. 16 lbs.)
External 15 Mbyte Hard Disk w/Controller & Data Cable

**Backed By a 6-Month Warranty!**

BEIIIHDPCSDBT **$50.00**
Required disk boot program for older original PCs with 128K memory, Using 4116 - 16K memory chips

## U.S. ROBOTICS MODEMS
### 1200 Baud, Auto Dial/Auto Answer

| Part Number | Description | List Price | Our Price |
|---|---|---|---|
| BEUSRADIAL212A | 1200 baud with LEDs | $599.00 | $459.95 |
| BEUSRS100 | 1200 Baud S-100 Card | $449.00 | $395.00 |

### TELPAC COMMUNICATIONS SOFTWARE

| | | |
|---|---|---|
| BEUSRTELPAC5A | Software on Apple 5¼" Format | $ 79.00 |
| BEUSRTELPAC8 | Software on 8" SSSD CP/M® Disk | $ 79.00 |

### D.C. HAYES

| | | | |
|---|---|---|---|
| BEDCH0400P | 1200 Baud Smartmodem | $695.00 | $479.95 |
| BEDCH0200P | 300 Baud Smartmodem | $279.00 | $229.00 |
| BEDCH0300P | Chronograph | $249.00 | $199.00 |
| BEDCH0100P | MicroModem 100 | $399.00 | $298.00 |
| BEDCH0000P | MicroModem II | $379.00 | $299.00 |
| BEDCH1200B | IBM-PC™ Modem Card with Software Included | $695.00 | $479.00 |

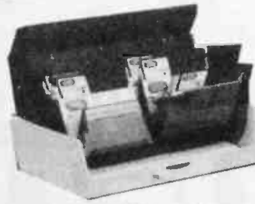
### RIXON
**1200 Baud Direct Connect w/10 Number Memory**

| | | | |
|---|---|---|---|
| BERIXR212A | 1200 Baud Stand-Alone Unit | $495.00 | $399.00 |
| BERIXPC212A | 1200 IBM PC™ Modem (2 lbs.) | $495.00 | $399.00 |
| BERIXPCCOM1 | IBM PC™ Modem Software (1 lb.) | | $ 89.00 |
| BEPDBRIXIBM | IBM Modem & Software Together (3 lbs.) | | $449.00 |

### MURA

| | | |
|---|---|---|
| BEMURMM100 | 300 Baud Modem (2 lbs.) | $99.95 $79.00 |

### FLIP 'N' FILE
### 50 Capacity



Stores 50 5¼" Diskettes (Sh. Wt. 9 lbs.)

BEINC03513139
**$29.95**

### 5¼" Double Density Soft Sector, 40 Track
**Use with IBM, Sanyo, Apple and Most Personal Computers.**

| Part Number | Manufacturer | Sides | PRICE 1 Box | 2 or More Boxes |
|---|---|---|---|---|
| BEULT51401 | ULTRA | 1 | $19.95 | $18.95 |
| BEULT52401 | ULTRA | 2 | $32.00 | $30.00 |
| BEMLXMD1M | MAXELL | 1 | $26.00 | $24.00 |
| BEMLXMD2DM | MAXELL | 2 | $39.00 | $37.00 |
| BEDSN1041D | DYSAN | 1 | $34.00 | $32.00 |
| BEDSN1042D | DYSAN | 2 | $41.00 | $39.00 |

CALL FOR HARD SECTOR & 77 TRACK DISKS NOT LISTED HERE

### 8" Double Density, Soft Sector

| | | | | |
|---|---|---|---|---|
| BEMXLFD1128M1200 | MAXELL | 1 | $44.00 | $38.00 |
| BEMXLFD2XOM1200 | MAXELL | 2 | $51.00 | $47.00 |

VISA **PRIORITY ONE ELECTRONICS** MasterCard

9161 Deering Ave., Chatsworth, CA 91311-5887

**ORDER TOLL FREE (800) 423-5922 - CA, AK, HI CALL (818) 709-5111**

Terms: U.S. VISA, MC, BAC, Check, Money Order, U.S. Funds Only. CA residents add 6½% Sales Tax. MINIMUM PREPAID ORDER $15.00. Include MINIMUM SHIPPING & HANDLING of $3.00 for the first 3 lbs. plus 40¢ for each additional pound. Orders over 70 lbs. sent freight collect. Just in case, include your phone number. Prices subject to change without notice. We will do our best to maintain prices through May 1984. Credit card orders will be charged appropriate freight. We are not responsible for typographical errors. Sale prices for prepaid orders only.

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# PRIORITY ONE ELECTRONICS

# MS-DOS™ Computer with Monitor, Printer, and Software

**SANYO**

## Hardware
**SANYO MBC555**
- 16 Bit 8088 CPU
- Socketed for Optional 8087 MPU
- 128K of RAM expandable to 256K
- Centronics Printer Port
- 2 Single Sided Disk Drives (160K Bytes Each)
- 10 Programmable Function Keys
- Speaker and Joystick Port
- Video and printer cables included

## Software
- MS-DOS™ Operating system
- SANYO BASIC

**MicroPro Software:**
- WordStar®
- SpellStar®
- CalcStar®
- DataStar®
- ReportStar®
- InfoStar®
- MailMerge®

***Runs Many Off-The-Shelf Programs for IBM-PC™***
BEPDB555SP1 w/Green Screen
BEPDB555SP3 w/Amber Screen

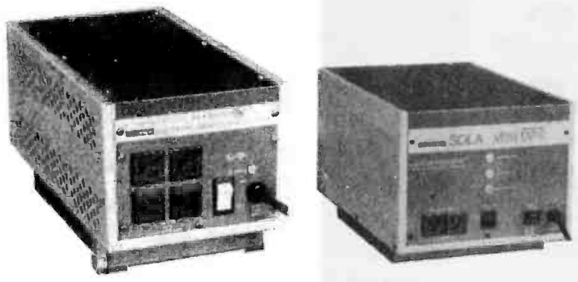
- **AMBER or GREEN Screen Monitor**
- **GEMINI 10X Dot Matrix Printer**

List Price: $2034.00

# $1495

(Shipping weights on above items: 3 boxes: 30 lbs., 30 lbs., and 20 lbs.)

***RGB Color Monitors and Letter Quality Printers may be substituted at additional cost.***



## Short-Circuit SOLA's Price-Increase!

A UNIT OF GENERAL SIGNAL GS

SOLA

**WE MAINTAIN OUR LOW PRICES THROUGH SOLA'S PRICE INCREASE!**

## MINICOMPUTER REGULATORS
- Constant Voltage
- EMI/RFI Filtering
- Total AC Isolation
- Better Than Dedicated AC Power!

| Part Number | | VA Rating | List Price | SALE PRICE |
|---|---|---|---|---|
| BESLA6313070 | 10 lbs. | 70 VA | $ 169.40 | $149.00 |
| BESLA6313114 | 18 lbs. | 140 VA | $ 259.44 | $219.00 |
| BESLA6313125 | 31 lbs. | 250 VA | $ 309.18 | $261.00 |
| BESLA6313150 | 47 lbs. | 500 VA | $ 428.84 | $362.00 |
| BESLA6313175 | 60 lbs. | 750 VA | $ 546.08 | $461.00 |
| BESLA6313210 | 75 lbs. | 1000 VA | $ 632.56 | $534.00 |
| BESLA6313220 | 108 lbs. | 2000 VA | $ 1075.54 | $895.00 |

## UNINTERRUPTABLE POWER SYSTEM!
- All The Features as a Minicomputer Regulator!
- AC Power Delivered When Power Fails!

| Part Number | VA Rating | | List Price | SALE PRICE |
|---|---|---|---|---|
| BESLA260050750300 | 750VA / 10 min. | 95 lbs. | $1862.00 | $1497.00 |
| BESLA260050400301 | 400VA / 20 min. | 125 lbs. | $1665.00 | $1406.00 |

## THE CLEAN POWER SOLUTION!

# SOFTWARE
## The Best Sellers At The Best Prices!

### IBM PC/MS™ DOS™ 5¼" FORMAT

| Part Number | Description | SALE PRICE |
|---|---|---|
| BE ASTDBIM | ASHTON-TATE - dBASE II | $389.00 |
| BE MPRPROPAKI | MICRO-PRO - WordStar professional, includes WordStar, MailMerge, SpellStar & Star Index | $425.00 |
| BE MSFMLTPLNI | MICROSOFT - Multiplan | $169.00 |
| BE SWSMMATEI | SOFTWORD SYS. - Multimate | $299.00 |
| BE ASTFRIDAYI | ASHTON-TATE - Friday! | $189.00 |
| BE OASVWDI | LIFETREE - Volkswriter Deluxe | $189.00 |
| BE SORSC3I | SORCIM - SuperCalc III | $249.00 |
| BE MCRRBASEI | MICRORIM - R:Base | $319.00 |
| BE STSSTARPARI | STAR SOFTWARE - Star Partner | $249.00 |
| BE WLFMOVI | WOOLF SOFTWARE - Move-It | $ 89.00 |
| BE HARPJMGRI | HARVARD SOFTWARE - Harvard Project Manager | $249.00 |
| BE SWPCPENAI | SOFTWARE PRODUCTS, INT. - Open Access | $369.00 |
| BE MSFBAS861 | MICROSOFT - MBASIC | $219.00 |

### CP/M-80™ 8 BIT 8" SSSD FORMAT

| Part Number | Description | SALE PRICE |
|---|---|---|
| BE DIRCB80 | DIGITAL RESEARCH - CBASIC 80 | $ 99.00 |
| BE LEXSPLBND | LEXISOFT - Spellbinder | $259.00 |
| BE SORSC280 | SORCIM - SuperCalc II | $179.00 |
| BE MPRPROPAK | MICROPRO - WordStar Professional (Includes WordStar, SpellStar, MailMerge, and Star Index) | $399.00 |
| FCMCSCRSTLK | MICROSTUFF - Crosstalk | $119.00 |
| BE MSFBAS80 | MICROSOFT - MBASIC | $219.00 |
| BE FXGQC80 | FOX & GELLER - Quickcode | $179.00 |
| BE STSSTARPAR80 | STAR SOFTWARE SYST. - Star Partner | $249.00 |
| BE ASTDB80 | ASHTON-TATE - dBASE II | $389.00 |
| BE ASTFRIDAY8 | ASHTON-TATE - Friday! | $189.00 |
| BE MSFMLTPLN | MICROSOFT - Multiplan | $169.00 |

### APPLE CP/M® & DOS™ FORMAT

| Part Number | Description | SALE PRICE |
|---|---|---|
| BE ASTDB8DA | ASHTON-TATE - dBASE II | $389.00 |
| BE MPRWDSTRZA | MICROPRO - WordStar 3.3 w/6MHz Z80 Card, 64K RAM, & CP/M 2.2® | $299.00 |
| BE MSFMLTPLNA | MICROSOFT - Multiplan | $169.00 |
| BE MSF357780 | MICROSOFT - Softcard Premium IIe (Z80A, 64K, & CP/M™, MBASIC) | $299.00 |
| BE LEXSPLBNDA | LEXISOFT - Spellbinder | $229.00 |
| BE OASWDPLUSA | OASIS - Word PLUS | $ 99.00 |
| BE MPRPROPAKOPA | MICROPRO - Prof. Optional Pack (Includes MailMerge, SpellStar, and Star Index) | $189.00 |
| BE WLFMOVA | WOOLF SOFTWARE - Move-It | $89.00 |
| BE BRDBNKWRA | BRODERBUND - Bank Street Writer | $ 49.00 |

**ORDER TOLL FREE (800) 423-5922 - CA, AK, HI CALL (818) 709-5111**

# PRIORITY ONE ELECTRONICS

## DRIVES & ENCLOSURES

### 5¼" FLOPPY DISK DRIVES

| | | |
|---|---|---|
| BEMPI51* | MPI Full Height SS 48TPI (5 lbs.) | $200.00 |
| BEMPI52* | MPI Full Height DS 48TPI (5 lbs.) | $270.00 |
| BEMPI91* | MPI Full Height SS 96TPI (5 lbs.) | $275.00 |
| BEMPI92* | MPI Full Height DS 96TPI (5 lbs.) | $400.00 |
| BEMPI501 | MPI ½-Height SS 48TPI (4 lbs.) | $280.00 |
| BEMPI502 | MPI ½-Height DS 48TPI (4 lbs.) | $300.00 |
| BETNDTM1001 | Tandon Full Height SS 48TPI | $179.00 |
| BETNDTM1002 | Tandon Full Height DS 48TPI | $219.00 |
| BETNDTM1014 | Tandon Full Height DS 96TPI | $329.00 |

*Replace with M for MPI Door, or S for Shugart SA400 Type Door

### 5¼" Disk Drive Cabinets

| | | |
|---|---|---|
| BEJMR1C5 | Single Drive Cabinet (5 lbs.) | $ 79.00 |
| BEJMR2C5 | Dual Drive Cabinet (9 lbs.) | $ 99.00 |
| BEJMR2C5C | Dual w/Internal Data Cable (9 lbs.) | $115.00 |

### 8" Floppy Disk Drives

| | | |
|---|---|---|
| BESHU801R | Shugart Full Height SS (18 lbs.) | $349.00 |
| BESHU851R | Shugart Full Height DS (18 lbs.) | $479.00 |
| BESIEFDD1008 | Siemens Full Height SS (18 lbs.) | $129.00 |
| BEQMETRAK842 | Qume Full Height DS (18 lbs.) | $459.00 |
| BEMITM2894638 | Mitsubishi Full Height DS (18 lbs.) | $375.00 |
| BEMPI41S | MPI Full Height SS (11 lbs.) | $380.00 |
| BEMPI42S | MPI Full Height DS (11 lbs.) | $460.00 |
| BEMPI410 | MPI Dual ½-Height SS (22 lbs.) | $760.00 |
| BEMPI420 | MPI Dual ½-Height DS (22 lbs.) | $830.00 |
| BEMPI41M | MPI ½-Height SS (9 lbs.) | $380.00 |
| BEMPI42M | MPI ½-Height DS (9 lbs.) | $460.00 |
| BETNDTM8481 | Tandon ½-Height SS (9 lbs.) | $325.00 |
| BETNDTM8482 | Tandon ½-Height DS (9 lbs.) | $399.00 |

### Dual 8" Disk Enclosures

All of these rugged enclosures feature forced, filtered air cooling, hefty power supply, with the heat producing elements mounted to outside for cool, reliable operation. The rear panels are punched for the appropriate data cables.

**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.

| Part Number | Description | List Price | SALE Price |
|---|---|---|---|
| BEIIIFDE002 | FDE002 Dual Enc. (35 lbs.) | $359.95 | $325.00 |
| BEIIIDTL002SHU | DTL002 Dual Thin Line (12 lbs.) | $225.00 | $175.00 |
| BEIIIDTLMPIKIT | MPI ½-Height DTL adapter kit | | $ 24.95 |
| BEIIICBLSQN304FM | Shugart to Qume AC Cable | | $ 4.95 |

### BUY CABINETS WITH DRIVES AND $AVE!

**Combinations with FDE002**

| | | |
|---|---|---|
| BEPDBIIIFDE2S2 | w/2 SHU801R Drives | $ 969.00 |
| BEPDBIIIFDE2M2 | w/2 MFM289463BS Drives | $1049.00 |
| BEPDBIIIFDE2Q2 | w/2 QMETRAK842 Drives | $1199.00 |
| BEPDBIIIFDE2851 | w/2 SHU851R Drives | $1239.00 |
| BEPDBIIISIE | w/2FDD1008 Drives | $ 499.00 |

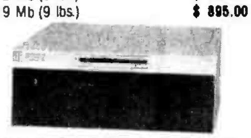
**Combinations with DTL002**

| | | |
|---|---|---|
| BEPDBIIITND1 | w/2 TNDTM8481 Drives | $ 879.00 |
| BEPDBIIITND2 | w/2 TNDTM8482 Drives | $1039.00 |
| BEPDBIIIMPI1 | w/2 MPI41M Drives | $ 879.00 |
| BEPDBIIIMPI2 | w/2 MPI42M Drives | $1039.00 |

### 5¼" Hard Disk

| | | |
|---|---|---|
| BETNDTM501 | Tandon 6 Mb (9 lbs.) | $ 699.00 |
| BETNDTM502 | Tandon 12 Mb (9 lbs.) | $ 795.00 |
| BETNDTM503 | Tandon 19 Mb (9 lbs.) | $ 895.00 |

International Instrumentation Incorporated



### DUAL 5¼" HARD DISK DRIVE CABINET

All of the necessary power for two TANDON TM500 series or equivalent hard disk drives. Just imagine, you can have 100 Mbytes 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.

| | | |
|---|---|---|
| BEIIIHD5002 | Dual Hard Disk Enclosure (Sh. Wt. 20 lbs) | $369.00 |
| BEIIIHD5001 | Single hard disk enclosure (Sh.Wt.15lbs.) | $249.00 |

### BUY CABINET WITH DRIVES AND $AVE!

| | | |
|---|---|---|
| BEPDB501HD5 | w/2 TM501 Drives | $1599.00 |
| BEPDB502HD5 | w/2 TM502 Drives | $1899.00 |
| BEPDB503HD5 | w/2 TM503 Drives | $2149.00 |

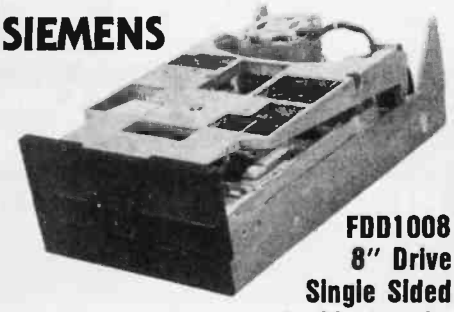
**Disk drives will be shipped separately from cabinets.**
**Don't forget to include shipping for each disk drive cabinet.**

## BUY DRIVE AND CABINET TOGETHER AND SAVE!!

### DUAL SIEMENS FDD1008's with IIIFDE002 Cabinet

**$499.00**
**SAVE $84.00**
BEPDBIIISIE
(Drives are shipped separate from cabinet. Package shipped in 3 containers)

### SIEMENS



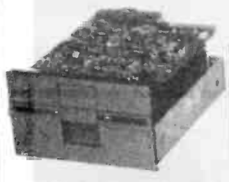
**FDD1008 8" Drive Single Sided Double Density**

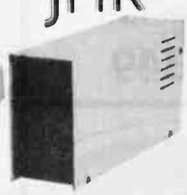
**$129.00** each

BESIEFDD1008 (be sure to include $7.00 per drive for shipping)

## ADD ON DRIVE FOR IBM PC™

Tandon JMR





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**$69**
BEJMR2SV5
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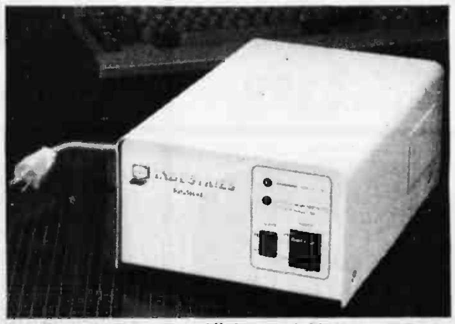

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|---|---|
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| **DUAL TRACE** | **DUAL TRACE** |
| BEHITV422 | BEHITV222 |
| **$695** | **$549** |
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## STATIC RAMS

| | | | |
|---|---|---|---|
| 2101 | 256 x 4 | (450ns) | 1.95 |
| 5101 | 256 x 4 | (450ns) (cmos) | 3.95 |
| 2102-1 | 1024 x 1 | (450ns) | .89 |
| 2102L-4 | 1024 x 1 | (450ns) (LP) | .99 |
| 2102L-2 | 1024 x 1 | (250ns) (LP) | 1.49 |
| 2111 | 256 x 4 | (450ns) | 2.49 |
| 2112 | 256 x 4 | (450ns) | 2.99 |
| 2114 | 1024 x 4 | (450ns) | 8/9.95 |
| 2114-25 | 1024 x 4 | (250ns) | 8/10.95 |
| 2114L-4 | 1024 x 4 | (450ns) (LP) | 8/12.95 |
| 2114L-3 | 1024 x 4 | (300ns) (LP) | 8/13.45 |
| 2114L-2 | 1024 x 4 | (200ns) (LP) | 8/13.95 |
| TC5514 | 1024 x 4 | (650ns) (cmos) | 2.49 |
| TC5516 | 2048 x 8 | (250ns) (cmos) | 9.95 |
| 2147 | 4096 x 1 | (55ns) | 4.95 |
| TMS4044-4 | 4096 x 1 | (450ns) | 3.49 |
| TMS4044-3 | 4096 x 1 | (300ns) | 3.99 |
| TMS4044-2 | 4096 x 1 | (200ns) | 4.49 |
| MK4118 | 1024 x 8 | (250ns) | 9.95 |
| TMM2016-200 | 2048 x 8 | (200ns) | 4.15 |
| TMM2016-150 | 2048 x 8 | (150ns) | 4.95 |
| TMM2016-100 | 2048 x 8 | (100ns) | 6.15 |
| HM6116-4 | 2048 x 8 | (200ns) (cmos) | 4.75 |
| HM6116-3 | 2048 x 8 | (150ns) (cmos) | 4.95 |
| HM6116-2 | 2048 x 8 | (120ns) (cmos) | 8.95 |
| HM6116LP-4 | 2048 x 8 | (200ns) (cmos)(LP) | 5.95 |
| HM6116LP-3 | 2048 x 8 | (150ns) (cmos)(LP) | 6.95 |
| HM6116LP-2 | 2048 x 8 | (120ns) (cmos)(LP) | 10.95 |
| Z-6132 | 4096 x 8 | (300ns) (Qstat) | 34.95 |
| HM6264 | 8192 x 8 | (150ns) (cmos) | 49.95 |

LP = Low Power  Qstat = Quasi-Static

## DYNAMIC RAMS

| | | | |
|---|---|---|---|
| TMS4027 | 4096 x 1 | (250ns) | 1.99 |
| UPD411 | 4096 x 1 | (300ns) | 3.00 |
| MM5280 | 4096 x 1 | (300ns) | 3.00 |
| MK4108 | 8192 x 1 | (200ns) | 1.95 |
| MM5298 | 8192 x 1 | (250ns) | 1.85 |
| 4116-300 | 16384 x 1 | (300ns) | 8/11.75 |
| 4116-250 | 16384 x 1 | (250ns) | 8/7.95 |
| 4116-200 | 16384 x 1 | (200ns) | 8/12.95 |
| 4116-150 | 16384 x 1 | (150ns) | 8/14.95 |
| 4116-120 | 16384 x 1 | (120ns) | 8/29.95 |
| 2118 | 16384 x 1 | (150ns) (5v) | 4.95 |
| MK4332 | 32768 x 1 | (200ns) | 9.95 |
| 4164-200 | 65536 x 1 | (200ns) (5v) | 5.95 |
| 4164-150 | 65536 x 1 | (150ns) (5v) | 6.95 |
| MCM6665 | 65536 x 1 | (200ns) (5v) | 8.95 |
| TMS4164-15 | 65536 x 1 | (150ns) (5v) | 8.95 |

5V = single 5 volt supply

## EPROMS

| | | | |
|---|---|---|---|
| 1702 | 256 x 8 | (1us) | 4.50 |
| 2708 | 1024 x 8 | (450ns) | 3.95 |
| 2758 | 1024 x 8 | (450ns) (5v) | 5.95 |
| 2716 | 2048 x 8 | (450ns) (5v) | 3.95 |
| 2716-1 | 2048 x 8 | (350ns) (5v) | 5.95 |
| TMS2516 | 2048 x 8 | (450ns) (5v) | 5.50 |
| TMS2716 | 2048 x 8 | (450ns) | 7.95 |
| TMS2532 | 4096 x 8 | (450ns) (5v) | 5.95 |
| 2732 | 4096 x 8 | (450ns) (5v) | 4.95 |
| 2732-250 | 4096 x 8 | (250ns) (5v) | 8.95 |
| 2732-200 | 4096 x 8 | (200ns) (5v) | 11.95 |
| 2732A-4 | 4096 x 8 | (450ns) (5v) (21vPGM) | 6.95 |
| 2732A | 4096 x 8 | (250ns) (5v) (21vPGM) | 9.95 |
| 2732A-2 | 4096 x 8 | (200ns) (5v) (21vPGM) | 13.95 |
| 2764 | 8192 x 8 | (450ns) (5v) | 6.95 |
| 2764-250 | 8192 x 8 | (250ns) (5v) | 7.95 |
| 2764-200 | 8192 x 8 | (200ns) (5v) | 19.95 |
| TMS2564 | 8192 x 8 | (450ns) (5v) | 14.95 |
| MCM68764 | 8192 x 8 | (450ns) (5v) (24 pin) | 39.95 |
| MCM68766 | 8192 x 8 | (350ns) (5v) (24 pin)(pwr dn.) | 42.95 |
| 27128 | 16384 x 8 | (300ns) (5v) | 29.95 |

5v = Single 5 Volt Supply  21vPGM = Program at 21 Volts

### ★ ★ ★ ★ HIGH-TECH ★ ★ ★ ★

**HM6264** HITACHI 8K x 8 STATIC RAM

- Fast—150 ns
- +5V Supply
- 28 Pin—Compatible w/2764 EPROM
- Low Power CMOS (TTL Compatible) 200 mW Operation/.01 mW Standby (LP)

HM6264P-15 $39.95  HM6264LP-15 $49.95

### ★ ★ ★ ★ SPOTLIGHT ★ ★ ★ ★

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## CRYSTALS

| | |
|---|---|
| 32.768 khz | 1.95 |
| 1.0 mhz | 3.95 |
| 1.8432 | 3.95 |
| 2.0 | 2.95 |
| 2.097152 | 2.95 |
| 2.4576 | 2.95 |
| 3.2768 | 2.95 |
| 3.579545 | 2.95 |
| 4.0 | 2.95 |
| 5.0 | 2.95 |
| 5.0688 | 2.95 |
| 5.185 | 2.95 |
| 5.7143 | 2.95 |
| 6.0 | 2.95 |
| 6.144 | 2.95 |
| 6.5536 | 2.95 |
| 8.0 | 2.95 |
| 10.0 | 2.95 |
| 10.738635 | 2.95 |
| 14.31818 | 2.95 |
| 15.0 | 2.95 |
| 16.0 | 2.95 |
| 17.430 | 2.95 |
| 18.0 | 2.95 |
| 18.432 | 2.95 |
| 20.0 | 2.95 |
| 22.1184 | 2.95 |
| 32.0 | 2.95 |

## UARTS

| | |
|---|---|
| AY3-1014 | 6.95 |
| AY5-1013 | 3.95 |
| AY3-1015 | 6.95 |
| PT1472 | 9.95 |
| TR1602 | 3.95 |
| 2350 | 9.95 |
| 2651 | 8.95 |
| IM6402 | 7.95 |
| IM6403 | 8.95 |
| INS8250 | 10.95 |

## GENERATORS

### BIT-RATE

| | |
|---|---|
| MC14411 | 11.95 |
| BR1941 | 11.95 |
| 4702 | 12.95 |
| COM5016 | 16.95 |
| COM8116 | 10.95 |
| MM5307 | 10.95 |

### FUNCTION

| | |
|---|---|
| MC4024 | 3.95 |
| LM566 | 1.49 |
| XR2206 | 3.75 |
| 8038 | 3.95 |

## MISC.

| | |
|---|---|
| UPD7201 | 29.95 |
| TMS99532 | 29.95 |
| ULN2003 | 2.49 |
| 3242 | 7.95 |
| 3341 | 4.95 |
| MC3470 | 4.95 |
| MC3480 | 9.00 |
| 11C90 | 13.95 |
| 95H90 | 7.95 |
| 2513-001 UP | 9.95 |
| 2513-002 LOW | 9.95 |

## CLOCK CIRCUITS

| | |
|---|---|
| MM5314 | 4.95 |
| MM5369 | 3.95 |
| MM5375 | 4.95 |
| MM58167 | 12.95 |
| MM58174 | 11.95 |
| MSM5832 | 3.95 |

## KEYBOARD CHIPS

| | |
|---|---|
| AY5-2376 | 11.95 |
| AY5-3600 | 11.95 |
| AY5-3600 PRO | 11.95 |

## CMOS

| | | | |
|---|---|---|---|
| 4000 | .29 | 4528 | 1.19 |
| 4001 | .25 | 4531 | .95 |
| 4002 | .25 | 4532 | 1.95 |
| 4006 | .89 | 4538 | 1.95 |
| 4007 | .29 | 4539 | 1.95 |
| 4008 | .95 | 4541 | 2.64 |
| 4009 | .39 | 4543 | 1.19 |
| 4010 | .45 | 4553 | 5.79 |
| 4011 | .25 | 4555 | .95 |
| 4012 | .25 | 4556 | .95 |
| 4013 | .38 | 4581 | 1.95 |
| 4014 | .79 | 4582 | 1.95 |
| 4015 | .39 | 4584 | .75 |
| 4016 | .39 | 4585 | .75 |
| 4017 | .69 | 4702 | 12.95 |
| 4018 | .79 | 74C00 | .35 |
| 4019 | .39 | 74C02 | .35 |
| 4020 | .75 | 74C04 | .35 |
| 4021 | .79 | 74C08 | .35 |
| 4022 | .79 | 74C10 | .35 |
| 4023 | .29 | 74C14 | .59 |
| 4024 | .65 | 74C20 | .35 |
| 4025 | .29 | 74C30 | .35 |
| 4026 | 1.65 | 74C32 | .39 |
| 4027 | .45 | 74C42 | 1.29 |
| 4028 | .69 | 74C48 | 1.99 |
| 4029 | .79 | 74C73 | .65 |
| 4030 | .39 | 74C74 | .65 |
| 4034 | 1.95 | 74C76 | .80 |
| 4035 | .85 | 74C83 | 1.95 |
| 4040 | .75 | 74C85 | 1.95 |
| 4041 | .75 | 74C86 | .39 |
| 4042 | .69 | 74C89 | 4.50 |
| 4043 | .85 | 74C90 | 1.19 |
| 4044 | .79 | 74C93 | 1.75 |
| 4046 | .85 | 74C95 | .99 |
| 4047 | .95 | 74C107 | .89 |
| 4049 | .35 | 74C150 | 5.75 |
| 4050 | .35 | 74C151 | 2.25 |
| 4051 | .79 | 74C154 | 3.25 |
| 4053 | .79 | 74C157 | 1.75 |
| 4060 | .89 | 74C160 | 1.19 |
| 4066 | .39 | 74C161 | 1.19 |
| 4068 | .39 | 74C162 | 1.19 |
| 4069 | .29 | 74C163 | 1.19 |
| 4070 | .35 | 74C164 | 1.39 |
| 4071 | .29 | 74C165 | 2.00 |
| 4072 | .29 | 74C173 | .79 |
| 4073 | .29 | 74C174 | 1.19 |
| 4075 | .29 | 74C175 | 1.19 |
| 4076 | .79 | 74C192 | 1.49 |
| 4078 | .29 | 74C193 | 1.49 |
| 4081 | .29 | 74C195 | 1.39 |
| 4082 | .29 | 74C200 | 5.75 |
| 4085 | .95 | 74C221 | 1.75 |
| 4086 | .95 | 74C244 | 2.25 |
| 4093 | .49 | 74C373 | 2.45 |
| 4098 | 2.49 | 74C374 | 2.45 |
| 4099 | 1.95 | 74C901 | .39 |
| 14409 | 12.95 | 74C902 | .85 |
| 14410 | 12.95 | 74C903 | .85 |
| 14411 | 11.95 | 74C905 | 10.95 |
| 14412 | 12.95 | 74C906 | .95 |
| 14419 | 7.95 | 74C907 | 1.00 |
| 14433 | 14.95 | 74C908 | 2.00 |
| 4502 | .95 | 74C909 | 2.75 |
| 4503 | .65 | 74C910 | 9.95 |
| 4508 | 1.95 | 74C911 | 8.95 |
| 4510 | .85 | 74C912 | 8.95 |
| 4511 | .85 | 74C914 | 1.95 |
| 4512 | .85 | 74C915 | 1.19 |
| 4514 | 1.25 | 74C918 | 2.75 |
| 4515 | 1.79 | 74C920 | 17.95 |
| 4516 | 1.55 | 74C921 | 15.95 |
| 4518 | .89 | 74C922 | 4.49 |
| 4519 | .39 | 74C923 | 4.95 |
| 4520 | .79 | 74C925 | 5.95 |
| 4522 | 1.25 | 74C926 | 7.95 |
| 4526 | 1.25 | 74C928 | 7.95 |
| 4527 | 1.95 | 74C929 | 19.95 |

## 6800

| | |
|---|---|
| 68000 | 49.95 |
| 6800 | 2.95 |
| 6802 | 7.95 |
| 6803 | 19.95 |
| 6808 | 13.90 |
| 6809E | 14.95 |
| 6809 | 11.95 |
| 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 |
| MB8877 | 34.95 |
| 1691 | 17.95 |
| 2143 | 18.95 |

## 8000

| | |
|---|---|
| 8035 | 5.95 |
| 8039 | 5.95 |
| INS-8060 | 17.95 |
| INS-8073 | 49.95 |
| 8080 | 3.95 |
| 8085 | 4.95 |
| 8085A-2 | 11.95 |
| 8086 | 24.95 |
| 8087 | CALL |
| 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 |

## 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 |
| Z80B-DART | 19.95 |
| Z80B-SIO/2 | 39.95 |

### ZILOG

| | |
|---|---|
| Z6132 | 34.95 |
| Z8671 | 39.95 |

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TERMS: Minimum order $10. For shipping and handling include $2.50 for UPS Ground and $3.50 for UPS Air. Orders over 1 lb. and foreign orders may require additional shipping charges — please contact our sales department for the amount. CA residents must include 6% sales tax, Bay Area and LA residents include 6½%. Prices subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sale.





Circle 215 on inquiry card.

# 2716 16K EPROMS $3.95 EA     4116 250 NS 8/$7.95

## BARGAIN HUNTERS CORNER

### D-SUBMINIATURE CONNECTORS

| | | |
|---|---|---|
| DB25P | 25 PIN MALE | 10/19.95 |
| DB25S | 25 PIN FEMALE | 10/24.95 |
| HOOD25 | GREY HOOD | 10/9.95 |

### CENTRONICS CONNECTORS

| | | |
|---|---|---|
| CEN36 | 36 PIN MALE | 5.95 |

### IC SOCKETS

| | | |
|---|---|---|
| 14 PIN | ST LOW PROFILE | 100/7.95 |
| 16 PIN | ST LOW PROFILE | 100/7.95 |

**SPECIALS END 5/31/84**

## RF MODULATOR

(ASTEC UM1082) QUANTITIES LIMITED

- ★ PRESET TO CHANNEL 3
- ★ USE TO BUILD TV-COMPUTER INTERFACE
- ★ +5 VOLT OPERATION

NOW ONLY $6.95

## 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 | |
| 8.2 | | | | | | 1.00 |
| 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 |
| | | | 500 | 16V | .42 |
| | | | 1000 | 16V | .60 |
| | | | 1500 | 16V | .70 |
| | | | 6000 | 16V | .85 |

### COMPUTER GRADE

26,000uf 30V 3.95

## 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 |

VISA

MasterCard

## WE HAVE THE COMPLETE LINE OF DISC. TANTALUM AND ELECTROLYTIC CAPACITORS IN STOCK!

## 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 | | |
| 16 pin ZIF | 5.95 | call |
| 24 pin ZIF | 7.95 | call |
| 28 pin ZIF | 8.95 | call |
| ZIF = TEXTOOL (Zero Insertion Force) | | |

## DIODES

| | | |
|---|---|---|
| 1N751 | 5.1 volt zener | .25 |
| 1N759 | 12.0 volt zener | .25 |
| 1N4148 | (1N914) switching | 25/1.00 |
| 1N4004 | 400PIV rectifier | 10/1.00 |
| KBP02 | 200PIV 1.5amp bridge | .45 |
| KBP04 | 400PIV 1.5amp bridge | .55 |
| VM48 | Dip-Bridge | .35 |

## 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 |

## LED DISPLAYS

| | | | |
|---|---|---|---|
| HP 5082-7760 | .43" | CC | 1.29 |
| MAN 72 | .3" | CA | .99 |
| MAN 74 | .3" | CC | .99 |
| FND-357 (359) | .375" | CC | 1.25 |
| FND-500 (503) | .5" | CC | 1.49 |
| FND-507 (510) | .5" | CA | 1.49 |
| TIL-311 4x7 | .270" | HEX W/LOGIC | 9.95 |

## LED LAMPS

| | 1-99 | 100-up |
|---|---|---|
| JUMBO RED | .10 | .09 |
| JUMBO GREEN | .18 | .15 |
| JUMBO YELLOW | .18 | .15 |
| LED MOUNTING HARDWARE | .10 | .09 |

## NEW UN-USED MUFFIN FANS

| | |
|---|---|
| 4.68" Square | 14.95 |
| 3.125" Square | 14.95 |

## HEAT SINKS

| | |
|---|---|
| TO-3 style | .95 |
| TO-220 style | .35 |

## SWITCHES

| | |
|---|---|
| SPDT mini-toggle | 1.25 |
| DPDT mini-toggle | 1.50 |
| SPST mini-pushbutton | .39 |

## 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 |

## DIP SWITCHES

| | |
|---|---|
| 4 POSITION | .85 |
| 5 POSITION | .90 |
| 6 POSITION | .90 |
| 7 POSITION | .95 |
| 8 POSITION | .95 |

## JDR Microdevices

1224 S. Bascom Avenue, San Jose, CA 95128
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(408) 995-5430 • Telex 171-110

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HOURS: M-W-F, 9-5   T-Th., 9-9   Sat. 10-3

*PLEASE USE YOUR CUSTOMER NUMBER WHEN ORDERING*

TERMS: Minimum order $10. For shipping and handling include $2.50 for UPS Ground and $3.50 for UPS Air. Orders over 1 lb. and foreign orders may require additional shipping charges — please contact our sales department for the amount. CA residents must include 6% sales tax, Bay Area and LA residents include 6½%. Prices subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sale.





Circle 216 on inquiry card.

# 2732 32K EPROM $4.95 — 2764 64K EPROM $6.95

## MICROCOMPUTER HARDWARE HANDBOOK FROM ELCOMP — $14.95

Over 800 pages of manufacturers data sheets on most commonly used IC's.

Includes:
* TTL — 74/74LS and 74F
* CMOS
* Voltage Regulators
* Memory — RAM, ROM, EPROM
* CPU's — 6800, 6500, Z80, 8080, 8085, 8086/8
* MPU support & interface — 6800, 6500, Z80, 8200, etc.

## DISK DRIVES

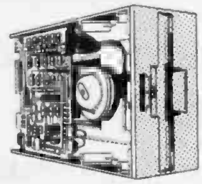
### TANDON
- TM100-1 5¼" (FOR IBM) SS/DD 229.00
- TM100-2 5¼" (FOR IBM) DS/DD 259.00

### SHUGART
- SA 400L 5¼" (40 TRACK) SS/DD 199.95
- SA 400 5¼" (35 TRACK) SS/DD 189.95

### PERTEC
- FD-200 5¼" SS/DD 179.95
- FD-250 5¼" DS/DD 199.95

### MPI
- MP-52 5¼" (FOR IBM) DS/DD 249.00

NOTE: Please include sufficient amount for shipping on above items.



## 8-INCH DISK DRIVE SALE

**FD 100-8**
SHUGART 801 EQUIV.
SS/DD — 10/$175 EA.
**$189.00**

**FD 200-8**
SHUGART 851 EQUIV.
DS/DD — 10/$220 EA.
**$239.00**

## BEST SELLING BOOKS

### OSBORNE/MC GRAW-HILL
- Apple II User's Guide ........... 16.95
- CRT Controller's Handbook ....... 9.95
- 68000 Assembly Language Programming ........... 16.99
- CBASIC User Guide ........... 15.00

### SYBEX
- Your First Computer ........... 8.95
- The CP/M Handbook ........... 14.95
- The PASCAL Handbook ........... 18.95
- Microprocessor Interfacing Techniques ........... 17.95

## EDGE-CARD CONNECTORS

| | |
|---|---|
| S-100 ST | 3.95 |
| S-100 WW | 4.95 |
| 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 |

MasterCard

VISA

## CABINETS FOR 5¼" DISK DRIVES

### CABINET #1 $29.95
* DIMENSIONS 8⅝ x 5¹⁵⁄₁₆ x 3¹⁵⁄₁₆"
* COLOR MATCHES APPLE
* FITS STANDARD 5¼" DRIVES, INCL. SHUGART
* INCLUDES MOUNTING HARDWARE AND FEET

NOTE: Please include sufficient amount for shipping on above items.

### 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
* FITS STANDARD 5¼" DRIVES
* PLEASE SPECIFY GRAY OR TAN

## TRANSFORMERS

### FRAME STYLE

| | | |
|---|---|---|
| 12.6VAC | 2amp | 4.95 |
| 12.6VAC CT | 2amp | 5.95 |
| 12.6VAC CT | 4amp | 7.95 |
| 12.6VAC CT | 8amp | 10.95 |
| 25.2VAC CT | 2amp | 7.95 |

### PLUG CASE STYLE

| | | |
|---|---|---|
| 12VAC | 250ma | 3.95 |
| 12VAC | 500ma | 4.95 |
| 12VAC | 1amp | 5.95 |
| 12VAC | 2amp | 6.95 |

### DC ADAPATER
6, 9, 12 VDC selectable with universal adapter 8.95

NOTE: Please include sufficient amount for shipping on above items.

## VISIT DURING OUR EXPANDED RETAIL STORE HOURS SATURDAY 10 to 3

## DIP CONNECTORS

| DESCRIPTION | HIGH RELIABILITY TOOLED ST IC SOCKETS | COMPONENT CARRIERS (DIP HEADERS) | RIBBON CABLE DIP PLUGS (IDC) |
|---|---|---|---|
| ORDER BY | AUGATxx-ST | ICCxx | IDPxx |
| CONTACTS 8 | .99 | .65 | |
| 14 | .99 | .75 | 1.45 |
| 16 | .99 | .85 | 1.65 |
| 18 | 1.69 | 1.00 | |
| 20 | 1.89 | 1.25 | |
| 22 | 1.89 | 1.25 | |
| 24 | 1.99 | 1.35 | 2.50 |
| 28 | 2.49 | 1.50 | |
| 40 | 2.99 | 2.10 | 4.15 |

For order instructions see "IDC Connectors" below.

## CENTRONICS

| | | | |
|---|---|---|---|
| IDCEN36 | Ribbon Cable | 36 Pin Male | 8.95 |
| IDCEN36/F | Ribbon Cable | 36 Pin Female | 8.95 |
| CEN36 | Solder Cup | 36 Pin Male | 7.95 |

## RIBBON CABLE

| CONTACTS | SINGLE COLOR 1' | SINGLE COLOR 10' | COLOR CODED 1' | COLOR CODED 10' |
|---|---|---|---|---|
| 10 | .50 | 4.40 | .83 | 7.30 |
| 16 | .55 | 4.80 | 1.00 | 8.80 |
| 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 |

## D-SUBMINIATURE

| DESCRIPTION | SOLDER CUP | | RIGHT ANGLE PC SOLDER | | IDC RIBBON CABLE | | HOODS | |
|---|---|---|---|---|---|---|---|---|
| | MALE | FEMALE | MALE | FEMALE | MALE | FEMALE | BLACK | GREY |
| ORDER BY | DBxxP | DBxxS | DBxxPR | DBxxSR | IDBxxP | IDBxxS | HOOD-B | HOOD |
| CONTACTS 9 | 2.08 | 2.66 | 1.65 | 2.18 | 3.37 | 3.69 | — | 1.60 |
| 15 | 2.69 | 3.63 | 2.20 | 3.03 | 4.70 | 5.13 | — | 1.60 |
| 25 | 2.50 | 3.25 | 3.00 | 4.42 | 6.23 | 6.84 | 1.25 | 1.25 |
| 37 | 4.80 | 7.11 | 4.83 | 6.19 | 9.22 | 10.08 | — | 2.95 |
| 50 | 6.06 | 9.24 | — | — | — | — | — | 3.50 |

For order instructions see "IDC Connectors" below.

**MOUNTING HARDWARE 1.00**

## IDC CONNECTORS

| DESCRIPTION | SOLDER HEADER | RIGHT ANGLE SOLDER HEADER | WW HEADER | RIGHT ANGLE WW HEADER | RIBBON HEADER SOCKET | RIBBON HEADER | RIBBON EDGE CARD |
|---|---|---|---|---|---|---|---|
| ORDER BY | IDHxxS | IDHxxSR | IDHxxW | IDHxxWR | IDSxx | IDMxx | IDExx |
| CONTACTS 10 | .82 | .85 | 1.86 | 2.05 | 1.15 | — | 2.25 |
| 20 | 1.29 | 1.35 | 2.98 | 3.28 | 1.86 | 5.50 | 2.36 |
| 26 | 1.68 | 1.76 | 3.84 | 4.22 | 2.43 | 6.25 | 2.65 |
| 34 | 2.20 | 2.31 | 4.50 | 4.45 | 3.15 | 7.00 | 3.25 |
| 40 | 2.58 | 2.72 | 5.28 | 4.80 | 3.73 | 7.50 | 3.80 |
| 50 | 3.24 | 3.39 | 6.63 | 7.30 | 4.65 | 8.50 | 4.74 |

**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 solder style header would be IDH10SR.



Circle 216 on inquiry card.

# FOR APPLE COMPUTER USERS

## JDR Microdevices

**THOUSANDS SOLD!**

### JDR 16K RAM CARD FOR APPLE II+

- ★ Expand your 48K Apple to 64K
- ★ Fully compatible with Apple Language System — Use in place of Apple Language card
- ★ Highest quality card features: gold edge connector, sockets for all IC's.
- ★ 2 YEAR WARRANTY

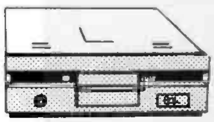
Kit with Instructions ...... $40.95
Bare PC Card ............ $14.95

**$44.95**

## GET SLIM IN 1984!

### JDR HALF-HEIGHT DISK DRIVE

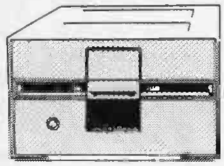
- ★ 35 Track if used with Apple Controller
- ★ 40 Track Controller and DOS Available (Call for Price)



**$209.95**

## MA SYSTEMS

### FD-35 DISK DRIVE



**$199.95**

- ★ Shugart Mechanism — Made in U.S.A.
- ★ Direct Replacement for Apple Disk II
- ★ Compatible with Apple Controller or other Apple compatible controllers
- ★ Specially designed electronics with low power consumption
- ★ DOS 3.3 and 3.2 compatible
- ★ One Year Warranty

**CONTROLLER CARD**
**$69.95**

VISA MasterCard

## APPLE COMPATIBLE POWER SUPPLY

- ★ Use To Power Apple-Type Systems
- ★ +5V @ 5A +12V @ 3A
  -5V @ .5A -12V @ .5A
- ★ Instructions Included

**$79.95**

## BMC BMX-80 PRINTER

- ★ 80 CPS Dot Matrix Printer
- ★ Prints Bi-Directional in 40, 80, 71 or 142 Columns in Normal, Double Width or Compressed Text.
- ★ Print Superscript As Well As Superb Graphics in Character or Bit Image

**$279**

## micromax

### VIEWMAX-80

**NOW ONLY $159.95**

- ★ 80 Column Card for Apple II+
- ★ Video Soft Switch
- ★ Inverse Video
- ★ 2 Year Warranty

### VIEWMAX-80e

**NEW $129.95**

- ★ 80 Column Card for Apple IIe
- ★ 64K RAM Expandable to 128K

**64K RAM Upgrade $47.60**

### GRAPHMAX $129.95

- ★ Hi Resolution Graphics
- ★ Printer Card
- ★ Centronics Parallel Interface

**Graphmax with Color & Zoom Options ... $149.95**

## NASHUA DISKETTES

| | | |
|---|---|---|
| **5¼" WITH HUB RING** | | |
| MD1 | SOFT SECTOR, SS/SD | 19.95 |
| MD1D | SOFT SECTOR, SS/DD | 26.25 |
| MD2D | SOFT SECTOR, DS/DD | 30.75 |
| MD2F | SOFT SECTOR, DS/QUAD DENSITY | 45.00 |
| MD110 | 10 SECTOR HARD, SS/SD | 19.95 |
| MD210D | 10 SECTOR HARD, DS/DD | 30.75 |
| **8" WITHOUT HUB RING** | | |
| FD1 | SOFT SECTOR, SS/SD | 24.75 |
| FD1D | SOFT SECTOR, SS/DD | 30.00 |
| FD2D | SOFT SECTOR, DS/DD | 36.75 |

## OTHER ACCESSORIES FOR APPLE II

**THUNDERCLOCK $129.95**

- ★ Real-Time Clock Calendar
- ★ Software Included
- ★ Mountain Software Compatible
- ★ BSR Control Options Available

**KRAFT JOYSTICK $39.95**

## VERBATIM DATALIFE DISKETTES

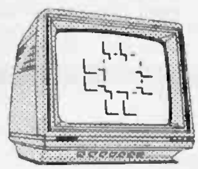
SS/DD SOFT SECTOR
**$29.95**
SS/DD 10 HARD SECTOR
**$29.95**

## 5¼" DISKETTE FILE

- ★ ATTRACTIVE, FUNCTIONAL DISK STORAGE SYSTEM
- ★ 75 DISK STORAGE CAPACITY
- ★ MOLDED FROM DURABLE SMOKED PLASTIC WITH FRONT CARRYING HANDLE

**$16.99**

## MONITORS



**BMC MONITOR STAND MODEL PA-900**
Your Display Will Tilt & Swivel $29.95

### MONOCHROME

| | |
|---|---|
| BMC BM 12AUW GREEN 12" | $89.95 |
| BMC BM 12EUY 18 MHZ AMBER | $139.95 |
| BMC BM 12EUN 18 MHZ HIGH RES GREEN | $115.00 |
| NEC JB1201M - 20 MHZ GREEN | $169.00 |
| ZENITH ZVM-121 - 15 MHZ GREEN | $99.00 |

### COLOR

| | |
|---|---|
| BMC BM-AU9191U COMPOSITE 13" | $279.00 |

NO C.O.D. ORDERS PLEASE

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Circle 217 on inquiry card.

# Unclassified Ads

**NEEDED:** The Center for Third World Organizing (CTWO), a progressive nonprofit minority organization, seeks tax-exempt donation of computer with word-processing and database management software. Computer will be used in legislative analysis and statistical projections, and editing newsletter and publications for Black, Latino, Native American, and Asian communities. Contact Margaret Shockley, CTWO, 4228 Telegraph Ave., Oakland, CA 94609, (415) 654-9601.

**WANTED:** Tax-deductible donations of computers, peripherals, and software for use by a public charity organization to teach computer skills to economically disadvantaged young people. San Pablo Institute, 234 Mullen St., San Francisco, CA 94110.

**NEEDED:** Information sought by United Nations computer novice (IBM-PC) from other microcomputer-equipped workers offering assistance to developing countries. This includes frequent field missions with portable computers for report generation, project evaluation, and on-site work that calls for communication via computer to other headquarters in industrialized countries. Correspondence with others interested in similar human applications of computerization welcome. Harumi Sakaguchi, 24 Chemin Briquet, Petit-Saconnex 1209, Geneva, Switzerland.

**WANTED:** Native American tax-exempt nonprofit organization seeks donation of Apple computer system, digitizer, plotter, dot-matrix printer, and 5–10 megabyte hard disk to improve management of resource information presently done by hand. Also seeking information on genealogical record keeping on microcomputers. Haunani Apoliona, Alu Like Inc., O'ahu Island Center, 1316-A Kaumualii St., Honolulu, HI 96817, (808) 845-1486.

**NEEDED:** A nonprofit community mental health center seeks any standard personal computer with disk drive, printer, and monitor for public relations, research, and evaluation. Will accept donation of any or all components and word-processing software. David S. Weed, Director of Consultation and Education, c/o Dr. John C. Corrigan, Mental Health Center, 49 Hillside St., Fall River, MA 02720, (617) 678-2901.

**WANTED:** Tax-deductible donation of microcomputer, disk drive, monitor, printer, and analog-to-digital converter for psychophysiology laboratory. Use includes digitization and storage of data from a Narco Bio-Systems 6-channel physigraph for subsequent analysis. David S. Holmes, Psychology Department, Kansas University, Lawrence, KS 66045, (913) 864-4131.

**NEEDED:** Mission seeks computer system as donation for educational programs and in conducting church business. Donations are tax deductible. Luis Vega, Trinity Episcopal Church, 423 East Spring St., Kingman, AZ 86401.

**WANTED:** Tax-deductible donation of IBM PC, Victor 9000, or Sanyo 550/555 for financial reporting, catalog files, mailing and donor list files sought by nonprofit Christian organization that freely distributes prerecorded audio-cassette tapes and Bible literature. Also, host for local bulletin board for Bible research and Christian activities. Other systems considered if software is available. Ministry of Love, 404 Laurel Hill, San Marcos, TX 78666.

**WANTED:** Tax-exempt nonprofit science museum seeks Apple IIs, IBM PC, VIC-20s or Texas Instruments for teaching computer basics and programming. Also, printers, monitors, disk drives, educational and accounting software, furniture and memory expansions are needed for a computer exhibit, membership drives, and financial reports. We'll give receipt and pay shipping. D. Costello, 5020 John R, Detroit, MI 48202, (313) 577-8415.

**WANTED:** Aspen School District needs an experienced director/teacher to help us establish a summer computer workshop for students ages 5 to 18. Workshop will be held in Aspen on July 9 through July 20, 1984. Computer Educator, Aspen School District, POB 300, Aspen, CO 81612.

**WANTED:** Information on how to get an RS-232C parallel port put in a Xerox 615 Memorywriter. John C. Toth, 411 Queen Margaret Lane, Jackson, MS 39209.

**WANTED:** Step-by-step instructions about how to duplicate the "$" SEQ file from one disk onto another on the Commodore 64. David Alexander, 1667 Midland Dr., East Meadow, NY 11554.

**WANTED:** A computer science student with experience in BASIC, FORTRAN, COBOL, Pascal, and assembly language for the 8085 seeks a computer-related job or interested people to offer accommodations in England or France from July through September 1984. Also has experience in software projects, teaching computer programming, and technical writing in computer magazines. Tareef Alattar, POB 1429, Safat, Kuwait.

**NEEDED:** Repairs for iCOM S100 controller card (200062-100(?)), runs FD2411 5¼-inch drives. Will pay reasonable repair costs. Larry Sheingorn, MD, 139 Lamont Lane, Gaithersburg, MD 20878, (301) 977-5450.

**WANTED:** IMSAI 8080 computer (unassembled kit). May consider completed unit if mint condition with full documentation. Also, want accessory boards and IMSAI peripherals. W. R. Coe, 11-B East Pointe Dr., Oswego, NY 13126.

**WANTED:** I would like to receive and/or trade any TRS-80 Color Computer software (games, business, or utilities in BASIC or Machine Language: cassettes, disks, or cartridges). Also, memory maps, hardware schematics, ROM disassemblies, BASIC or Machine Language programming techniques, or any TRS-80 Color Computer or Dragon-80 information. Jim Kalac, 193 Bond St. #5, Astoria, OR 97103.

**FOR SALE:** Used Hazeltine MOD I terminal: $375. Used DEC LA-36 DECwriter II terminal: $500. New California Computer Systems 2810 S-100 bus Z80 CPU card and used 2422 S-100 bus floppy-disk controller card: $425 for both. Used CONRAC CNB-8 black-and-white monitor: $25. Buyer pays shipping. Charles B. Wall, 533 Stratford Way, Clarksville, TN 37043, (615) 552-2199.

**FOR SALE:** Compucolor II Color Computer 16K. Software includes editor/assembler, utilities, and games. Also, back issues of Colorque and other user groups letters: $800. Ohio Scientific C1P, 28K with software and manuals: $275. Intel 8748 Single Chip Micro (12 total): $25 each or $225 for the lot. David Ross, POB 12278, Hamtramck, MI 48212, (313) 892-5960.

**WANTED:** Apple user who would like to exchange programs, especially games and utilities. Please send a list of your collection, and you'll receive mine. Jason Cheek, 1034 South Catalina, Los Angeles, CA 90006.

**WANTED:** Correspondent with interest in the design and assembling of microcomputers and peripherals, preferably the Z80. Ronald Bastien, 2927 Baldwin, Montreal, Quebec H1L 5B6, Canada.

**FOR SALE:** Early issues of BYTE: first issue through Vol. 4 #9 (September 1979) plus one each extra copies of issues #1 and #2. 50 magazines in all: $110 includes shipping. Ed Appleyard, (616) 637-1714.

**NEEDED:** 4040 disk drive for the Commodore. Will pay 33 percent of retail plus shipping or will trade approximately $2000 of good software on 100 disks (with documentation). Also, will exchange software. Charles Strusz, 714 West Elm, Carbondale, IL 62901.

**FOR SALE:** Electronic surplus assortment: transformers, video IC, analog modem, RF modulator, many small components: $40. Also, VCR commercial killer that will automatically edit out commercials on any black and white program when recording on VHS recorder with remote-pause jack: $45. Mark Mitckes, 138 Lake Hills Dr., Oak Ridge, TN 37830.

**WANTED:** Copy of BYTE vol. 1, no. 3, November 1975. Also, have one copy of BYTE vol. 1, no. 11, July 1976 for sale or trade. Dave Lambarth, Old Amherst Rd., Mont Vernon, NH 03057, (603) 884-6177 days; (603) 673-3566 evenings and weekends.

**WANTED:** Any information concerning availability of software that will allow a Kaypro 2 (CP/M 2.2) to emulate a Lear-Siegler ADM-II terminal (using a Hayes Smartmodem 300). Also, any information concerning software to fill out preprinted forms using boilerplate responses (also for use on a Kaypro 2). Ken Rossman, 7 Mariner Circle, West Islip, NY 11795, (516) 587-2589 evenings.

**WANTED:** Texas Instruments information on where to obtain their equipment. Also I want to join a club. Will buy or trade floppy disks for TI-99/4A disk drive. Norman Guertin, (617) 798-3517.

**FOR SALE:** Heathkit Hero One robot, completely assembled. Includes arm, voice, and robotics course. New: $2500, will sell for $1450. Jim Schieder, 53 East Washington St., Hornell, NY 14843, (607) 324-0344.

**WANTED:** An August 1980 issue of BYTE. Scott Sewall, 2004 Randolph, St. Paul, MN 55105.

**FOR SALE:** 12-slot S-100 mainframe (9 slots installed) with 25A power supply: $200. Two Qume DT8 disk drives (DSDD) with cabinet and power supply (new): $1000. Godbout Disk 1 DMA disk controller with CPM 2.2 (new): $350. Signalman I 300-bps direct-connect modem: $75. 15-MHz green-phosphor 12-inch monitor: $90. Jade Big Z CPU board (without UART): $90. BYTE 2/78 through 6/83: $100. Mark Derthick, 871 Mirror St., Pittsburgh, PA 15217.

**FOR TRADE:** Want to trade software with other TRS-80 Model III users. Send a disk or list of your best software and I will do the same. Also interested in an external disk drive (DSDD). Buc Burgess, 433 Oak Haven Dr., Altamonte Springs, FL 32701.

**FOR SALE:** Complete set of BYTE in mint condition from issue #1 to present; sold only as complete set: $500 firm. Dan Goldish, POB 778, Sudbury, MA 01776, (617) 734-3744 nights.

**WANTED:** High school student would appreciate donated S-100 computer equipment to program and experiment with. I will pay postage. Nick Shue, 13910 Hough Rd., Berville, MI 48002.

**FOR TRADE:** Items for Spectrum Microdrive and interface. Most in like-new condition. Also, software. John Brown, 1405 Van Ness #603, San Francisco, CA 94109.

**FOR SALE:** Commodore 64 with 64K, 320 by 200 high-resolution color graphics, etc. Has 10 hours of use, complete with power supply, cables, etc. in original box. Also, have Cardco cassette-interface adapter new in box, Panda Electronics EMI surge protector and programmer's reference guide: all for $225 or best offer. Joseph Cross, POB 3633, Langley Park, MD 20787.

**FOR SALE:** BYTE January 1977 through April 1981 and Kilobaud Microcomputing January 1977 through April 1982 at $30 per complete year. Some issues of Interface Age from 1977, 1978, and 1979 for $2 an issue. Also, some issues of Dr. Dobb's Journal. Jerry Chandik, 3407 Cannon Pass Court, Sugar Land, TX 77478, (713) 980-9071.

**WANTED:** To trade all kinds of programs for the Apple II. Sanjay V. Deshmukh, 521 South Gunderson, Oak Park, IL 60304.

**FOR SALE:** S-100 boards: two Ithaca Audio 8K memory, $55 each. Morrow cassette interface with parallel port and RS-232C: $50. Vector Graphic 16K memory kit, all parts less 4114 RAMs: $45. SSM VB-1B 64 by 16 memory-mapped video: $45. Data Vector 16K EPROM including 12 2708s: $60. All boards working (except kit), in excellent condition with original documentation. Bill Eisinger, 11510 Alejandro, Boise, ID 83709, (208) 376-2378.

**WANTED:** Apple II Plus programs to trade with my large selection of games, utilities, etc. Send a list of your programs and I'll do the same. Bill Vargas, Box 239 Sunlea Village, Peru, NY 12972.

**FOR TRADE:** Apple II Plus and IIe programs: games, utilities, business, etc. Send your list or disk of your best programs, with your name and address and I will return it with the best of mine. Lance Stewart, 101 4th Ave. NE, Clarion, IA 50525.

**FOR SALE:** BYTE issue #2, October 1975 through (and including) issue #16, December 1976. Some doubles. In addition, February, March, June, July, August, November, and December of 1977. Bernard Greenblott, POB 1328, Boca Raton, FL 33432.

**FOR SALE:** Hewlett-Packard HP-87A with 160K bytes of RAM, I/O ROM, Plotter ROM, 82902M 5¼-inch single-disk drive, HP-IB cable, carrying case, and dust cover. Visicalc Plus, Word/80, File/80, Statistics Pac, and FORTH operating system included. Everything in excellent condition: best offer over $2150. Steve Rodia, 1734 Plateau Dr., Jackson, MI 49203, (517) 784-3255.

**FOR SALE:** Blue case Osborne computer: factory modified for double density: 54, 80, or 104 columns; Smart Modem, Amdek high-resolution green-screen monitor, with software in both single and double density. Manuals and many disks included. Original cost, $3027; asking $1850 or best offer. E. J. Gentsch, 5060 Falcon Ridge Rd., Roanoke, VA 24014.

**FOR SALE:** WH11A Heath/Zenith Data Systems computer in excellent condition with: LSI11 CPU with 64KB memory, WH27 floppy-disk-drive sysytem with two drives of 250KB capacity each, two WHA11-5 serial-interface modules. Software includes HT11 operating system BASIC interpreter, editor, disk utilities, and all manuals: $1895. Carl E. Smith, 8200 Snowville Rd., Cleveland, OH 44141, (216) 526-4386.

**FOR SALE:** Vector Graphic System B, a word processing and small-business system. Memorite III word processor with Mailing List System, Execuplan spreadsheet, COMMX Comm-Pac communications software, CP/M 2.2, Raid debugger, Scope editor, MBASIC 5.2, S-100 (18-slot), Z80, 56K, dual 315K Micropolis drives, 12-inch black and white terminal, three serial and two parallel ports. Everything in excellent condition. Cost over $6000, asking $1950. Jack W. Long, 2518 East 54th, Tulsa, OK 74105, (918) 749-6393.

**FOR SALE:** Problem Solver Systems mainframe 12-slot S-100 bus, Solid State Music VB1B Video Interface Board, Microdaysys MD-690 6800-based microprocessor board, Memory Merchant MM16K14 16K static RAM board. All barely used with documentation: $300 or $75 each. J. Reina, 39 Thomas St., Staten Island, NY 10306, (212) 979-1547.

**WANTED:** College engineering student needs any used or surplus computer and electronics equipment in any condition. Vance Morgan, 8422 Beverly, Shawnee Mission, KS 66207.

**WANTED:** Documentation for the following S-100 boards: Franklin Electric I/O Interface—it has three RS-232C ports (board has P/N 48005A) and Vector Graphic Z-80 (rev 3). Will pay postage and copying costs. Jim Wolfe, POB 6601, Torrance, CA 90504, (213) 376-2931.

**WANTED:** Software for Victor 9000. All kinds needed, games and functional purpose, in MS-DOS or CP/M. Using up to 896K of RAM, (prefer to use 128K) twin disk, single-sided at 612K-bytes each. Also, need memory boards and battery-based clock. Mike Carpenter, Suite 8, 1930 South Westwood Dr., Mesa, AZ 85202.

**WANTED:** Apple II owners for software exchange. Send your list of programs. B. Olsen, Oterstien 1, N-1487 Toyenhaugen, Norway.

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## BOMB

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### THE CHAMPIONS OF FEBRUARY

Readers selected February's two cover stories for top billing this month: Gregg Williams's exposé on "The Apple Macintosh Computer" won first place, and second-place winner was "An Interview: The Macintosh Design Team," written by Phil Lemmons. Because both authors are on BYTE's staff, they will forgo the prizes. Third place was scooped up by Jerry Pournelle's User's Column, "Chaos Manor Gets Its Long-awaited IBM PC." A feature written by Gregg Williams about the new Lisa's compatibility with the Macintosh, entitled "Apple Announces the Lisa 2," placed a close fourth. And in fifth place was Steve Ciarcia's "Build the Circuit Cellar Term-Mite ST Smart Terminal, Part 2: Programming and Use." Congratulations to these authors.

### CORRESPONDENCE

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