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BYTE

the small systems journal

INSIDE THE IBM PC

- Hundreds of Peripheral Boards
- Big Blue Goes Japanese
- The Compatibility Question

ICOT—Japan's Fifth Generation

Workslate—A Dedicated Portable

Reviews: IBM XT, Corona PC, Superwriter

Inside Apple

Vol. 1, No. 3

Apple's new Monitor II. A sight for sore eyes.

If you've been using a TV as a monitor, perhaps you can get a friend to read this for you:

Apple's brand new Monitor II will improve your vision.

It features all the latest ergonomic improvements in monitor technology.

For example:

Studies have shown that the leading cause of eye fatigue for computer users is lack of contrast between the displayed characters and their background.

So we designed the Monitor II around a high contrast green phosphor CRT that provides an extremely dark background. That means you can read text at a lower brightness. And that means you can be more productive — working longer and more comfortably.

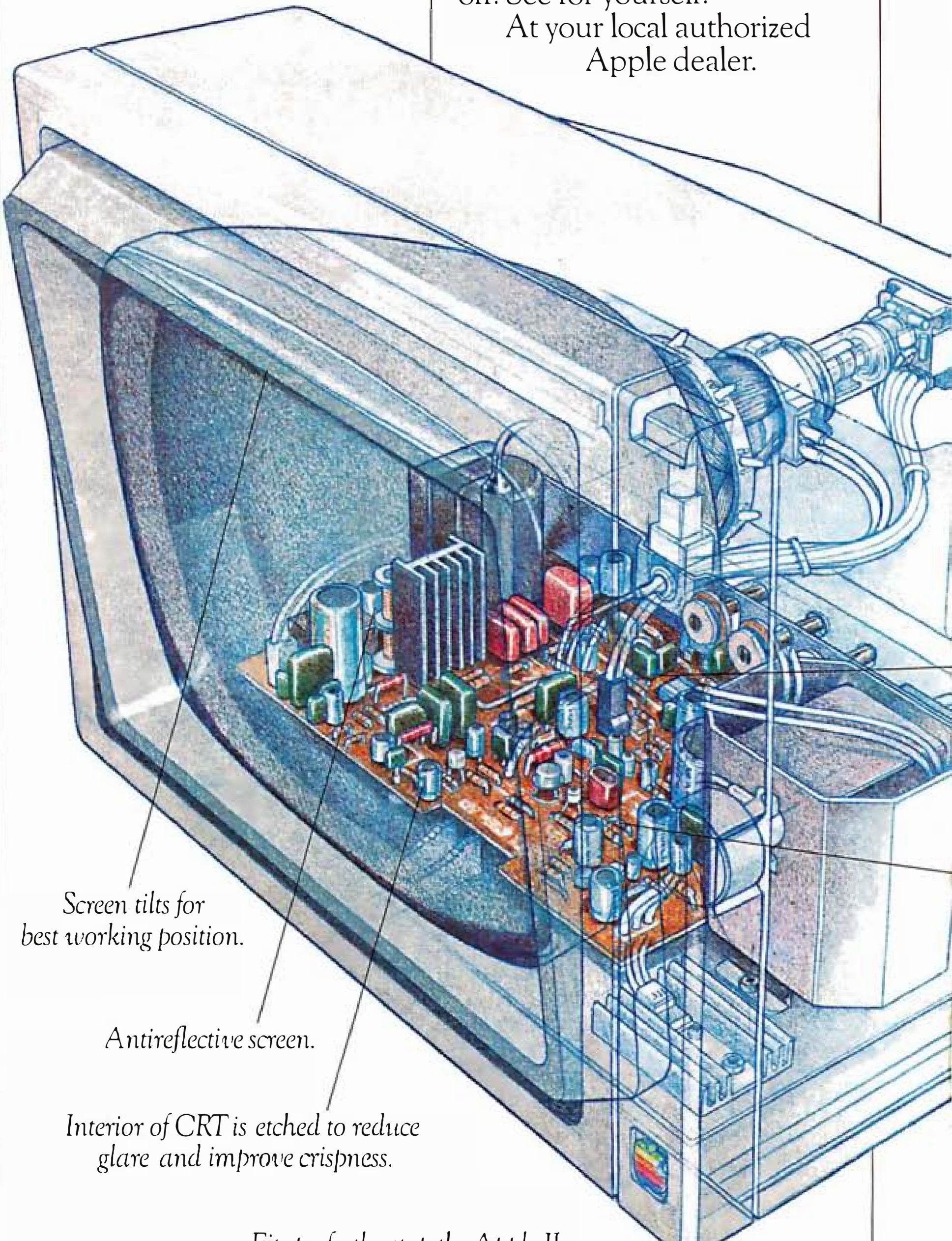
Toward that same end, we also gave Monitor II a tilt screen. So you can angle it perfectly for your working position, without scooting your chair around or sitting on phone books.

And we made that screen antireflective to reduce glare from ambient light.

Monitor II also features a high bandwidth video amplifier and a high tolerance linearity circuit. The former keeps characters from smearing on the screen and eliminates the annoying "ghosts" left by a fast moving cursor. The latter keeps characters crisp, legible and prevents "keystoning" right up to the edges of the display. Both add up to superior display of 80-column text and extremely accurate graphics.

Designed as the perfect system partner for the Apple® IIe Personal Computer, Monitor II requires no monitor stand. It's a perfect fit, aesthetically as well as technically. So it's pleasing to the eye even when it's turned off. See for yourself.

At your local authorized Apple dealer.



Now Apple plots color.

Since color graphics are becoming ever more important in business, we've been hearing more and more calls for a color plotter as reliable as an Apple.

Here it is:

Apple's new Color Plotter can generate all kinds of presentation graphics, engineering drawings or anything else you have to illustrate in up to eight brilliant colors.

And it can perform its art on any size paper up to 11" x 17." Or, with optional transparency pens, it can draw right on transparent film for overhead projection.

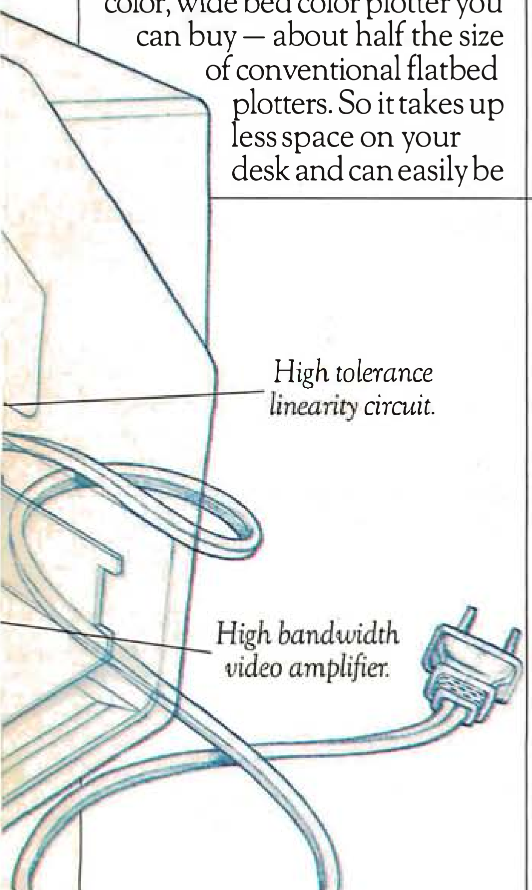
Measuring just 4.8"H x 16"W x 12"D, it's the smallest four-color, wide bed color plotter you can buy — about half the size of conventional flatbed plotters. So it takes up less space on your desk and can easily be moved to someone else's desk.

There are two color plotter accessory kits to choose from to assure a perfect marriage with your Apple II or IIe, or Apple III.

Each kit comes with eight color pens — red, blue, green, black, burnt orange, gold, violet and brown. Plus a starter package of plotter paper. Plus all the manuals, documentation and cables appropriate to your particular kind of Apple. So you can get up and coloring right away.

Apple also offers a complete selection of 24 different pen packages — so you can choose whatever colors you need in a variety of widths for a variety of applications and media types.

As you might expect, all of the above is available at many of our authorized Apple dealers.



Carry on with AppleCare℠ Carry-In Service.

No matter how long you've owned your Apple system, you can now get a long term service contract at a very reasonable cost.

AppleCare Carry-In Service is a service plan that will cover most Apple-branded components in your system for one full year.

It covers an unlimited number of repairs and is honored by over 1500 authorized Apple dealers nationwide.

Apple-trained technicians assure you of the highest quality service, fast — in most cases less than 24 hours.

AppleCare Carry-In Service is ideal for anyone who needs to know ahead of time the cost of maintenance for their system.

So check out the details — you'll find it's the lowest cost health plan an Apple can have.

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In The Queue

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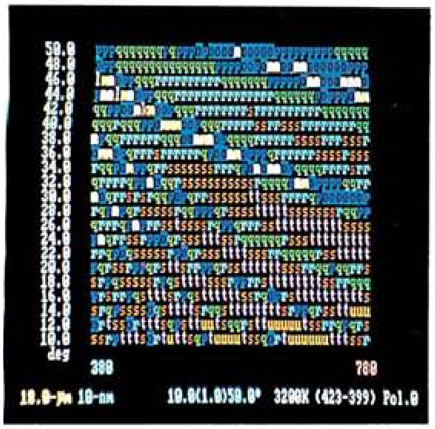

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Reviews

Features

Nucleus

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ABC

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Growth vs. Quality

Lawrence J. Curran, Editor in Chief

The exploding market for personal computers has created tremendous prospects for growth in revenues and profits for suppliers of both systems and software. But as companies race to satisfy a seemingly insatiable demand for small systems, there's a growing risk that they may cut corners in their quality-assurance programs. Never before has the admonition of *caveat emptor* been more appropriate than it is today in the personal computer business.

For their part, hardware and software suppliers should constantly evaluate existing quality-assurance procedures. One major supplier to do so recently is Hewlett-Packard Co. An article by John A. Young, the company's president and chief executive officer, on the *Wall Street Journal*'s editorial page outlined the program Hewlett-Packard undertook to analyze its methods for achieving product quality. Some surprising results flowed from that analysis.

For example, Young notes that Hewlett-Packard had previously believed—erroneously—that the "find-it-and-fix-it" method of ensuring quality was sufficient. Upon close examination, however, the company discovered that as much as 25 percent of its manufacturing assets were tied up in solving quality problems—a situation that increased production costs and product prices.

Young relates that after learning of the high cost of quality assurance, management decided that a bold and highly visible program was required to alter Hewlett-Packard's approach to quality assurance, even though "with above-average quality standards already established, it would be difficult to ask for better results." Nevertheless, Hewlett-Packard set out to improve quality standards with a program that included establishing a tenfold reduction in product failure rates in the 1980s, selecting a team of key people in the company to "champion the quality cause" and spread their gospel throughout the company, and sending several team members to Japan "to see what kinds of approaches worked well there."

The study team's most significant finding in Japan, Young notes, was that Japanese companies achieved impressive quality and low-cost manufacturing by following the simple principle of "doing it right the first time."

There are other elements in the Hewlett-Packard quality-assurance program, but that simple axiom is its most fundamental building block. The program is only a third of the way toward the goal of a tenfold reduction in product failure rates, but early results are convincing. At one division, service and repair costs for desktop computers were reduced by 35 percent through improved design and manufacturing. Further, the drive for quality has helped cut company-wide inventory over three years by an amount equal to about $200 million.

Other computer and software suppliers who want to maintain standards of quality as pressure builds to push products out the door should stop to determine whether their quality-assurance methods are founded on the principle of doing it right the first time. ■

How to buy a computer by the numbers.

Introducing the Cromemco C-10 Personal Computer. Only $1785, including software, and you get more professional features and performance for the price than with any other personal computer on the market. We've got the numbers to prove it.

The C-10 starts with a high-resolution 12" CRT that displays 25 lines with a full 80 characters on each line. Inside is a high-speed Z-80A microprocessor and 64K bytes of on-board memory. Then there's a detached, easy-to-use keyboard and a 5¼" disk drive with an exceptionally large 390K capacity. That's the C-10, and you won't find another ready-to-use personal computer that offers you more.

But hardware can't work alone. That's why every C-10 includes software—word processing, financial spread sheet, investment planning and BASIC. Hard-working, CP/M[R]-based software that meets your everyday needs. Software that could cost over $1000 somewhere else. FREE with the C-10. There's really nothing else to buy.

But the C-10's numbers tell only part of the story. What they don't say is that Cromemco is already known for some of the most reliable business and scientific computers in the industry. And now for the first time, this technology is available in a personal computer.

One last number. Call **800 538-8157 x929** for the name of your nearest Cromemco dealer, or to request literature. In California call 800 672-3470 x929. Or write Cromemco, Inc., 280 Bernardo Avenue, P.O. Box 7400, Mountain View, CA 94039. In Europe, write Cromemco A/S, Vesterbrogade 1C, 1620 Copenhagen, Denmark.

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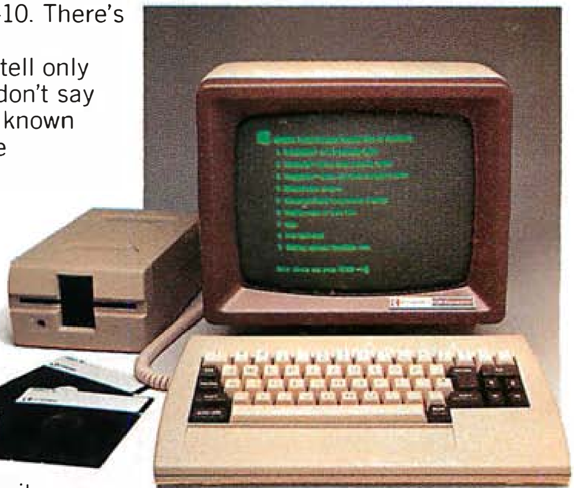

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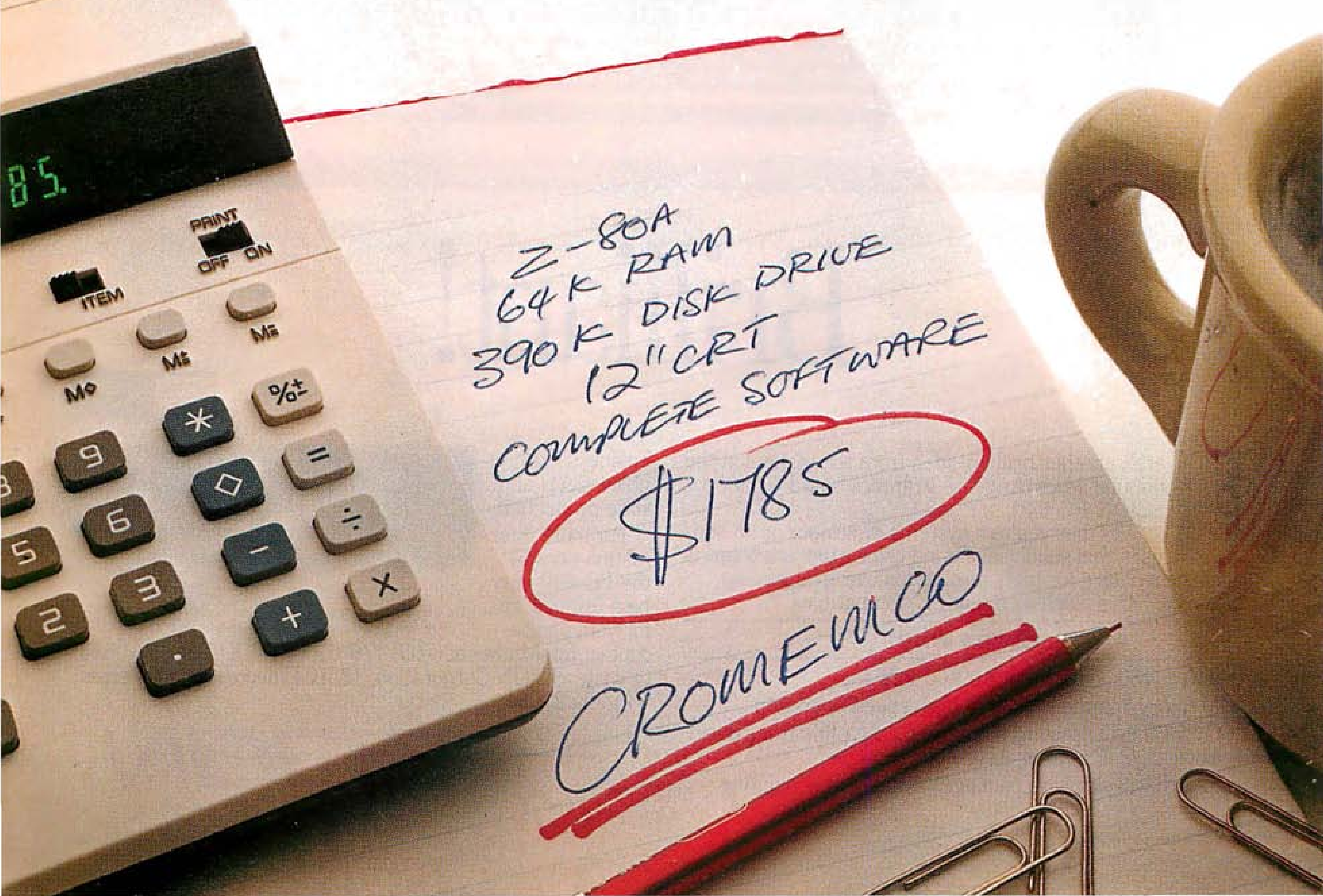


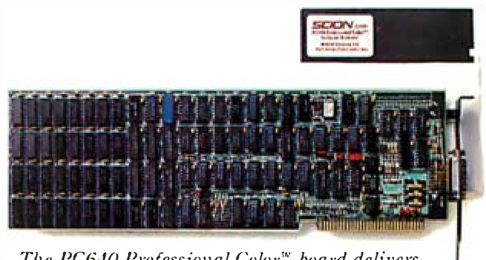
Brilliant!

Here's another brilliant idea from the makers of the popular MicroAngelo® graphics board — the SCION PC 640.

Whether you're a systems developer or an end-user, this solidly-designed color graphics board is your best choice for high-resolution color graphics on the IBM PC, as well as many PC-compatibles.

Here's why:

- 640 × 480 × 16 out of 4096 colors
- Memory-mapped for very high speed operation
- Over 60 2-D drawing primitives, accessible from Basic, Fortran, C, Pascal or Assembler
- High-level software packages available for painting, business graphics, CAD and slide production



The PC640 Professional Color™ board delivers superior resolution at 640 × 480, and the simultaneous use of 16 out of 4096 colors.

For more information on why the PC 640 may be a brilliant idea for you, please contact Jim Mather at (703) 476-6100, TWX: 710-833-0684, or write: SCION Corporation, 12310 Pinecrest Road, Reston, Virginia 22091.

SCION

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MICROBYTES

Staff-written highlights of late developments in the microcomputer industry

NEW IBM-COMPATIBLE AND MS-DOS COMPUTERS WILL FLOOD COMDEX

Several computer manufacturers are developing 16-bit MS-DOS computers, most of which will be formally announced at COMDEX, an industry trade show, scheduled for November 28 to December 2 in Las Vegas. Leading Edge Products, Canton, MA, which announced its word processor for the IBM Personal Computer several months ago, plans to unveil a complete line of IBM-compatible hardware and software, including a computer it says is more IBM-compatible than the Compaq portable computer.

Leading Edge says its computer's 8088 microprocessor will run at 7.16 MHz, 50 percent faster than the IBM PC, which runs at 4.77 MHz. The Leading Edge Personal Computer also will have seven expansion slots, two more than the IBM PC. With a clock, parallel and serial ports, 128K bytes of RAM, a monitor, and word-processing software, the Leading Edge computer will list for about 40 percent less than a comparably equipped IBM PC.

Olivetti plans to announce the M18 computer, which is based on Corona Data Systems' Personal Computer, uses an 8088 microprocessor, and runs MS-DOS. With 128K bytes of RAM, serial and parallel ports, one 5¼-inch disk drive, four expansion slots, and a high-resolution monitor, the M18 will sell for $2595. A hard-disk version will be $4495. Olivetti is working on two portable computers—notebook-size and transportable—for possible introduction in early 1984.

Three new MS-DOS portable computers are scheduled for announcement at COMDEX. Eagle Computer, Los Gatos, CA, is working on an 8088-based IBM-compatible portable with a 10-megabyte hard disk. With a 9-inch display, serial and parallel ports, four expansion slots, 128K bytes of RAM, and both the CP/M-86 and MS-DOS operating systems, it will be priced at between $4000 and $4500.

STM Electronics, Menlo Park, CA, is preparing an 80186-based MS-DOS portable with a liquid-crystal display, a built-in 40-column printer, a modem, two 5¼-inch disk drives, and bundled software for a target price of $2500. Panasonic, Secaucus, NJ, is developing an 8088-based portable with a built-in thermal printer.

Jonos Ltd., Anaheim, CA, will sell an 80188 processor board to enable its Z80-based portable computer to run MS-DOS and CP/M-86 software. The 80188 combines the 8088 microprocessor and related peripheral chips in a single chip.

Burroughs Corp., Detroit, MI, is making an 8086-based computer to be marketed as an ergonomic intelligent terminal. With two 5¼-inch disk drives, MS-DOS, and 256K bytes of RAM, the ET-2000 lists for $3795.

TWO NEW INTEGRATED SOFTWARE PACKAGES JOIN A CROWDED MARKET

Ovation Technologies, Canton, MA, has announced Ovation Software, a new integrated software package for the IBM Personal Computer that combines spreadsheet, word-processing, graphics, database-management, and communications capabilities. The package will be able to read from and write to files from existing software packages such as 1-2-3, Visicalc, Wordstar, and dBase II.

Ovation Software will include templates for common word-processing and spreadsheet applications, and users may define macros to perform any series of commands. It will require an IBM PC with 256K bytes of RAM and either two floppy disks or one floppy and one hard disk. The package, which Ovation will market as an enhancement of Lotus's 1-2-3 and Visicorp's Visi On, will sell for between $695 and $895 in early 1984.

Fox & Geller Inc., Elmwood Park, NJ, has announced Oz, a "financial-management system" for the IBM PC. Oz features three-dimensional viewing of data, allowing users to view budget information, for example, in charts by department and month, line item and month, or line item and department. The package, which also features graphics capabilities and variance analysis, enables managers to locate and explain budget changes. Oz will sell for less than $500.

MODULA RESEARCH INSTITUTE OFFERS A $40 MODULA-2 COMPILER FOR THE IBM PC

The Modula Research Institute, Provo, UT, has announced a full Modula-2 compiler for the IBM Personal Computer for $40. The four-pass compiler generates intermediate M-code, similar to the p-code used by Pascal compilers. MRI, a nonprofit organization, will sell the source code for the compiler for $160 and plans to offer a native-code (machine-language) generator later this year. MRI has versions of the compiler for the 68000 and PDP-11 as well.

COMPUTER-AIDED DRAFTING SYSTEM UNVEILED FOR IBM PC XT

United Networking Systems, Houston, TX, has unveiled a series of computer-aided drafting programs for the IBM Personal Computer XT. A "Pro 100" package for $595 is designed for drafting departments and professionals, while a $395 "Academic" version is aimed at colleges and technical schools. A starter version is available for $95. United Networking Systems also offers a complete hardware and software system for drafting service centers for $50,000 to $100,000.

SEAGATE PROPOSES A HIGH-CAPACITY HARD-DISK INTERFACE STANDARD

Seagate Technology, Scotts Valley, CA, maker of 5¼-inch Winchester hard-disk drives, proposed a new interface standard for high-performance, high-capacity small Winchester drives. Three other hard-disk manufacturers—Tandon, Priam, and Atasi—said they would support the proposed ST412HP standard, and Adaptec Inc. and Western Digital Corp. planned to develop controllers for the standard. Seagate also announced it would begin making and selling disk controllers based on the SCSI interface standard.

DATAPRO RELEASES RESULTS OF SURVEY OF COMPUTER USERS

Datapro Research Corp., Delran, NJ, has announced the results of a survey filled out by 5615 personal computer users who read *BYTE* and *Popular Computing* magazines. Among systems, the Apple II Plus was the most popular (17 percent), with the IBM Personal Computer in second place (16 percent), edging out Radio Shack's Model III (15 percent). The Osborne 1 was the fifth most popular computer, after the Apple IIe. Only 15 percent of the respondents had computers more than two years old, and 56 percent had owned their computers less than one year.

Among software packages, Datapro noted that Wordstar, Visicalc, and dBase II still held the leads for word processing, spreadsheet, and database management, respectively, although each program received a relatively low rating from users. Datapro suggested that these packages may have become popular because they were the first, rather than the best, in their application areas. Datapro will sell the survey results for $25.

NANOBYTES

Coleco Industries Inc., Hartford, CT, has obtained exclusive rights to market home computer and video-game versions of Dragon's Lair, a popular arcade game that uses a laser disk to store high-resolution animation. Coleco also announced a joint venture with AT&T to develop an interactive game and entertainment service using existing phone lines, a special modem, and a home computer or video-game system. . . . **DMA Systems Corp.**, Goleta, CA, has announced a removable 5¼-inch Winchester cartridge disk drive to sell for $500 in OEM quantities. The half-high DMA-360 will have a storage capacity of 7.5 megabytes and measure only 1⅝ by 5¾ by 8 inches. . . . **Apple** dealers will give free "tool kit" software to owners of Apple's $175 Apple Logo programming language. The tool kit includes utilities, sample programs, and documentation. . . . **Digital Equipment Corp.**, Maynard, MA, announced a hard-disk version of the Rainbow 100. Intended to compete with IBM's PC XT, it will sell for $6295. Digital's Professional 350 computer is now available in a coin-operated version, with a printer, for use in colleges and libraries. . . . **Apple** has dropped the price of its Lisa computer from $9995 to $8190, which includes six applications software programs. The Lisa will also be available without software for $6995. . . . **IBM** officially withdrew its 4-inch disk system from the market in mid-September, leaving three sizes in the sub-5½-inch marketplace: 3-, 3¼-, and 3½-inch disks. In another product area, IBM announced an experimental 512K-byte dynamic RAM chip. . . . **Radio Shack** has unveiled a transportable version of the TRS-80 Model 4. The 26-pound Model 4P includes a 9-inch display, two 5¼-inch disk drives, 64K bytes of RAM, and a parallel printer port for $1799. . . . **LQ Corp.**, Meriden, CT, has introduced a $595 sheet feeder for printers, including versions for the NEC 3500 and 2050, the Daisywriter, and the C. Itoh F10. The company will add new versions soon. . . . **Televideo Corp.**, Sunnyvale, CA, announced a graphics program using Digital Research's CP/M and GSX graphics extension. Teledraw is an interactive drawing system for the Televideo TS-803 and TS-1603 computers, compatible with Epson printers and Hewlett-Packard plotters. The package, which requires Televideo's Supermouse, will sell for $295. . . . **The Department of Commerce** is accepting nominations through November 31 for the new National Medal of Technology, which is to be awarded to "innovators in technology" who develop new products or processes. Instructions and nomination forms are available from the Assistant Secretary for Productivity, Technology and Innovation, U.S. Dept. of Commerce, Washington, DC 20230.

ATARI COMPUTER OWNERS:

Pick the positively perfect, practical, printer-port peripheral package, from PERCOM DATA!

That's right... the positively perfect PERCOM DATA 5¼", floppy disk drive with a BUILT-IN PRINTER-PORT, for your Atari® 400/800 is now available!

Until now, Atari computer owners who wanted to hook a printer to their computer had only one choice... spend about $220 for an interface device. THOSE DAYS ARE OVER. PERCOM DATA has built a parallel printer-port right into its new AT88 PD model. Now you can add a quality disk drive system AND have a place to plug in a printer... WITHOUT BUYING an interface.

The AT88 S1 PD™ disk drive operates in both single density (88K bytes formatted) and double density (176K bytes formatted).

What more could you want? NO INTERFACE... a high quality PERCOM DATA disk drive... AND a built-in PRINTER-PORT... all with a price of $599.

Pick up a positively perfect PERCOM DATA disk drive, with printer-port... pronto!

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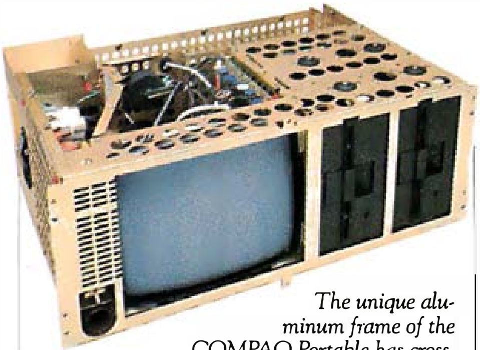
With all the clamor about personal computers, a fundamental fact is often overlooked: some simply *work* better than others.

Consider the COMPAQ Portable.

A computer will make you more productive. A computer will make you more efficient. You hear it everywhere. But you don't hear about which computer actually *works* best.

A computer isn't magic. It's a tool. And just like other tools, some computers work better than others.

The COMPAQ™ Portable is a combination of 20th-century electronics and 19th-century pragmatism. It simply does personal computing better. Here's why.



The unique aluminum frame of the COMPAQ Portable has cross-members that strengthen it front-to-back, side-to-side, and top-to-bottom. It's a design practice commonly used in race cars.

Works in more places

You don't do all your thinking in one place. Why have a computer that stays in one place?

The COMPAQ Portable has all the capabilities of a large desktop computer. But now those capabilities can go where you go.

You can move it from office to office to share its resources. You can move it into the conference room to answer questions when and where they come up.

With the COMPAQ Portable, you can be as productive in your hotel room or your lake house as in your own office. It's a reliable companion on a business trip. It's a powerful sales aid in your customer's office.

What's more productive than a computer? A computer that works for you in more places.

Works with the greatest number of programs

The most important consideration when you choose a computer is "what programs will it run?" And that's one more reason for choosing the COMPAQ Portable.

The COMPAQ Portable runs more programs than any other portable. In fact, it runs more than most non-portables. That's because it runs all the popular programs written for the IBM® Personal Computer. There are hundreds of them. They are available in computer stores all over the country, and they run without any modification, right off the shelf.

The COMPAQ Portable was designed to fit under a standard airline seat so you can take it on business trips.

Imagine the power of a *portable* word processor. There are dozens of different word processing programs available for the COMPAQ Portable.

Planning, problem-solving, and "what-ifs" are a cinch with a variety of popular electronic spreadsheet programs. The COMPAQ Portable runs them all.

There are accounting programs for anything from computerizing your family budget to full-scale professional management of payables, receivables, inventory, and payroll for your company.

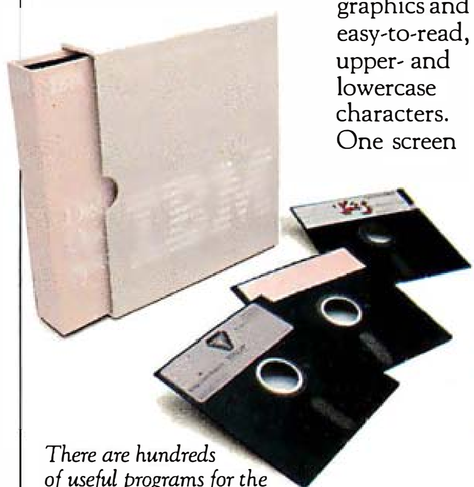
There are programs for making charts and programs for communicating with other computers. Or if you want something really specialized, there are even program languages for writing your own programs.

So, you get portability and you don't give up problem-solving power. The combination adds up to the most useful personal computer on the market today.

Works better because it's easy to read

The display screen of the COMPAQ Portable measures nine inches diagonally. It shows a full "page width" of 80 characters on a line so tasks like word processing are easier. And those characters are big enough to read even if you're leaning back in your chair.

The display shows both high-resolution graphics and easy-to-read, upper- and lowercase characters. One screen for all the information. With some personal computers, including the IBM, you can have either the graphics or the legible characters, but you can't have both unless you buy two different displays.



There are hundreds of useful programs for the COMPAQ Portable because it runs all the popular programs written for the IBM.

Incidentally, computer prices are often quoted without a display. The display of the COMPAQ Portable is built in, of course.

Add-on options make it work the way you work

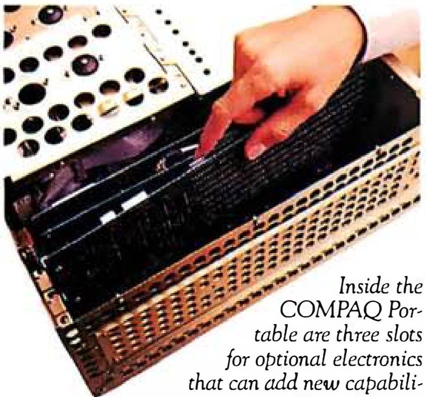
Inside the COMPAQ Portable are three open slots. Electronic devices called expansion boards fit those slots and give the COMPAQ Portable new powers.

Just like the programs, expansion boards designed for the IBM work with the COMPAQ Portable, so there are dozens available right now. With them, you can make your personal computer more personal.

Want to check a stock price? Or look up something in The New York Times Information Service? One expansion board enables the COMPAQ Portable to handle those communications over ordinary phone lines.

Want to use your company's central computer files while you're on a trip? There are boards that allow the COMPAQ Portable to communicate with a variety of large mainframe computers.

Other boards let you hook up controllers for computer games or increase memory capacity. Still others let you connect personal computers in a network so several people in your office can share the same information.



Inside the COMPAQ Portable are three slots for optional electronics that can add new capabilities. Most portables have none.

Works better because it's tough enough for the road

Portable doesn't just mean smaller. Portable means tough, too.

The COMPAQ Portable was built to withstand the hard knocks of constant travel. An aluminum frame within the case completely surrounds the computer's working components. Each disk drive is mounted in rubber shock absorbers instead of being bolted directly to the frame.

To test internal components, the COMPAQ Portable was subjected to impacts of 40 G's *while running a program.* After impacts on each side, there was no internal damage and the program was still running. Without error.

Computers are for getting rid of worries, not giving you new ones.

Designed to help you work better, too

The COMPAQ Portable was designed to *feel* good.

Specifications

Software
- ☐ Runs all the popular programs written for the IBM PC

Memory
- ☐ 128K bytes RAM
- ☐ Expandable to 640K bytes

Storage
- ☐ One 320K-byte minifloppy disk drive, second drive optional

Display
- ☐ 9-inch (diagonal) monochrome screen
- ☐ 25 lines by 80 characters
- ☐ Upper- and lowercase, high-resolution text characters
- ☐ High-resolution graphics

Expansion board slots
- ☐ Three IBM PC-compatible slots

Interfaces
- ☐ Parallel printer interface
- ☐ RGB color monitor interface
- ☐ Composite video monitor interface
- ☐ TV RF modulator interface
- ☐ Communications interface optional

Physical specifications
- ☐ Totally self-contained and portable
- ☐ 20″W × 8½″H × 16″D

The keyboard is detached so it can fit into your most comfortable working position.

The keyboard cable remains connected at all times. So you don't have to unpack it and hook it up every time you use your computer.

Because the display is built in, the COMPAQ Portable makes a neat, small package on your desk, instead of a big obstacle you have to talk around. The built-in display also avoids the usual cable clutter because there's no need for separate cables for the display.

The COMPAQ Portable even has an electronically synthesized sound to create the familiar keyclick of a typewriter. With a simple keyboard command you can adjust the volume to suit the level of background noise in your office.

The added usefulness is free

The COMPAQ Portable can do what desktop computers do and do it in more places. But it doesn't cost any more than an ordinary desktop.

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Letters

Views on BYTE Content

In the June BYTE, you gave us 13 "theme" articles on 16-bit designs. These included a report on the DEC Professional 300 written by a DEC product manager; a piece on the TI 99/2 written by two representatives of Texas Instruments; an article about the Pronto Series 16 by a vice-president of that company; and four other articles, all penned by staff members of the companies supplying the products.

I, for one, do not buy BYTE to read PR material disguised as objective reviews.

Mike Lewis
48 Willoughby Rd.
London N.W.3.
England

As a (fairly) longtime reader of BYTE, I have mixed feelings about the recent shift in editorial policy that seems to have taken place. For the past several months, a large portion of the articles have been descriptions of products written by the people who developed (and/or sell) that product. While these articles have been well done for the most part, I am concerned that BYTE may lose its position as a source of trustworthy information about "small systems." I don't want to see BYTE become another *Mini-Micro Systems*, serving primarily as a mouthpiece for companies that provide the magazine's advertising revenue.

A small but telling example of the type of distortion that can creep into articles such as these appears in Stephen Heywood's article "The 8086—An Architecture for the Future" (June, page 450) where he proclaims that the 8086 can address "1,048,576 bytes of memory. . . *more than* 16 times the memory capacity of an 8-bit microprocessor." Granted, this incorrect use of "more than" is rather trivial and harmless hype, but I have always believed that there was no place for hype in BYTE (excluding the ads, of course!). More important, one must wonder whether articles such as this, with their underlying motivation to "sell," are concealing more serious errors.

Don't get me wrong: if the developer of a product can provide uniquely valuable insights, then by all means take advantage of this. I think Tim Paterson's "An Inside Look at MS-DOS" (June, page 230) is an excellent case in point. But, whenever possible, please try to seek out alternative reviewers, or perhaps you could make a point of providing a "counterpoint" article, or box, for each "in-house" article that you print.

I suppose that the series of articles from Motorola on the 68000 and Intel on the 8086 serve to counterbalance each other to some extent, but, in addition, a comparative article written by an outsider would be helpful to weigh the various merits of these two processors.

Christopher J. Kapilla
Cybernetic Systems
1109 Edward Terrace
St. Louis, MO 63117

We share your concern about product-related articles written by the companies making the products, and we hope that our judicious use of such articles does not damage our reputation with our readers. We carefully select such articles from a much larger group of articles offered to us, and we try in both the selection and editing of such manuscripts to make sure that the information content is high and the promotional content is low.

In all cases, we prefer to have a review by an independent reviewer over one from the manufacturer (in fact, we are doing independent reviews for some of the products profiled in the June issue). There are, however, some good reasons for going with articles from the manufacturers. First, as you mention, who is more qualified than the designers to contribute significant insights about a product? A second reason is timeliness: because of the ratio of qualified reviewers to important machines (perhaps 1 to 10) and the difficulty of obtaining prerelease copies of new machines, a full product review often comes out six months later than a company-supplied article discussing the design of the machines. Always we face a choice of providing readers with some information or no information at all.

Your point on providing counterpart articles is a good one, and we do that whenever we can. For example, we had company-supplied articles about the National Semiconductor NS16000, the Intel 8086, and the Motorola 68000 in our April and June issues. Strictly speaking, these are not counterpoint articles, but they give coverage to three important chip families. This was the best we could do under the circumstances.


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In conclusion, we publish company-written articles only when we feel that the information contained in them is important and useful to you, the reader. We edit out the "hype" wherever we find it and continue to commission independent reviews, but we also must trust you to read these articles with a discriminating eye and to judge a product based on the quality of the manufacturer's arguments in presenting its viewpoint.

A Lament from "Down Under"

The article by Gregg Williams on the Lisa Computer System (February, page 33) was fascinating.

However, reading the article also left me feeling rather sad. Gregg Williams hit the nail on the head with his comment: "The history of microcomputing has been exciting so far because it has enabled individuals working in their spare time to make significant contributions to the state of the art. . . . The days of the successful entrepreneur/programmer are probably gone." I believe that the fascination and attraction of microcomputers to individuals has been the opportunity to indulge in creative and mentally stimulating activity, which is unfortunately lacking for most people at work and at home. Lisa and her successors will probably destroy that opportunity in areas that many BYTE readers are currently involved in.

Recall how the staple fare of electronics magazines some years ago was constructional articles on radios and hi-fi stereo systems. The mass production of these and their reasonable selling price has destroyed them as topics for electronics magazines, except for reviews of commercial units. Microcomputer magazines such as BYTE are already following the same path. Over the past couple of years many more pages have been devoted to reviews of commercial systems and software.

Mass production and standardization of microcomputer hardware and software are to be applauded in making computers accessible to the masses. However, it will mean that microcomputer design and construction, the writing of systems software, language implementations, and applications such as word processors, etc., will no longer be fertile ground for those seeking creative and mentally stimulating activity. Perhaps this is good, as it shifts the emphasis away from the computer itself to more creative applications where the ideas of the individual are still needed to provide the concepts that will advance the state of the art.

David L. Craig
2 Bridle St.
Mansfield, 4122
Queensland, Australia

Gregg Williams replies:

Thank you for your kind words about my Lisa article. In turn, I think that your letter has also hit the nail on the head. We are no longer in a hobbyist/homebrew industry; we are in a consumer industry where you can (and are likely to) buy the hardware and software you want. Although it follows that BYTE reflects that change, we are still speaking to the hobbyist part of our readership. Steve Ciarcia's hardware construction articles always place high in our BOMB readership popularity contest. John Smith's "Public Key Cryptography" article in the January issue placed second in that month's BOMB, and a two-part article by Richard Fobes, "Program Your Own Text Editor" (September and October 1982), won fifth place in the BOMB both months. These articles indicate both our and our readers' interest in seeing such articles published, and I assure you we will continue to do so.

As for the importance of the lone programmer, I have two thoughts. First, most (but not all) applications software will be designed and executed by more than one person. In contrast, most (but not all) game software can be designed by one person—this, I feel, is cause for rejoicing. However, my second point is this: today, all software, game or otherwise, requires a staff of people doing marketing, verification, documentation, and other tasks to make a product successful. So my original premise still stands: the days of the successful (individual) entrepreneur/programmer are probably gone.

In Praise of Public-Domain Software

In February BYTE's Bits (page 127), you mentioned the "large amount of *public-domain* software available" for the Apple. I purchased the software mentioned in that article, Dr. Cat's Grafix Disk, and I found it to be tremendous. My hat is off to the author, David Shapiro.

My question is: does there exist a source for more of this "free" software? If so, I'd like to contact this group. Please provide more reviews of, and information about,

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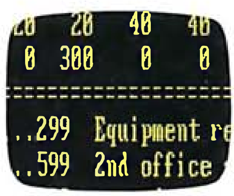

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public-domain software in future issues. I congratulate you on advertising these sources. It must be a little like biting the hand that feeds you to add this to your magazine.

John H. DeRosa
150 Birchwood Rd.
Lake Marion, IL 60110

Not at all, John; no advertiser is biting our hand over such listings. Their products give good value for the money—including such things as documentation, professionally tested software, and customer support, things you don't get with public-domain software (sometimes called "freeware"). We would like to mention more public-domain software and will print recommendations that you send us.

As for getting more public-domain software, you should find the nearest Apple users group and join it; most have libraries of public-domain software available to members at moderate cost. If you don't have a users group nearby, A.P.P.L.E. (Apple Pugetsound Program Library Exchange) is a nationwide users group that offers a variety of commercial and public-domain software. The group also publishes an excellent Apple magazine, Call-A.P.P.L.E. *Contact A.P.P.L.E. at 21246 68th Ave. S., Kent, WA 98032 (206) 872-2245) for membership information. If you're a CP/M user, SIG/M, jointly sponsored by Amateur Computer Group of New Jersey and the New York Amateur Computer Club, distributes public-domain CP/M software; their address is SIG/M, Box 97, Iselin, NJ 08830.*

8086 Controversy

After reading Stephen Heywood's article, "The 8086—An Architecture for the Future" (June, page 450), I am compelled to respond. I would like to title this letter "The 8086—An Architecture for the PAST."

I cannot argue with Mr. Heywood's justifications for the existence of the 8086; it is obvious that the 8080, a processor with only 64K bytes of memory, no hardware multiply/divide, and only 8-bit operations was insufficient in the burgeoning microprocessor marketplace. Unfortunately, Intel chose to continue worshipping that false god of marketing, upward compatibility. Rather than breaking away from the 4004/4040/8008/8080/8085 ancestry to produce a truly modern

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

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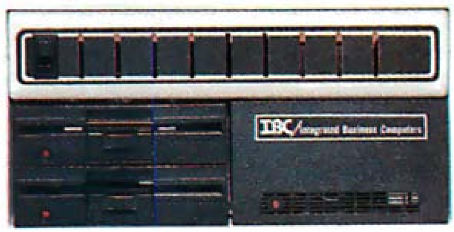

For more information on the Middi Cadet, see your local IBC dealer.

To locate the dealer nearest you, call or write:

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machine, it chose to merely stretch the venerable old 8080 into a 16-bit machine with a few extra registers. This incestuous dedication to purity of bloodline has just as damaging an effect in the microprocessor world as it does among humans.

Keeping upward compatibility in mind, Intel carefully embedded the ancient 8080 register set into the "new" machine. Also in keeping with the 8080 tradition, each of these new registers has a special purpose, instead of creating a good set of general-purpose registers. If the "general" registers were truly general, there would be no such thing as a "data group" or a "pointer and index group."

Instead of a 64K-byte memory, Intel chose to implement a fixed number of segments (four), each of a fixed size (64K bytes, of course). The only ways these segments can be of other than 64K-byte size is either through very careful programming or physically missing memory. Segmented memory is an excellent idea, but a very limited set of fixed-size segments is not.

Due to the complete lack of hardware-memory protection and privileged instructions, it is impossible to implement an operating system for this machine that has even the slightest hope of keeping different tasks from interfering with each other. A more modern processor would provide for this.

I would like to point out that Intel has historically been the first manufacturer in the industry to bring out new sizes of microprocessors: perhaps, someday, it will make one I'd like to use.

Paul Hoefling
Software Engineer
7095 SW Oleson Rd.
Portland, OR 97223

Stephen Heywood replies:

You have raised a lot of points in your letter that I will attempt to address individually.

First of all, the 8086 is not upwardly compatible with the 8080 microprocessor. Yes, there is software available to convert the 8080 source code to make it run on the 8086. The registers may even look the same on these processors. But that is where the similarity ends. The 8086 took the modern approach of using segments instead of linear addressing, having addressing modes that support the programmer's needs, and support for compilers with its registers and instructions.

When you begin writing software for an

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Circle 18 on inquiry card.

application, one of the first things that you do is set down the ground rules for your application. You may be dedicating the registers to perform a particular function within your application as well as having some general-purpose functions to perform. Part of your software development might be done in a high-level language. If you are writing assembly-language routines to be called from that compiled language, you have to know the compiler's rules for register use. Also, you want this final application to take the smallest possible space. The instruction set in the 8086 is designed to place as much information in 1 byte as possible to save coding space. To do this, some instructions require that certain registers contain the proper information. The 8086 would then require fewer bits to define an instruction and allow you to have instructions that would take only 1 byte of memory space. The registers and the instruction set have been designed for the compilers so that they can produce compact code. This makes it a lot easier to add your assembly-language procedure because you don't have to worry about things such as which register is pointing at the stack. If you want general-purpose operations, then the general-purpose registers are just that for the more commonly used arithmetic and logical instructions (such as ADD, SUB, AND, OR, etc.).

Most programming consists of code to be executed, data variables, a stack for saving information, and possibly an extra data area for additional data storage. You can execute only one piece of code at a time, but your application may consist of several pieces of code located throughout the memory. You can go to one of these other code segments by simply changing the code segment register to point to the new segment and begin execution from there. To accomplish this, you would use interrupts and the far jumps and calls. Multiple data segments can be supported by changing the data segment register to point to the new data. Therefore, the fixed numbers of four segment registers are all the segment registers you need at one time.

The maximum length of a segment is 64K bytes, but they are by no means fixed to that length. Most assemblers' and compilers' outputs will have segments that will be smaller than that. As these final segments are placed contiguously in memory, the segment register, which must be on a paragraph boundary with the least

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significant 4 bits equal to 0, will point to the beginning of the segment, and the offset will be the first byte or word in that segment. These segments do not have to have their own 64K-byte space to reside in.

The beginnings of memory protection are in the 8086 with its segmented architecture. This is a step toward future microprocessors. This same architecture, for example, is taken one step farther to include hardware-memory protection with privileged instructions in the 80286 microprocessor. The 80286 keeps the same concepts of the 8086 but expands the segmentation by including descriptors to describe these segments more fully as to their length, type, access rights, and other properties.

No More JETSET

My article "JETSET" won an award in BYTE's 1982 Games Contest and was subsequently published in the November 1982 BYTE. The article mentioned that readers could obtain a copy of the program, a flight simulator for the TRS-80 Model II, by sending $8.00 and a blank disk.

Please be advised that I discontinued this service several months ago. Readers from the U.S. and abroad are still sending me disks and requests for copies of JETSET—often for the wrong computer. Perhaps this message will spare others the inconvenience of having their material returned to them unopened.

For interested readers, I've designed an enhanced and fully programmable version of the flight simulator for the IBM Personal Computer. This model is named CADET. To obtain more information about the IBM PC version, please contact me directly at my home address in Princeton, or write to Avell Inc., POB 6051, Lawrenceville, NJ 08648.

Eugene Szymanski
693 Rosedale Rd.
Princeton, NJ 08540

It's Not That Simple

In his letter "A More Powerful Pencil" (August, page 26) Mr. Yriart made some good points but did *not* hit the nail on the head about the use of turnkey systems—that is, not if he's ever operated a Radio Shack TRS-80 Model I with interface and disk drives.

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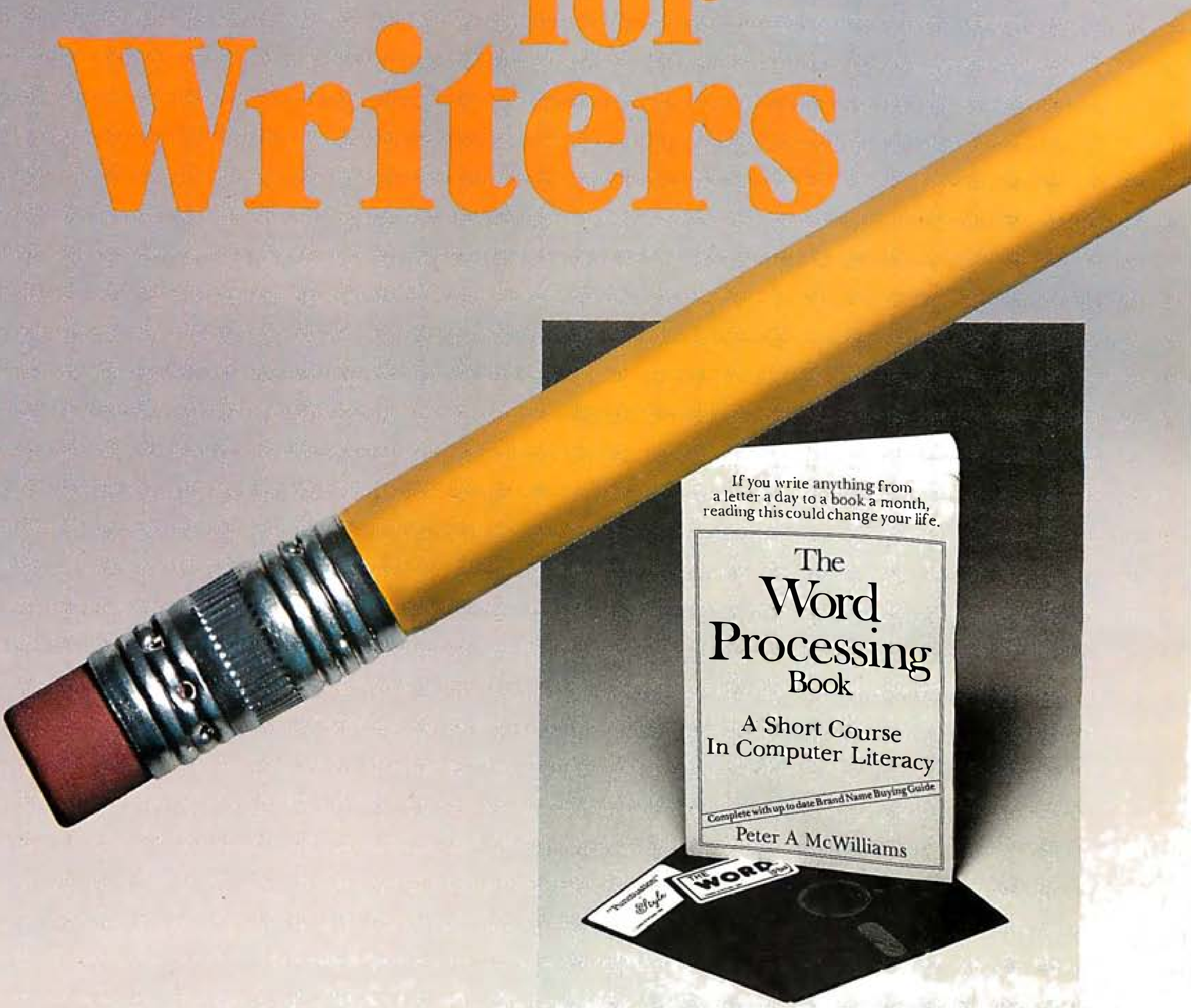

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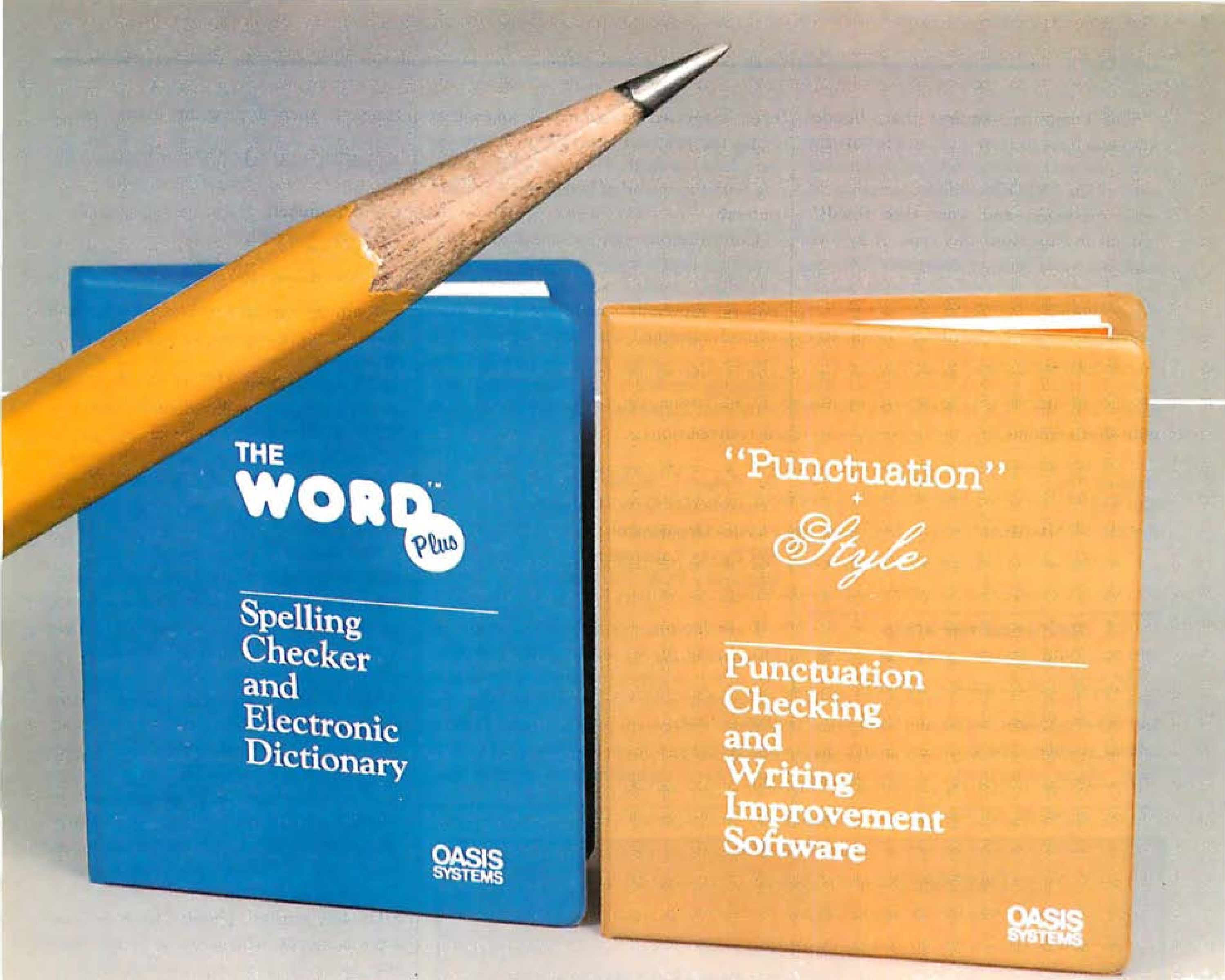

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This computer requires that, besides knowing how to turn it on and follow the prompts, you become thoroughly familiar with all the TRSDOS utilities, commands, error messages, and some disk BASIC, too. In my opinion, this type of knowledge is a valid form of computer literacy, though not to be confused with actual programming.

With a Model 1, the idea of being able to just turn it on and load and run a program is strictly a pie-in-the-sky idea that rarely was the case in my 4-year battle with that machine!

Helmut Vles
Box 416
Rockland, ME 04841

Requests for Help

For an anthology, I welcome contributions of humor in the sciences, historic and contemporary, especially computer-related science. The ordinary man's disquiet about computers has sometimes been expressed in contrived jokes that bring the resented superiority of the expert down to earth. How are jokes changing with the spread of personal microcomputers?

Contributions can be anecdotes, biographical notes, witty accounts, cartoons, parodies, verse, self-deception, and hoaxes. Especially sought are items that, while humorous, also have value in the history of a science, providing insight into changing attitudes or illuminating personalities. Please fully identify the sources of contributions.

Dr. Robert L. Weber
Pennsylvania State University
Physics Department
104 Davey Laboratory
University Park, PA 16802

I am looking for a public-domain or moderately priced (under $150) commercial screen-oriented program editor that is compatible with Apple CP/M and the Videx Videoterm 80-column display board (ED just doesn't cut the mustard). It must have comprehensive editing features. If such a program exists, please notify me. If not, I will try to write one myself—a task I do not look forward to!

Chris Campbell
2843 Harmony Pl.
La Crescenta, CA 91214

I am a newcomer to computing and have been reading BYTE regularly, and I thought perhaps you could put me in touch with readers with the same interests or problems as myself who would be willing to assist me.

I have acquired a previously owned Zenith-89 with three disk drives (5¼-inch single-sided single-density hard sector) and CP/M.

My special interests/problems are:

- BASIC-E: this is a public-domain compiler and interpreter that I have recently obtained. The documentation that I have is sketchy and I need to locate a BASIC-E users manual or other documentation for BASIC-E that will allow me to better understand this language.
- COBOL: I am a neophyte COBOL programmer and I would like to communicate with someone who has implemented COBOL on a microcomputer, particularly the Z-89. I would be interested in an evaluation of the Nevada COBOL that I have seen advertised.
- IDS-460 printer: I would like to hear from someone who is using or has used this particular printer. I am especially interested in learning how to use the graphics capability of the IDS-460.

Wm. F. Fowler
4014 Hillwood Court
Beltsville, MD 20705

More on Using Computers in Aircraft

I must take issue with Alexander Raue's statement that "the operation of portable electronic devices aboard a commercial aircraft or an aircraft flying under instrument conditions is prohibited by law." (Letters, July, page 10). He makes reference to Federal Aviation Regulations, section 91.19. It is a pity he did not quote the next two sentences of that regulation, which state, in part, that "the air carrier or commercial operator of the aircraft on which the particular device is to be used" may determine that the "portable electronic device. . . will not cause interference with the navigation or com-


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munication system of the aircraft. . . ." Upon such determination by the air carrier, operation of the portable electronic device is permitted.

Most portable computers bear a label indicating that they are "certified to comply with Class B limits, part 15 of the FCC rules." The Class B requirement limits the permissible field strength at 3 meters to well under a millivolt per meter, depending on the frequency. This requirement, which has been in effect for about two years, has been and will be a help to airlines in deciding which pieces of equipment may be operated aboard the aircraft.

It bears noting that nearly all airlines permit use of handheld calculators. Many calculators now in use were manufactured before the Class B rules went into effect and emit radio-frequency energy at far higher levels than those permitted by the Class B rules for computing devices.

Carl Oppedahl
Kreindler & Kreindler
99 Park Ave.
New York, NY 10016

Alexander Raue replies:

My principle concern was not with isolated, individual units in good working order, but rather with the cumulative emissions of multiple units and/or the excessive emissions radiated by those units which are, for one reason or another, in less than perfect condition.

Part 15, Subpart J of the FCC Rules and Regulations sets electromagnetic interference standards for individual devices or systems tested pursuant to procedures outlined in Section 15.840. These procedures test a sample unit for compliance with the following emission standards for Class B computing devices:

Frequency (MHz)	*Distance (m)*	*Field Strength (μV/m)*
30-88	*3*	*100*
88-216	*3*	*150*
216-1000	*3*	*200*

These standards were designed to minimize the possibility of radio interference in a normal environment. They do not pretend to be a safety standard to determine the suitability of certificated equipment for use aboard aircraft. Class B standards regulate emissions between 30 and 1000 MHz. Unfortunately, airborne navigation equipment relies on signals that range between 10.2 kHz and 5250

MHz. This is a considerably broader spectrum than is addressed in Part 15.

Furthermore, Class B standards specifically do not address the problems of the cumulative EMI of multiple units or provide for units in less than perfect working order due to manufacturing defects, use, abuse, or subsequent modification. Portable units, by their very nature, will be subjected to considerable abuse by the user which can result in emissions in excess of Part 15 standards.

In the never-ending war for passengers, the airlines may decide to allow personal computers. Already, in the effort to lure the all-important "business-class" traveler, they "allow" considerable violation of the law with regard to carry-on luggage. The next time you fly, take a good look at what is stuffed in the compartments above your head. Then take a look at the legal limits set by the manufacturer and the FAA for your safety. If the compartments pop open from the strain in the take-off roll, imagine what they will do in any form of accident.

Officially, the airlines say it is against their policy to allow these violations; in practice, they do nothing but encourage them.

In the end, carry-on luggage won't cause a major accident. The same cannot be said for equipment that causes navigational jamming.

In Defense of APL

Jerry Pournelle remarked that APL was great "as a quick calculator" but he could not imagine APL being used for large programs ("The User Goes to the Faire," June, page 306). Many people at companies like IBM, Xerox, Mobil, Upjohn, and others have come to a quite different conclusion after actually using APL for large-scale systems. APL may look strange at first, but so does anything else, and APL is not hard to learn or teach.

If the many APL operators are thought of as macros or subroutines, APL is structurally similar to other powerful programming languages. For people with some mathematics background, many of these APL operators are already familiar symbols; for those without a mathematics background, I believe APL symbols are no more foreign or hard to learn than their alternative idioms. For example, how many times does a person have to code a quick or sync sort before he is familiar enough with its coding to think of it as an elementary idiom? In APL a sort consists of (C) ↑ MAT, where C is an optional alternate collating sequence, ↓ is the ascending sort operator, (↑ would be a descending sort), and MAT is an alpha or numeric vector or matrix to sort. Other high-level languages have similar capabilities but are generally less succinct.

Because of its power, APL can reduce the total code required for a system by a factor of 10 or more; this speeds the coding and actually makes support easier (would you rather look through 10 or 100 pages of code for a bug or enhancement change?). Because the language is interpretive, each APL operation within each line of code can be (and often is for complex computations) tested while coding; thus, development time is greatly shortened. Finally, APL can be very efficient even with the overhead of interpretation (for example, the Sieve benchmark, which is possibly the worst case for APL because of its iterative method).

Over the last 14 years I have programmed systems in many languages (a few different assembly languages, BASIC, several levels of FORTRAN, PL/I, COBOL, many packages, etc.). None of these languages has given me the power, speed, or flexibility of the APL. Having this experience, I cannot imagine how I, or others, endured large-scale system development with primitive tools such as BASIC, COBOL, FORTRAN, and other such languages. APL is not perfect, but it is one of the languages that I believe is heading down the right road to improved productivity. As an unknown author put it: "Life is too short to spend it coding do-loops."

Michael C. Rowe, PhD
The Upjohn Company
7000 Portage Rd.
Kalamazoo, MI 49001 ■

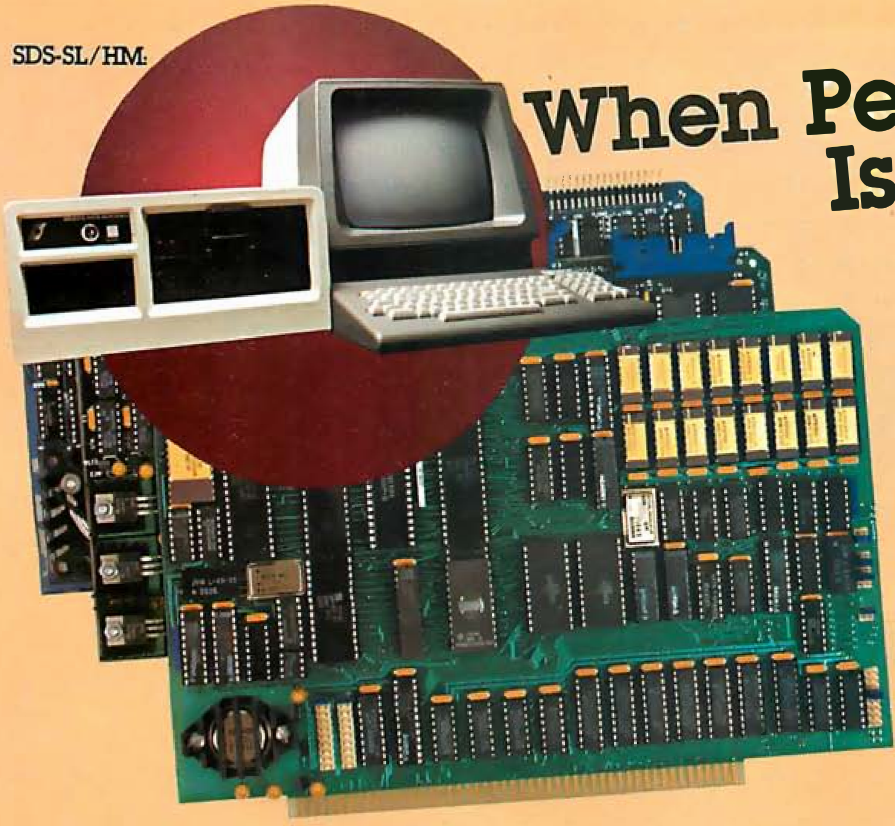
BYTE's Bugs

Table 4 of "The Unix Tutorial, Part 2: Unix as an Applications-Program Base" listed an incorrect address for Structured Methods Inc. The correct information is

Rod Manis
c/o Structured Methods Inc.
7 West 18th St.
New York, NY 10011
(212) 741-7720

SDS-SL/HM.

When Performance Is A Factor...



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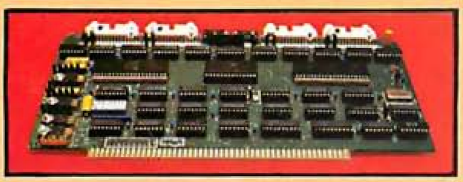

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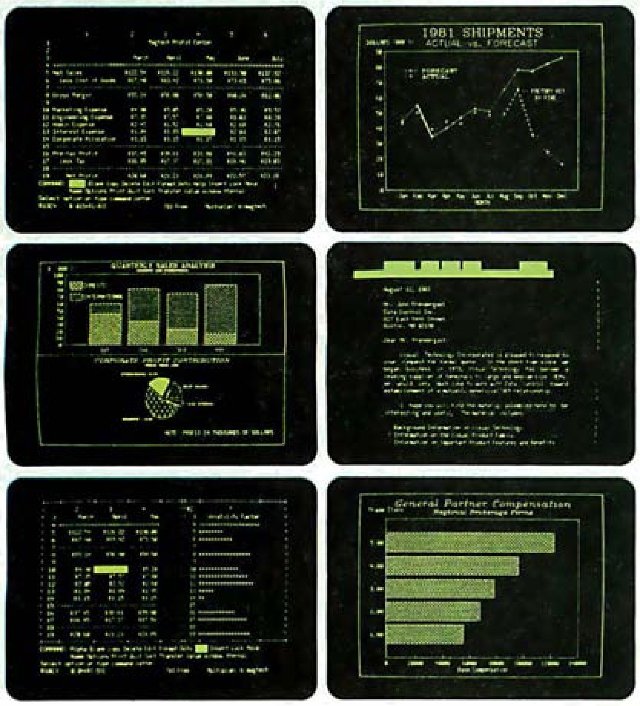
VISUAL 1050 Personal Computer System...



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Dual Drive Capacity	**800 KB**	640 KB	280 KB	2.5 MB	800 KB
Graphics Resolution	**640 x 300**	640 x 200	280 x 192	640 x 240	800 x 240
Keys on Keyboard	**93**	83	63	82	105
Expandable Memory	**YES**	YES	YES	YES	YES
Optional Winchester	**YES**	YES	YES	YES	YES
Tilt and Swivel Display	**YES**	NO	NO	NO	NO

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Build the H-Com Handicapped Communicator

by Steve Ciarcia

During an engineering assignment a few years ago I went to meet a man we'll call Dave, the owner of a small development company and its chief designer. As I sat in the lobby waiting to see him, I couldn't help but notice the many plaques, patents, citations, and honors bestowed on the company. "Surely," I thought, "to possess such impressive credentials, the manager of this company must be a real dynamo." I pictured him barking orders and moving at a furious pace, carrying a memocorder in one hand and a wireless phone in the other, being pursued by a cadre of support personnel. How else could anyone accomplish so much?

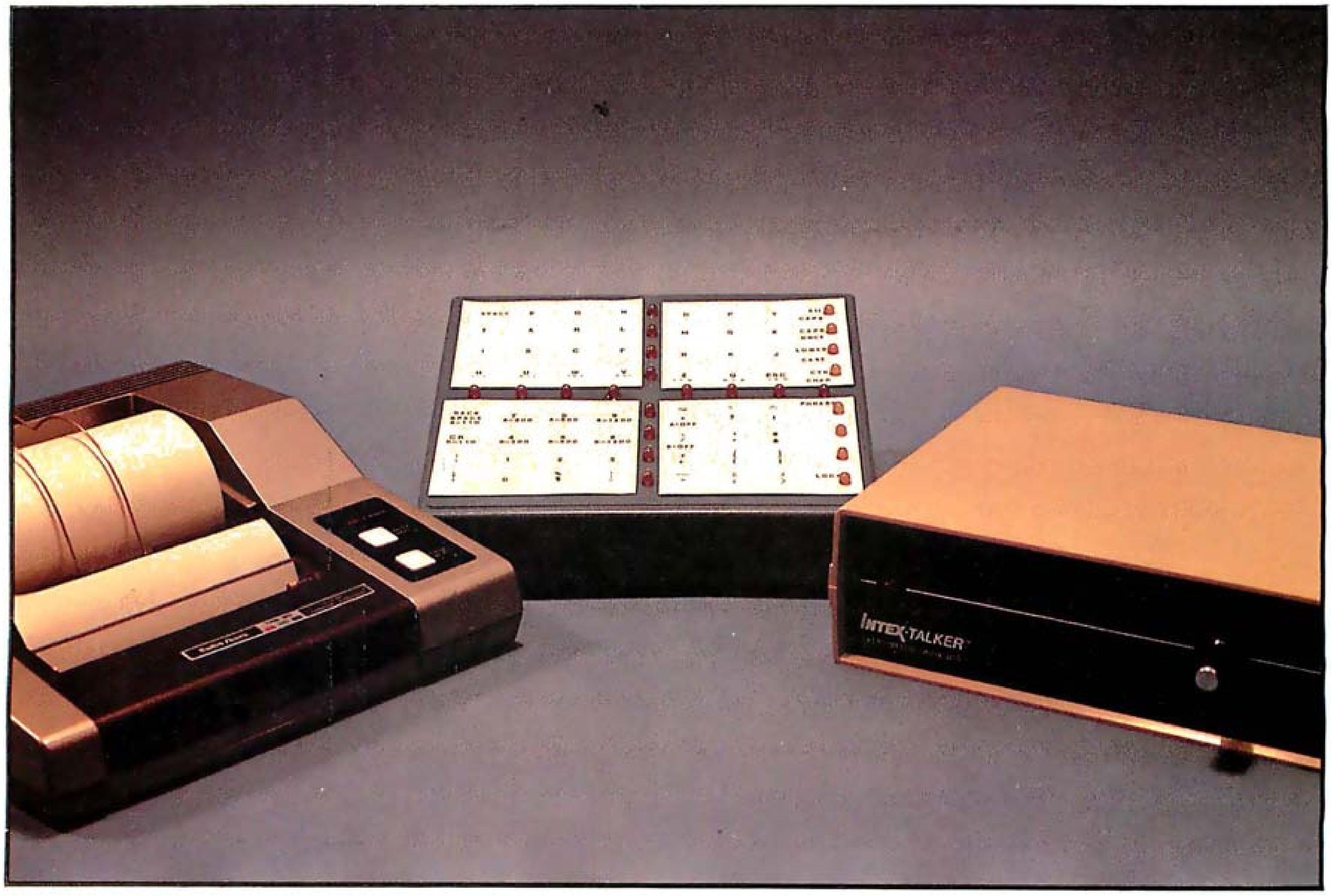


Photo 1: *The H-Com scanning communicator, a kind of keyboard simulator, can be used to send text directly to a printer, such as the Radio Shack CGP-115 shown here, or to a text-to-speech synthesizer, such as the Intex Talker, in this fully configured system. Using the serial-output commands and phrase mode, the H-Com can transmit words and sentences from a prestored vocabulary.*

The Intel 8748 self-contained microprocessor forms the heart of a scanning communicator

I don't now remember what we discussed at that first meeting. I only remember my shock at discovering that this super executive was a quadriplegic, suffering from a degenerative disease of the nervous system that left him with no fine motor control, virtually paralyzed.

During our meeting Dave used a one-switch scanning communicator, a sophisticated machine that enabled him to type on an electric typewriter. A scanning communicator presents a display of alphabetic, numeric, and punctuation characters. Under or beside each character is a lamp indicator. The device illuminates the lamp for one character (or group of characters) in a sequence. By biting down on a mouth switch at the right instant, Dave could cause the indicated character to be typed. The machine also stores a vocabulary of frequently used words and phrases. In later conversations with other staff members I learned that Dave often wrote entire design proposals using this technique.

Dave's body was frail, but he had one of the sharpest minds I've ever met. I've since given up dealing in stereotypes.

My purpose in relating this experience to you is not to solicit your sympathy but rather to inform you how technology has helped one man compensate for physical limitation. This meeting left me with a profound appreciation for the value of communication and the important role that electronics can play in aiding disabled people.

While it would be hard to duplicate the sophistication of the scanning communicator that Dave used, technology has advanced to a state where we can reproduce certain of its primary functions at minimal expense. In view of this, I decided to present a project that can serve both as an example of an application for the Intel 8748 single-chip microcomputer and as a demonstration of the potential benefits of technology.

Build the H-Com

This month's Circuit Cellar project is called H-Com, which stands for "handicapped communicator." It's intended to do the same job as a normal computer keyboard, but using only one "key," a single user-input point hereinafter referred to as the switch. Because there is only one switch in the H-Com, its user need control only one muscle to actuate it. Any kind of normally open momentary-closure switching contacts will work. An eye-blink detector would work, or the system could even use the biofeedback detector I wrote about in a previous Circuit Cellar article (see reference 4).

The H-Com has three outputs: two RS-232C ports and one audible horn. The RS-232C output ports can be turned on or off and the data rate set by user input. For serial communication, the full ASCII (American National Standard Code for Information Interchange) character set, including all control characters, can be generated. The horn can be used to beep out seven different patterns, intended principally for obtaining the attention of other people nearby.

The H-Com terminal has a prestored vocabulary of words and complete sentences that can be transmitted upon receipt of a single command. These canned transmissions can take the form of ASCII-encoded text sent to a voice synthesizer (such as the one discussed in reference 3) or control codes sent to an autodialing telephone (or modem) that directly links the user to help in an emergency. And the H-Com is designed with eventual expansion in mind. All of these design criteria require that the H-Com contain one of the devices we've used so often lately in high-performance electronic equipment—a microprocessor.

The microprocessors you're probably most familiar with are the general-purpose Z80, 6502, and 8088. But these chips are designed to be used in relatively large digital systems; other less well known microprocessors have been built to be easier and cheaper to use in simple control applications.

The Intel 8748

One of Intel Corporation's product lines is a set of VLSI (very large-scale integration) chips—containing processor, memory, and support-logic circuitry—of which the flagship product is the 8048. The 8048 features mask-programmed ROM (read-only memory), which is good for applications that require thousands of the chips to be installed in identical pieces of equipment, such as the keyboards of IBM Personal Computers. But small-scale experimentation can more practically use its cousin, the 8748, which sports on-chip EPROM (erasable programmable ROM). Figure 1 is a functional block diagram of the Intel 8748 single-chip 8-bit microcomputer, which is shown in photo 2.

The resident program memory in the 8048 consists of 1024 (1K) words 8 bits wide (in other words, the memory is 1K bytes), which are addressed in random-access fashion by the program counter. In the 8748 this memory consists of EPROM, which allows the processor's program to be loaded in the system designer's workshop rather than at the factory. To burn the program into the 8748's EPROM, external circuitry must activate the program mode, apply and latch an address, apply data, and pulse the chip's program line. Each word of memory is verified immediately after it has been burned. The entire EPROM contents can be erased by exposing the 8748 to ultraviolet light (see reference 2).

The 8748 contains 64 eight-bit registers, called the *resident data memory,*

Materials pertaining to the 8748 are reprinted courtesy of Intel Corporation.

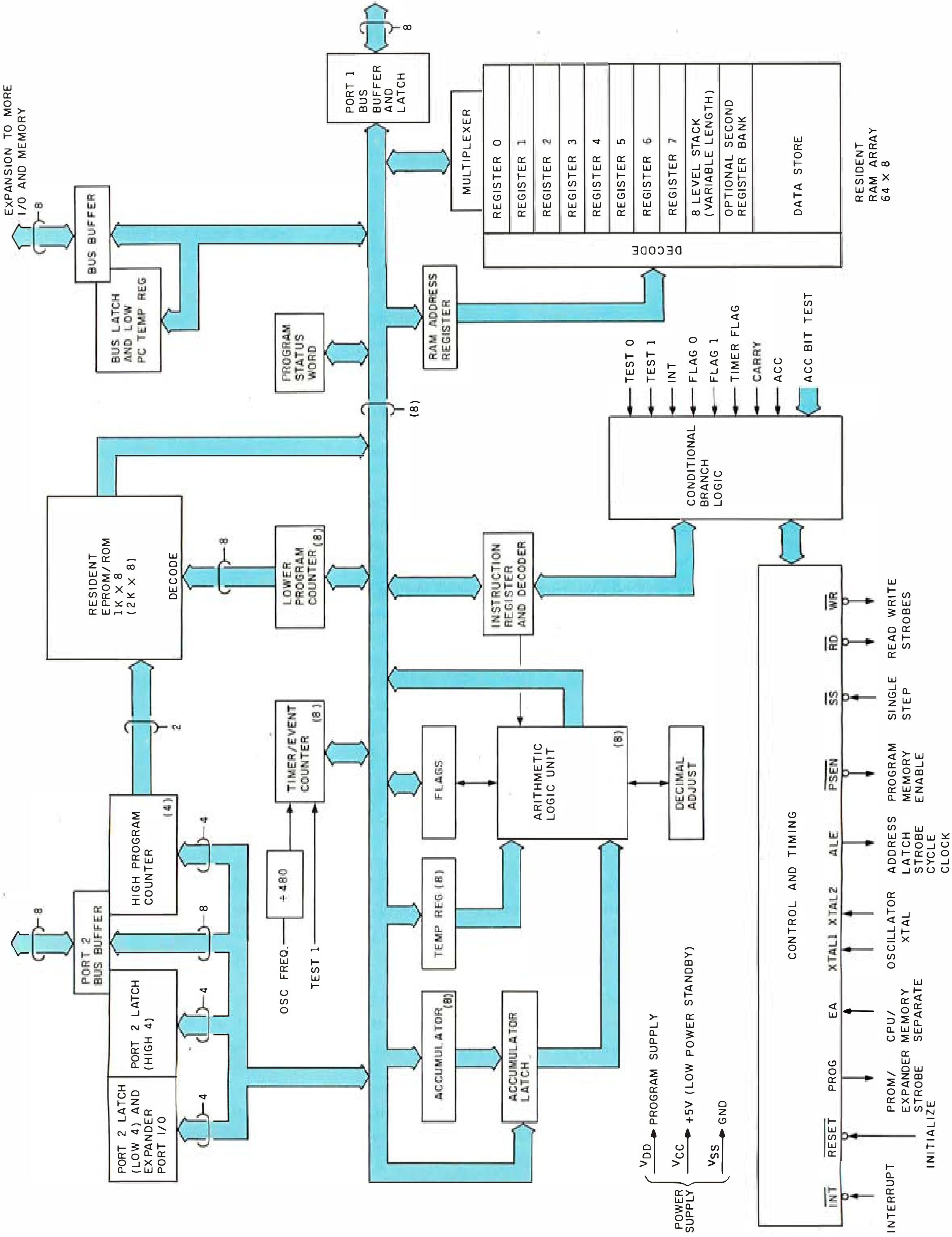


Figure 1: *A functional block diagram of the Intel 8748 self-contained microprocessor.*

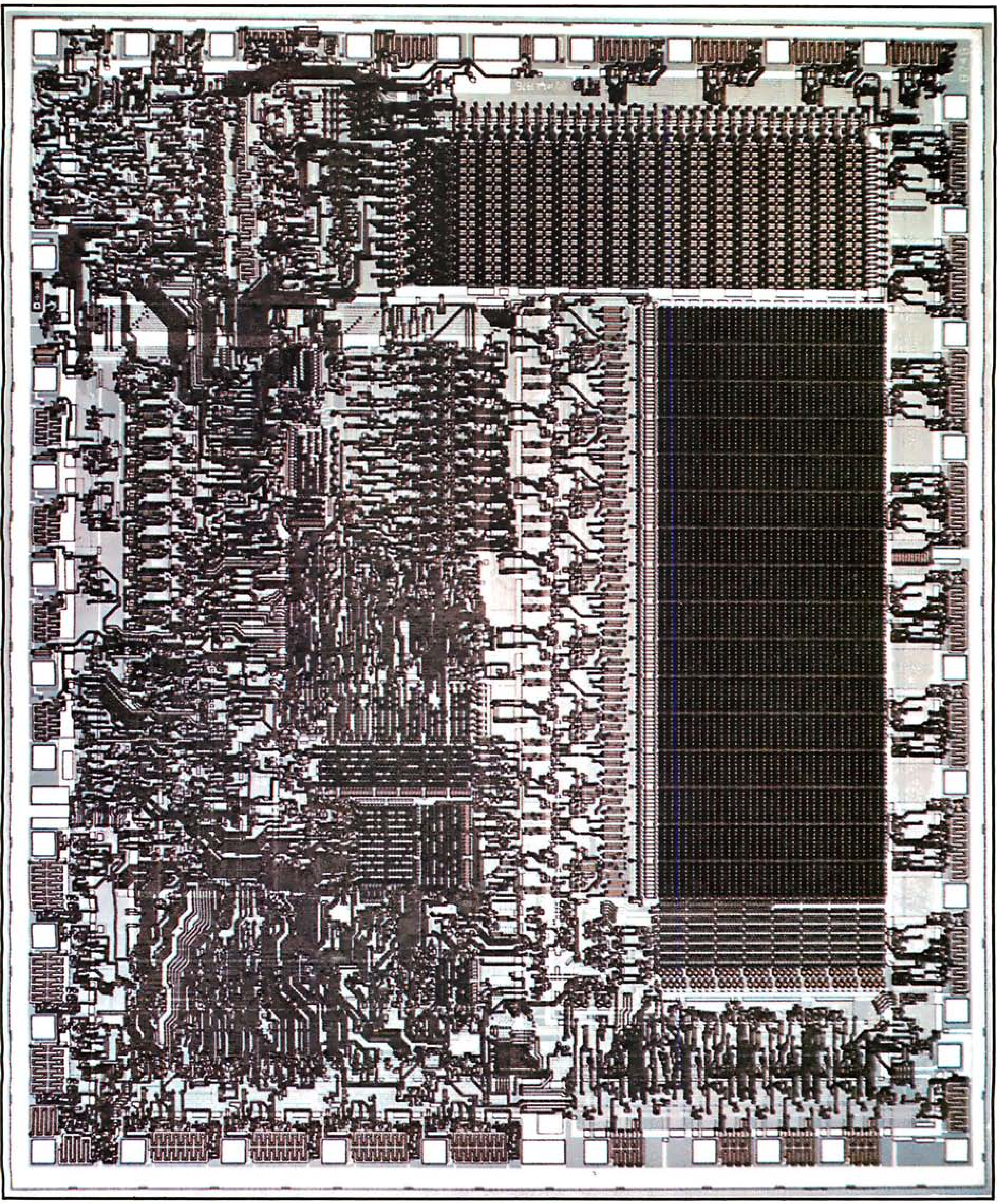


Photo 2: *Shown in this photomicrograph, Intel Corporation's 8748 microprocessor is largely self-sufficient, containing its own EPROM, scratchpad RAM, and I/O circuitry.*

The Intel 8048/8748 Instruction Set

The processor contains the basic data-manipulation functions and can be divided into four major functional sections: the arithmetic/logic unit (ALU), the accumulator, the carry flag, and the instruction decoder.

In a typical operation, data stored in the accumulator is combined in the ALU with data from another source on the internal bus (such as a register or I/O port), and the result is stored in the accumulator or another register. The ALU accepts 8-bit data words from one or two sources and generates an 8-bit result under control of the instruction decoder. The ALU can perform the following functions:

- *add with or without carry*
- *AND, OR, exclusive OR*
- *increment/decrement*
- *bit complement*
- *rotate left, right*
- *swap nybbles in accumulator*
- *decimal adjust accumulator (BCD)*

One machine instruction makes very efficient use of the working registers as program-loop counters: the DJNZ (decrement, jump if not zero) instruction allows the program to decrement and test the register in a single instruction.

which can be used as scratchpad RAM (random-access read/write memory). The first eight locations in this array (numbered 0 through 7) are designated as special-purpose "working" registers and are directly addressed by several instructions. All 64 locations are indirectly addressable through either of the two RAM-pointer registers, registers 0 and 1. Because the first eight registers are more easily addressed, they are typically used to store frequently accessed data or intermediate results. The text box above discusses the 8748's instruction set.

The 8748 has 27 I/O (input/output) signal lines. Twenty-four of these lines are grouped into three I/O ports of eight lines each; these can be used for input, for output, or bidirectionally. The remaining three lines are single-bit "test" inputs, which can alter program flow when tested by conditional-jump instructions.

I/O ports 1 and 2 are each 8 bits wide and have identical characteristics. The lines of these ports are called *quasibidirectional* because they employ a special output-circuit structure that allows each line to serve as an input, an output, or both, even though the outputs are statically latched (that is, data written to these ports for output remains unchanged until new data is loaded into them). However, when used as input ports, these lines are nonlatching; this requires the external circuitry to keep the levels for each transferred byte valid until the 8748 reads the byte by an input instruction. The I/O ports are fully compatible with TTL (transistor-transistor logic); the outputs will drive one standard TTL load.

The third I/O port is called the *bus port.* It is also an 8-bit port, but it is truly bidirectional, having associated input and output strobe signals. If bidirectional operation is not needed, the bus port can serve as either a statically latched output port or a nonlatching input port. However, input and output lines on this port cannot be mixed. In some modes of operation, the bus port is used to address external memory.

In static-port operation, data is written and latched using the 8748's OUTL instruction; data is input using the INS instruction. The INS and OUTL instructions generate pulses on the corresponding $\overline{RD}$ and $\overline{WR}$ output strobe lines; however, in the static-port mode these signals are generally not used. In bidirectional-port operation, the MOVX instructions are used to read and write to the port. A write to the port generates a pulse on the $\overline{WR}$ output line, and output data becomes valid at the trailing edge of the pulse. Reading the port generates a pulse on the $\overline{RD}$ output line; input data must be valid at the trailing edge of the $\overline{RD}$ pulse. When not being written or read, the bus-port lines are in a high-impedance state.

The 8748 also contains a counter/timer register intended for use in enumerating external events and generating accurate time delays without placing an extra burden on the processor. This 8-bit binary up counter can be preset and read with two MOV processor instructions, which transfer the contents of the accumulator to the counter, and vice versa. The contents of the counter are not cleared by a processor reset; they can be initialized solely by the MOV instructions. Counting is stopped either by a processor reset or when a STOP TCNT instruction is executed. After counting has stopped, it can be restarted for use as a timer by a START T instruction or as an event counter by a START CNT instruction. Once started, the counter is continually incremented, overflowing to zero when its maximum value (hexadecimal FF) is reached but continuing its count until stopped by a STOP TCNT instruction or processor reset.

The 8748 contains all necessary circuitry for generating timing signals, with the exception that a frequency reference, which can be a crystal, inductor, or external clock pulse, must be connected. The on-board oscillator is a high-gain series-resonant circuit with a frequency range of 1 to 6 MHz. A crystal or inductor connected between the 8748's pinouts X1 and X2 provides the feedback and phase shift required for oscillation. A 6.144-MHz crystal allows easy derivation of all standard serial-communication frequencies.

Implementation of the H-Com

The H-Com consists of a small case with a character grid of 64 elements arranged into 8 horizontal rows and 8 vertical columns (see photo 3). Each element is the equivalent of a keyboard key.

The characters are arranged in the array such that the ones most frequently used are clustered in the upper left, the position reached most quickly during the scanning process. The least used characters (special punctuation) are placed at the end of the scan in the lower right. The rightmost (eighth) column is used to control the H-Com's operation rather than transmit characters. A practiced

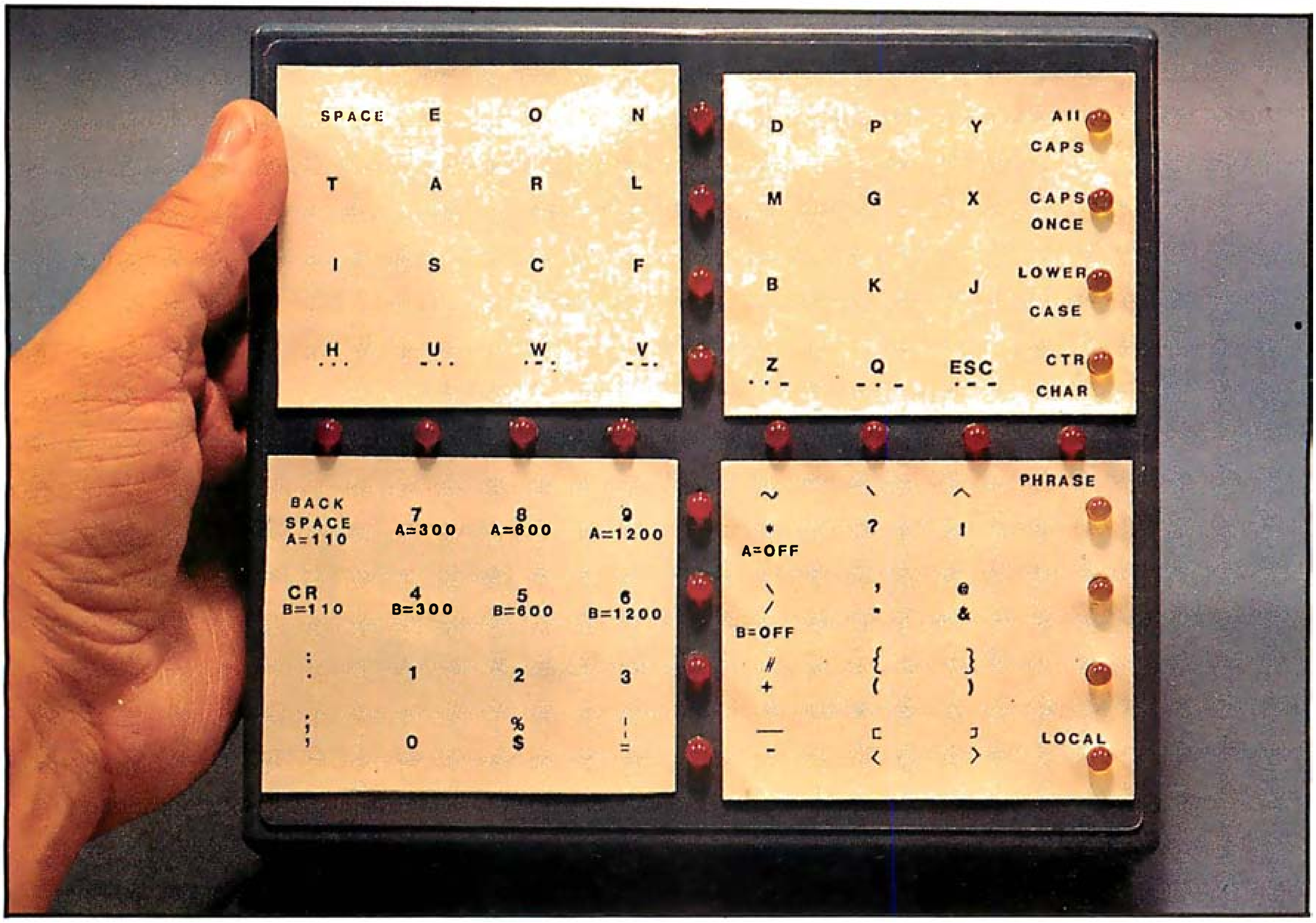


Photo 3: *The H-Com's character display contains 8 rows and 8 columns of characters and control functions, numbered from top to bottom and from left to right. The intersecting lines of red LEDs are used in scanning the row and column positions, while the yellow LEDs along the right edge indicate which mode is in use.*

user can select and transmit characters with relative ease and surprising speed.

Each of the 8 rows and 8 columns has a corresponding selection indicator, a total of 16 red LEDs (light-emitting diodes). The scanning operation proceeds as follows. The LEDs for the 8 rows are lighted individually in sequence from top to bottom: first row, second row, third row, and so on to the eighth row, then back to the first row and repeat. The row scan continues until the H-Com senses that the switch is closed, indicating that the user has made a selection of the row for which the LED is lit. The H-Com program stores the selected row number and proceeds to the column scan. In this second phase of selection, each of the column LEDs is lit in succession from left to right. Once again, the user closes the switch during the interval in which the LED is lit that corresponds to the column containing the desired character.

When both a row and a column have been selected, the microprocessor looks in a table to find the character associated with the row and column position (x and y coordinates, if you will). The character or function assigned to the position may vary according to the major mode of operation selected. If the character is in the printable set, the H-Com transmits it through either or both RS-232C ports.

H-Com Modes

The rightmost column, as I mentioned, is used for controlling the H-Com, mostly for shifting its six modes of operation. Beside each mode square is a yellow LED, which is lighted when the corresponding mode is in use. When the H-Com is powered up, it starts out in the All-Caps mode, in which it will transmit only the main character set consisting of uppercase A through Z, numerals 0 through 9, and commonly used punctuation. Separate modes generate lowercase characters, braces, ASCII control characters, and special functions.

For example, to send a Control-C, you first select the control-characters mode (by closing the switch first during the row-4 interval and then in the column-8 interval), and then select the particular character ("C") with the next row/column scan. Immediately after sending the Control-C character, the H-Com reverts to the All-Caps mode. One of the modes even lets you transmit lengthy prestored messages by selecting a two-character mnemonic key. Let's look at the six H-Com modes:

All Caps: This is the default mode. All characters are converted to uppercase (capital letters) before being sent.

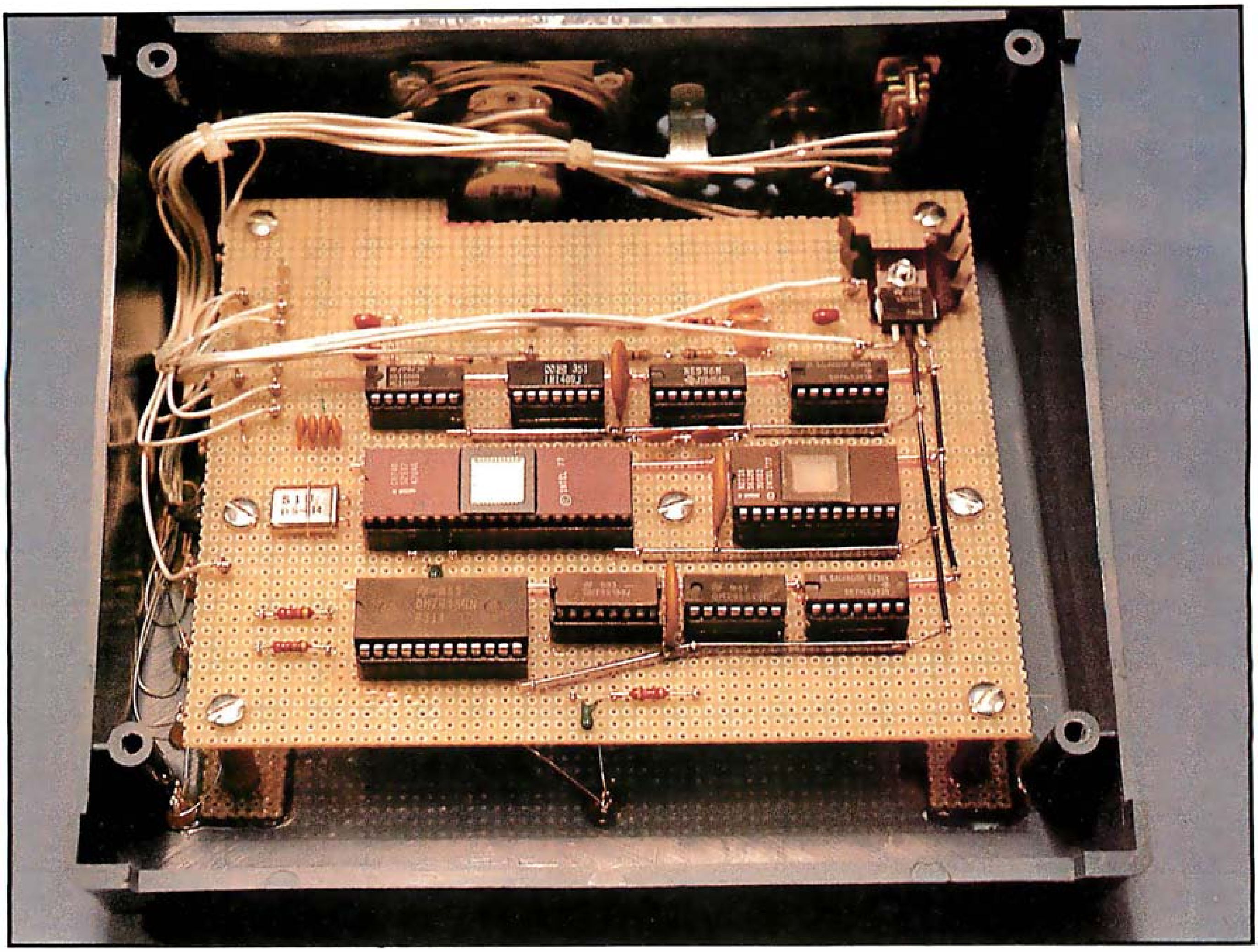


Photo 4: *The prototype of the H-Com circuit, viewed from the rear to show the integrated circuits. The light-emitting diodes are mounted on the other side.*

One Cap: This mode, when selected, sends the first character after its invocation as uppercase, and then all subsequent characters as lowercase. This is useful for capitalizing words because normally only the first letter is uppercase.

Lowercase: In this mode, characters are sent out lowercase.

Control Characters: This mode is used to generate the control codes. It acts much like One Cap except that it converts the next character selected to its control equivalent for transmission. Because the Escape control code is treated as a normal character, you need not use the Control Characters mode to generate it. The control codes normally used for cursor control are accessed by Control-8, -4, -6, and -2. Also, seldom used punctuation is generated in this mode, not in one of the caps modes.

Phrase: This mode is used to generate sequences of many characters to form complete words, sentences, etc. The text strings are stored serially in a type-2716 EPROM, each phrase tagged with a mnemonic key. For the H-Com to transmit the sequence, you select the Phrase mode, the characters of the mnemonic key, and then the space character. When the H-Com has detected the scan selection of a space while in Phrase mode, the 8748 takes the key and looks through the EPROM until it finds the corresponding text string; it then sends the string exactly as if the letters were being selected one at a time. If there is no phrase associated with the entered key, the H-Com beeps the horn and returns the mode to All Caps or Lowercase, whichever was last selected. The internal storage format for the EPROM is shown in listing 1, a simplified example. Normally this listing would be several pages long and contain hundreds of words.

Local: This mode is used for tasks that don't involve sending characters. The first three rows of the character array do nothing in Local mode.

The fourth row in the array controls the horn. The dot and dash symbols in the squares indicate the beep patterns, which superficially resemble Morse code. To sound a pattern of three short honks, for example, you select Local mode, then the H key, which causes three short beeps to be emitted. Each letter of the fourth row beeps a different pattern.

In Local mode, the fifth row selects the operating parameters for serial port A. The first position in the row, labeled Backspace/A = 110, sets port A to communicate at 110 bps (bits per second). The second position, 7/A = 300, sets port A to 300 bps, the third position to 600 bps, the fourth to 1200 bps, and the fifth (labeled */A = OFF) turns the port off. To turn port A on, you select the data rate desired (if you want it off, select Local and then */A = OFF). The sixth row controls port B in the same manner.

The seventh and eighth rows control the scanning rate of the row- and column-select LEDs. The seventh-row, first-column position sets the slowest rate, and each succeeding column sets a rate faster by a factor that increases geometrically.

H-Com Hardware

Shown in the schematic diagram of figure 2, the circuitry of the H-Com can be divided into seven sections: the power supply, the RS-232C drivers, the microprocessor, the LED decoder/drivers, the phrase-lookup EPROM, the horn-tone generator, and the input switch. The prototype circuit board is shown in photo 4.

The H-Com draws about 300 mA (milliamps) at 12 V (volts). Current could be drawn from a motorized wheelchair's battery, a separate battery pack, or a 110-V AC-powered supply. If a 12-V supply is chosen, the currently available Radio Shack CGP-115 printer can be used as a convenient portable display device. The +12-V potential is reduced to +5 V through a type-7805 voltage regulator to power the logic circuitry.

IC1, a type-556 dual-timer chip, serves two purposes. It produces an audio signal at pin 9 to sound the horn and generates a second AC signal used as input to a charge-pumping circuit to produce a −9-V supply for the RS-232C transmitter section.

The horn signal, the direct output of IC1, drives a loudspeaker, which generates a sound low enough in frequency and loud enough to be heard by someone in an adjacent room. (Solid-state piezoelectric transducers, while efficient and compatible with TTL circuits, are not loud enough or low enough.) A series resistor (about 100 ohms) keeps the volume at a comfortable yet noticeable level. Sounding of the horn is controlled by an output bit on the 8748.

User inputs to the H-Com are handled through the 8748's T1 test input. This line is one of three input pins (T0 and INT are the others) that allow conditional program branches without using I/O instructions of the type that load the accumulator from the input port. Because T1 is to be connected to a mechanical switch, a debouncing integrator (resistor/capacitor combination) and a Schmitt trigger (IC6) smooth out its transitions.

Control of the H-Com functions is handled through the three parallel ports. Four bits of port 1 are reserved for serial communication. (The four remaining bits could be programmed to provide more ports if necessary.) With the data rates and character framing generated by software, each

The only unconventional part of the circuitry is the phrase-memory section.

port transmits independently at data rates from 110 to 1200 bps. When the H-Com is first turned on, the program sets port 1 to 600 bps to be compatible with the CGP-115 printer. IC8 and IC9 are the familiar MC1488 and MC1489 RS-232C driver and receiver chips. The −9-V supply mentioned earlier is used in the 1488. These devices were chosen primarily for simplicity; they could be replaced with a couple of transistors if you wanted to reduce the number of integrated-circuit packages.

Port 2 drives the LED display. The high-order 4 bits of port 2 are connected to a 4- to 16-line decoder driver, IC2, which produces the row/column scanning action. Depending upon the 4-bit value appearing at IC2's input, one of the 16 LEDs will be lit. As the count is incremented, the next LED in the row or column lights up, and scanning takes place.

The low-order 3 bits of port 2 are connected to a 3- to 8-line decoder/driver, IC3. Functioning in a manner similar to IC2, this circuit drives the yellow LEDs that indicate what mode the H-Com is in. The remaining bit of port 2 controls the horn.

The program for the 8748 single-chip microcomputer, IC9, is stored in the on-chip 1K- by 8-bit EPROM.

The only unconventional part of the circuitry is the phrase-memory section. The signals to address this memory are not generated by the processor, as is commonly the case. Instead, they are generated by two 8-bit binary counters (IC5 and IC7).

Initially, the counters are cleared (reset) by a low-level signal on the $\overline{\text{WR}}$ (pin 10) line of the 8748 (IC9), under the direction of a bus-port write instruction. When the processor needs to look up a phrase from the memory, it reads the bus port. After each such read instruction, an active-low pulse appears on the $\overline{\text{RD}}$ line, increasing the value in the counters by 1. When you request transmission of a stored phrase, the 8748 clears these address counters and begins reading at the beginning of the 2716 EPROM. The 8748 keeps reading and incrementing the counters until it finds a match to the phrase key.

This circuit, although not commonly seen, requires few chips and uses a relatively simple searching algorithm. Also, because the counters produce 16 address bits, up to 64K bytes of text storage can be easily accommodated. In fact, simply changing the type-2716 EPROM to a type-27128 would add 14K characters. But even with as many as 64K characters of stored phrases, the search would take less than one second.

Words and phrases are stored in the EPROM as ASCII character strings preceded by one or more mnemonic key characters that identify the particular word or phrase. As you can tell from listing 1, the mnemonic key is stored first in the EPROM, followed by a space character (hexadecimal 20), followed by the word or phrase (any length), and concluded by a null character (hexadecimal 00). Phrase storage could also be used to remind you how to operate certain features, with a help message triggered simply by setting Phrase mode and then selecting H, P, and a space on successive scans.

Number	Type	+5 V	GND	−9 V	+12 V
IC1	LM556		7		14
IC2	74154	24	12		
IC3	74L5138	16	8		
IC4	2716	24	12		
IC5	74LS393	14	7		
IC6	74LS14	14	7		
IC7	74LS393	14	7		
IC8	MC1488		7	1	14
IC9	MC1489	14	7		
IC10	8748	40, 26	20		

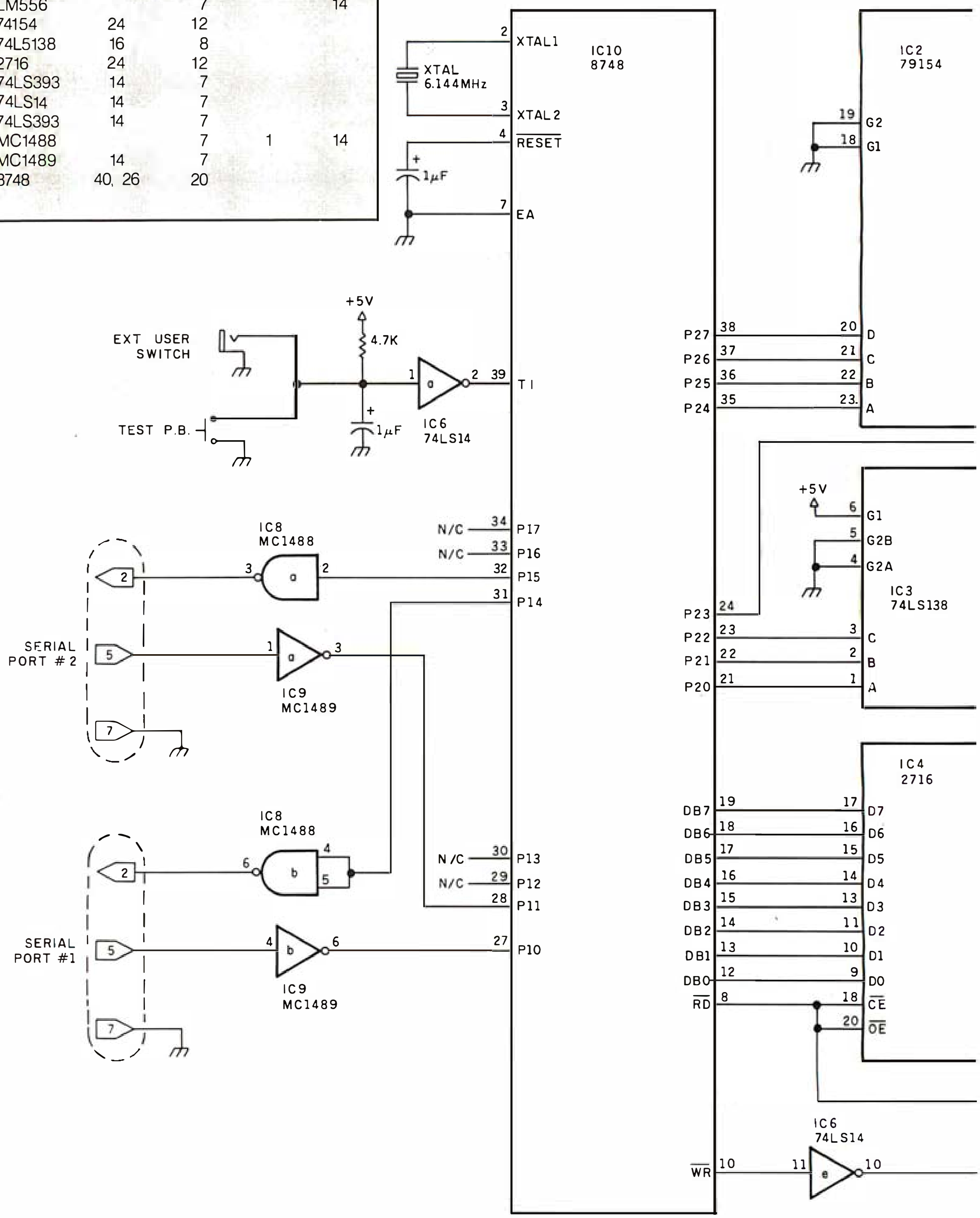
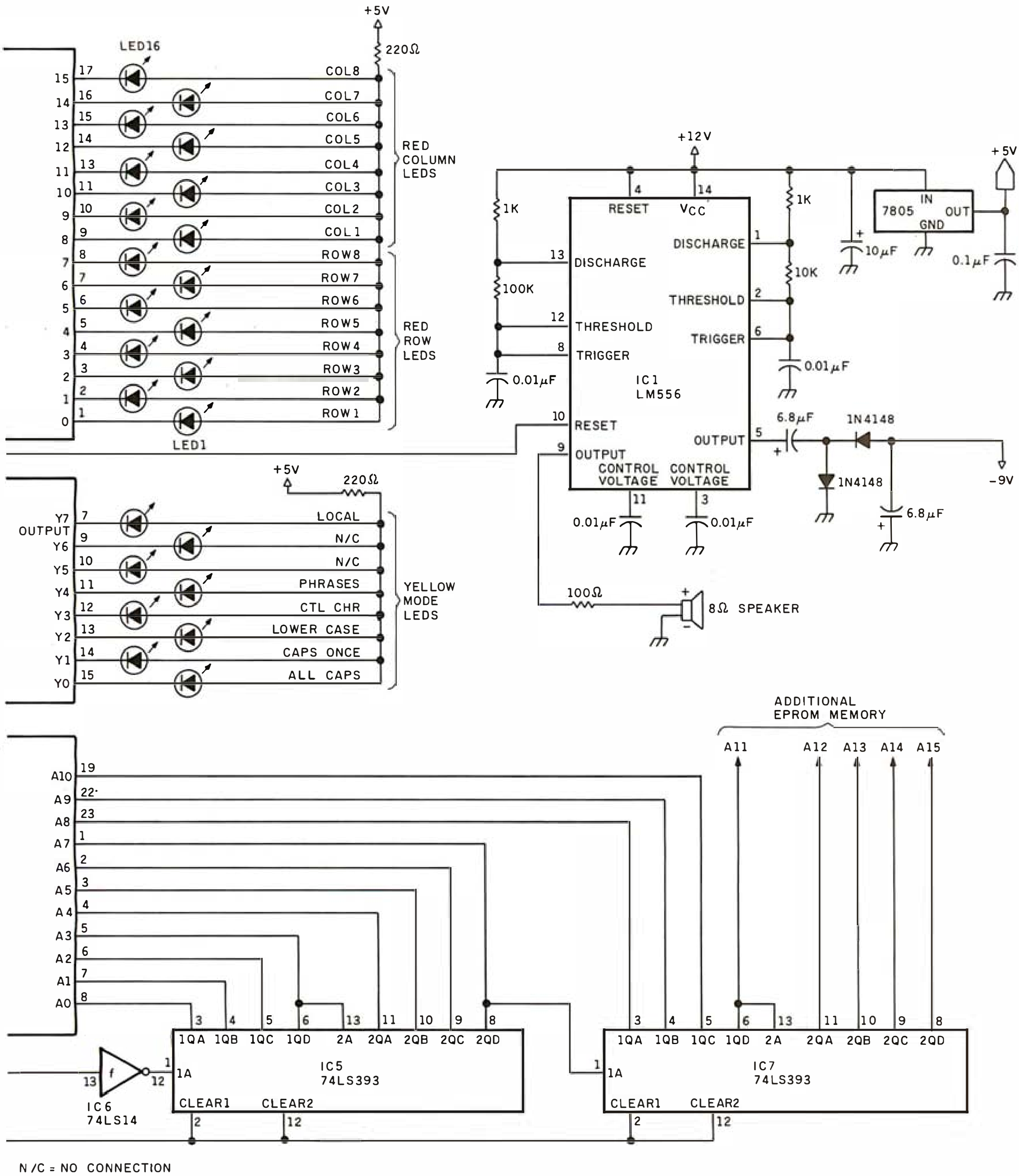


Figure 2: *The schematic diagram of the H-Com. The external EPROM (IC4, a 2716) is used for storage of mnemonically keyed phrases; addresses for the EPROM are generated by the two binary counters IC6 and IC7.*

H-Com Software

The source code of the control program stored in the 8748's memory is shown in listing 2. The program is structured to deal with one quirk of the 8748's instruction set, its eight-level fixed-size stack. When the stack pointer is incremented beyond 7, it "wraps around" to 0, reusing its memory area and subsequently limiting the programs to no more than eight levels of subroutine nesting.



However, at any point in the program, control can branch to a second point without having to clean up the contents of the stack. The H-Com control program uses this feature.

But the jump (branching) procedure is odd, too. Conditional jumps are restricted to within the 256-byte page of memory containing the jump instruction. This characteristic is not particularly convenient, but it can be circumvented by condi-

Text continued on page 50

Listing 1: *Part of the customized vocabulary of words, sentences, and phrases, as formatted for storage in the 2716 EPROM.*

```
                 ;EPROM text must be assembled with the following form:
                 ;phrase key
                 ;one space
                 ;text, which may include any ASCII char except a NUL (00H)
                 ;one NUL character (hex value of 0) to end the text

000D             CR       EQU     0DH

0000                      ORG     0

0000 747420               DB      'tt '
0003 74686174             DB      'that ',0

0009 7720                 DB      'w '
000B 77697468             DB      'with ',0

0011 747920               DB      'ty '
0014 74686579             DB      'they ',0

001A 747320               DB      'ts '
001D 74686973             DB      'this ',0

0023 6620                 DB      'f '
0025 66726F6D             DB      'from ',0

002B 6820                 DB      'h '
002D 68617665             DB      'have ',0

0033 777420               DB      'wt '
0036 77686174             DB      'what ',0

003C 786120               DB      'xa '
003F 49742077             DB      'It was so nice to get your letter.',CR ,0

0062 786220               DB      'xb '
0065 506C6561             DB      'Please excuse my spelling - it never',CR
008A 68617320             DB      'has been one of my strong points.',CR ,0

00AC 786320               DB      'xc '
00AF 4D79206E             DB      'My new address is 1234 Perth Avenue.',CR
00D4 49742069             DB      'It is a small cottage with pink walls',CR
00FA 616E6420             DB      'and a large oak tree in the front',CR
011C 79617264             DB      'yard.',CR ,0

0122 6E20                 DB      'n '
0124 4A6F686E             DB      'John Doe',CR
012D 31323334             DB      '1234 Perth Avenue',CR
013F 486F6D65             DB      'Homestead FL 33030',CR,CR,0

0154 687020               DB      'hp '
0157 48454C50             DB      'HELP  HELP  HELP  HELP',CR
016E 49206E65             DB      'I need medical help. Would anyone',CR
0190 72656164             DB      'reading this message please dial',CR
01B1 31323320             DB      '123 4567 and tell the person answering',CR
01D8 74686520             DB      'the phone that John Doe is having',CR
01FA 616E6F74             DB      'another seizure.',CR,0

020C FF                   DB      0FFH    ;end of file marker

0000                      END
```

Listing 2: *The control program for the H-Com, written for the Intel 8748, using an external EPROM for storage of canned phrases.*

```
                 ;This code is hereby placed in the public domain

                 ;test 0 and test 1 pins reserved for human interface
                 ;interrupts, internal timer, and alternate registers 0-3
                 ;also reserved for human interface

                 ;bus port reserved for text EPROM
                 ;writing to the port resets the serial address counter
                 ;reading from the port fetches the "next" byte, and
                 ;increments the serial address counter after the read

                 ;port 1 reserved for RS-232C I/O:
                 ;b0 - b3 (P10 - P13) input to 8748
                 ;b4 - b7 (P14 - P17) output from 8748
                 ;specific assignments made according to implementation

                 ;port 2 reserved for LED scan and beeper:
                 ;b0 - b2 (P20 - P22) select yellow "page" indicator LEDs
                 ;b3      (P23)       beeper control, high = beeper on
                 ;b4 - b7 (P24 - P27) select red row/column scan LEDs

                 ;main register set:
                 ;R0
                 ;R1 - pointer for phrase match key
                 ;R2
                 ;R3
                 ;R4 - LED scan rate
                 ;R5 - current key pressed, also data to send
                 ;R6 - shift counter for serial output stream
                 ;     also countdown storage for WSCAN
                 ;R7 - serial port parameters as follows:
                 ;     b0 - b1 baud rate port A
                 ;     b2 - A status 0 = active, 1 = inactive
                 ;     b3 - unused
                 ;     b4 - b5 baud rate port B
                 ;     b6 - B status 0 = active, 1 = inactive
                 ;     b7 - unused

                 ;RAM:
                 ;00H - 07H, main register set, see above
                 ;08H - 17H, 8 level stack area
                 ;18H - 1BH, alternate registers R0 - R3 reserved for human
                 ;           interface interrupt routine if necessary
                 ;1CH - 1FH, storage for phrase match key
                 ;20H - 3FH, high memory unused at present

                 ;ROM (8748 program memory)
                 ;000H - 0FFH main housekeeping program
                 ;100H - 1FFH serial ascii output routines
                 ;200H - 2FFH user interface routines (KBIN)
                 ;300H - 3FFH

000D             CR       EQU     0DH

0000                      ORG     0        ;page 0
0000 0409        START:   JMP     INIT     ;skip interrupt vectors

0003                      ORG     3
0003 83          EINT:    RET              ;external interrupt vector

0007                      ORG     7
0007 83          TINT:    RET              ;counter/timer interrupt vector
```

Listing 2 continued on page 47

Listing 2 continued:

```
0009                 ORG    9          ;main program here
0009 BF22    INIT:   MOV    R7,#22H ;set both ports hot, B = 600, A = 600
000B BC32            MOV    R4,#50  ;led scan raate
000D 89FF            ORL    P1,#0FFH;port 1 all hi at start
000F 9A00            ANL    P2,#0   ;port 2 all lo at start

0011 85      ALLCAP: CLR    F0
0012 95              CPL    F0      ;caps flag set
0013 9AF8            ANL    P2,#0F8H;light all caps LED
0015 5400            CALL   KBIN    ;get key (row/col) in r5
0017 FD              MOV    A,R5    ;fetch keypress
0018 E3              MOVP3  A,@A    ;look up char
0019 AD              MOV    R5,A    ;put char in R5
001A 3400            CALL   SEND    ;send it to whichever ports are hot
001C 0411            JMP    ALLCAP  ;loop back to caps

001E 85      ONECAP: CLR    F0
001F 95              CPL    F0      ;set caps flag
0020 9AF8            ANL    P2,#0F8H
0022 8A01            ORL    P2,#1   ;light caps once LED
0024 5400            CALL   KBIN    ;get next key
0026 FD              MOV    A,R5    ;load key
0027 E3              MOVP3  A,@A    ;look up char
0028 AD              MOV    R5,A    ;put char in R5
0029 3400            CALL   SEND    ;send it, then drop into...
002B 85      LOCASE: CLR    F0      ;caps flag down
002C 9AF8            ANL    P2,#0F8H
002E 8A02            ORL    P2,#2   ;light lower case LED
0030 5400            CALL   KBIN    ;get next key
0032 FD              MOV    A,R5    ;load key
0033 E3              MOVP3  A,@A    ;look up char
0034 AD              MOV    R5,A    ;put char in R5
0035 3400            CALL   SEND    ;send it to whichever ports are hot
0037 042B            JMP    LOCASE  ;loop to lower case

             ;control sends one character and branches back to the
             ;previous mode - either all caps or lower case.  The
             ;character sent is not necessarily an ASCII control
             ;character, it's whatever is in the lookup table at
             ;address 380H.
             ;The previous mode branch is also used by other routines.

0039 9AF8    CTRL:   ANL    P2,#0F8H
003B 8A03            ORL    P2,#3   ;light ctrl LED
003D 5400            CALL   KBIN    ;get next key
003F FD              MOV    A,R5    ;load key
0040 4340            ORL    A,#40H  ;set b6
0042 E3              MOVP3  A,@A    ;look up char
0043 AD              MOV    R5,A    ;put char in R5
0044 3400            CALL   SEND    ;send it to whichever ports are hot
0046 B611    MODE:   JF0    ALLCAP  ;loop to all caps if caps flag set
0048 042B            JMP    LOCASE  ;else loop to locase

             ;Phrase resets the serial address counter with the WR strobe
             ;and looks for the phrase requested.

004A 9AF8    PHRASE: ANL    P2,#0F8H
004C 8A04            ORL    P2,#4   ;light up the phrase LED
004E B91C            MOV    R1,#1CH ;R1 points to key storage

0050 5400    PHRA1:  CALL   KBIN    ;get next keypress
0052 FD              MOV    A,R5    ;load key
0053 E3              MOVP3  A,@A    ;look up char (note - it's lowercase)
0054 A1              MOV    @R1,A   ;put char in lookup key memory
0055 19              INC    R1      ;bump pointer
0056 03E0            ADD    A,#0E0H ;NZ if nonspace
0058 9650            JNZ    PHRA1   ;loop till space was loaded
005A 23FF            MOV    A,#0FFH ;pattern to send to bus port
005C 02              OUTL   BUS,A   ;actually all we use is the WR strobe

             ;The key, terminated with a space, is set up in mem at 1CH.
             ;The eprom is reset (equivalent of tape rewound).

005D B91C    PHRA2:  MOV    R1,#1CH ;reset key pointer (R1)

005F 08      PHRA3:  INS    A,BUS   ;read der prom data
0060 F27D            JB7    ERROR   ;end of prom - no phrase matched
0062 AD              MOV    R5,A    ;save eprom char
0063 37              CPL    A
0064 17              INC    A
0065 61              ADD    A,@R1   ;NZ if no match with key
0066 9675            JNZ    ADPROM  ;no match, advance eprom to next phrase
0068 FD              MOV    A,R5    ;match, see if itsa terminating space
0069 03E0            ADD    A,#0E0H ;NZ if it was a nonspace
006B 967A            JNZ    BUMPR1  ;if nonspace, we bump pointer & continue
006D 08      PHRA4:  INS    A,BUS   ;we're at the phrase
006E C646            JZ     MODE    ;here's where we bail out
0070 AD              MOV    R5,A    ;chuck it into R5 to send
0071 3400            CALL   SEND
0073 046D            JMP    PHRA4

0075 08      ADPROM: INS    A,BUS   ;advance eprom to just past next 00H
0076 9675            JNZ    ADPROM
0078 045D            JMP    PHRA2   ;reset R1 pointer and try next phrase

007A 19      BUMPR1: INC    R1      ;advance the key pointer and loop
007B 045F            JMP    PHRA3   ;we seem to be matching one up

007D 8A08    ERROR:  ORL    P2,#08H ;raise honker control line
007F 5439            CALL   WSCAN
0081 9AF7            ANL    P2,#0F7H ;lower honker
0083 0446            JMP    MODE

0085 8A07    LOCAL:  ORL    P2,#7   ;light local LED
0087 5400            CALL   KBIN    ;get next key
0089 FD              MOV    A,R5    ;look at key pos (not char)
008A 77              RR     A
008B 77              RR     A
008C 77              RR     A       ;move row number to lo 3
008D 5307            ANL    A,#07H  ;strip to low 3
008F 43E8            ORL    A,#0E8H ;address of branch table
0091 B3              JMPP   @A      ;indirect jump to command
0092 FD      NOISE:  MOV    A,R5
0093 67              RRC    A       ;lo bit to accum
0094 AD              MOV    R5,A    ;save it
0095 14A3            CALL   BEEPC   ;beep according to cy flag
0097 FD              MOV    A,R5
0098 67              RRC    A       ;lo bit to accum
0099 AD              MOV    R5,A    ;save it
009A 14A3            CALL   BEEPC   ;beep according to cy flag
009C FD              MOV    A,R5
009D 67              RRC    A       ;lo bit to accum
009E AD              MOV    R5,A    ;save it
009F 14A3            CALL   BEEPC   ;beep according to cy flag
00A1 0446            JMP    MODE

00A3 F6AE    BEEPC:  JC     BEEPL   ;CY = long beep
00A5 8A08    BEEPS:  ORL    P2,#08H ;raise honker control line
00A7 5439            CALL   WSCAN
00A9 9AF7            ANL    P2,#0F7H ;lower honker
00AB 5439            CALL   WSCAN
00AD 83              RET

00AE 8A08    BEEPL:  ORL    P2,#08H ;raise honker control line
00B0 5439            CALL   WSCAN
00B2 5439            CALL   WSCAN
00B4 5439            CALL   WSCAN
00B6 9AF7            ANL    P2,#0F7H ;lower honker
00B8 5439            CALL   WSCAN
```

Listing 2 continued on page 48

Listing 2 continued:

```
00BA 83                 RET

00BB FD        SETA:    MOV     A,R5      ;look at key pressed
00BC 5307               ANL     A,#07H    ;low 3 bits have status
00BE 2F                 XCH     A,R7      ;store for now
00BF 5370               ANL     A,#70H    ;save port b configuration
00C1 4F                 ORL     A,R7      ;"or" in port a configuration
00C2 AF                 MOV     R7,A      ;record both ports config
00C3 0446               JMP     MODE      ;and back

00C5 FD        SETB:    MOV     A,R5      ;look at key pressed
00C6 5307               ANL     A,#07H    ;low 3 bits have status
00C8 47                 SWAP    A         ;swap nibbles (b config in hi nibble)
00C9 2F                 XCH     A,R7      ;store new b, get old a
00CA 5307               ANL     A,#07H    ;save port a configuration
00CC 4F                 ORL     A,R7      ;"or" in port b configuration
00CD AF                 MOV     R7,A      ;record both ports config
00CE 0446               JMP     MODE      ;and back

               ;scan speed set - put new wait constant in R4

00D0 FD        SCANSP:  MOV     A,R5      ;look at key pressed
00D1 43F0               ORL     A,#0F0H   ;point to high 16 bytes of page
00D3 A3                 MOVP    A,@A      ;get new wait const
00D4 AC                 MOV     R4,A      ;and store it
00D5 0446               JMP     MODE      ;and back

00E8                    ORG     0E8H      ;jump table to 1 of 8 commands

00E8 46464692           DB      MODE,MODE,MODE,NOISE,SETA,SETB,SCANSP,SCANSP

00F0                    ORG     0F0H      ;geometric ratio, .83 common mult

00F0 FFD4B092           DB      255,212,176,146,121,100,83,83
00F8 45393028           DB      69,57,48,40,33,27,23,23

               ;RS232 OUTPUT - sends ASCII byte in r5 to hot ports

               ;Note: when the comments refer to "hi" or "lo" signals, ;they
               ;are referring to the TTL levels at port 1 of the
               ;microprocessor, NOT the levels on the RS232 connector.

               ;The RS232 levels are: 1 = negative, 0 = positive with respect
               ;to ground.  An oscilloscope connected to the RS232 data output
               ;should show a normally negative (about minus 6 volts) DC level,

               ;with data appearing as bursts of positive voltage (about 10
               ;volts).

0100                    ORG     100H

0100 B60B      SEND:    JF0     FOLD      ;if f0 set, fold all lowercase
0102 FF        SEND1:   MOV     A,R7      ;get bit storage
0103 37                 CPL     A         ;invert bit 2 (ignore others)
0104 521B               JB2     SENDA     ;RS232 port A hot, ship byte
0106 FF        SEND2:   MOV     A,R7      ;get it again
0107 37                 CPL     A         ;invert bit 6 (ignore others)
0108 D241               JB6     SENDB     ;B hot, send it
010A 83        SEND3:   RET

010B FD        FOLD:    MOV     A,R5      ;get character
010C 039F               ADD     A,#9FH    ;NC if 60H or lower
010E E602               JNC     SEND1     ;bye bye
0110 FD                 MOV     A,R5      ;get char again
0111 0385               ADD     A,#85H    ;C if 7BH or higher
0113 F602               JC      SEND1     ;bye bye
0115 FD                 MOV     A,R5      ;get char again
0116 03E0               ADD     A,#0E0H   ;subtract 20H
0118 AD                 MOV     R5,A      ;folded char in R5
0119 2402               JMP     SEND1     ;return to caller

011B 15        SENDA:   DIS     I         ;disable interrupts
011C 09        SA1:     IN      A,P1      ;xxxx xxx1 if printer busy
011D 5681               JT1     UNHANG    ;so's we don't hang up forever
011F 121C               JB0     SA1       ;hi line = busy
0121 343D               CALL    AOUTLO    ;send a start bit
0123 BE07               MOV     R6,#7     ;set up loop counter
0125 FD        SA2:     MOV     A,R5      ;get data
0126 67                 RRC     A         ;CY holds next bit
0127 AD                 MOV     R5,A      ;store what's left
0128 3437               CALL    AOUTC     ;wiggle the port
012A EE25               DJNZ    R6,SA2
012C 3439               CALL    AOUTHI
012E 3439               CALL    AOUTHI    ;two stop bits
0130 FD                 MOV     A,R5
0131 67                 RRC     A
0132 67                 RRC     A         ;straighten out r5
0133 AD                 MOV     R5,A
0134 05                 EN      I         ;re-enable interrupts
0135 2406               JMP     SEND2     ;maybe send to b,too

0137 E63D      AOUTC:   JNC     AOUTLO
0139 891F      AOUTHI:  ORL     P1,#1FH   ;raise bit4
013B 246D               JMP     WTBIT     ;and wait one bit time

013D 99EF      AOUTLO:  ANL     P1,#0EFH;lower bit4
013F 246D               JMP     WTBIT

0141 15        SENDB:   DIS     I         ;disable interrupts
0142 FF                 MOV     A,R7
0143 47                 SWAP    A
0144 AF                 MOV     R7,A      ;rotate nibbles for wtbit

0145 09        SB1:     IN      A,P1      ;xxxx xx1x if printer busy
0146 5681               JT1     UNHANG    ;break the possible lockup w/button
0148 3245               JB1     SB1       ;hi line = busy
014A 3469               CALL    BOUTLO    ;send a start bit
014C BE07               MOV     R6,#7     ;set up loop counter
014E FD        SB2:     MOV     A,R5      ;get data
014F 67                 RRC     A         ;CY holds next bit
0150 AD                 MOV     R5,A      ;store what's left
0151 3463               CALL    BOUTC     ;wiggle the port
0153 EE4E               DJNZ    R6,SB2
0155 3465               CALL    BOUTHI
0157 3465               CALL    BOUTHI    ;two stop bits
0159 FD                 MOV     A,R5
015A 67                 RRC     A
015B 67                 RRC     A         ;straighten out r5
015C AD                 MOV     R5,A

015D FF                 MOV     A,R7
015E 47                 SWAP    A
015F AF                 MOV     R7,A      ;straighten out r7

0160 05                 EN      I         ;re-enable interrupts
0161 240A               JMP     SEND3     ;b sent, back to caller

0163 E669      BOUTC:   JNC     BOUTLO
0165 892F      BOUTHI:  ORL     P1,#2FH   ;raise bit5
0167 246D               JMP     WTBIT     ;and wait one bit time

0169 99DF      BOUTLO:  ANL     P1,#0DFH;lower bit4
016B 246D               JMP     WTBIT

016D FF        WTBIT:   MOV     A,R7      ;get baud rate selection
016E 43FC               ORL     A,#0FCH   ;a points to one of top 4 addr
0170 A3                 MOVP    A,@A      ;this page, get wait time in accum
0171 07        WTBIT2:  DEC     A
0172 00                 NOP               ;it takes 15 machine cycles to
0173 00                 NOP               ;go through this inner loop
0174 00                 NOP               ;for a total of 225 clock cycles
0175 00                 NOP               ;which is 36.62 microseconds if the
```

Listing 2 continued on page 49

Listing 2 continued:

```
0176 00            NOP               ;clock is running at 6.144 MHz
0177 00            NOP
0178 00            NOP
0179 00            NOP
017A 00            NOP
017B 00            NOP
017C 00            NOP
017D 00            NOP
017E 9671          JNZ     WTBIT2
0180 83            RET

0181 0446  UNHANG: JMP     MODE      ;back to the former loop

01FC               ORG     1FCH      ;last 4 bytes this page

01FC F2            DB      242       ;110 baud wait const
01FD 59            DB      89        ;300
01FE 2C            DB      44        ;600
01FF 16            DB      22        ;1200


           ;Kbin goes through the keyboard selection game and updates r5
           ;to the key position selected.
           ;b7 - b6 returned zero
           ;b5 - b3 designate rows 0-7 (numbered from top to bottom)
           ;b2 - b0 designate cols 0-7 (numbered from left to right)
0200               ORG     200H
0200 5600  KBIN:   JT1     KBIN      ;hang if button pressed (active)
0202 9A0F          ANL     P2,#0FH ;set hi nibble = 0 (red LEDs)
0204 5439  ROW:    CALL    WSCAN     ;wait one scan interval
0206 560C          JT1     COL       ;this the one, skip out
0208 5445          CALL    NEXROW    ;otherwise shine next row scan LED
020A 4404          JMP     ROW

020C 560C  COL:    JT1     COL       ;hang if button active
020E 0A            IN      A,P2      ;get the LED phase in accum
020F 77            RR      A         ;bits 654 to 543
0210 5338          ANL     A,#38H    ;strip to bits 543
0212 AD            MOV     R5,A      ;store bits 5,4 & 3
0213 9A0F          ANL     P2,#0FH ;set hi nibble = 0
0215 8A80          ORL     P2,#80H ;set bit 7 for col scanning
0217 5439  COL2:   CALL    WSCAN     ;wait one scan interval
0219 561F          JT1     GOT       ;this the one, skip out
021B 544C          CALL    NEXCOL    ;otherwise shine next col scan LED
021D 4417          JMP     COL2

021F 561F  GOT:    JT1     GOT       ;hang if button active
0221 0A            IN      A,P2      ;get the LED
0222 47            SWAP    A         ;swap nibbles
0223 5307          ANL     A,#07H    ;strip to bits 210
0225 4D            ORL     A,R5      ;or in previous 3
0226 AD            MOV     R5,A      ;store it in r5
0227 5439          CALL    WSCAN     ;wait a tad, unless delete
0229 5600          JT1     KBIN      ;oops, a keypress in the cancel
022B                                 ;time window, start over

022B FD            MOV     A,R5      ;if A  is xxxx x111 itsa mode shift
022C 43F8          ORL     A,#0F8H ;"  "  "  1111 1111  "   "   "
022E 37            CPL     A         ;"  "  "  0000 0000  "   "   "
022F 9638          JNZ     NOTMODE

0231 FD            MOV     A,R5      ;A has 00nn n111, where nnn is mode #
0232 77            RR      A         ;"  "  100n nn11
0233 77            RR      A         ;"  "  1100 nnn1
0234 77            RR      A         ;"  "  1110 0nnn
0235 43F8          ORL     A,#0F8H ;"  "  1111 1nnn
0237 B3            JMPP    @A        ;jump indirect via table at 2F8H
0238                                 ;which in turn points to the vectors
0238                                 ;on this page - if you understand this
0238                                 ;sequence, give youself a jellybean, and
0238                                 ;thank Intel for a nonmarchable stack
0238 83    NOTMODE:RET

0239 FC    WSCAN:  MOV     A,R4      ;get current scan rate
023A AE            MOV     R6,A      ;256 gives 2.4 sec per row/col
023B 27    WSCAN2: CLR     A
023C 3471          CALL    WTBIT2    ;9.375 milliseconds
023E 5644          JT1     WSCAN3    ;return if switch on
0240 CE            DEC     R6        ;bump scan count
0241 FE            MOV     A,R6      ;look at it
0242 963B          JNZ     WSCAN2
0244 83    WSCAN3: RET

0245 0A    NEXROW: IN      A,P2      ;get current phase
0246 0310          ADD     A,#10H    ;bump hi nibble
0248 537F          ANL     A,#7FH    ;make sure b7 is lo
024A 3A            OUTL    P2,A
024B 83            RET

024C 0A    NEXCOL: IN      A,P2      ;get current phase
024D 0310          ADD     A,#10H    ;bump hi nibble
024F 4380          ORL     A,#80H    ;make sure b7 is hi
0251 3A            OUTL    P2,A
0252 83            RET

           ;This here is the vector table which gets you off of this page.

0253 0411  V0:     JMP     ALLCAP
0255 041E  V1:     JMP     ONECAP
0257 042B  V2:     JMP     LOCASE
0259 0439  V3:     JMP     CTRL
025B 044A  V4:     JMP     PHRASE
025D 0411  V5:     JMP     ALLCAP
025F 0411  V6:     JMP     ALLCAP
0261 0485  V7:     JMP     LOCAL

           ;This here is the indirect page jump address lookup table, used
           ;by the JMPP A,@A instruction.  The indirect jump in an 8748
           ;chip cannot make it across a page boundary (multiple of 256
           ;bytes).  The doubly confusing double jump used here is a way
           ;around this limitation.

02F8               ORG     2F8H

02F8 53555759      DB      V0,V1,V2,V3,V4,V5,V6,V7

           ;page 3, lookup table for keyboard layout
0300               ORG     300H

0300 20656F6E      DB      ' eondpy '
0308 7461726C      DB      'tarlmgx '
0310 69736366      DB      'iscfbkj '
0318 68757776      DB      'huwvzq',1BH,20H
0320 08373839      DB      08H,'789*?! '
0328 0D343536      DB      0DH,'456/"& '
0330 2E313233      DB      '.123+() '
0338 2C30243D      DB      ',0$=-<> '

0340 20050F0E      DB      20H,05H,0FH,0EH,04H,10H,19H,20H
0348 1401120C      DB      14H,01H,12H,0CH,0DH,07H,18H,20H
0350 09130306      DB      09H,13H,03H,06H,02H,0BH,0AH,20H
0358 08151716      DB      08H,15H,17H,16H,1AH,11H,1BH,20H

0360 7F371E39      DB      7FH,37H,1EH,339H,7EH,60H,5EH,20H
0368 001C351D      DB      00H,1CH,35H,1DH,5CH,27H,40H,20H
0370 3A311F33      DB      3AH,31H,1FH,33H,23H,7BH,7DH,20H
0378 3B30257C      DB      3BH,30H,25H,7CH,5FH,5BH,5DH,20H


0000               END
```

Text continued from page 45:
tionally jumping to an unconditional-jump instruction (which is not so restricted). Unconditional jumps include normal direct jumps to any place in program memory and several types of indirect jumps within the page. (For an extreme example of this technique, look at location hexadecimal 0237 in listing 2, where the mode switching occurs. Here, subroutine KBIN is called, with the calling routine expecting control to return with the character-selection code held in register 5. But if you actuate the switch to select a mode, such as the Phrase mode, the subroutine calculates where to continue execution and simply jumps there. Structured programming hasn't made much progress on the 8748.)

The H-Com program is arranged in three sections, plus a lookup table. These four modules fit conveniently in the 8748's four pages of program memory. The first page (page 0) is where the code for all the various modes of operation reside; each code section considers itself the main routine and calls the other sections as subroutines. The first section of code sets up the major modes (All Caps, Phrase, etc.)

The second section (page 1) is the text-transmission section. It sends the contents of register 5 out to one or both RS-232C channels, according to which are active at the time. It sends the data at the most recently selected data rate or at the default data rate set up by code in the first page. If the H-Com "hangs up" waiting for a device-ready status that never comes, you can resume the active scanning mode by pressing the switch.

The third section (page 2) is the scanning subroutine. As we've seen, it scans the rows and then columns until you make a selection. When in the column scan, you can return to the row scan by pressing the switch twice instead of once. If any position in the first seven columns is selected, this subroutine returns to the calling routine with the element *position* (not an ASCII value) in register R5. The calling routine must either convert this into a character or take some appropriate action (e.g., beeping the horn). If a position in the eighth (mode-select) column of the array is selected, this subroutine disregards the normal subroutine return and jumps to the appropriate mode routine.

The first half of page 3 of program memory is the character-lookup table. Its layout corresponds to the character-display arrangement, which serves to minimize access time. If you would prefer some other "keyboard" layout, merely change this table.

The H-Com program does not make use of the 8748's interrupts, interval timer, or alternate registers R0 through R3. These have been reserved for customization of the system to an individual user. The alternate register set R4 through R7 is used for phrase-key storage, and keys longer than three characters use the high end of scratchpad memory. Other than this, the memory above the alternate registers is unused.

The software for this project was written by Ralph McElroy. To encourage use and further development of the H-Com and similar devices, we are placing the software in the public domain.

Parting Thoughts

This project has been on my mind for some time. Its subject matter was suggested by my meeting with Dave, but I'm doing it now because of the recent increase in the number of letters I've received describing how disabled individuals are being helped by the speech synthesizers I've presented in these articles.

I can guarantee that I'll continue to investigate speech-related topics, but specific projects like this one will require some reader feedback and suggestions. I'd like to hear your comments and suggestions. If there is sufficient interest in the H-Com, I may make arrangements for it to be manufactured commercially. For information on its availability, contact Intex Micro Systems Corporation, 725 South Adams Rd., Suite L8, Birmingham, MI 48011, telephone (313) 540-7601.

If you want to see how a research group at Tufts University approached the same problem, you can read an article in the September 1982 issue of BYTE (reference 5); that issue also contained a number of articles on computer applications to help disabled people.

Next Month:

There are dark clouds on the horizon. Thunder is rumbling through the hills of central Connecticut. . . . I'm getting worried. So next month we'll look at what happens when electronic devices are hit by high voltages and discuss how to prevent it. ■

Editor's Note: *Steve often refers to previous Circuit Cellar articles as reference material for each month's current article. Many 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.*

Special thanks to Ralph McElroy for his contributions to this project.

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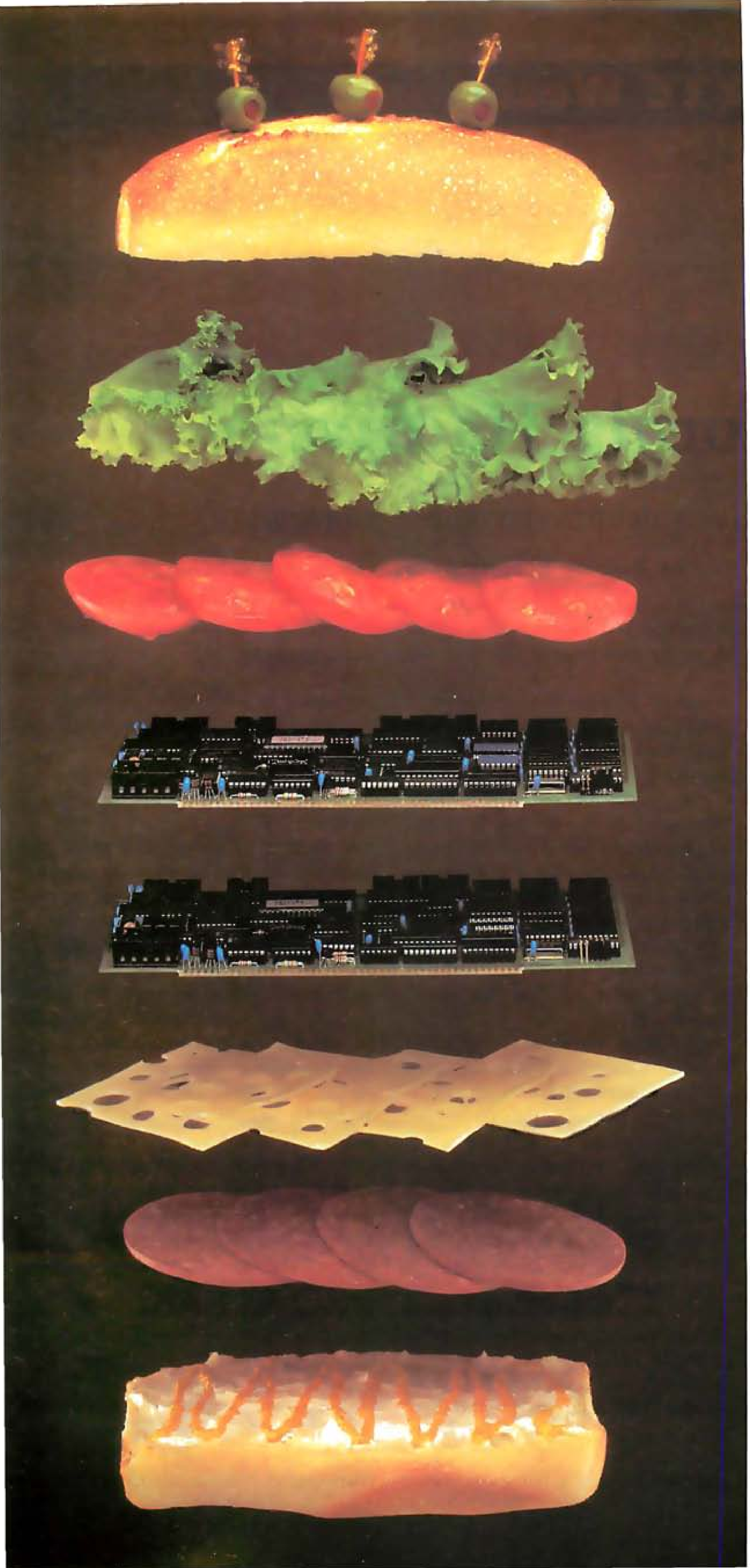
Steve Ciarcia (POB 582, Glastonbury, CT 06033) is an electronics engineer and computer consultant with experience in process control, digital design, nuclear instrumentation, product development, and marketing. In addition to writing for BYTE, he has published several books.

To receive a complete list of Ciarcia's Circuit Cellar project kits available from the Micromint, circle 100 on the reader service inquiry card at the back of the magazine.



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California Hardware

New products deliver specialized functions

by Barbara Robertson

This month BYTE West Coast looks at three products from the Silicon Valley: Convergent Technologies' new portable computer called the Workslate, Intel's BPK70-4 Bubble Storage Subsystem, and the Cygnet Communications Cosystem; and one from Southern California: bubble-memory boards for the IBM Personal Computer from Helix Laboratories.

Workslate

Monday morning. You plug a telephone into the Workslate and listen to the Dow Jones report on the speaker phone while you're getting dressed. Nothing earthshaking, so you check the Workslate calendar. Oops. There's a 10 o'clock marketing meeting today. The pricing-analysis spreadsheet was prepared last week, and a few things have changed since then. You use the Workslate's calculator to try out a couple of possibilities, adjust a number in one of the spreadsheet cells, and recalculate the totals.

Driving to work. As random thoughts cross your mind, you pull the Workslate out of your briefcase, turn on the recorder, and begin dictating. No need to worry about turning it off. The Workslate does that for you if you haven't used it for 5 minutes.

At the office. You hand the tape with your notes and the new pricing data to your secretary, sit down at your desk, and once again use Workslate to call Dow Jones. This time, though, you read the current stock quotes into one window on the display and enter the new prices into a stock-portfolio worksheet in the other window. Because this worksheet is set to automatically recalculate, new totals appear on the screen while you update prices.

An alarm beeps. The screen message tells you to "Sell 50 shares of Quicktech." You check the Quicktech cell and remember that you set the alarm to beep if the price fell below $25. Leaving the worksheet on the screen, you disconnect Dow Jones, autodial your broker, and give him the order over the Workslate's speaker phone.

The alarm beeps again, and this time the message reminds you of the 10 o'clock meeting. You slip the Workslate into your briefcase just as your secretary shows up with the transcribed notes and printout of the pricing spreadsheet. You're ready.

The Workslate (see photo 1) is small, lightweight, and packed with features. A 16-line by 46-character LCD (liquid-crystal display), 60-key button-style keyboard, 64K bytes of ROM (read-only memory), 16K bytes of RAM (random-access read/write memory), 300-bits-per-second (bps) modem with auto-answer and autodial, microphone, speaker, and a microcassette recorder for voice or data all fit into a battery-powered portable computer about the size of this issue of BYTE. Workslate weighs in at about 3½ pounds.

Driven by Hitachi's 6303 microprocessor (a CMOS version of the 8-bit Motorola 6800) and powered by four AA alkaline batteries (or a nickel-cadmium pack), the Workslate has spreadsheet capabilities that rival those of software packages designed for desktop computers. It's quick, powerful, and sells for $895. You can order it now from the American Express Christmas catalog and pay for it in monthly installments with no interest charges or shop later this year at Computerland or Businessland stores. First delivery is scheduled for November 17.

But before you run out and buy a Workslate, you should bear one thing in mind. One reason Convergent Technologies was able to pack so much in such a small package is because this machine is designed specifically for people whose business is numbers rather than words. In fact, a group of 50 to 100 potential users in this vertical market, including bank managers, body-shop owners, construction estimators, and data-processing managers actively participated in the product's design.

At a Glance

Name
Workslate

Manufacturer
Convergent Technologies Inc.
Advanced Information Products Division
2441 Mission College Blvd.
Santa Clara, CA 95050
(408) 727-8830

Uses
Portable spreadsheet computations, dictation, time management, telecommunications

Dimensions
8½ by 11 by 1 inch (under 4 pounds)

Features
A 16-line by 46-character liquid-crystal display, 60-key button keyboard with dedicated function keys and numeric keypad, 6303 microprocessor, 64K bytes of ROM, 16K bytes of RAM, built-in microcassette recorder, built-in 300-bps modem with auto-answer and auto-dial, clock-calendar, A/C adapter/recharger, modular phone jack cable, 9600-bps serial-interface port, and soft case

Software
Proprietary operating system, spreadsheet, communications including terminal emulation, ROM templates for calendar, memo pad, and phone list. Optional Taskware tapes (templates) range in price from $29.95 to $49.95

Documentation and Customer Support
Software developers guides; "Teach Me Now" and "Teach Me Later" audiotapes, owners manual, exercise workbooks, reference guide, and user newsletter; 800 "hot line" number for users; return for repair service

Price
$895

Options
Microprinter: battery-powered portable plotter with four colored pens and one roll of 4½-inch paper, 7 by 8½ by 1½ inches, under 2 pounds, plugs into serial port: $250
I/O box with RS-232C and Centronics port: $199
Nickel-cadmium battery pack: $29.95
Microprinter pens (four black or one each blue, green, red, and black): $3.95
Microprinter paper (four-pack): $5.95

Although the software in ROM includes the operating system, a spreadsheet, time and date management, and communications functions, from a user's point of view there is only one application: a spreadsheet. Even the ASCII (American National Standard Code for Information Interchange) terminal emulator is built into the spreadsheet. This is not necessarily a limitation once you begin thinking of the many uses of a spreadsheet program.

The Workslate comes with three spreadsheet application templates built into ROM: a calendar, a phone list, and a memo pad (for audio or text). Ten more templates, called Taskware, are available on tapes for $49.95 and under. (See table 1.) Keeping the razor-blade theory of marketing well in mind, Convergent has plans for 20 more tapes to be available within a year.

Serious hackers will probably lament the lack of an available language. All the software was programmed in assembly language, no BASIC is provided, and the operating system is proprietary and confidential. The only way to add programs to the Workslate is to use the programming capabilities within the spreadsheet (see table 2) to design new Taskware templates. As for expansion possibilities, we weren't able to look inside the machine, but we were told there are two empty 32K-byte ROM slots.

Writers will probably decide against this machine because the keyboard and the software were obviously not designed with them in mind. But businesspeople, managers, note-takers, appointment keepers, cost estimators, and a wide range of other people will find the Workslate very useful.

Physical Dimensions

The Workslate fits on your desk or in your briefcase as easily as a thick pad of paper. It's 8½ by 11 by 1 inches and weighs less than 4 pounds with

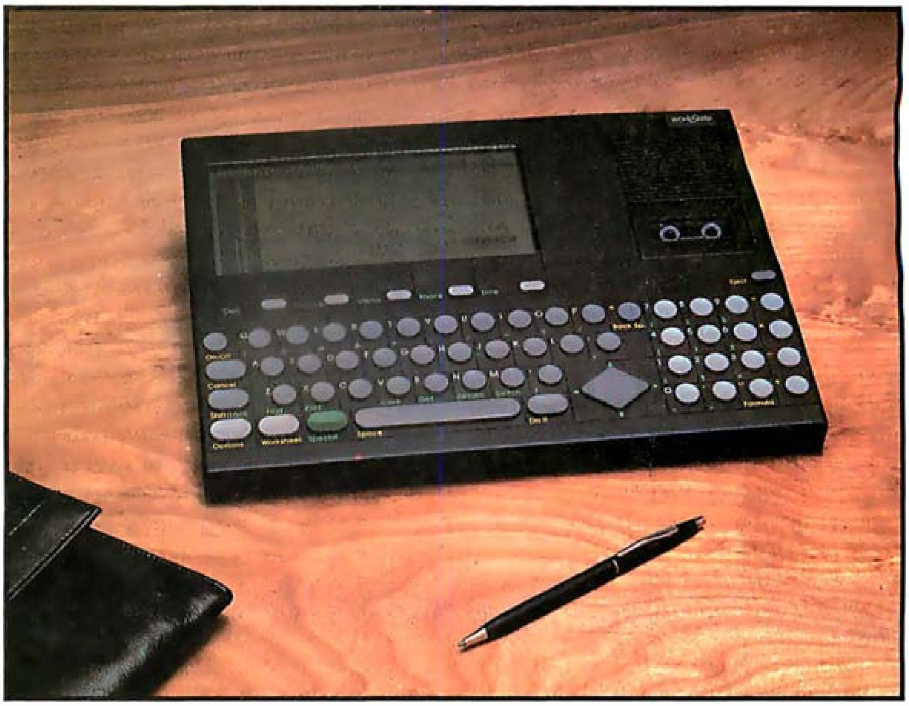

Photo 1: *A standard Workslate spreadsheet. White pointer arrows within the dark, inverse-video Cell and Row label lines and the block of inverse-video on the selected cell help you keep track of where you are. The status line at the top shows the worksheet name, the formula for Cell D12, the percentage of remaining memory, and the date and time.*

Personal tax	1040 Form Major Schedules (A,B,D,G) Forms 2106, 2119, 3903 Monthly/Quarterly Withholding Analysis	Estate planning	IRA planning and analysis Insurance-requirement analysis Life-insurance coverage Personal net worth, current/projected College-fund planner Trust account
Travel	Expense Reporting a. Travel expenses b. Client and entertainment expenses Traveler's check log Itinerary Airline miles log Foreign-currency converter Metric converter	Financial statements	Balance sheets Income statements Owners-equity statements Ratio analysis Changes in working capital Changes in cash flow 5-year comparative-income statement Fixed assets Product cost
Sales reporter	Account log Commission report Daily contact report Expense report Inventory availability and pricing Proposals Rental/leasing analysis Sales forecasting 30/60/90/quarter/year	Cash management	Cash modeling Investment analysis Selected ratio analysis Actual expenses Cash disbursements Cash receipts Currency conversion Planned expenses Planned versus actual
Business tax	Sole proprietor and partnership taxes a. Standard forms b. Standard schedules Personal tax preparation FICA Quarterly tax estimator Tax-alternative calculator	Marketing management	Advertising-expense analysis Advertising response-ratio analysis Pricing analysis Sales analysis Commissions Sales forecasting Budgets Expenses Sales-performance ranking
Portfolio analysis	Dow Jones Reporting Service a. Price-drop warning b. Auto-dial at Market opening or close Annual-report analysis Bond analysis Cash-flow analysis Current-investment analysis Industry analysis Stock portfolio Summary profit report Unrealized/realized gains and losses	Loan analysis	Amortization schedule Break-even analysis Interest expense Loan comparisons Personal-financial statement

Table 1: *Workslate Optional Taskware. Taskware is provided on microcassette tape (see photo 3). Prices for the tapes listed range from $29.95 to $49.95.*

batteries. The color is dark slate gray with button keys in two lighter shades of gray (see photos). The display is on the left near the top of the machine, and a speaker and cassette drive are on the right. The built-in microphone fits in a barely noticeable slit in the front of the machine. On the right side are plugs for an external microphone and headset and a volume control. Two phone connectors, the serial port for the optional portable plotter (see photo 2), and the A/C adapter/recharger connector are in the back; the LCD brightness control is on the left side. Batteries can be replaced by removing a small panel on the underside of the machine.

Keyboard

The calculator-style button keys are well spaced and have a nice touch. With the help of the 10-key buffer, I found I could type very fast. All the keys on the keyboard repeat.

Notice the large diamond-shaped pointer control pad between the typewriter keys and the numeric keypad. Pressing a ribbed area at the top, left, right, or bottom moves the pointer between cells in the expected direction. Within a cell, data is entered by typing and edited by backspacing and retyping. However, in the edit mode, the pointer-control pad can move the cursor across characters for selective editing.

Five function keys at the top of the keyboard have green labels identifying them as Calc, Finance, Memo, Phone, and Time. Memo, Phone, and Time are spreadsheet application templates. Calc splits a display into two windows, with the lower window functioning as a calculator. Finance produces sets of software keys that help you calculate depreciation, loans, and net present value.

All the software templates have five softkeys (called "action keys" in the Workslate) at the bottom of the display that correspond to the keyboard function keys. When no softkeys are displayed, a function key calls up its labeled function. When softkeys are displayed, the corresponding function key calls into action a softkey function. However, with the use of the green Special key (at the bottom of the keyboard), the labeled functions can always be accessed.

The photos show that green labels are assigned to many keys other than the function keys and that green characters are next to some of the keys. Pressing the Special key along with a second key produces the result labeled in green next to the second key.

A row of dedicated keys on the left side of the keyboard includes the On/Off control and the traditional Shift key. The Cancel and Options keys work with the software. Cancel rescinds a command or returns you to a previous layer of softkey functions; Options calls up three sets of softkey commands, including an On/Off toggle for the keyboard click. (More on these options in the software section.)

The Worksheet key to the right of Options is used to move between worksheets. Pressing this key produces softkeys labeled with worksheet names.

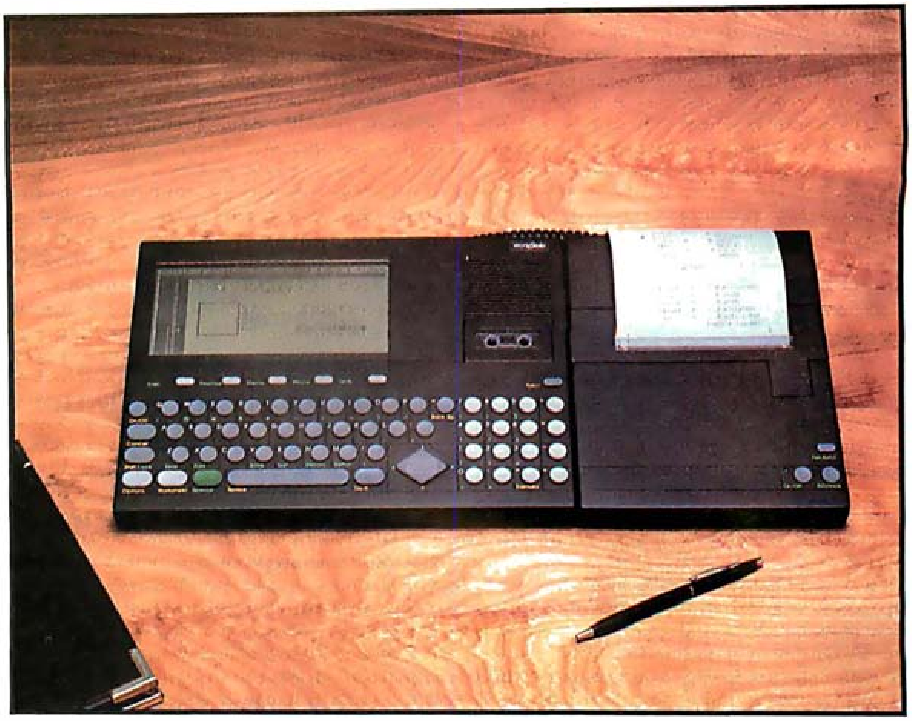

Photo 2: *The Workslate options. The battery-powered plotter can form 40 to 80 characters in four colors on a line or print them sideways for extra-wide spreadsheets. The Metric converter template on the screen comes on the Travel Taskware tape.*

The familiar Return (or Enter or left-legged arrow) key has been moved to the bottom row (to the right of the space bar) and relabeled Do It.

The numeric keypad, to the right of the typewriter keyboard, has numbers 0 through 9 and dedicated keys for addition, subtraction, multiplication, division, decimal point, and calculation (formula or =). A variety of other characters often used in formulas, such as parentheses, brackets, and less-than and greater-than signs, appear on the keypad in green and can be accessed with help from the Special key.

The numeric keyboard can be reconfigured as a telephone keypad rather than a calculator by using one of the Options softkeys, and Convergent Technologies provides an appropriate overlay.

People who make their living with typewriter keyboards rather than numeric keypads will find this keyboard inconvenient. A typewriter it isn't. The Return key, period, and apostrophe, for example, are in the wrong places, and there is no right Shift key. However, this keyboard should be fine for two-finger typists and occasional note-takers.

Display

The 16-line by 46-character LCD was designed by Convergent Technologies and built in Japan by a company Convergent Technologies won't identify (it's neither Sharp nor Epson). The software uses the top line of the display as a status line telling you the name of the worksheet, the contents of a cell, the percentage of memory remaining, and today's date and time. (Remember, there's really only one application—you're always in a spreadsheet program.) The status line may also contain a phone icon, an alarm message, and a tape counter if appropriate. The bottom three lines are used for the softkeys (lines 15 and 16) and system messages or prompts (line 14).

The display is easy to read, and contrast can be adjusted. With a display size of more than half that of a desktop monitor, several spreadsheet rows and columns can be viewed on the screen at once. Scrolling is by line or page.

Microprocessor

The Workslate uses the Hitachi 6303 microprocessor, a low-power CMOS (complementary metal-oxide semiconductor) version of the 8-bit Motorola 6800. This central processor was chosen for its ability to move blocks and its onboard I/O ports. Clock speed is 1.228 MHz.

Memory and Power Supply

The Workslate comes with 64K bytes of ROM and 16K bytes of RAM. One spreadsheet with 16K bytes of data or up to five spreadsheets with a total of 16K bytes of data can be resident in RAM. The amount that can be stored in RAM depends on actual data entered into a spreadsheet, not the number of cells in the spreadsheet. The 16K bytes of stored data could, for example, be in 1000 cells, each with 16 bytes, or in 2000 cells, each with 8 bytes. RAM memory is saved whether the machine is on or off. Power can be supplied with four AA batteries, an external A/C adapter/recharger, or an optional nickel-cadmium power pack. One backup button battery protects memory for up to two months. Warning messages indicate when to replace main and backup batteries. The maximum power requirement is 1 watt.

Standard microcassette tapes provide external storage for audio and digital information. The built-in dual-track microcassette recorder from Olympus can store 30 minutes of audio or 5 worksheets (80K bytes) on each side of a tape. Normally, audio is stored on one side of a tape and digital information on the other. Worksheets, however, can have 1 minute of voice annotation on the same side of a tape. Users can listen to this recording while worksheet data is being loaded into RAM. A typical 16K-byte spreadsheet can be loaded into RAM in about 60 seconds. The transfer rate to tape is 2400 bps, and data is stored in a density of 2560 bits per inch (bpi).

Communications

Both voice and data communications capabilities were given very high priority in the Workslate design. The machine comes with a 300-bps internal LSI (large-scale integration) modem and can dial in Touch-Tone or pulse mode. The Workslate comes with a phone cable and has two phone plugs in the back. Workslates can be plugged into a standard modular telephone jack or connected in series between the wall and a standard telephone.

The Workslate comes with a phone cable and has two phone plugs in the back.

In data mode, modem/phone functions include auto-dial, auto-answer, manual answer, manual originate, acoustic coupler, and data-to-talk mode-switching. Voice mode gives you auto-dial, auto-answer with taped message, manual voice answer, speaker phone, call holding, conversation recording/playback to phone, and talk-to-data mode-switching. The Workslate can answer the phone and play a message tape, but it can't record phone messages. Chances are, though, you would keep the machine with you rather than use it as a telephone answering machine.

Communications can be unattended. Terminal configurations include XON/XOFF, DTR/CTS (with an optional I/O box), or "no" handshake; even, odd, zero, one, binary (for receiving 8-bit code) or no parity; character echo on or off; and line termination with crlf, cr, or lf. Acoustic coupler, answer-back password memory, send/receive security, and single-keystroke transmission of user-defined strings are also available. Worksheets are represented in 7-bit ASCII; 8-bit codes (such as line drawings) are sent masked down to 7 bits and surrounded by tildes.

The serial port can be used for 9600-bps direct-connection data transfers. An optional I/O (input/output) box ($199) plugs into this port and provides 300-, 1200- , or 9600-bps communications. Convergent Technologies is currently working on software that will run on its other machines as well as on the IBM Personal Computer to facilitate data transfer from Workslate to those machines.

Printer

The optional ($250) battery-powered portable plotter connects to the serial port and plots worksheets at a rate of about 8 characters per second. The Microprinter is 7 by 8½ by 1½ inches and weighs less than 3 pounds with batteries. It's powered by four AA alkaline batteries or a nickel-cadmium pack, has an A/C recharger, uses roll paper, and comes with four colored pens. (Negative numbers print in red.) It can print 40-character lines, 80 characters in condensed mode, or 90-degree sideways characters for extra-wide spreadsheets. The printer is based on the pen mechanism developed by Alps, a Japanese corporation, but manufactured by Convergent Technologies.

The optional I/O box has RS-232C and Centronics ports and can be used to connect letter-quality or dot-matrix printers to the Workslate.

Software

The operating system is proprietary, multitasking, and invisible to the user. Multitasking lets you work with spreadsheet data while you're on the phone, printing, or loading or saving data. You can create your own spreadsheet forms using a blank worksheet or start with one of the three ROM templates: memo pad, phone list, or time/calendar.

The operating system is proprietary, multitasking, and invisible to the user.

The ROM templates are always available through the five function keys. If a displayed softkey label doesn't correspond to the matching function-key label, you just press the Special key and then the particular function key.

Each ROM template has its own set of softkey functions. Memopad is used for audio or text and includes record, stop, play, forward, and reverse functions for controlling the tape. The default column width in this template is set at 40 characters for note-taking. Text is entered one line at a time; there is no word wrap. The contents of a cell (one line of text) can be moved to an edit line for word-processing functions such as inserting characters.

The Phone List template controls communications. Softkey functions include dial, answer, speaker, terminal, and hang-up on the top level. Selecting "terminal" brings up pause, send, receive, talk, and hang-up softkeys. The Workslate draw option was used in this template to create divisions between columns. Column A, titled Name, is 15 characters wide; Column B is a vertical line (draw character) 1 character wide; Column C, Phone Number, is 13 characters

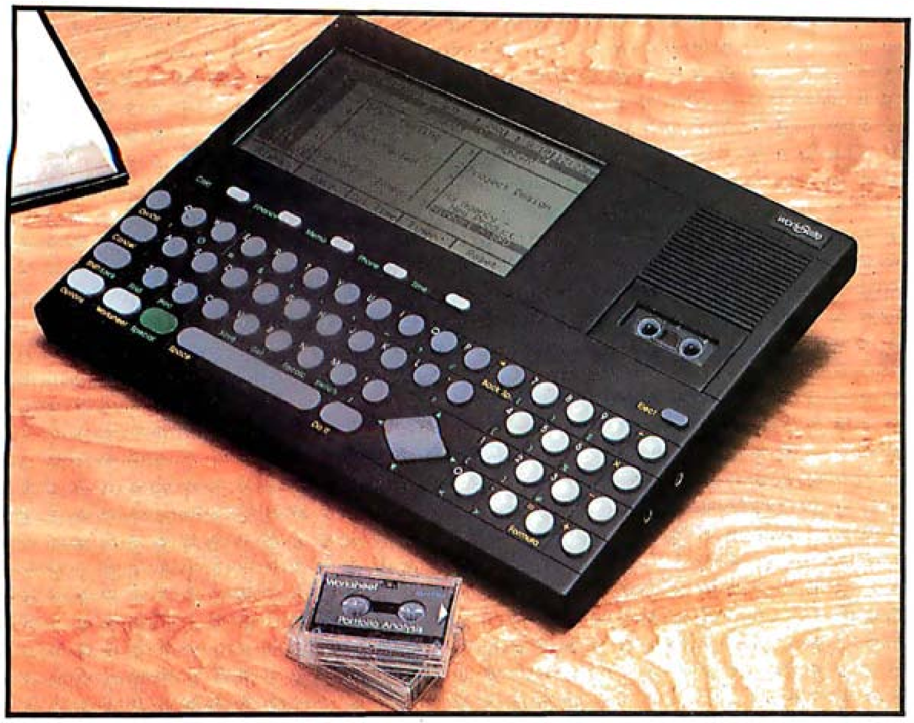

Photo 3: *The Workslate's calendar is resident in ROM and can be assigned to any Worksheet with the Time function key. The user-modifiable template has formulas for a two-week calendar. Reminder alarms can be set for any appointment. Battery power keeps RAM memory active, and a backup battery provides an extra two months of memory protection.*

wide; D is again a vertical line; and E, Company, is 10 characters wide.

The Calendar (or Time) template (see photo 3) is designed to hold a two-week calendar. Column A is used for morning times, B for dates and date formulas, C for afternoon times, and D for the day of the week. Date arithmetic is built-in so that when a current date is typed in to cell B1, the Workslate calculates the remaining dates. The softkey functions are alarm, date, set time, timer, and reset. When the "timer" function is set, the Workslate tracks the length of a phone call. You can then enter this time into a client billing spreadsheet.

ROM templates can easily be modified by a user and their softkey functions can be assigned to any worksheet. Worksheets can use 128 columns and 128 rows; however, the maximum spreadsheet size is 1000 cells. Worksheets without ROM templates attached can be Standard (no softkey labels assigned) or Finance (financial formula softkeys assigned). Cells can hold words, numbers, dates, times, formulas, or "draw" characters.

The depth of the spreadsheet capability belies the size of the computer. More than 40 formula functions (see table 2) are available for any cell, and more than 30 editing/formatting options can be accessed by pressing the Options function key at the bottom of the keyboard.

There are two methods of entering formulas. In the interactive mode, the system builds formulas such as average, minimum, maximum, total, and copy cell for you depending on the softkey selected. You can enter your own formulas in direct entry mode. Cell references may be specific cells, a number of individual cells, a range, or any combination. Relative cell references are entered by pointing to a cell. If a relative reference changes, the worksheet is automatically readjusted.

Options are organized into three sets of five, each selected by using the function key corresponding to the softkey label. Each set of options has additional layers of softkey functions. Within this structure you can sort columns of data in ascending or descending alpha or numeric order; copy, move, delete, and format data in cells; draw lines and boxes using and expanding ASCII characters (photo 2); recalculate a worksheet; specify printer-pen colors and margins; set communications protocol and password protection; change column width; and create or link vertical and horizontal windows.

The Workslate has no Help function. The project team decided at the beginning that the software design would have to be understandable without additional on-screen help.

Designing the Workslate

The Workslate's design reflects an enormous amount of end-user interaction during development and the company's intention from the beginning to design a machine to do a few specific tasks very well.

Matt Sanders, vice-president and general manager of Convergent Technologies' new Advanced Information Products Division, said the project began for him about a year and a half ago. At that time, as the sole employee of the new division, he was charged with developing a computer for the low-end market. His first responsibility was to develop proposals for the next generation of machines. He began researching the project by wandering through corporations and from one small "Main Street" business to another asking people what they were doing with their computers.

It became obvious to him that while clerical and administrative people were using word-processing functions, managers and proprietors were using spreadsheets. In addition, this latter group of business professionals spent much of its time on the telephone and managing its calendars. While the managers were interested in communications to larger machines and databases, they were not at all interested in word processing. Sanders became convinced that an electronic-spreadsheet machine with integrated time-management and communication functions could be designed and targeted specifically for this audience. (This decision to build hardware and software in tandem, starting from the ground up, probably accounts for some of the

Workslate's surprisingly quick processing speed.)

Sanders's second responsibility and what he found the hardest part of the project was hiring the project team. He said you begin with a vision of the team and the machine in your mind, but once you begin hiring people, you find you're completely wrong. "You hire the first person and suddenly it's not your product, it's the two of yours. Then you look for the third person. The result is that the product gets better and changes right in front of your eyes." The Ultra team (as the project came to be called) is composed of people hired away from Savin, Texas Instruments, Motorola, Atari, and Hewlett-Packard.

The Ultra team started by taking its ideas on the road, testing the Workslate concept with groups of potential end users in New York, San Francisco, and Chicago. These one-day brainstorming sessions evolved into an ongoing interaction. Local members of the users group have participated on a weekly basis, stopping by Convergent Technologies' offices nights, weekends, and at lunch time to try out the latest software and hardware designs. Long-distance communications have been kept up through newsletters, questionnaires ("Rate the following 10 functions in order of priority"), and exercises ("Imagine you're a copywriter describing this product").

Karen Toland, marketing manager for Convergent Technologies, acted as a liaison between the user groups and the software-development team. She noted that being able to cite actual examples from end users gave her additional support when she was bargaining for changes with software engineers constrained by 64K bytes of ROM and aggressive schedules. End users were no longer invisible. They were in the next office. The result of this iterative process is evident in the simplicity and depth of the software, in labels such as Do It assigned to dedicated keyboard function keys, the use of softkey labels, and the integration of communications and time management within spreadsheet applications.

$	Puts dollar sign at beginning of formula result. Does not convert to dollar decimal position.
@	Specifies cell reference to be absolute, not relative.
Abs	Returns absolute value of argument. Single parameter is numeric value, cell reference, or formula.
ACRS	Accelerated depreciation. Calculates depreciation value based on number of periods, percentage rate, cost, investment-tax-credit percentage, and period number. Any value may be cell reference.
Alarm	Sets date and time when alarm should activate. Alarm may be set to beep when conditions entered in formula are met.
And	Returns logical value true if all specified argument values are true. Otherwise, returns false. Argument entries must be logical values.
Average	Calculates numerical mean average of all cells contained in given argument. If no numeric cells are in the list, the average is zero.
Count	Returns number of cells that contain numbers or formulas that evaluate to numbers in a specified area.
Date	Value of cell is equal to current system date when recalculation is performed. There are no parameters for this function.
Decline	Declining balance. Indicates specific depreciation value based on number of periods, percentage rate, book value, and period number.
Delay	Number of seconds to delay the system from sending information.
Dial	Dials the number supplied. A second parameter determines the nature of the call, talk, or data. Default is "talk" if no parameter is supplied.
FutrValue	Calculates future value in interest calculations based on percentage rate, periods, payment, and present value.
GoTo	Moves pointer to a specified cell reference.
If	Describes logical value, then value, and optional else value.
Index	Returns value of cell selected by a relative numeric subscript reference within a specified range of cells (area and single cell reference). The result is the contents of that cell.
Int	Integer. Returns argument as a whole number. Calculated as nearest whole number less than the value entered.
IsErr	Returns the logical value true if argument is any of the error values.
Keep	Requires four parameters. First describes where incoming information should be stored in a worksheet. The next three describe the exact location of information as it would display in terminal window in terms of beginning line number, starting character position, and number of characters per line of the area to be kept.
Line	Replicates a specific character a specific number of times.
LookUp	Searches for arguments in first row or column of area reference as table. Returns contents of the cell from the last row or column of table. Numeric value and range parameters are required.
Max	Produces largest arithmetic value in area specified. Area may be specified by a list or range of cell references.
Min	Produces the least arithmetic value in area specified. Area may be specified by a list or range of cell references.
Mod	Returns remainder of dividend divided by divisor.
NPV	Produces present value of a series of periodic future receipts, given a discount rate. The two parameters are percentage rate and list.
Not	Returns the opposite of the logical value argument.
Or	Returns the logical value true if any value in the list is true.
Payment	Calculates the amount of payments based on periods, percentage rate, present value, and future value.
PresValu	Calculates present value in interest calculations based on percentage rate, periods, payment, and future value.
Round	Rounds a value to the number of digits specified.
Send	Transmits a string of information. Used in sign-on functions.
Straight	Straight-line depreciation calculation based on periods, book value, salvage value, and period number.
SumYears	Sum of the year's depreciation calculation based on periods, book value, salvage value, and period number.
Total	Calculates the total amount of area specified.
WaitFor	Waits for a specified string to be sent to the system.
; or –	Pause
/	Date
:	Time
<	Less than
>	Greater than
=	Equal to
≠	Not equal to
%	Percent
< =	Less than or equal to
> =	Greater than or equal to

Table 2: *The Workslate includes more than 40 function formulas that can be used in a direct-entry formula mode.*

Trends

It will be interesting to watch the development of portable computing. The Workslate machine comes to market a short time after the introduction of the first battery-powered portables and points in a direction different from that of the full-functioned Dynabook concept that the Gavilan and Grid portables try to approach. The concept of designing a machine specifically to handle the most important tasks for a particular segment of the population could easily be carried into other areas. An obvious choice would be to target a machine for people who work with words. It wouldn't be a surprise if the Workslate team began putting its energies into designing a "word" slate or perhaps a slate for students, doctors, or architects.

In last month's BYTE West Coast, Trip Hawkins of Electronic Arts said that one reason he built Electronic Arts on the model of individual producers and artists was because the framework of large corporations often inhibits the quick development of innovative products. Indeed, as you look through this month's BYTE, it becomes apparent that the only way IBM Personal Computer peripheral and compatible manufacturers can keep their edge is if they can move faster than IBM.

Convergent Technologies, primarily known as a manufacturer of multifunctional workstations for the OEM (original equipment manufacturer) market, took a radical, if not entirely new, approach when it sent Sanders on his mission. The Ultra team had the best of both worlds. Its members had the advantage of "start-up" enthusiasm and corporate financial backing. The entire Workslate project took little more than a year.

The fate of the Workslate will be due at least in part to the contributions from end users drawn into the product design early in the project. Sanders called the Ultra team a "talented group of software engineers, marketing, human-interface, and testing people all working as a team on behalf of the end users." He said that a clinical laboratory and cognitive psychological approach rather than an interactive approach to design probably would have resulted in a different product—perhaps a more efficient one. But Sanders went on to say that the company decided it was going to have fun. "We did it grass roots. We wanted to do it interactively."

If the Workslate is a resounding success, it's possible that other companies will borrow Convergent Technologies' idea of small design teams working directly with potential users to design products specifically for vertical markets.

Intel's BPK70-4 Bubble Storage Subsystem

Whatever direction the portable computing field takes, it will undoubtedly be influenced by Intel's recent announcement of a price drop for its BPK70-4 1-megabit (128K-byte) Bubble Storage Subsystem.

Bubble-memory storage falls somewhere between RAM and disk storage in application. Like RAM, bubbles offer compact, solid-state read/write memory storage, but they're much slower. Bubble memory is six times faster than floppy disks with one-third the power requirements and 1000 times better error rates, and, like disks, the memory is nonvolatile. But until now, bubble systems have been too expensive for wide application such as mass-storage memory. As a result, bubble memory has often been the forgotten stepsister in the microcomputer industry.

Intel's 1979 price for its bubble-memory system was a whopping $2500. Today's volume price for the Bubble Storage Subsystem is $199 (in production lots of 5000), and a two-step, two-year price-reduction program will drop the tab to a guaranteed $99 (for lots of 25,000) by the fourth quarter of 1984. That will mark the first time bubble memory will cost less than $100.

With a BPK70-4 system you get 1 megabit of nonvolatile, solid-state, read/write memory and a mean-time-between-failure rate of 40 years with a system operating continuously at a

Circle 454 on inquiry card.

Circle 21 on inquiry card. →

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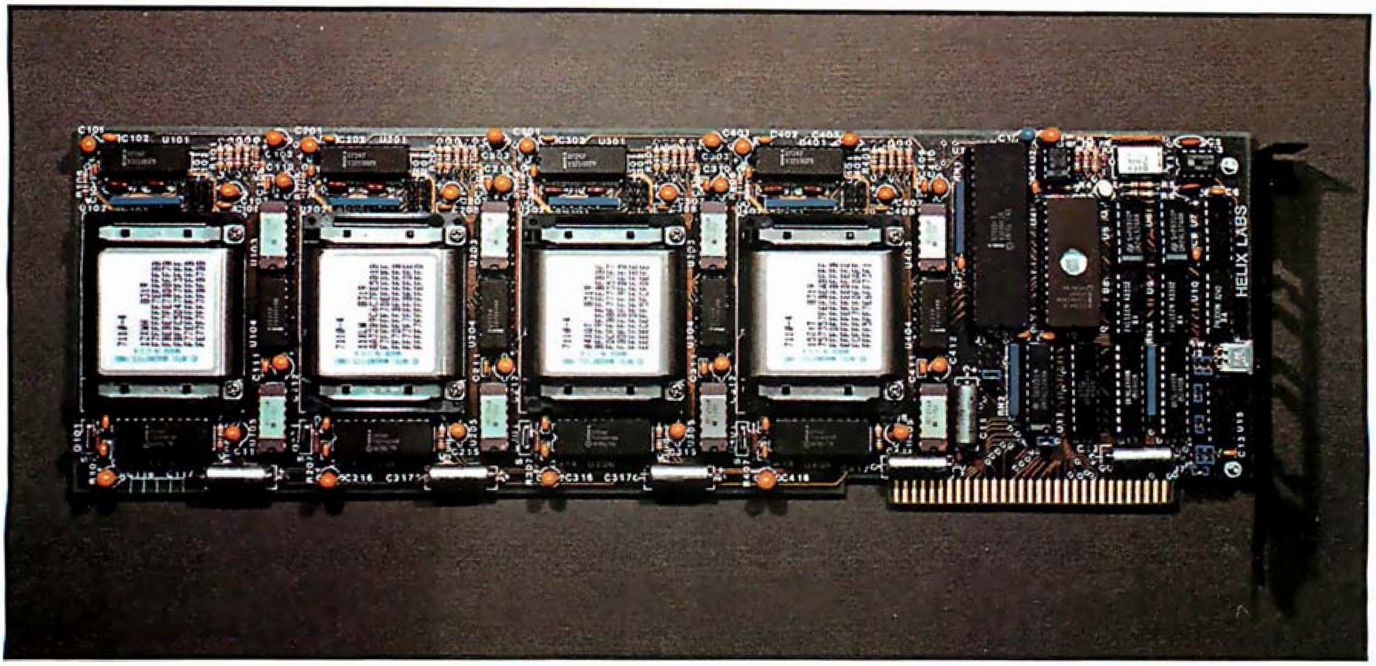

Photo 4: *The 4-megabit Helix bubble-memory board plugs into an IBM Personal Computer slot for quiet, nonvolatile mass storage. The Helix PCBM is switch-selectable (on-board ROM BIOS bootstraps DOS from the bubble or floppy disk) and is configured as a fixed disk.*

temperature of 55 degrees centigrade. Average access time is 40 milliseconds.

The "subsystem" consists of a 7110 1-megabit bubble-storage device accompanied by a set of Intel's LSI support chips that run the storage unit and interface with the microprocessor. The set includes a 7220-1 controller, a formatter/sense amplifier, current pulse generator, and driver circuits. The bubble-memory subsystem can operate in parallel for faster memory transfer or multiplexed for low power consumption. A software program acts as a conduit for information between the bubble system and the external system.

An additional controller, the 7220-4, which supports up to eight BPK70-4 Bubble Storage Subsystems, can be purchased separately and is also being reduced in price.

The next price step for Intel is a targeted $150 tab by 1986 for its 7114 4-megabit bubble system. The 7114 will be compatible in form and function with the 1-megabit kit for easy upgrade design paths. By that time, a new generation of bubble devices, built around the 16-megabit bubble, should make its first appearance.

Because of their high price, reliability, and immunity to environmental stresses, bubbles have been used primarily for mass storage in military, manufacturing, and industrial applications. They've found homes in battlefield command and communications terminals, factory-floor robots, aircraft navigational systems, and numerical control machines for machine-tool manufacturers.

A bubble's nonvolatility eliminates the need for backup batteries and lowers the power consumption.

Price reductions to less than $300 per unit in 1982 have helped bubbles move into point-of-sale and banking terminals and portable computers, notably the Grid Compass (with 3 megabits of bubble memory) and the Teleram.

Bubble memory has many advantages over tape and disk storage for portable manufacturers and users. A bubble's nonvolatility eliminates the need for backup batteries used to protect RAM memory and lowers the power consumption. (The Teleram uses power cycling techniques to shut off power to the bubble when it is not accessed.) With no moving parts in the system, problems caused by dust, vibration, shock, and wide temperature ranges disappear, reducing maintenance problems and increasing reliability. In addition, because the system is protected with a sleeve of magnetic shielding material, it can be used in the vicinity of strong magnetic fields without damage. The density and compactness of bubble systems make 128K bytes of mass storage easily possible in a briefcase computer, and the absence of disk drives reduces a portable's weight.

Grid's solution to the problem of how to load programs into a computer that (initially) didn't have a disk drive was to have Compass owners use the built-in modem to load programs over telephone lines from a Grid central computer.

Loading programs is not a problem, though, when bubbles are used in networked office systems. In this type of system, bubbles can provide a large amount of working storage for application programs and data loaded from large computers into workstations that may or may not be portable. It's possible that we'll see portable workstations plugged into an information network during the

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Tim Daneliuk, InfoWorld - May, '83

'VEDIT's 'visual' mode, where you will spend most of your time, has a multiplicity of valuable one-or-two-keystroke commands which make it very easy to enter and modify text.'

Frederick Zimmerman, Sextant - Fall, '83

'VEDIT's by all odds the most flexible programming editor I've ever seen.'
'One of its best features is multiple buffers; that is, you can store chunks of programs in various places and pull them out into your main file when needed.'

Jerry Pournelle, Byte - September, '83

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- Load/Save Buffers on Disk
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day and riding home in a briefcase at night.

Helix PCBM

Helix Laboratories of San Diego, California, has announced the first bubble-memory board for the IBM Personal Computer (photo 4). The 4-megabit Helix PCBM uses four Intel 7110-4 1-megabit bubble memories and offers 512K bytes of nonvolatile, high-speed mass storage for the IBM PC. Its operation is completely silent and several times faster than a floppy disk. The 4-megabit Helix PCBM will retail for $1500, and a 2-megabit (256K-byte) board will cost $1000. When Intel's price reductions go into effect in 1984, bubble memory will become highly competitive with RAM disks—comparable in cost, slower, but nonvolatile.

The Cygnet Communications Cosystem

Cygnet Technologies of Sunnyvale, California, introduced the Cygnet Communications Cosystem at the IBM PC Faire in San Francisco in August. The Cosystem (see photo 5) takes up a little more space than a telephone but provides a much greater range of communications. The Cosystem is designed to work concurrently with a personal computer—at first release, the IBM PC.

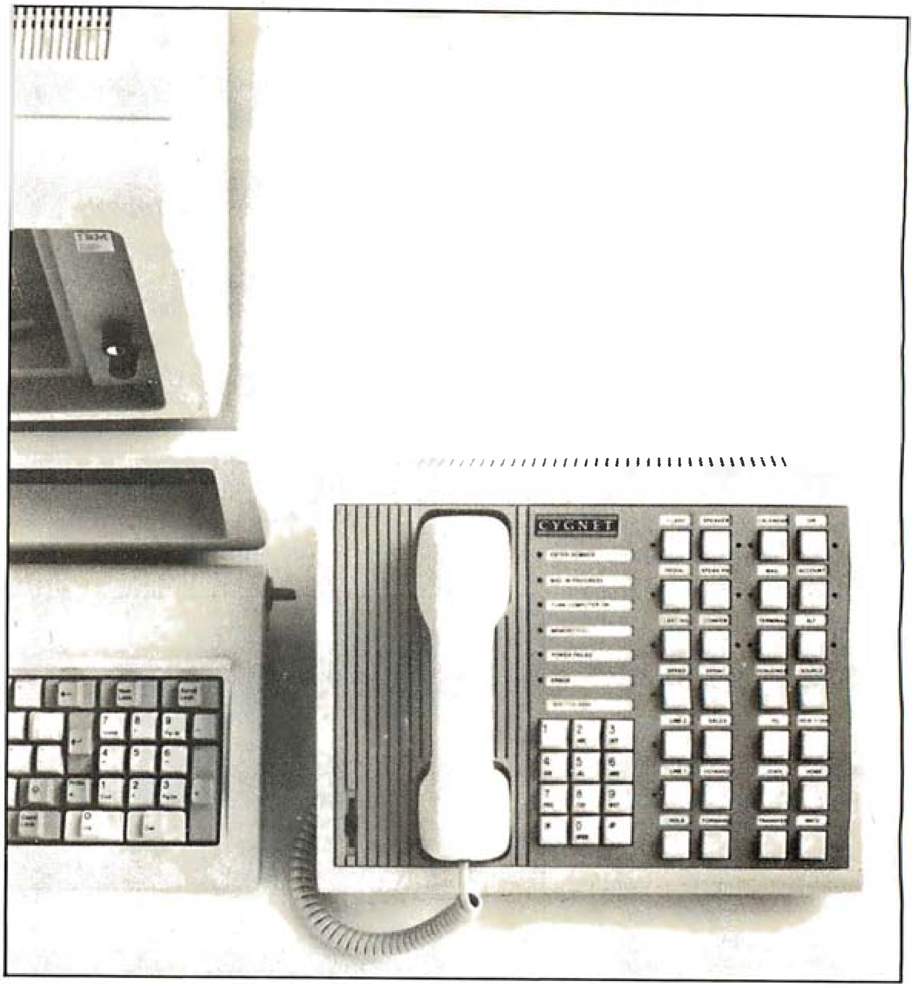

Photo 5: *The Cygnet Communications Cosystem works with an IBM Personal Computer (and some compatibles), extending the PC's communications capability by providing simultaneous voice and data communications, unattended automatic electronic mail, automated database access, and intelligent telephone features.*

The Cosystem contains its own Z80 central processor and 90K bytes of RAM, including 64K bytes of battery-backed CMOS RAM for storing messages. While the user performs normal operations on the PC, the Cosystem will perform background communications—automatically receiving or sending messages. The Cosystem automatically dials telephone numbers from a directory of 400 names. If a number is busy, the Cosystem will automatically redial it. A built-in text editor permits composing messages, a calendar/clock provides for scheduling appointments and receiving automatic reminders, and communications management provides unattended sending and receiving of electronic mail, including distribution lists and copies to listed parties. Communications software emulates 15 common terminals and supports file transfers and attachment of data files such as spreadsheets to electronic mail. The Cosystem permits simultaneous spoken and textual communications and three-way teleconferencing. PBX functions are also included.

With a built-in 1200-bps 212A modem, the Cosystem costs $1845. With a 300-bps modem, the price is $1495. A speaker phone costs an additional $150.

That's a fairly high price, but when you consider all the features that the Cygnet Cosystem provides, the price seems more reasonable. Its features include a telephone, an auto-dial/auto-answer modem, sophisticated communications software, concurrent operating system capabilities, a data buffer, and PBX (private branch exchange) functions. The only other feature that you might need is a voice-synthesis module that could politely tell unwanted callers that you were "in a meeting."

One of the nicest things about the Cosystem is that you apparently can interrupt work in a program on the PC, answer a telephone call (voice or data) on the Cosystem, and then return automatically to your previous place in the program. The Cosystem thus offers personal computer owners an easy way to move into some very sophisticated telephone management and electronic communications. And all of this is accomplished without tying up the computer's central processor.■

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The Latest from Chaos Manor

A discussion of disk formats leads this month's foray into microland

by Jerry Pournelle

As Alice said, things *flow* here so. If that's true in microland, it's particularly so here at Chaos Manor. We try to stay out at the edge of what's happening. It's not always easy. One thing I've always insisted on is the best possible software, particularly for operating systems. I **hate** it when systems crash with text in them.

Alas, it's not easy for users to understand what's going on inside the operating system. Digital Research's new CP/M documentation is greatly superior to the gibberish it used to publish, but the intricacies of the CBIOS (customized basic input/output system) can be arcane indeed and are usually well beyond me.

Fortunately, I don't have to know all these things. We've had Tony Pietsch. The good news is that Bill Godbout has put Tony to work doing software for Compupro; by the time you read this, the standard CBIOS that comes with Compupro equipment will be what I'm using now.

That carries a number of pluses. For example, you can do amazing things to reconfigure your keyboard. Terminals operate reliably at 19,200 bits per second. It's now easy to tell the system that you have a "Silicon Disk" (see apology below). I can operate 5¼-inch as well as 8-inch disk drives. Moreover, it's simple to change things around. You can do it inside the CBIOS, or you can change an external Submit program that runs automatically on start-up. Either works, and it sure makes things convenient.

The good news is that Tony's CBIOS will be standard with Compupro equipment bought through its Systems Centers. It will become the standard BIOS for all Compupro equipment, including previous stuff. Updates will be available for those who have older Compupro equipment. In addition, the company intends to set up a CBBS (computerized bulletin board system) to help distribute new BIOS ideas, but only on the understanding that this sort of thing isn't supported by Compupro itself.

Things are a bit up in the air on this; it's also possible that Workman and Associates will distribute a heavily supported version of Tony's BIOS (Workman will supply the support). Watch this column for more details. In any event, the CBIOS will come complete with source code, and you'll need Digital Research's RMAC to assemble it. Previous versions had to be assembled with Sorcim's ACT assembler.

Let This Be a Lesson to You . . .

Tony brought over the new CBIOS as soon as he's finished testing it. His machine is similar to our Golem: an 8085 Dual Processor with lots of extra memory and various other bells and whistles. He'd even borrowed my 5¼-inch disk controller and drives.

It was simple enough setting it up for the Golem, and while he was doing it he told me of some of the more interesting problems he'd run into, such as a bug in the disk-controller chip that interacted with the disk-format routines to cause real quality-assurance problems. That, however, was all fixed.

The new CBIOS worked fine. Then came the bad news: Tony couldn't put the new system into Zeke II, the Compupro Z80 I write with, because he hadn't had a Z80 to work with, and it would take a couple hours to set up and check out.

There was only one answer to that. "Be my guest," I said. After a while he got tired of me hanging over his shoulder, and I went in to watch *The A-Team*. About midnight all was well, we tested everything, and he went home.

I now had a new Systems Master Disk for Zeke II. Naturally I wanted to transfer a bunch of the programs from the old Systems Master over to it. Then I'd copy the whole works onto the old Systems Master, archive the new disk, and use the old one as the working copy. I expect you can guess what happened next.

Late at night. Tired. Through an asinine series of mistakes, I managed to reformat the *new* disk. As soon as it happened I knew, and despite a frantic stab at the Reset button I was too late. Frantic call to Tony.

He hadn't made a copy.

We shouted "Rule One!" at each other a couple of times, then laughed, although there wasn't anything very funny about it. More than two hours' work was gone, and Tony was leaving town. The result was that I had the new system on the Dual Processor, and the old one on Zeke II, and I had a week to contemplate the error of my ways.

Rule One: Thou Shalt Make A Backup Copy Immediately.

Rule Two: Thou Shalt Not Insert

The Only Master In Thy Machine Except For The Purpose Of Making A Backup Copy.

On these two rules hang all the law and the profits.

One Overdue Apology

As regular readers know, I'm enamored of disk emulators—that marvelous trick whereby you convince your computer that a lot of memory is really a disk drive. It does wonders for spelling checkers, speeds up long assemblies, and in general makes life a lot easier. Eventually, I suppose, "memory drives" will be replaced by hard disks; but at the moment they're sufficiently good that I've been able to wait while hard-disk prices fall (and hard-disk software gets better).

Comes now the apology. In tracing the story of disk emulators, I've sometimes mentioned Mr. Peter Cheesewright and his Microcosm Research company in London, but alas, I've often forgotten; worse, I've even tended to use his product name, Silicon Disk, as if it were a generic name for disk emulators.

That's less than fair. To the best of my knowledge, Mr. Cheesewright's Silicon Disk was the first disk emulator available for microcomputers. I've never used Silicon Disk (a great name, that), but I have used his Microcache, and I'm quite impressed; and people I respect tell me his Silicon Disk works quite well also.

I know better, and I'll try not to do it again. My apologies.

Ye Immortal Gods, Where Are We?

Dr. Allan Trimpi and I are working on a book. He doesn't have a word processor. I, however, wasn't about to work with Stone Age tools like typewritten pages, so I told him I'd lend him one of the computers floating about Chaos Manor.

Comes now the problem of selecting a machine. What's needed is an easy means of getting his files onto disks readable by Zeke II, since I'm pretty set in my ways. Of course, that ought to be easy.

Hah. Easy it wasn't. Nobody's machines read other people's disk formats. This situation is plain getting out of hand!

There is some hope in sight, but it's limited. A program called Uniform comes with the Kaypro II. It will let the Kaypro II read, write to, and format many single-sided 5¼-inch disk formats. However, that presents a number of problems even so.

Example: Dr. Trimpi did much of his preliminary work with the Kaypro II. Now we needed to make 8-inch disks for Zeke II to read. I asked my son Alex and his partner Barry Workman to help out. If I'd known what I was getting them into, I might not have.

Step One: the Kaypro II will read and write, but not format, 5¼-inch disks readable by the Xerox 820 (which is also Cromemco CDOS-compatible). They used Ralph, Barry's Lobo Max 80, to format some disks in Xerox 820 format. (This step is no longer needed; Uniform now allows the Kaypro II to format disks for the Xerox 820.)

Step Two: put a system track, and PIP, onto each and every one of Dr. Trimpi's data disks. Now use PIP to transfer all the files from his disks (in the left drive) to the Xerox 820-format data disk.

Step Three: put the Xerox 820 disks back in Ralph and use PIP to transfer to 8-inch IBM single-sided single-density disks. These are readable by Zeke II.

So far so good. There's worse . . .

Oh No!

We needed the Kaypro II before Dr. Trimpi was finished. However, we weren't using the Z-100, so we lent him that. Only one problem: getting his Kaypro II files onto the Z-100. That wasn't hard.

The Z-100 will transfer files from an 8-inch disk drive; just plug it into the 8-inch drive connector on the back of the Z-100.

This is easy except for one tricky point: when you boot up the Z-100, the 8-inch drives *must be connected at that time.* If they aren't—if you boot up and *then* connect the 8-inch drives—the Z-100 will *never* learn that the 8-inch drives exist even if you do Control-C until you starve.

Note well: the Z-100 will write to Compupro-formatted 8-inch double-density disks, but the results are not always good. It will *reliably* write only to single-sided single-density IBM-format (3740/1) 8-inch disks. On the other hand, it will (almost always) *read* double-sided double-density disks, Compupro format. If you want to be utterly safe, transfer your files to single-sided double-density Compupro-format disks before reading them with the Z-100. That *always* works (although, alas, *writing* to them doesn't).

Late addition: the Z-100 will reliably read and write 8-inch single-sided disks formatted by the Compupro Disk One Controller and the new Compupro Format program. You must select format 3, 8 tracks by 1024 bytes, double-density. Other double-density formats are not reliably read.

However: then we got a Kaypro 4, which has double-sided 5¼-inch disks. We decided to lend that to Dr. Trimpi. (Poor chap, he gets to check out the new machines.) Now, the Kaypro 4 will read Kaypro II disks. Just boot up as usual, and put the Kaypro II disk in the "B:" drive. All's well.

Alas, he'd done a lot of work on the Z-100. We were recalling the Z-100 for tests with a new memory board. Nothing for it but to transfer his work to the Kaypro 4.

Step One: transfer from Z-100 to 8-inch disks. Easy.

Step Two: make Xerox 820 disks on the Kaypro II using the Uniform program.

Step Three: use the Lobo Max 80 to transfer from 8-inch to the 5¼-inch Xerox 820-format disks.

Step Four: transfer from Xerox format to Kaypro II. Alternatively, you can boot up the Kaypro 4 as if it were a Kaypro II (i.e., using the Kaypro II boot disk in your Kaypro 4); this makes the Kaypro 4 believe it has only single-sided disks. Alas, the Kaypro 4 cannot read Xerox 820-format disks, or indeed any other single-sided 5¼-inch disk except the Kaypro II—and it cannot run the Uniform program unless you boot it up as a II. (Kaypro says it's fixing this Real Soon Now.)

Step Five: remove the Kaypro II-format disk from the 4; reboot the 4 as a 4; use the Kaypro II disk as a data disk and use PIP to send the files from it to a Kaypro 4 disk.

Step Six: take a long pull at the slivovitz . . .

Whimper

There are a few problems with all this. As an example, the Xerox 820 format, which is the common format through which these transfers had to be made, holds only 80K bytes per disk. Because an IBM single-sided single-density disk holds 241K bytes, it takes quite a few of these transfer operations before you're done. Alex learned a lot of patience.

There are also bugs, most of which are said to be fixed.

The original distribution of Uniform from Micro Solutions had a menu option to make a Z-100 single-sided disk (on the Kaypro II, which, recall, is a single-sided-disk machine). Alas, it didn't do that. It made disks that the Kaypro could read and write, but the Z-100 could make no sense of them at all.

This stopped direct transfer from the Z-100 to the Kaypro II. The bug is now fixed; owners of the old version can send in their original distribution disks and receive the updated version with the bug fixed. Those who received Uniform with their Kaypro II need not bother: your version doesn't even offer the option of formatting Z-100 disks. You'll have to buy the new Uniform (which has 15 formats) from Micro Solutions.

In case you're wondering why we didn't use the Z-100 to format Z-100 disks—I mean, it does seem reasonable, doesn't it?—you may be able to guess the answer. The Z-100 *cannot* format single-sided disks. It can read them. It can write to them. It just can't format them.

You may recall that the Z-100 uses disk-controller circuitry very close to that of the Compupro Dual Processor—which is identical to the IBM PC disk format. Thus, one ought to be able to read Z-100 ZDOS disks in an IBM PC, and vice versa, and indeed one can. You just can't format single-sided disks in a Z-100 (double-sided disks are no problem). There is one expensive solution: you can get an external single-sided 5¼-inch disk drive for your Z-100. Otherwise, forget the whole thing.

Tony tells me there's another solution: you can install a switch that makes the Z-100 believe one of its drives is single-sided. This is way out of my department, though, and I mention it only for completeness.

A final note, in case anyone's still listening: the Morrow Micro Decision will read and write Osborne 1 single-density disks. However, if you make one with the Lobo, although the *Osborne* will read and write to that disk, the Morrow can't. I have no explanation, and by now I'm beyond emotion; I merely report . . .

Help at Last

There is a remedy to this, at least for me. After considerable persuasion, Tony worked into his new BIOS the capability for supporting a whole raft of different 5¼-inch disk formats. All you need is a 5¼-inch disk-controller board and a 5¼-inch disk drive (plus, of course, a Compupro Dual Processor S-100 computer). You can then read, write, and format about 65 percent of all the 5¼-inch disks in existence. This includes Otrona, Kaypro, Compupro, all flavors of Osborne, and Z-100.

With Tony's new system we can painlessly read and transfer not only data files but software.

There is one problem. *With* 40-track disk drives—such as the IBM PC drives—things are *very* slow. This means you must read off the programs onto some other disk, such as a hard disk, 8-inch disk, memory disk, or, for that matter, even a different format of 5¼-inch disk, and operate them from that; otherwise, you pay a severe (factor of two) speed penalty.

It seems a small price to pay. This too will be available from Compupro about the time you read this. (I have it now, so I know it will work; the uncertainty is in getting it all into production.)

Mrs. Pournelle's Dilemma

Roberta Pournelle has had the summer off from her school and has decided to write her own book about how to teach people to read. She has, after all, been teaching incarcerated illiterate teenagers for a dozen years and has yet to find one she couldn't teach. But she thinks she can't write and *wants* me to work on the book with her. Fine, says I, only you'll have to work with a word processor.

That was all right by her.

When Roberta decided to do her book, the Epson QX-10 with Valdocs was still on my secretary's desk, and I was out of town. Valdocs was very easy at first, but sufficient problems arose to cause her to abandon it.

She wasn't about to invade my office. Query: which machine should she use?

Simple, thought I. Use Adeline, my Otrona portable.

She did. She loved it. Came the next weekend, when I was scheduled to go make speeches. I packed up Adeline. Now what? "Use Zeke," said I. But she wouldn't, for fear of breaking something and ruining our livelihood.

I showed her the Osborne Executive. There was only one problem. Adeline has WRITE, my favorite text editor, and she'd learned that; she wasn't about to learn a new text editor in midstream.

I solved the problem by setting up the Z-100, which does use WRITE, and at last count she'd finished some 30,000 words including 50 lessons. At least it's simple enough to transfer her files from the Z-100 to Zeke II. I merely have to carry the Z-100 from one end of the house to the other. Once it's physically next to Zeke, there's nothing to plugging in the 8-inch disk drives. I'm sure the exercise is good for me.

Back to Dr. Trimpi

Every now and again I get evidence to support my prejudices.

By now, Allan Trimpi, MD, has used just about every machine and text editor around. He's had a spell using Zeke II while I was out of town. He's used Select on the Kaypro II. He's used Wordstar on the Kaypro 4 and the Osborne Executive. He's used WRITE on both Adeline the Otrona and Zorro the Z-100. He's even used Spellbinder on the Eagle 1600.

He prefers WRITE, regardless of the machine it's on; enough so that we've had to go to some lengths to make that possible. Of course, he's creating text, much as I do, not programming, or doing fancy formatting; but it's one more data point. I have yet to meet a creative writer who, having given WRITE a fair chance, didn't prefer it to the text editor now in use.

Incidentally, Allan also loves the Kaypro 4, and the newer hard-disk Kaypro 10, both of which now run WRITE.

WRITE Now

Meanwhile, Tony Pietsch, who wrote WRITE more or less to specs drawn up by Larry Niven and me, has made arrangements to bundle WRITE in with some upcoming Compupro machines. By the time you read this, Compupro's "Shirley" (that was Compupro's internal code name; as of this afternoon, Bill Godbout still didn't know the official name of the machine) will come with a large array of software that includes both WRITE and Sorcim's Superwriter.

I have also seen a version of WRITE with an install program that lets it run with a fairly wide variety of terminals and printers. This will probably be distributed through Workman and Associates.

I've seen a lot of text editors. One day I'll see one I like better than WRITE; certainly I can think of features I want that WRITE doesn't have. For example, I'd like a "line" count.

That is: WRITE doesn't have "lines." It's text oriented and marks the ends of paragraphs, not lines. (I can instantly change the on-screen format from a width of as low as two characters per line to as wide as the screen.) However, I sure wish WRITE gave me a count of the number of paragraph markers. I'd also like a command to allow me to jump to a particular paragraph; as it is, I have to page my way through the text. That's easier than it sounds because WRITE *scrolls* so fast, and of course I can always use the FIND feature, but a "JUMP *x* PARAGRAPHS" command would be useful.

There are other features I'd like to see in a text editor. For example, I'd like an internal "desk calculator" and a way to embed "variables" into the text easily. Tony is keeping track of my suggestions; he swears that before I find a text editor I like better than WRITE, he'll have incorporated the new stuff.

I love it when a plan comes together . . .

More Apple Polish

We have an updated Applicard for the boys' Apple II. This one has 128K bytes of memory disk.

The Applicard, like the Microsoft Softcard, plugs into your Apple II and makes it think it's a Z80 running CP/M—indeed, while the Applicard is running, it *is* a Z80 running CP/M. Unlike the Softcard, the Applicard has on-board memory, so that your Apple becomes a full 64K-byte CP/M system.

The new card with memory disk is very easy to install and customize. It has some very nice features. Item: it reads CP/M into the Apple's memory; thus, whenever you do a Control-C, it gets that from Apple memory. The result is that you can insert disks without systems tracks and run them (after you've booted with the CP/M system master, of course).

Applicard also installs uppercase and lowercase. It supports such peripherals as a Centronics printer card, although there are no ports on the Applicard itself.

We've had only one major problem with it. If you have a serial port in your system, Applicard will find it and initialize it; but, alas, it initializes it to "Modem 7 format," which is 8 data bits, 1 stop bit, and no parity. There's no mechanism for changing that. Whether that's the problem, or something else is, we've been unable to get the Apple with Applicard and serial port to communicate with other machines.

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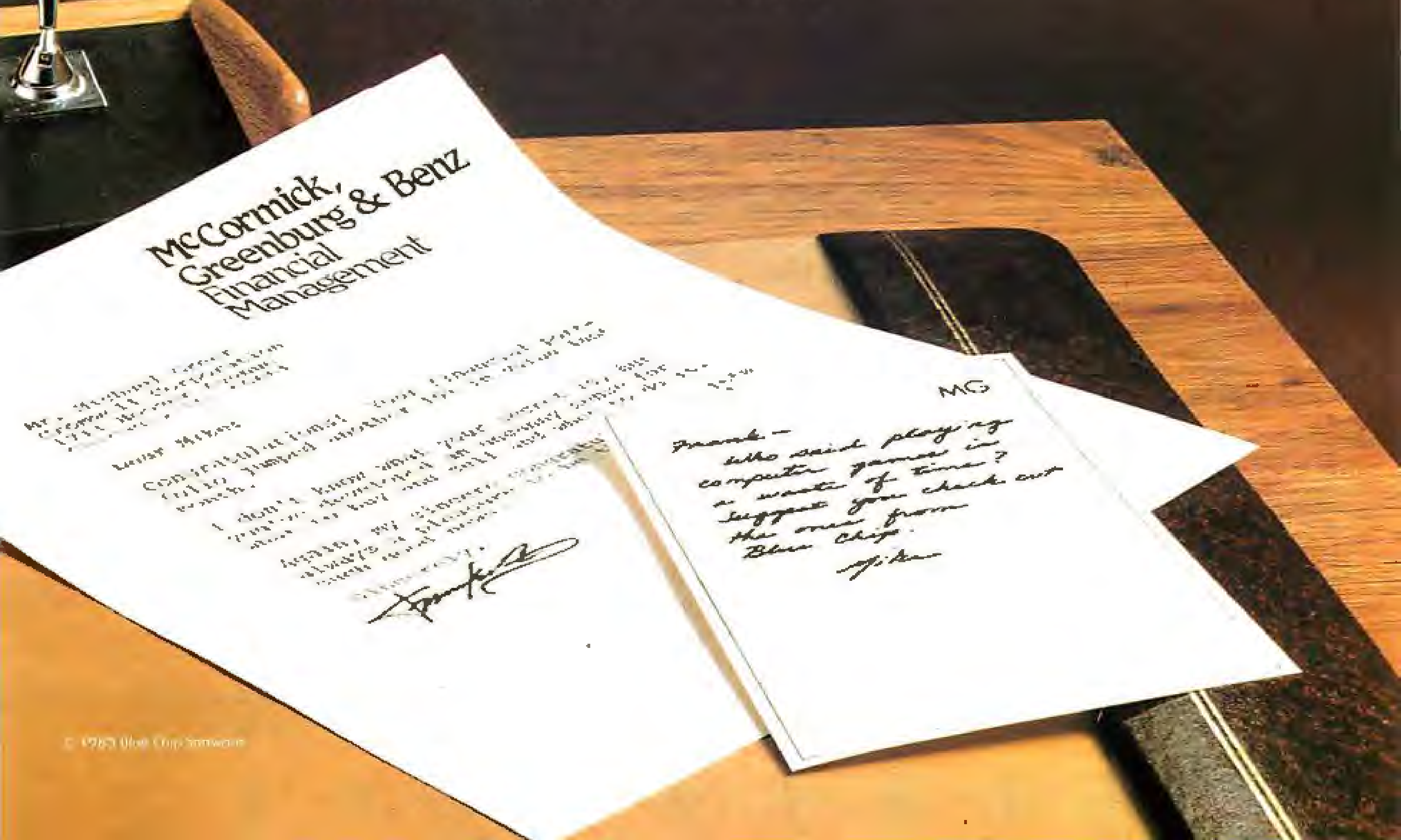


However, help is at hand. Alex has been on the phone to Winthrop Saville of Personal Computer Products (the Applicard people), and they're working on a generalized program to fix the problem. I'm supposed to get it Real Soon Now, and I'll let you know when I do.

However, I don't want to leave you with negative impressions. The new Applicard, with its memory disk, speeds up Apple CP/M something wonderful.

Unlike the Softcard, Applicard lets you operate with a full-up Apple. This is because it does most of its processing on-board, relegating the Apple to a smart terminal with a bit of extra memory. The Softcard works the Apple more heavily, and since full-up Apples are already at the edge of reliability, Apples with lots of cards plus Softcard often make strange errors. We haven't noticed those with the Applicard.

The Applicard people also make a board that will trick your Apple into thinking it's an IBM PC. I don't have one yet, but I'm looking forward to testing it.

Word Handler

The Apple II belongs to Phillip, 15, and Richard, 13. For about a year they used it only to play games. Lately, though, I notice they're using Word Handler, which they're really pleased with. They're doing their homework with the Apple now (but they're also still playing Temple of Aphsai and other games). Phil is also designing his own dungeon.

I confess I know little about Word Handler. However, I can guarantee that young computer users can learn it without help, because I've yet to tell the boys one thing about using it—and they're certainly doing their homework with it.

I'm no great fan of the Apple as a professional computer because I think you can get a lot more for your money; but as an all-around machine for learning that mysterious skill known as "computer literacy," there's a lot to be said for it. Besides, you can play Crush, Crumble, and Chomp, which is *still* my favorite computer game.

Printmates

When my mad friend first got me into the small-computer business way back in the dark ages of the seventies, the only letter-quality printer was the Diablo Daisy Wheel. Later came the NEC Spinwriter. Both were impact printers.

I still have my Diablo 1620. I also have an elderly NEC 7710. The Diablo has been to the shop two or three times and is covered by a service contract. Amazingly, the NEC 7710 has never been out of service except for about 15 minutes when the housekeeper had inadvertently thrown a switch while dusting.

In those days you simply wouldn't consider a dot-matrix printer for professional work.

That's no longer the case. True: I still think professional writers would do well to have real letter-quality printers, since their output is marginally easier to read, and anything that saves an editor's eyesight is a plus for sales; however, really good dot-matrix printers have become good enough.

Some are better than good enough. The machines from Micro Peripherals Inc. ("The Printer People") certainly are. We have two, the large Printmate 150, which usually operates with the Z-100, and the smaller Printmate 99. Both work exceptionally well. The 150 has a "Screen Dump" program for the Z-100, so that anything you can see on the screen, you can get a paper copy of. That's neat.

One important thing about dot-matrix printers is that the matrix have enough dots. Some of the really cheap printers don't, and therefore they have no true descenders. Descenders are those letters (g, j, p, q, y) that extend below the normal line of print. Some printers can't print below the line, so that the q looks a lot like the figure 9, while the j and p are simply ugly. Print without descenders is surprisingly hard to read, at least for me.

Graphics are an important advantage dot-matrix printers have over letter-quality machines like the Diablo. In theory you could, I suppose, make a daisy-wheel printer do crude graphics by programming periods and squiggles and other simplistic characters, but in fact it's very hard to do, and there's almost no commercial software to simplify the task.

Finally, dot-matrix printers allow you to change typeface and font without physically changing the type elements; it's all done under software control.

The MPI printers all have these desirable features. They also come with readable documentation, so that it's not all that hard to use the advanced features. It's also easy to get the paper in, change the ribbons, and do all the other stuff needed to make full use of the machines.

We've had ours for some time now and have experienced no difficulties. True, I haven't worked the MPI printers as hard as I have the NEC Spinwriter, because I'm still old-fashioned enough to prefer the letter-quality print output of the NEC. However, that's changing. I'm setting up the Printmate 99 to work with the Dual Processor as the primary device for program listouts and other stuff for internal use. In the next few months we'll *really* bash it about. I don't expect any trouble from it.

John Matlock of MPI tells me the company will soon come out with a small, very rugged, and very portable printer. I'm hoping it will be small and rugged enough that I can have a fitted case built for it and take it with me on trips as checked luggage. If it can survive the airport baggage smashers, it will be just what I want.

Where Do We Go From Here?

A year ago it seemed clear enough: systems based on the Intel 8086 chip would dominate the market. The 8086 would be followed by the 1-86, then the 2-86, and so forth; each upgrade would be able to run the previous chip's software.

The only real rival to the 8086 and its successors was the 68000, and it had no clear follow-on, no clear path to future development.

I still believe that the 8086 and its successors will win out, but the battle is going to take longer than I thought. The reason is that the successor chips aren't being produced in quantity. For reasons I don't quite understand, Intel took some shortcuts, resulting in 1-86 chips that ran slower than the 8086s do. That's been fixed, but the result is that 1-86 chips are in very short supply.

Meanwhile, the 68000 has arrived, and people are writing software for it. We have the Sage, running both UCSD Pascal and CP/M-68K. Modula-2, which is so far my favorite language, is available for the Sage (although only as a p-code generator; as I write this, there's still no native code compiler). I have a database and a text editor for the Sage.

The Compupro 68000 S-100-bus board is also available. This took a bit longer to deliver than anyone thought, but it's alive and well now. I've yet to do any serious comparisons between the Compupro 68000 and the Sage (this time it's not sloth; I had to run a Citizen's Advisory Council on National Space Policy meeting, and it ate more time than I thought it would); however, so far I've seen no really dramatic differences between the two machines when running CP/M-68K.

It's clear that machines based on the 68000 chip are here to stay. Moreover, a lot of software is being written in the C programming language. CP/M-68K thrives on C programs; thus, much of what's written in C for the IBM PC, and even for Z80 machines, can, with varying amounts of effort, be made to compile and run on 68000 systems.

Even so, I think the future belongs to the 8086 family.

First: the 8086 has IBM behind it. Big Blue isn't likely to go away. It's clear that IBM has a 1-86 machine already designed, and it's a good guess that the company is working on 2-86 follow-ons.

Second, Digital Research's Concurrent CP/M-86 (CCP/M) will one day catch on. This will be spurred on when Digital brings out its already-developed PC-DOS emulator—that is, a program that will let you run MS-DOS software under the CCP/M operating system. Much of that IBM PC software will be available to any 8086 computer.

Third, Logitech has an 8086 native code compiler for Modula-2. This may not seem like much, but watch: in a year there will be a flood of software for 8086 machines written in Modula-2. The language is just too good to be passed up, and Modula-2 plus CCP/M is a dynamite package, comparable in power to some really expensive minicomputer systems.

Fourth, the portability of C goes both ways: if programs written in C for the 8086 can be brought over to 68000 systems, the reverse will be true also.

Finally, the tiger teams are working on CP/M-86. The original CP/M-86 was not a lot more than a translation of CP/M-80; the result was that it sure was slow. MS-DOS wasn't a heck of a lot better. Digital's people—including some outsiders—are now getting inside CP/M-86 with a view to optimizations to use the inherent speed and efficiency of the chip. The results are likely to be dramatic.

Items Reviewed

Applicard Personal Computer Products 16776 Bernardo Center Dr. San Diego, CA 92128 (619) 485-8411	$375 $595 with 128K-byte RAM extender
CBIOS **Dual Processor** Compupro 3506 Breakwater Court Hayward, CA 94545 (415) 786-0909	standard $695
Concurrent CP/M-86 2.0 Digital Research 160 Central Ave. Pacific Grove, CA 93950 Available from dealers only	$350
Kaypro II **Kaypro 4** **Kaypro 10** Kaypro Corporation 533 Stevens Ave. Solana Beach, CA 92075 (619) 481-3424	$1595 $1995 $2795
Modula-2 Logitech 165 University Ave. Palo Alto, CA 94301 (415) 326-3885	$495
Printmate 99 **Printmate 150** Micro Peripherals Inc. 4426 South Century Dr. Salt Lake City, UT 84107 (801) 263-3081	$599 $995 and up, depending on features
S-100 Memory Board Macrotech International Corporation 20630 Lassen St. Chatsworth, CA 91311 (213) 700-1501	$2449
Silicon Disk Microcosm Research 26 Danbury St. London N1 8JU, England	Not available
Uniform Micro Solutions 125 South 4th St. De Kalb, IL 60115 (815) 756-3421	$49.95
Word Handler Silicon Valley Systems 1625 El Camino Real Belmont, CA 94002 (415) 593-4344	$59.95
WRITE Workman and Associates 112 Marion St. Pasadena, CA 91106 (213) 796-4401	$239

Help!

Every time I write about something—anything—three things happen. One, I carefully look up the names of the companies, and their addresses, and include them; BYTE's editors dutifully verify price and availability data, then list the company names and addresses in a special boxed feature that's inserted into my column.

Two, someone writes to ask how to get more information on the programs. Sometimes a lot of people do that.

Three, all these people get mad at me when I don't answer their letters. I realize that in some cases they've read a borrowed magazine and can't go look up what they want, and I feel a bit guilty; but, alas, I have neither the time nor the staff to do the job.

That's typical problem one.

Typical problem two: someone writes to ask that I analyze his particular situation and make recommendations. He's sure I can help, and no one else can. Alas, he's asking for several hours of work.

If I answer those letters, then a lot of other letters don't get answered. Either way I'm thought unfriendly. Besides, I was taught that one ought always to answer one's mail; alas, my mother never told me what to do when it became impossible.

That kind of problem causes some guilt feelings. There's another that doesn't: the form letter "requesting more information about" some product or another that I've mentioned. Unfortunately, word processors make it possible to write such letters without it being obvious that they are form letters, so I waste a certain amount of time reading them before I see what they are and pitch them in the circular file.

Then I worry: maybe it wasn't a form letter after all.

However, though I'm buried in mail, I do appreciate all the information I get, and I want to thank all those who write. I also apologize for not answering every letter I get. There's just no way I can do it. Worse, the pattern is capricious: some days I get to more mail than on others, and mail I don't get to on the day it comes in usually settles into piles that the housekeeper eventually removes on grounds of public health.

If I didn't answer your letter, it may have been because it deserved a better answer than I could give. That's an awful thing to have to say, but alas, it's all true.

Coming Up

Astute readers will by now have noticed there's little correlation between what I think I'll do "next month" and what I actually write about. However, I'm told that my new IBM PC will indeed arrive in about a week; I look forward to playing with it.

Another neat toy is Macrotech's *full-megabyte* S-100 Memory Board. Mr. McMannis, our research assistant, had this to say:

"Finally brings true memory management to the microcomputer, with on-board memory-map registers, each allocating a 4K-byte block just like the PDP-11s use. There is also a 'bank-switched' mode as well as a '24-bit' mode so it can be used on both newer and older systems."

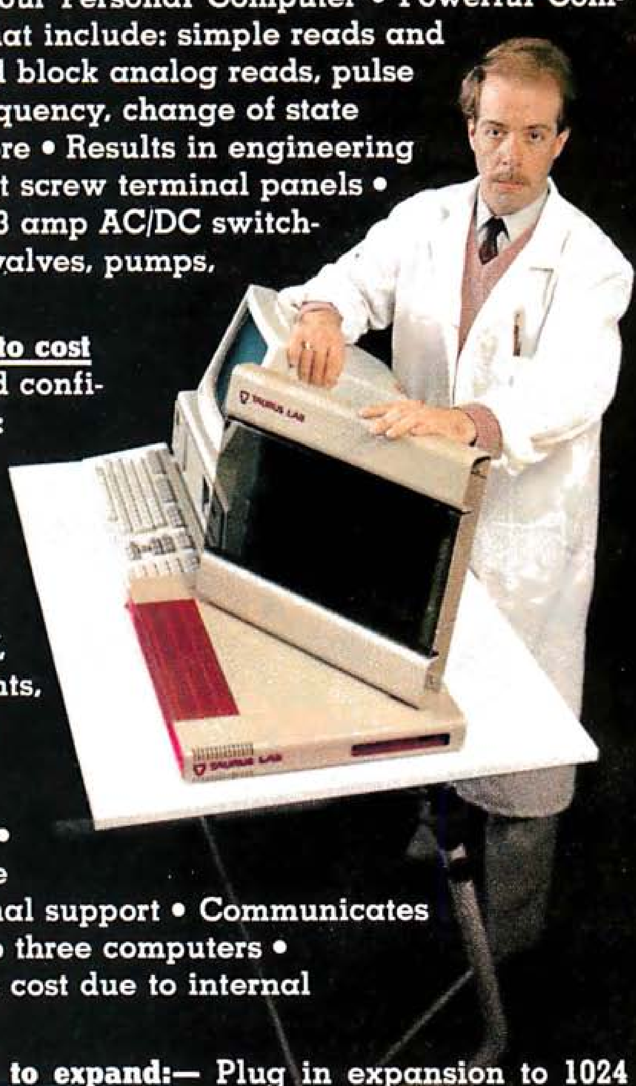
We've had Macrotech's board here far too long; it's time it got a thorough workout. It looks well made. I've a mild worry about airflow and heat dissipation. We'll see.

Other stuff I hope to look at includes Nevada Pilot, Cache/Q, Digital Research's Access Manager, and The Stiff Upper Lisp. Having learned my lesson about promises, I won't say next month; but Real Soon Now . . .■

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.

Circle 461 on inquiry card. →



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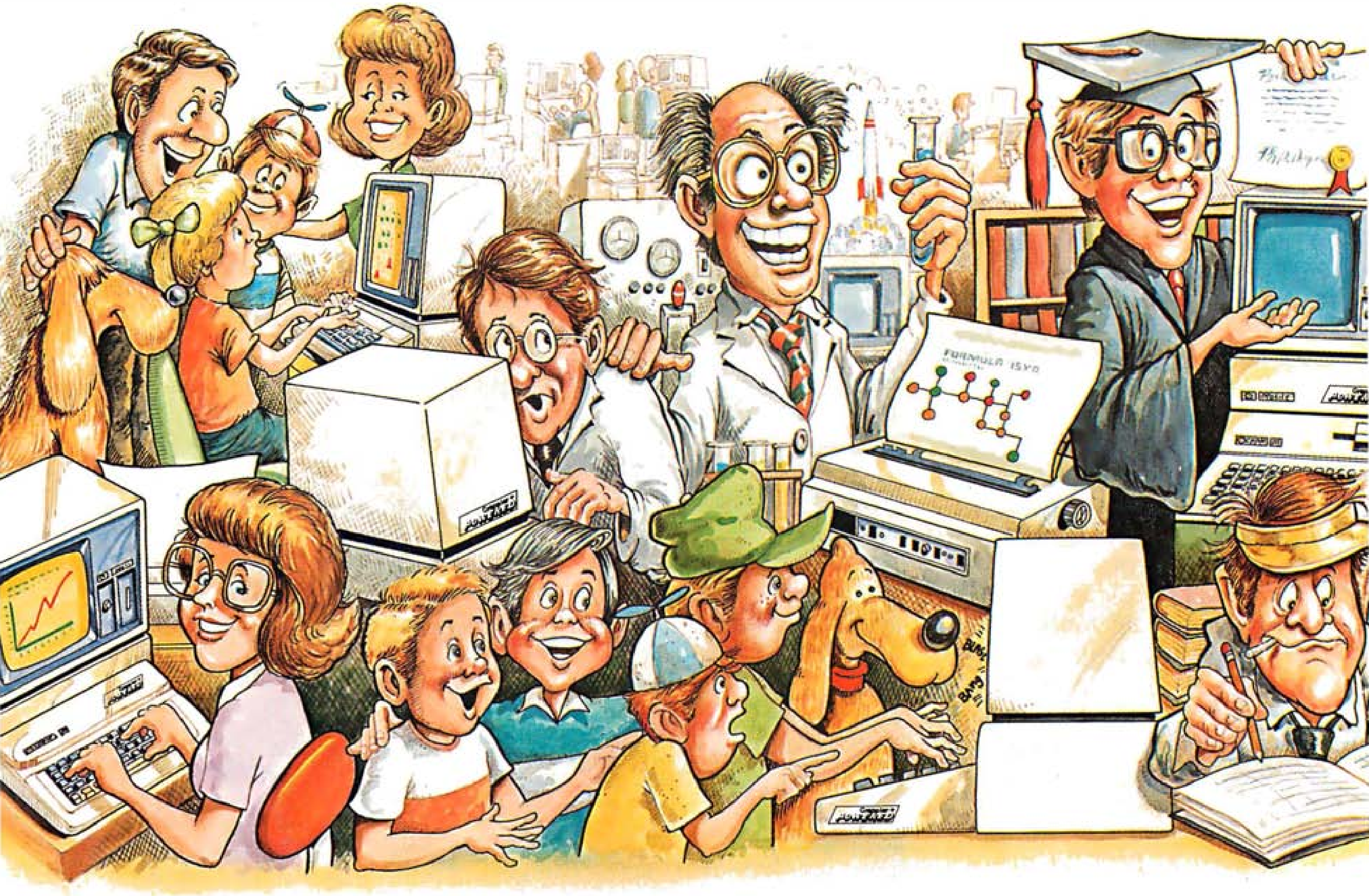

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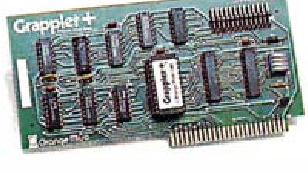

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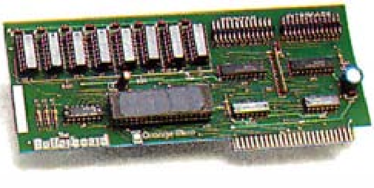

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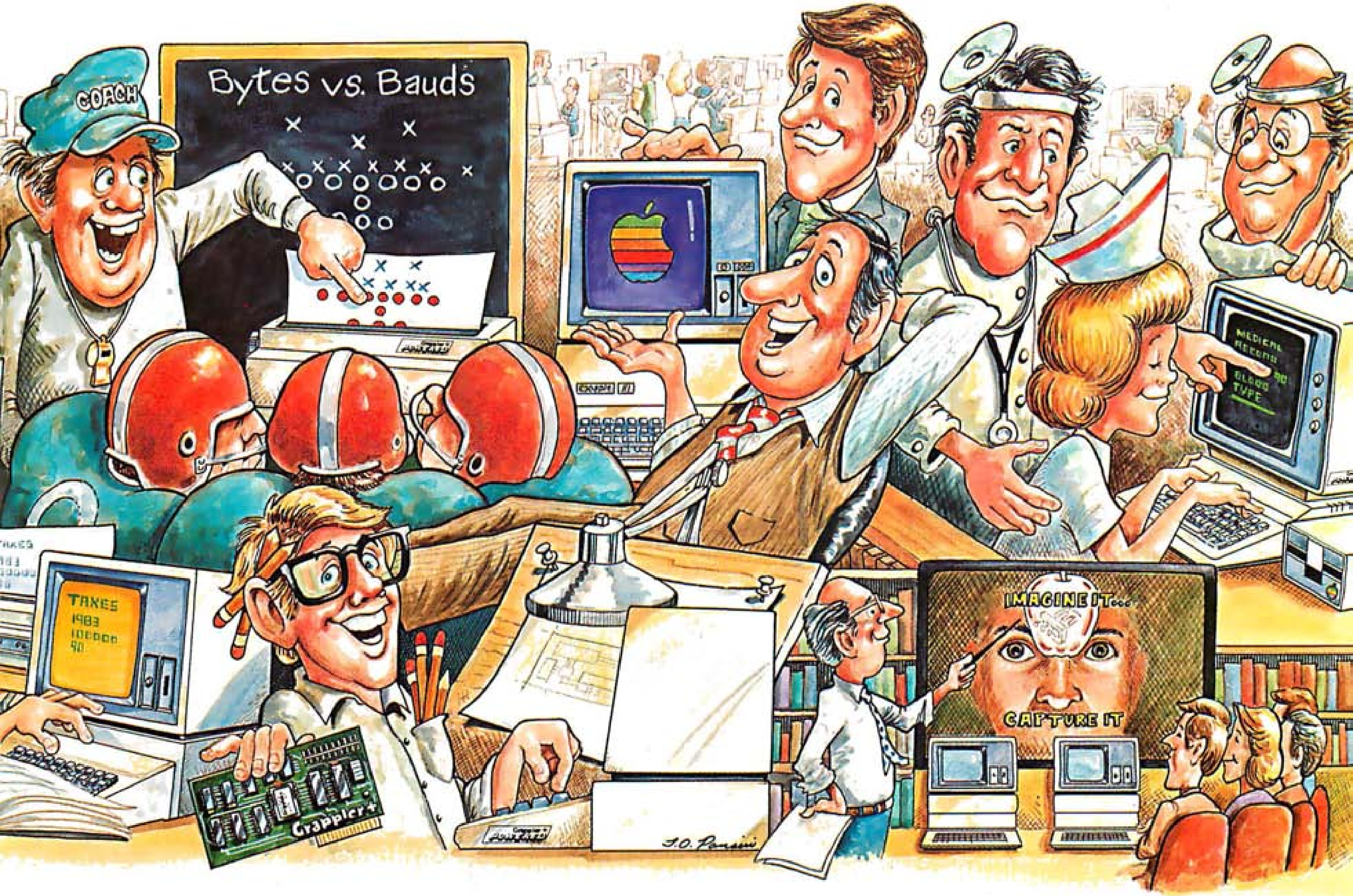

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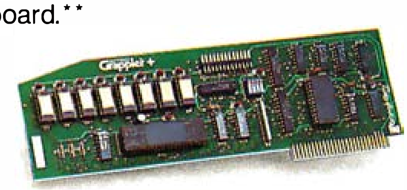

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Inside the IBM PC

In 1977, I was using a computer, the IBM 5100. The machine was so expensive that my company could hardly afford it, but there it sat on my desk. It had BASIC, APL, and a magnetic-tape cartridge, and I was the only one using it—hence, it was a personal computer. Little did I know that only six years later the world of personal computers would be so different.

The introduction of the IBM Personal Computer transformed the computer industry: it spawned the largest group of third-party vendors the microcomputer industry has ever seen, it legitimized personal computers to an entire generation of executives, and it single-handedly enabled microcomputers to assume a greater percentage of the world's computational tasks. At the same time, it can be argued that the effect of IBM's preeminent position has not been all positive. Companies jumping on the IBM bandwagon to reap some of the profits may be holding back the technological innovation that would bring us computers that are more powerful and easier to use. Nevertheless, the world of IBM PC-compatible computing remains an immense and fascinating one.

One of the most compelling things about computers is that you can change their function by changing the software that drives them. In this issue, you can explore the IBM PC through several articles on software construction. On a higher level, several theoretical articles explain what makes the PC the machine it is.

Without doubt, the PC continues to influence the microcomputer market: the fortunes of many companies ebb and flow with IBM's moves. Beginning with an interview with Philip D. Estridge, president of IBM's Entry Systems Division, we analyze the PC and its place in the market.

The amount of activity surrounding the IBM PC is evident in the number of companies providing specialized hardware and software for it. In this issue, we report on state-of-the-art work being done by Microsoft, Digital Research, 3Com, and Small World Communications.

Several general-interest articles explore the PC in other ways. We have special reports on a Japanese IBM PC, expansion boards, and some of the more interesting uses people have found for their PCs.

The IBM PC will undoubtedly continue to influence the microcomputer industry. It remains to be seen if the spread of this machine throughout the world will provide us with the best of personal computing or, less ideally, an adequate but universally accepted standard. —Gregg Williams

Painting by Robert Tinney

IBM PCs Do the Unexpected

Proving that it is indeed a personal computer, the PC performs all sorts of unusual tasks; it's even an electronic therapist

by Steven S. Ross

In one of IBM's comical commercials advertising its Personal Computer, a Charlie Chaplin look-alike stands between two conveyor belts in a bakery. As he tries to jam a big cake into a little box on one line, disaster strikes: the other conveyor belt drops cakes all over the floor.

Could it be that bakeries are actually using PCs to avoid such accidents? And what other interesting tasks are being accomplished by the ubiquitous machine? I called around to find out—to PC user groups, to my friends who own PCs, and even to IBM-computer-user bulletin boards (which never seemed to detect that it was my Kaypro II doing the talking). I even asked a class I addressed at Rensselaer Polytechnic Institute if any of the 120 technical writers assembled there had any good leads.

Well, just about everybody did.

"Funny you should ask about bakeries," said Joe Rigo of the New York City PC Users Group. (He hadn't seen IBM's bakery ad.) "*Time* magazine called and asked if I knew of a bakery that might be using a PC for inventory control, or whatever, for use in its cover story on IBM." He suggested that I talk instead to Al Goldstein, controversial publisher of a sex magazine called *Screw* and of *Gadget*, a fascinating newsletter that features mechanical, nonsexual toys for adult-age "children."

A congenial Goldstein said that his company has four PCs. "I've had one at home for five months. I haven't used it; I'm intimidated by it," he confessed. "But my 9-year-old son loves it."

The PC is replacing larger computers in many imaginative applications.

And what would Goldstein do with the PC, once he overcame his computer phobia? "I want an electronic schedule, so I can call my office and get a copy of my appointments and trip itineraries printed out at home. I want to do word processing. I want to be able to retrieve facts and articles quickly. I want to file names and addresses of friends. The office [already] does use it to keep track of airline incentive mileage for bonus trips."

Until he feels comfortable with the PC, though, he said, "I feel like I'm standing outside a bordello. I can guess at the wonders inside, but the front door is stuck."

Fortunately for the PC market, however, the door is open for many other users, wide enough to push a mainframe through. Dr. Haig Kafafian of the Washington-based Cybernetics Research Institute, for example, has been developing ways of disabled people to communicate, work, and run a household using PCs and other computers with standard hardware and software. Making use of standard equipment and programs would hold the cost of such an electronic aid to a price that many disabled people could afford.

Artists such as Paul Ravina and John Schnell of New York have programmed PCs for complex graphics tasks. The PC can be used to increase their productivity as well as their creativity. Indeed, PCs are performing many scientific, business, and educational tasks previously handled by much larger machines.

Emulating the Cray-1

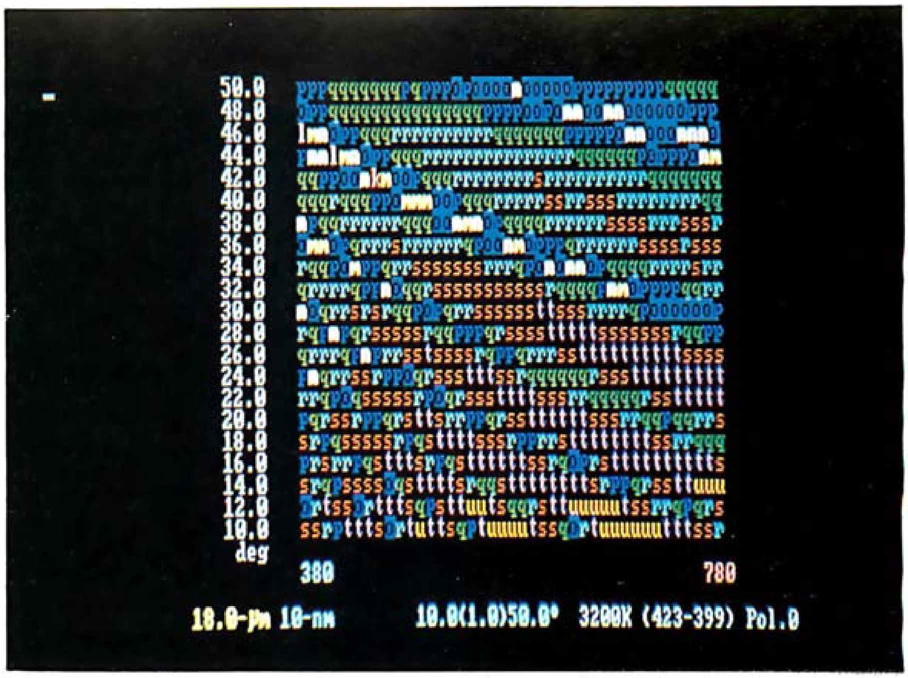
One researcher, for instance, is using the PC to study how energy is transferred from the sea to the atmosphere. "It turns out that bubbles are the most important mechanism," says Ferren MacIntyre, a physical chemist turned oceanographer and research professor with the University of Rhode Island. The number and size of bubbles in the ocean can be measured two ways—optically, by measuring the intensity and color of light reflected back from the bubbles, and acoustically, by determining how much sound energy they absorb.

"Unfortunately, the two methods give answers that vary by orders of magnitude," says MacIntyre. So, with Duncan Blanchard of the State University of New York at Albany, he set out to learn why, by examining the optical properties of bubbles.

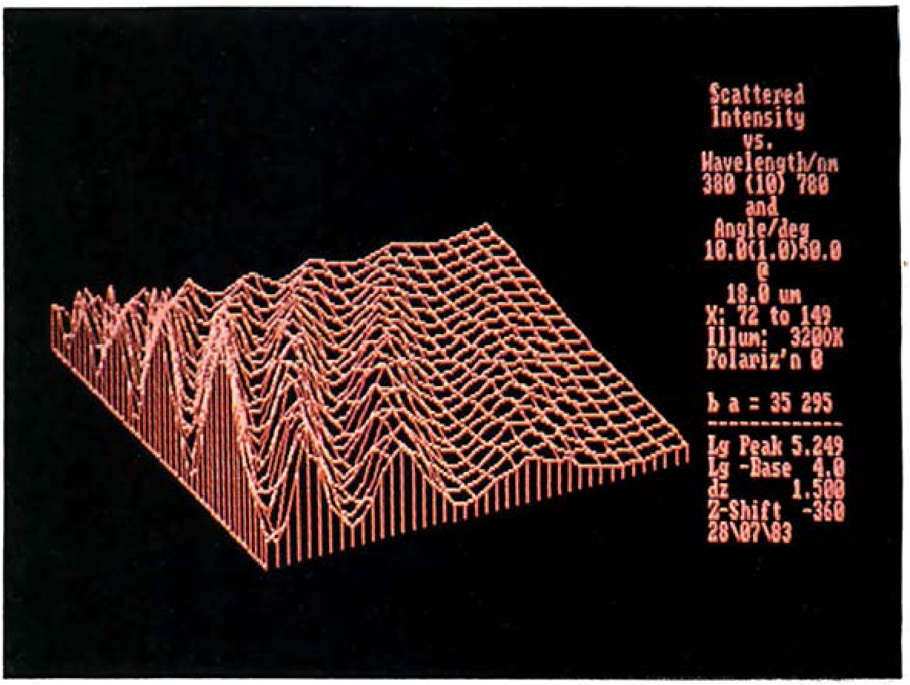
"We borrowed some programs to do the calculations from the National Center for Atmospheric Research in Boulder, Colorado, and ran them on the NCAR Cray-1 supercomputer," said MacIntyre. Using those programs, it took less than a second to perform the necessary calculations. To avoid the headaches involved in writing additional grant proposals and working with the NCAR through transcontinental phone calls from Rhode Island, MacIntyre decided to rewrite the programs to run on his PC.

He has adapted the programs to let him examine how different wavelengths of light interact with the bubbles in different ways, depending on the size of the bubble and the angle at which an observer looks at the reflection (see photo 1). The problem is solved by computing the amount of scattering separately for horizontally and vertically polarized light. Each function, in turn, is a seemingly infinite sum of series approximations made up of two terms: an angular dependence term that equals the sum or the difference of the derivatives of Legendre polynomials, involving trigonometic functions and complex fractions; and the sum or difference of two Bessel functions, each of which is a series with 20 or 30 terms that include factorials.

Because the second term does not converge properly (that is, it "blows up" to infinity once the series goes beyond a certain number), MacIntyre solves it by backward recursion—checking the size of the final function against the differences between successive terms in the function. Checking the scattering of 20 different wavelengths of light at



(1a)



(1b)

Photo 1: *Two plots showing the scattering of unpolarized light by an 18-micrometer bubble as a function of the wavelength (x-axis) and the viewing angle (y-axis). Photo 1a is a quick-and-dirty plot that represents intensity as a given color. Photo 1b, which takes longer to plot, produces a true three-dimensional contour plot.*

20 different angles for a bubble requires calculating 5000 terms—each of which is a complex fraction.

MacIntyre can perform those calculations with the software he wrote to run on his PC in MMSFORTH. He explains: "I keep hearing that FORTH is a lovely language for simple-minded work and that it's no good to do complex arithmetic. But it allows double precision, complex numbers, and large arrays. It's also 20 to 50 times faster than BASIC. FORTRAN is clumsy on micros, and I just won't use a language like Pascal that requires me to write '=:'; I just won't!"

FORTH had another allure for MacIntyre. He is friendly with a FORTH vendor. "I went to MIT with Dick Miller of Miller Microcomputer Service [which supplied MMSFORTH]. It's like having my own contract software shop. I call him up and say, 'You know, it would be great if we could do this,' and a couple of weeks later, we can."

MacIntyre has experienced one problem with FORTH, though. It is set up for four-digit hexadecimal addresses, but he needed to access more memory, so the software was modified to put his large arrays at the top of 64K. (His PC has 128K bytes, two single-sided floppy-disk drives, and two monitors—one color and the other monochrome. MMSFORTH is its own operating system and formats the floppies for about 195K bytes each instead of the "standard" 160K bytes.)

What the Cray had accomplished in well under a second, it took the PC 9½ hours to do—until MacIntyre installed an 8087 coprocessor chip last April. "Although the 8087 arrived with no software documentation and only enough hardware documentation to tell me how to stick it into the board, it took only two days to make the conversion," he said. One reason that conversion went well is that FORTH allows slow-running sections of code to be lifted out and replaced with machine-language instructions without disturbing the rest of the program.

"When I got the chip, I ran some simple benchmarks and wasn't too excited," MacIntyre said. "Addition speed was only doubled, calculations of logarithms went just 30 times faster. My real program, however, is computation-bound. By reducing memory seeks and other loop overheads, I got a 115-fold speedup." Routine computation time on the PC is now five minutes, seven seconds—a quite respectable 1000 times slower than the speedy Cray-1.

And what does MacIntyre get after five minutes? Easily interpreted color diagrams displayed on the color monitor. He has also learned that existing optical counting methods miss the small bubbles and thus account for much of the difference between optical and acoustical accounting.

Just What the Doctor Ordered

MacIntyre isn't the only one substituting BASIC with another language for use on a microcomputer. Bill Noel of Physicians Practice Management in Indianapolis says that firm has developed software compiled on COBOL for medical practices. Designed to run on an IBM PC with a minimum of 128K bytes and a 10- or 20-megabyte hard disk, the package handles billing, accounts receivable, patient records, and clinical data. Through a 1200-bps (bits per second) modem, it will even dial a central computer to transmit insurance claims automatically. Noel uses the Microsoft version of COBOL, packaged for the IBM PC and running on MS-DOS.

"We've been a timesharing vendor since 1978, but we saw our market in danger of disappearing, so we got onto the micro bandwagon," Noel said. "The PC does everything our Data General C350 does, but only for one user at a time." The firm assembled the C350 system over several years, at a cost of roughly $150,000.

Why COBOL? "When we got into the timesharing business originally, we bought a standard package written in BASIC for the mini," said Noel. "It was a nightmare. After a while, it

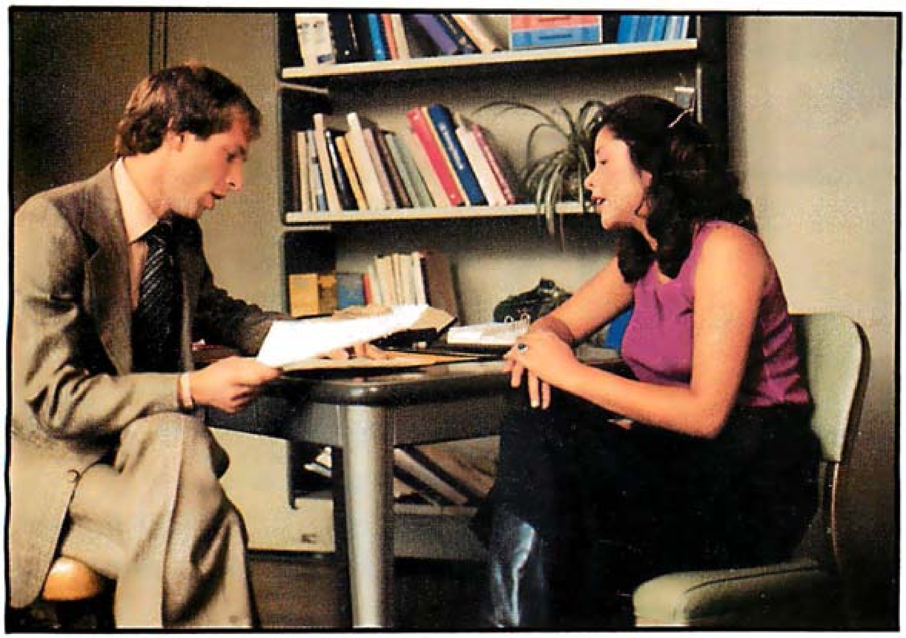


Photo 2: *Two actors play the roles of interviewer and interviewee for an instructional videotape on presenting oneself at an interview. Professor Adkins plans to transfer such videotapes to a videodisc, which will then be controlled by an IBM PC and related software.*

was completely unmaintainable. Programmers get carried away with the things they can do in BASIC, while COBOL leads them down a more structured path."

COBOL also handles large files more easily than most BASICs would. "We can search easily by fields, rather than with the hashing routines developed for floppy-disk-based systems," Noel said. "A two- or three-person practice has 10,000 or 12,000 charts a year. To be useful, the files all have to be in the same place."

And, of course, COBOL allows code that is wordy enough to be almost self-documenting. It's common to find statements using full-length data names (e.g., "Patient Name = PATIENT NAME") instead of assigning string variables with symbolic designations.

"The only problems came up when we looked for off-the-shelf packages because there are so few for COBOL on a micro," said Noel. "For example, we couldn't talk directly to the asynch port directly out of COBOL. So we got someone to write an interface in assembler for a few hundred dollars."

The firm is making the software package (actually 120 separate, linked COBOL programs totaling more than 5 megabytes) available to doctors this fall through General Electric Information Services at a cost of $5500. A properly equipped PC with a modem, a 200-cps (characters per second) printer, a hard-disk drive, and a backup tape drive costs about $15,000.

"In Indiana, we cut the turnaround time on Medicare claims from six weeks to six days," said Noel. "Internal-medicine practices or cardiopulmonary teams, which do a lot of business with Medicare, can accelerate their cash flow enough to pay for the whole thing in two or three weeks."

An Electronic Therapist?

Sam just can't control himself in an argument. Even a minor disagreement with his wife, for instance, quickly escalates into an all-out shouting match where reasoning is impossible.

Fortunately, Professor Win Adkins, founder of the Institute for Life Coping Skills at Columbia University's Teachers College in New York, has developed multimedia learning materials that can help Sam and other "underdeveloped" adults handle the stresses of everyday situations (see photo 2).

About 500,000 people in 30 states have participated in groups that view Adkins-inspired videocassettes dealing with such matters as quick tempers and overcoming the fear of changing jobs. Unlike conventional on-the-couch therapy, these materials are not meant to delve into a person's overall environment—family background, education, finances, and so forth. Instead, they emphasize changing a person's outlook and timing. The aim is to promote an alternative, a more responsible reaction to a given kind of stress.

The sessions are now offered by 300 nonprofit organizations, including community hospitals, women's counseling centers, and adult-education centers. These organizations typically commit $10,000 for the equipment and training needed to run the institute's courses. Staff salaries are extra.

"Our goal now is to use the computer to make the process more interactive, more flexible," says Adkins. "The people would see dramatic vignettes depicting some aspect of the problem they are seeking help with."

Adkins plans to link the PC to a videodisc player, so that people like Sam can view a dramatic scene, such as the beginning of a family fight. They then choose which course of action they would take under the same situation. The videodisc will immediately show the consequences in a new scene. Each choice will lead irrevocably down a path to the next choice, then the next and the next, in almost endless variety.

"I like the computer because it lets people rate their performance, too," says Adkins. "They could rate their actions against a norm and not simply an abstraction or a personal feeling. After all, what *is normal*? And we can arrange for the computer to provide many possible outcomes for a given behavior pattern, depending on the circumstances. That's just like real life. It's acceptable to people in the program because there can be more than one model of effective behavior in any situation."

Because his program lets users observe many models, it should, he says, "allay fears that technology will limit the soaring human spirit." In-

stead, the opposite is true, he says—the computer allows lessons to mimic the rich variety of everyday human experience. Furthermore, Adkins says, "We can greatly improve the efficiency of learning in this soft field of 'coping,' and, by automating the delivery, we can lower costs and improve availability."

At first, Adkins said, adults will use their computer/therapists in the home or at the sponsoring institution, while occasionally getting together in groups to explore the norms. Eventually, the machines will be sufficiently inexpensive so that the institution will have to supply only the software—most adults will already own the hardware.

"There's a big 'if' in all this, though," Adkins says. "It all has to be designed right. Human experience is complex."

Adkins doesn't expect to have a complete system up and running for another two years or so. But his successful pioneering work with videotape suggests that he will succeed with computer-accessed videodiscs as well.

Why did Adkins choose the PC? "Simple. I knew I had to get educated about computers, the same way I taught myself how to produce slides and videotape vignettes. So I went out and bought the best."

As for me, I never did find a bakery using a PC. I'm sure there's at least one, though. Bakeries, with their perishable products and their high energy consumption, have long been leaders in computerization for inventory control and energy conservation.

In fact, the very first commercial computer in Great Britain was the Leo I, designed and built by a London-area baked-goods distributor, the Lyons Organization, in the late 1940s for near-real-time daily inventory control. Leo I handled data for more than 200 bake shops yet had only a fraction of the power of an IBM PC.■

Steve Ross, a New York-based writer and consultant living temporarily in Honolulu, holds degrees in physics and journalism. He first learned to program on an IBM 1620 twenty years ago. His mailing address is 120 Irving St., Leonia, NJ 07605.

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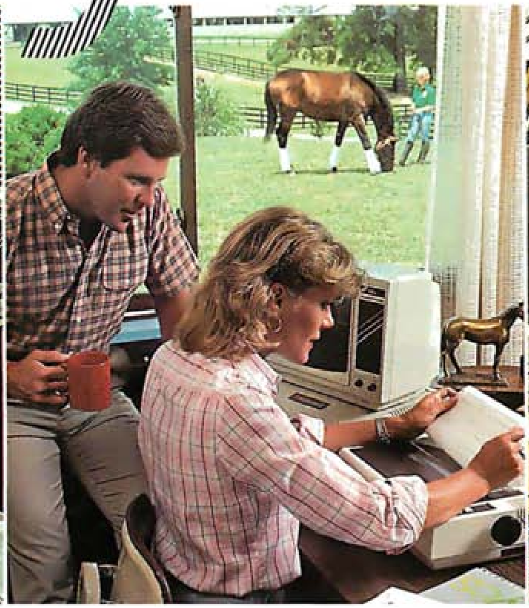
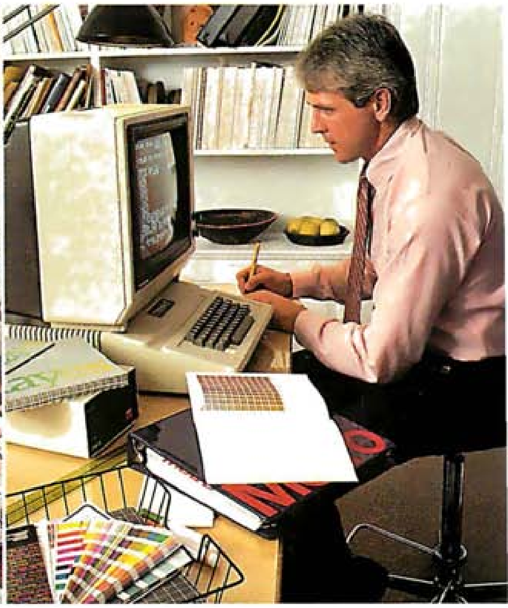


"Gary: The pedigrees for next week's auction are as follows..."



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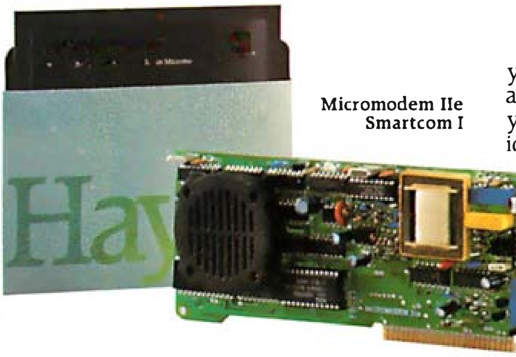

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Alphanumeric	8	8	8
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IBM's Estridge

The president of IBM's Entry Systems Division talks about standards, the PC's simplicity, and a desire not to be different

by Lawrence J. Curran and Richard S. Shuford

The desire to offer a system that would appeal to experimenters who would be able to add value easily was one of the motivations that guided designers at International Business Machines (IBM) Corporation when it undertook development of the IBM Personal Computer (PC) in 1980. Philip D. Estridge, president of the IBM Entry Systems Division in Boca Raton, Florida, explained that desire to develop what is called an "open system" to BYTE editors in a recent interview.

IBM wanted to provide a simple system that offered customers the ability to experiment with very little effort, Estridge says. He adds that the idea for a system that customers could easily apply as they saw fit had been implemented by other personal computer manufacturers.

Simplicity was a key consideration in the IBM PC design, but counterbalancing simplicity was the need for a product that had durability as well as enough capacity and power to grow. The latter considerations immediately led to the selection of a 16-bit processor, says Estridge, who notes that the Intel 8088 was a particularly fortuitous choice: "It happened to be there when we needed it to introduce the power of a 16-bit computer and keep the affordability of the 8-bit I/O [input/output] architecture." Estridge explains that the 8-bit I/O architecture makes it simple for users to add equipment to the IBM PC "without doing a lot of work or spending a lot of money" because the 8-bit interfaces are easy for hobbyists and third-party add-on manufacturers to understand.

Estridge would not discuss unit shipments or dollar sales of the IBM PC, and he would not talk about future IBM product plans or competitive products when he spoke with Richard S. Shuford, BYTE's special projects editor, and Lawrence J. Curran, editor in chief. BYTE's questions are in boldface and Estridge's answers are in lightface.

Did you consider what impact the IBM PC would make in terms of establishing standards?
When we first conceived the idea for the personal computer in 1980, we talked about IBM being in a special position to establish standards, but we decided that we didn't want to introduce standards. We tried to do everything we could to understand the existing infrastructure and propensities [in personal computers] across the board—in marketing, distribution techniques, pricing, customer alternatives, software suppliers, hardware add-on suppliers, and peripheral manufacturers. We tried to fit into what has become a very exciting, well-structured, and well-working business. We firmly believed that being different was the most incorrect thing we could do. We reached that conclusion because we thought personal computer usage would grow far beyond any bounds anybody could see back in 1980. Our judgment was that no single software supplier or single hardware add-on manufacturer could provide the totality of function that customers would want. We didn't think we were introducing standards. We were trying to discover what was there and then build a machine, a marketing strategy, and distribution plan that fit what had been pioneered and established by others in machines, software, and marketing channels.

There is a 3.9-inch disk drive in the IBM family that is not the same size as some of the more popular drives that are becoming de facto standards; is that of concern to IBM?
I can only tell you what we're doing in the personal computer group. There are many activities within IBM. Each has its own goals, and I wouldn't comment on what they're doing. But when we were developing the product in 1980 and 1981, alternative disk sizes were emerging—3½-inch, 3.9-inch, and 5¼-inch. But then you look at the tremendous number of people who manufacture the 5¼-inch media, the number who have equipment that produces the reproduced programs, and the number of customers who have the media, and you have to conclude that

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In 1979, our recreational manufacturing business was booming. And we had developed a new product that looked like a real winner. The new product was extremely important, in that it appeared to be the answer to a seasonality problem associated with our other product lines.

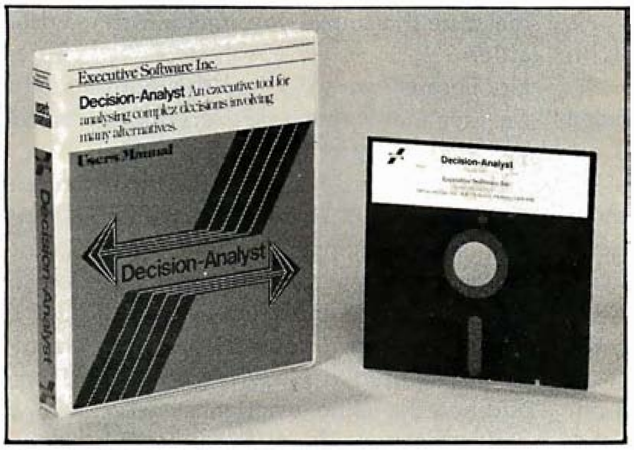
By early summer, our order book was bulging. It really looked as if our off-season sales and production problems were over. Then just as quickly the roof fell in. Gas shortages devastated the recreational vehicle market overnight. And our order book for over two *million* dollars worth of the new product disintegrated.

Faced with a fall and winter of virtually no sales, many thousands of dollars of unneeded parts and excess production staff, I had no choice but to shut down the production lines. And if a solution to our problem couldn t be found, the business itself was in jeopardy.

A life saving decision

I spent many sleepless nights trying to come up with a solution to this nightmarish situation. Then I remembered a course I had taken in decision analysis. I spent the rest of that night reviewing course material and other books I had bought on the subject. The next day, I called an emergency meeting.

Using the decision making techniques I had learned, we spent the rest of the week searching for and analysing potential solutions. The net result was that not only was the company pulled back from the brink of destruction, but we added over $1,000,000.00 in gross sales during that off-season.



A way of life

From that point on, almost every critical decision (and there were many) regarding new products, marketing channels, pricing, advertising, production equipment, engineering projects, received this same type of analysis.

Although the process was very time consuming and clumsy, because it had to be done by hand, our decisions were much improved. And there were some real benefits that we had not anticipated.

1. Our understanding of each problem was greatly increased.
2. We uncovered opportunities that we would not have thought of in any other way.
3. Our decisions were documented, preventing us from slipping off the selected path or 'rehashing' the same things over and over.
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Decision~Analyst was created because the process of evaluating complex decisions with multiple alternatives and many criteria is very tedious and time-consuming if you do it on paper. And doing it in your head is virtually impossible.

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Decision~Analyst overcomes these problems by asking for the minimum input possible from you, in the correct sequence. It leads you step by step through the decision making process, then does all the necessary calculations and produces polished reports without any further effort. And all of your input is stored on your disk so that revisions and updates can be made easily at any time.

Comprehensive but easy to use

Decision~Analyst is probably the easiest program you'll ever use. You can literally learn to operate the program using only the 'help' screens. But it comes with a thoroughly indexed manual which includes many pages of examples plus a step by step guide to the decision making process.

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developed something called the user shell interface for MS-DOS 2.0, and we don't seem to have that in IBM's 2.0. We have a command-prompt line that is much the same as it was.
PC-DOS and MS-DOS are two different products; you can buy either one.

Is IBM happy using the command-line scheme of having people type things in?
Microsoft has helped us enormously with PC-DOS, but it's our product. Microsoft has its own product. Although they are very similar—and I'm not trying to telegraph anything—I don't know how they're going to be in the future. All I can tell you is that our product works, it's fairly simple, and we're happy with it.

Are you satisfied with the language compilers and interpreters that are available for the IBM PC?
If you're talking about the ones under the IBM logo, we've had very good response, and we're pleased with everything except the FORTRAN compiler. The performance of the FORTRAN compiler is not what we think it ought to be. We've told our customers that we're trying to work on the problems. Whether or not we can do anything about them remains to be learned, although there are a tremendous number of satisfied FORTRAN compiler users.

As greater amounts of memory become more common, do you foresee that another version of a BASIC interpreter will allow easier use of all that memory than the current BASIC interpreter does?
I don't know whether we'll do that or not. It was obvious from day one that the machine had more memory than the Microsoft BASIC interpreter could use. We decided not to change the interpreter right from the beginning. I think it's been a good decision. The BASIC interpreter is essentially bug-free. To go back in and make it handle bigger address spaces would essentially mean a rewrite that would expose us to introducing error into the code. That flies in the face of the novice user's learning the BASIC language for something very simple. We traded quality for the additional capacity of the interpreter. I would make that same choice today. I think of the BASIC interpreter as an answer to a lot of things except big, complicated programs. If you need a lot of address space to solve the application, you should use languages that are designed for those kinds of problems. It doesn't bother me that BASIC handles programs that fit into only 64K bytes. We have moved the code—service routines and operating systems—out of the 64K-byte user-program space into the other address spaces so that the use of 64K is more efficient.

Are there any gaps in the lineup of software that IBM offers for the machine that make you uncomfortable?
No, because we went into this with the idea that we can't do everything. We tried to create a machine, some software offerings, and a set of business practices that made it easy for others to participate.

Are you happy with Easywriter 1.1?
Yes, I like it. People seem to like it.

Have you used it yourself?
Yes. I also tried to use Easywriter 1.0 and had the same experience everybody else had. There is almost no product [that runs] on the machine that we have produced that I haven't used.

Have you backed up the contents of a hard-disk drive? Are you satisfied with that procedure?
Let's go back to the 5¼-inch disk discussion. You can put only so many bytes on a 5¼-inch disk, and that introduces some disk handling. I don't have any other way to do it.

Do you think the industry will eventually solve the problem?
I don't know that it's a problem. When the machine first came out, people asked, "Aren't you upset that there is more memory than there is disk capacity on the machine so you can't dump your memory to disk?" The answer is no. It has never been a problem. It's a theoretical problem. If you insist that you must read the entire contents of your file when you do a backup, there will be a delay in handling disks, but people are smarter than that. They don't dump the entire contents of their file; they only dump the stuff they're really concerned about. Most applications build transaction files; they have to dump only transactions. If they take the time to recreate the file, they'd have a problem.

It's my understanding that the PC and the PC XT have recently been introduced in Europe and elsewhere overseas. Do you think that IBM will be coming out with some software packages that will be specifically for the international market?
I don't want to speculate on that.

Why did it take so long to bring out the Intel 8087 coprocessor?
We wanted it to work.

Are you saying there were troubles with it?
Sure.

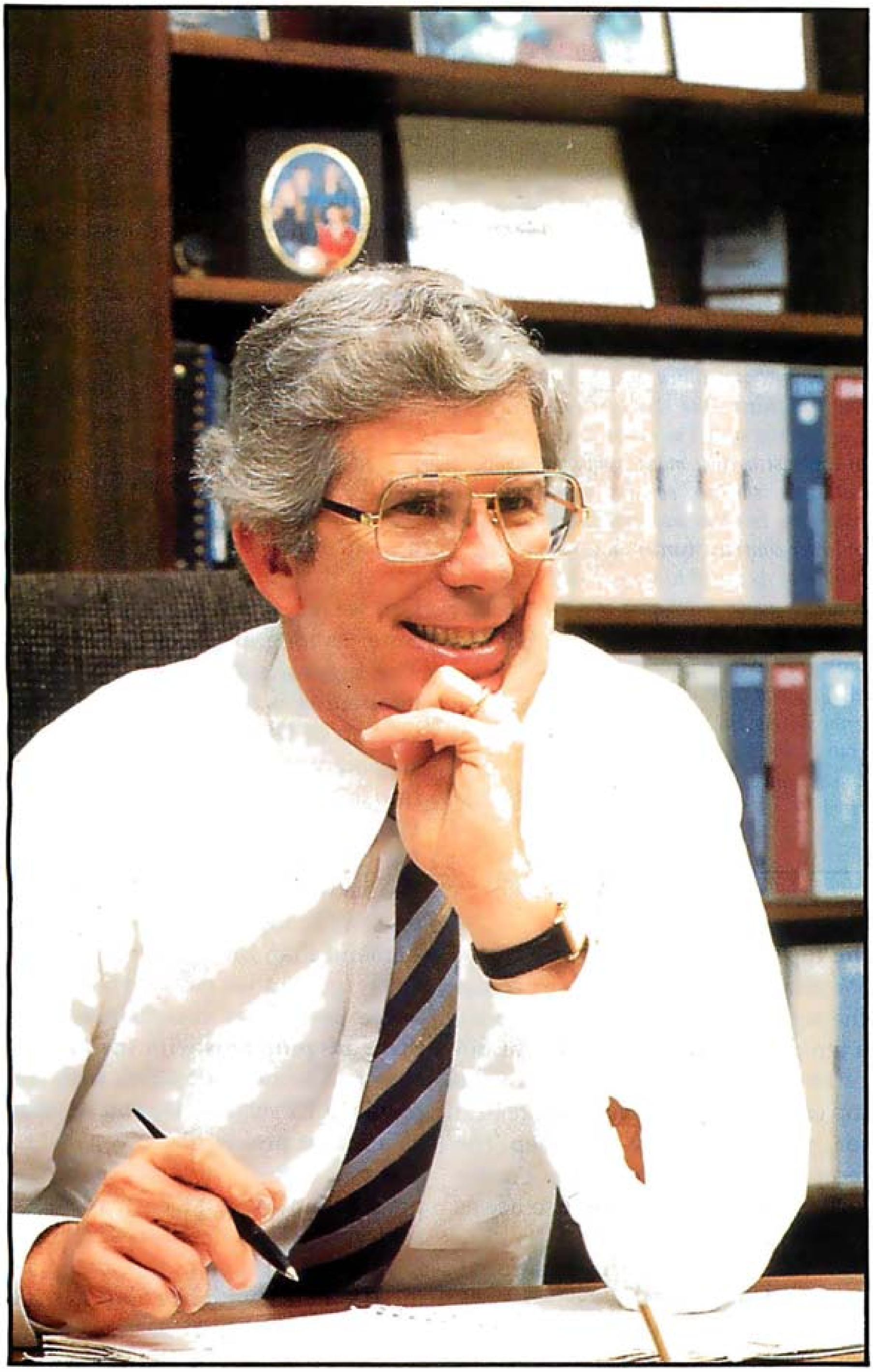
Is that why you now get a matched set of an 8088 and an 8087?
The newer 8088s have slightly different characteristics that result in better performance of the 8087 coprocessor. By shipping both processors we know the customer will get the best possible performance from the 8087.

Do you foresee the extra power that you now get with the 8087 being an extra selling point, or do you think that the casual user won't care?
I think for the casual user to feel the effects of the power of that device, some support and programming would be required to be available on the machine that are not there today. The people who are going to get it and benefit from it are the people who will write programs with the device in mind, and there are a lot of people like that, but I don't think it's the general population.

So you see that as being kind of an extra turbocharger that the drag-racing set will like?
Yes, the ones who'll need it will love it.

Sometimes IBM makes product changes that some people can't see the reasons for. Why has IBM stopped doing knock-out panels in the back of the machine?
Because they produced quality problems, and we wanted to produce a machine with no defects. They fell out during shipping and handling.

So it was a shipping annoyance?



Estridge: an eye toward experimenters.

you don't need to take on the extra burden of introducing a disruptive medium, no matter how good it is. None of the disk alternatives offered enough of an advantage to warrant that kind of disruption. [*IBM withdrew this drive from the market in September.*]

What were the software considerations that resulted from your desire to "fit in" with the PC?

Let's take BASIC as an example. IBM has an excellent BASIC—it's well received, runs fast on mainframe computers, and it's a lot more functional than microcomputer BASICs were in 1980. But the number of users was infinitesimal compared to the number of Microsoft BASIC users. Microsoft BASIC had hundreds of thousands of users around the world. How are you going to argue with that? Many who wrote about the IBM PC at the beginning said that there was nothing technologically new in this machine. That was the best news we could have had; we actually had done what we had set out to do.

Did you try to discipline yourselves not to stretch the state of the art with the PC?

Yes. For example, you can handle a higher-performance I/O device with a 16-bit I/O channel than you can with an 8-bit I/O channel. Having an 8-bit I/O channel inherently limits the performance of the main processor because you have to move twice as many bits per operation. But that was a trade-off we chose to make to fit into what was already there. It wasn't too difficult a trade-off to make because there were no programs—and there are still few—that demand a higher performance processor than most that are out there.

Do you have a profile of your typical customer or user?

I don't think we have a typical user because the machine is so communal that typical doesn't have meaning, except for the fact that more and more people are discovering that they have needs that can be answered rather nicely by a personal computer. And they are in all walks of life—all the way from very young children to very elderly people—in every profession.

Is there a typical minimum configuration emerging?

I don't know. We've forced that answer somewhat because we build the machines that are most frequently ordered. We build four or five configured systems to make it easy for the dealer to put the systems together so that the work is done partly by us and partly by the dealer. We know that there are a lot of people building complete machines starting with a very rudimentary form of our product.

You say that you don't have a typical user, but is there a set of typical user characteristics that you have to deal with? For instance, do you find people who don't want to type on the machine because of the keyboard?

Yes, we find those reactions, but not quite the way you said it.

Human Factors in the IBM PC

The placement of certain keys in the keyboard of the IBM PC has been widely criticized, but Philip D. Estridge cites prior IBM experience in building typewriters as being helpful in designing the PC keyboard. He points out further that various human-factors considerations are reflected in the overall PC design that he says make the machine comfortable to use.

The keyboard can be tilted, for example, to assume a flat-surface angle or a tilted-up angle. Estridge says both are standard angles that make users feel comfortable. "We don't know why people feel comfortable with one of those two angles," Estridge says, "but we've learned from building typewriters that these are the two popular angles for wrists."

He also cites studies of eye-pupil dilation that influenced the PC's design. He says these studies have shown that there's a direct relationship between pupil dilation and fatigue; the more a user's pupil dilates, the more fatigued he may become.

"If you can cut down on contrast changes as people use the equipment, you reduce the likelihood of frequent pupil dilation."

How has that principle been applied to the IBM PC? Estridge explains it this way: "Imagine that the center of the machine is a high-contrast area and the outside of the machine—the background—is a low-contrast area. The machine has grades of contrast as you move from the screen outward. Its highest contrast is on the display tube. Immediately around the tube is a lower-contrast border, and then the cabinet curls round to form an even lower-contrast frame.

"The eye then progresses from seeing dark gray to light gray to medium white, and, beyond that, essentially a noise background. As the eye moves across those boundaries, it doesn't experience much contrast change, and the viewer doesn't get tired."

Some people are upset about the placement of the left-hand Shift key and the Return key.

I wasn't thrilled with the placement of those keys, either. But every place you pick to put them is not a good place for somebody, and it's a large enough group of somebodies so that there's no consensus. The left-hand Shift key is located where it is because we wanted to have the character-typing keys inside the control keys. That means that the arrangement with the one extra key, instead of being the Shift key with the character on the outside, is just the reverse. I have since gone back and looked at a lot of keyboards and found that a lot of them are just like ours—with one more key on the bottom. They may not have the same character in that position, but there is one more key along the bottom. It's not much of a problem in the long run. Fortunately, people adjust; in fact, if we were to change it now we would be in hot water.

Why are the function keys in two rows on the left rather than across the top?

We didn't want to put them across the top because we wanted to have a template there in case some applications needed a template across the top of the keyboard. That's the reason for that little ridge—to keep the template from falling down on the keys. The ridge is also there to use as a book prop.

Did you look at the international keyboard standards?

That's what's on the board; that's why there are symbols on the keys.

Is there anything different that you would do to the keyboard now that it's been out a while?

No. I'm not saying we would never come out with another keyboard that's different, but I don't have any regrets about the keyboard.

Are you familiar with the mice that are creeping around in the world?

Yes. That's a perfect example of the kind of experimentation that you would expect to go on.

Have you ever used a mouse?

Yes.

Do you like it?

It was just another way to do things. It didn't strike me one way or another.

Are you comfortable with the keyboard?

Yes. More than two million personal computers [from all suppliers] were shipped in the United States last year. Predictions for the future are more grandiose. They must not be very hard to use. When you look at the age levels of people using the machine—both the very young and the very old— and when you look at the backgrounds of the individuals, you have to conclude that the computers must be pretty darn easy to use, or else you would never have gotten that far.

Can we talk about specific software?

Sure, as long as it's ours.

The biggest software change that's happening is the upgrade to the 2.0 version of DOS; are there delays in shipment of the product?

Initially, yes.

Why is there a delay?

We guessed wrong on how many people would order the PC from day one. We thought there would be less demand than there is, so we had to catch up, and we passed that point.

Some people are complaining that there are problems with the 2.0 version and incompatibilities with the previous 1.1 version. Do you see that as a major problem?

There are some differences in the products, most notably in memory utilization. The 2.0 product is larger. If you had a program that barely fit in 64K bytes with version 1.1, it's almost certain that it doesn't fit if you move the program to 2.0. We haven't heard any significant unhappiness with customers or with the software suppliers, and that level of incompatibility is one that's understandable as you enrich your product.

Will IBM sell 1.1 indefinitely?

I won't speculate about our plans, but it's not a good idea to mistreat customers. We will do what our customers need us to do. If that means keeping 1.1, we will do it. If all the customers move to 2.0, it will be uneconomical to keep 1.1, but I don't know which way it will go.

We understand that Microsoft had

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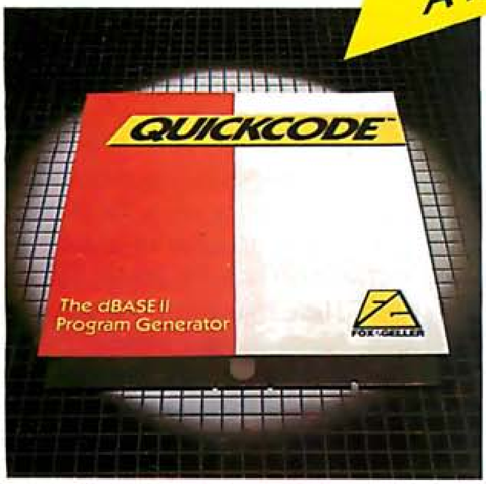

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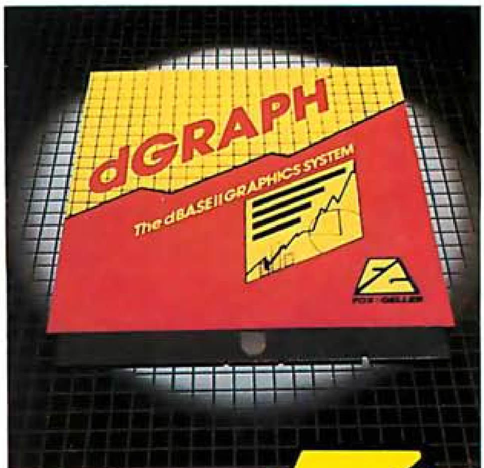

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A defect is a defect—it doesn't matter if it's a corner crushing on the cardboard box you ship it in or the machine not functioning at all. It's exactly the same for all defects. And when you start out with that mentality, if you have a defect, you ask not only how to fix it but also what is the source of this problem, and how do we eliminate the source? In that particular situation we eliminated it by not having it. We couldn't sense that there were a lot of people who needed it.

Back to the design of the case. Did you consider trying to go for a smaller footprint for the machine, possibly by trying things like stacking the motherboard on top of the disk drive?

It was the smallest footprint we could figure out. We wanted to have the machine work in a wide range of environments: heat, temperature, humidity, and electrical interference. When you start considering all this, you can't make it as small as you would physically make it because of the electrical characteristics. We have what we think is a balance. The more closely you put it together, the more difficult it is for somebody to add something to it; you get hard-to-manage mechanical assemblies. That makes putting it together and taking it apart hard and error-prone, or you create fittings that are not generally available, so other people can't get the equipment they need to build an add-on piece of hardware.

You've talked a lot about designing the machine to make it easy for people to use—to experiment with the machine, to add to it. Were you thinking more of dealers than experimenters or hobbyists?

First, we knew that dealers would have to provide warranty service. We tried to design the machine mechanically and electrically so that it was simple to understand and work with. We chose electronic components so that there would be commonly available parts, with the serviceman at the bench in the store in mind. Our goal was to make the machine as easy for him to use as for a customer, because he's a customer too. If we burden him with high-technology complexities—tools and equipment that are unfamiliar, hard to get, or expensive, parts that are in limited supply or available only from IBM—these things would make the machine difficult to service.

The new IBM color monitor is certainly appreciated, but are you satisfied with the display quality you get with the color display adapter?

Yes. I think it's a good balance between price and function.

Did you consider making a special color monitor that used higher frequencies?

Yes, but then you have to buy more memory that fits on the color adapter card. It raises the price. We think the granularity, number of colors, and number of memory bits on the card strike a good balance between definition, function, and price.

Do you think we will be seeing more applications that use graphics—that graphics will be a dominant segment

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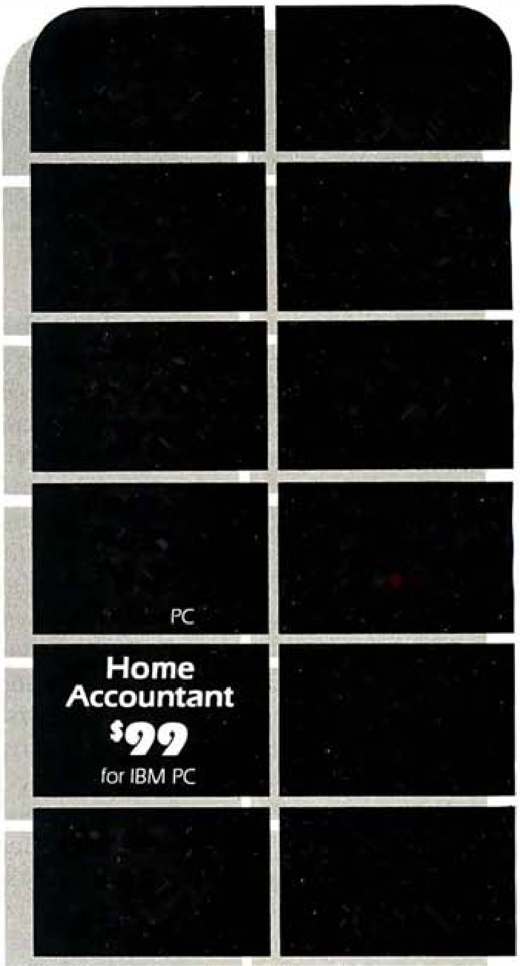

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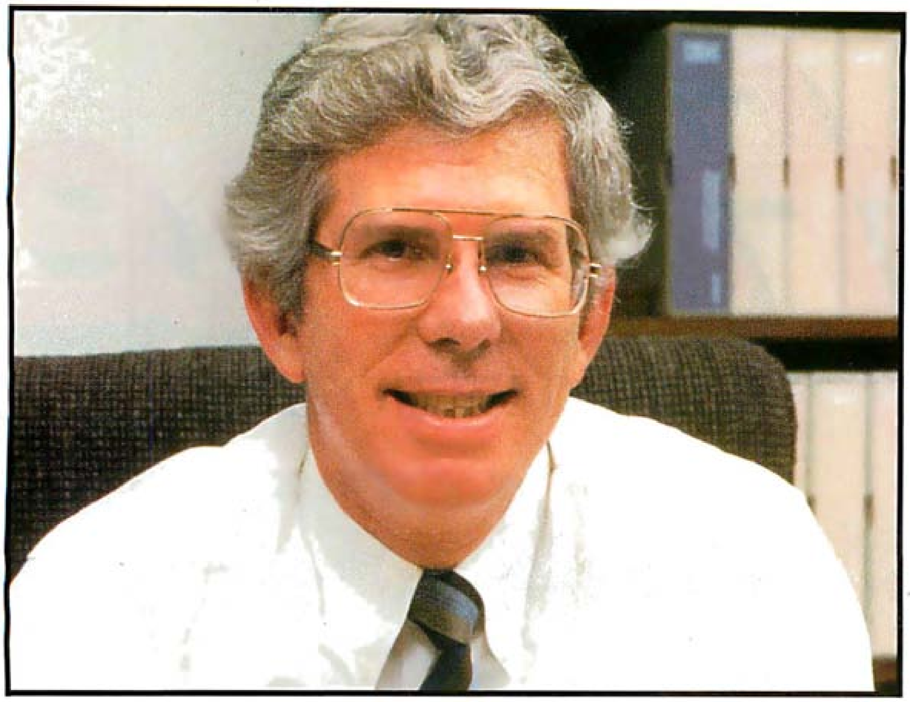

Theft is a threat to software development.

of the market?
Yes. I think the old saying that a picture is worth a thousand words is true.
Do you see color as a practical tool now in business graphics, or simply a nice feature to have?
I think that color is going to change over the next short period—maybe a couple of years— from being something we think about as an interesting curiosity to something we won't know how to get along without. It will be that dramatic a change. Look at color TV. You're using more senses, and it's probably well proven that the more senses you involve, the more likely you'll get the message through. If you don't think color is important, turn it off the next time you watch a football game and see how you like it. It's a feature that is going to quickly find use in all applications, not just in business.
Were you disappointed that so many users were not getting the color display adapter for a while?
I wouldn't say that so many were not getting it.
There was a study that said 90 percent of the people were using just the monochrome display.
I'm not going to comment on somebody else's study. I know how many are buying it.
Most IBM software seems to allow users to make a limited number of copies. Do you have any thoughts about copy protection?
Do I ever. It's wrong to copy-protect programs. The only reason anybody does it is because there are thieves who steal your product. That's wrong, too. There ought to be some way to stop that without creating products that are unusable.
What do you think of having serial numbers in the hardware match to the software?
None of those techniques work. There is no one who has a technique for protecting against copying code that works in all environments—hard disks, communications, local-area networks, single-user, easy-to-use, or hard-to-use. I guarantee that whatever scheme you come up with will take less time to break than to think of it. I think theft is also a threat to software development. It's going to dry up the software. It's incredibly difficult to write software, and people are going to stop doing it if they can't get a legitimate return for their efforts.
Are you satisfied with the market success of operating systems other than PC-DOS—CP/M-86 and the UCSD Pascal p-System?
We came out with three operating systems because we couldn't figure out where the propensity would be; we wanted customers to decide that.
Why were CP/M-86 and UCSD Pascal so much more expensive than PC-DOS?
You'd have to talk to Softech Microsystems, which did the research.
Was the price determined by Softech Microsystems' licensing agreements with you?
Yes.
What do you think about Digital Research's recent moves to cut the price?
You'd have to talk to them.
Have you looked at any of the up-and-coming languages, such as Logo?
We've announced Logo for our machine, to be available in the fourth quarter.
Do you think that's a good package?
I think it's terrific. What we have on our machine is really dazzling. It's been a lot of fun to experiment while we were developing it. I don't know how to project its popularity, but I've had a lot of fun with it.
Why did you decide to put Logo on the machine?
Because people in the education industry said they needed it.
Have you used it yourself?
I use everything we're producing.
Do you have a machine in your office and at home?
Yes, to both. I prepare letters at home. I have some bookkeeping information. We have a few investments that I like to pretend I can manage. I play games. I use it as a way to see every package we're developing and planning to introduce.
Do you use non-IBM software?
All the time.
Do you care to say which?
No, but I get my hands on as much of it as I can and see what it looks like.
Do you think other people are developing good software?
Absolutely. They sure are.
Are you pleased that a certain subculture is growing up around your machine?
I love it. I think we're in an era in which the public has adopted personal computing in the same way it

adopted the automobile. People want to know everything they can about it. That era will probably pass, but that curiosity is almost sensational right now, and I think it's good.

Can we expect to see the same kind of shakeout that happened in automobiles?

Logic tells you that it has to happen. But logic also predicted the industry wouldn't sell one and a half million personal computers until 1985, and the industry surpassed that last year. So who knows what's going to happen?

Has IBM been surprised at the success of the PC?

I think the world's been surprised by the success, but not just about the IBM machine; I'm talking about personal computing as a phenomenon. All the industry reports you could find in 1980 projected one and a half million in unit sales [of personal computers] in 1985. You could have called Future Computing or Dataquest or anyone else and they would have told you much the same thing. We don't have a crystal ball that is better calibrated than anybody else's.

It seems that you have the same problem—forecasting—that most people have in this explosive market; it's an imprecise art.

It's not that you can't predict what will happen in those areas that you understand. The problem lies in the very thing that makes this product family popular—its application to completely unknown uses. That's exciting, but it's also the very thing that makes the business totally unpredictable. [See "The Perils of Forecasting."]

Are customers for larger IBM computers moving to buy PCs as well?

They're doing it in great numbers.

Will that fundamentally change anything in your relationship with those customers?

I think we're providing them with the solution that they want, and that's what they expect of IBM, so I don't think that's a fundamental change.

Is the existence of so many distributed personal computers going to change data processing as we know it?

No, but I think it will involve a lot of people who aren't now involved.

Can you characterize sales of the personal computer through different distribution channels?

I could, but I don't want to. That information is important to us in running our business, but not important to anyone else.

We have heard that some IBM direct-sales people inadvertently have undercut a dealer's price.

I think you could hear the other side just as easily. For every story you can tell me about a dealer feeling that he lost a sale to an IBM direct salesman, I can tell you about a salesman who thinks he lost a sale to a dealer, so we probably have it about right. I think there's another phenomenon that's new in this equation, and it may be particularly unique to IBM personal computers. Every other IBM product prior to the personal computer was available only through IBM salesmen. IBM customers were never faced with the question of support versus product because they both came via the same organization. Now the customer can distinguish support of the product. That's an adjustment that all of the distribution channels are going through. The customer now has to participate in a two-step decision: determining what product he wants and from whom to buy it.

We wouldn't be doing our jobs if we didn't ask about a "Peanut" machine or any extension to this product line.

Call the *Wall Street Journal*. They're the only ones I know of who have written about the Peanut.

How about "Popcorn?"

They've written about that, too. I think it's fascinating that they decided to get into product design.

Did they seem well informed?

I have no idea.

Well, we had to try.

Estridge finally alluded to the inevitability of follow-up products in summing up his thoughts about the IBM PC. He characterizes the PC as having enough horsepower and capacity to have a long life cycle: "It's an affordable product, there's a lot of software for it, it's easy to use, and it can be extended. I'm comfortable that it will be around for a long time, and it will probably be extended. It would be silly not to follow it up. More important, I think customers expect IBM to follow it up." ■

Lawrence J. Curran is BYTE's editor in chief. Richard S. Shuford is special projects editor.

The Perils of Forecasting

IBM's Estridge explains how his division's forecasting procedure works in the following manner.

Each quarter, IBM asks everyone who is selling the PC, including IBM's direct sales force and dealers, for a projection of purchases for two periods: the next quarter and the three quarters following it. In October 1982, for example, the division asked customers how many systems they expected to buy for the period from January through March, 1983. "We're kind of asking for a commitment," Estridge says of the process, "although no contractual penalty is attached to it."

Then IBM asked these customers what they expect to buy for March through December, 1983. "We do that every single quarter by product. It's pretty boring, but we do it with all the people who sell our products," Estridge says.

When customers returned in January of this year, ostensibly to talk about their system needs for April 1983 and beyond, they wanted to talk about January through March all over again. They doubled their orders for that first quarter. "They told us that they'd given us the wrong numbers, and the numbers were low by a factor of two since October 1982," Estridge says.

"Then the same darn thing happened again in March, when we were supposed to be talking about July through September. We can only handle so many factors of two," Estridge says. "We've upped our production rate three times this year; production is very high. We're extremely pleased that we can build a quality product at that rate, but it's not enough. The demand is increasing at a very fast rate, and we're doing everything we can to stay with that demand. But if the demand keeps on going at these rates," Estridge warns, "at some point there won't be any more parts. We're not there yet, but we can see where it is from here."

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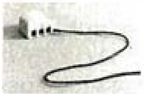

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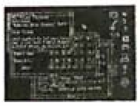

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Enhancing Screen Displays for the IBM PC

This program takes full advantage of the PC's color and monochrome monitors

by Tim Field

You can purchase the IBM Personal Computer (PC) with either a monochrome or a color display, or you can use both monitors on one system. This article briefly compares the features of both displays and demonstrates how you can use a program called Screen to take full advantage of both monitors' capabilities and simultaneously adapt them to your own needs. This set of easy-to-use enhancements is implemented as a short resident routine that is transparent to applications programs and the DOS (disk operating system).

The two displays offered with the IBM PC and the new PC XT can be used in any of three configurations. A system can, for example, be outfitted with the IBM monochrome monitor that provides green characters on a black background with excellent resolution. Or you can choose the IBM color monitor adapter that provides color and graphics capabilities; its characters, however, aren't as well defined as those on the monochrome display. The most advantageous configuration, though, is to set up both monitors on one system, making each available for a wide range of needs. Regardless of which arrangement you choose, comfort should be a major factor in your decision because prolonged use of a difficult-to-read display can cause such problems as eyestrain and irritability.

Both displays are limited in terms of user friendliness. Systems set up with the color monitor would be more useful if operators could easily change the foreground and background colors for text display. The inability to change colors limits the user to black-and-white text combinations or the whim of the programmers who designed a particular applications program. The ability to change colors, on the other hand, provides welcome variety and can relieve the eyestrain that often results from extended use.

Such flexibility would also enable you to adjust the color scheme to the display's environment. A soft scheme, such as yellow on black, would be easy to read at night, whereas a bright setup, such as white on blue, would be pleasant for a sunlit room. Changing the screen's colors also makes it possible to enjoy a three-color display for applications programs that take advantage of the PC's highlighting capabilities.

Using the monochrome monitor for reference, you can create graphics on the color display.

A choice of display schemes for the monochrome display—the standard video combination of green characters on a black background and reverse video, black characters on green, affords the same advantages as those offered by the color monitor—reduced eyestrain, the ability to match the display to the operating environment, and the opportunity to work with personal preferences.

A system that incorporates both color and monochrome monitors could allow you to alternate between two display types, thus doubling the flexibility you have using individual monitors. For example, you could edit a program using the monochrome display and then switch to the color display for graphics output. Or you could take advantage of a type of dual-windowing capability, setting up one screen to display text or graphics and switching to the other to perform another task, referring to the contents of the first screen for guidance.

The Screen program presented here makes the PC's displays easier to use for both textual and graphics applications by supplying these enhanced capabilities. Indeed, PC-DOS 2.0 does provide limited capability to switch from a monochrome to a color monitor using the MODE command; however, it requires that the computer be under direct DOS control to make the switch. This means any applications program you might be running must be terminated to take advantage of this capability. Using Screen, however, you can switch monitors at almost any time, even while the PC is running an applications program. Another advantage is that it's easy to use—you don't need technical expertise to enhance the displays' operations.

FUNCTIONS	KEYS
INCREMENT *FOREGROUND* COLOR*. (ALTERNATE BETWEEN STANDARD AND REVERSE VIDEO ON MONOCHROME MONITOR.)	ALT F1
INCREMENT *BACKGROUND* COLOR*. (ALTERNATE BETWEEN STANDARD AND REVERSE VIDEO ON MONOCHROME MONITOR.)	ALT F3
ALTERNATE BETWEEN 40- AND 80-COLUMN MODE. (VALID FOR COLOR ADAPTER ONLY.)	ALT F5
SWITCH BETWEEN COLOR AND MONOCHROME MONITORS.	ALT F7
REPAINT THE SCREEN WITH CURRENT ATTRIBUTES.	ALT F9

NOTE: THE COLOR SEQUENCE IS AS FOLLOWS: BLACK, BLUE, GREEN, CYAN, RED, MAGENTA, YELLOW, WHITE, BLACK, ETC.

Figure 1: *Implement one of Screen's five functions by pressing the Alt key and the key assigned to the display change you want to make.*

Design Goals

My initial design goals for Screen included specific criteria. First, the program must be easy to use, providing its functions at virtually any time, without requiring the user to load and run a special program to execute every function. Second, the enhancements must not interfere with the normal workings of the PC; that is, Screen should not obstruct the computer's operation.

The program provided in listing 1 attains these goals. When you first run Screen, it sets itself up to work as though it were an internal part of the DOS. It works automatically with most applications programs that use standard DOS and BIOS (basic input/output system) screen and keyboard device handlers.

You initiate the program by merely running it once after you power up the PC or execute a system reset. (You can also set up an AUTOEXEC.BAT file to automatically invoke Screen on system start-up. Consult the section on batch files in the DOS manual.) When first executed, Screen initial-

Text continued on page 110

Listing 1: *A screen-enhancement program for the IBM PC.*

```
                          PAGE 64,132
                          TITLE SCREEN - IBM Display Enhancement. Copyright 1983 Tim Field
000A                      .RADIX 10
                          ;*****************************************************************
                          ;
                          ;       Define interrupt vectors for both keyboard interrupt 16H and
                          ;               screen interrupt 10H.  Both in segment 0.
                          ;
                          ;*****************************************************************

0000                      KEYVECT SEGMENT AT 0            ; Define KEYBOARD interrupt vector
0058                              ORG     16H*4
0058                      KEYINT LABEL DWORD
0058                      KEYVECT ENDS

0000                      SCRVECT SEGMENT AT 0            ; Define SCREEN interrupt vector
0040                              ORG     10H*4
0040                      SCRINT LABEL DWORD
0040                      SCRVECT ENDS

                          ;*****************************************************************
                          ;
                          ;       Define constants
                          ;
                          ;*****************************************************************

= 0007                    BW_VAL     EQU 07h      ; Standard B&W attribute sent to monitor
= 0410                    EQUIP_FLAG EQU 410h     ; Area in RAM that contains EQUIPMENT status
= 000F                    CHK_MODE   EQU 15       ; Screen interrupt function to check mode
= 0007                    MONO_MODE  EQU 7        ; Screen mode of 7 indicates monochrome
= 0003                    COLOR_ADPT EQU 3        ; Modes from 0 to 3 are non-graphics color

                          ;*****************************************************************
                          ;
                          ;       Start code area
                          ;
                          ;*****************************************************************

0000                      CODE SEGMENT PARA
                          ASSUME CS:CODE
0100                      ORG 100h         ; Start code at offset 100h from starting segment.
                                           ; (This leaves room for DOS's work area

0100                      KEY PROC FAR
0100                      START:
                              ; Initialization code...used only once, on system startup
0100  E9 0300 R               JMP INIT_CODE                    ; Call initialization routine
0103  90                  EVEN
0104  46 43 50 21             VALIDCHK DB 'FCP!'  ; used by INSTALL to check for valid SCREEN pgm

                          ;*****************************************************************
                          ;
                          ;       Define storage areas and data structures
                          ;
                          ;*****************************************************************

                              ; Define keystroke scan codes for the five SCREEN functions
0108  6800                    FORE_INC DW 6800h   ; Foreground increment
010A  6A00                    BACK_INC DW 6A00h   ; Background increment
010C  6C00                    C80_40   DW 6C00h   ; 80x25 to 40x25 flip-flop key
010E  6E00                    COL_MON  DW 6E00h   ; COLOR/MONO flip-flop key
0110  7000                    REPAINT  DW 7000h   ; Repaint screen using current mode

0112  011A R                  CUR_MODE  DW COL80_AREA ; Initialize starting mode
0114  012A R                  MONO_SET  DW MONO_AREA  ; Pointer to monochrome area
0116  011A R                  COLOR_SET DW COL80_AREA ; Pointer to 'active' color area

0118  70                      SCRN_ATTR DB 70h    ; Current screen attribute
0119  FF                      SCRN_MODE DB 255    ; Saves current screen mode

                              ; Define structure used to contain information about 40 and 80
                              ; column color modes as well as monochrome mode.

                              S  STRUC
0000  0000                       CORNER  DW 0   ; Defines COL/ROW count of characters for monitor
0002  0000                       BF      DW 0   ; Colors of FORE and BACK
0004  0000                       EQUIP   DW 0   ; Equipment setting
0006  0000                       MODE    DW 0   ; AX value for setting mode of monitor
0008                          S ENDS
```

Listing 1 continued on page 102

Listing 1 continued:

```
                                ; Now, set up three screen structures with default conditions

011A  5019                      COLB0_AREA S <5019h,0107h,20h,3>   ; 80x25, White FORE, Blue BACK
011C  0107
011E  0020
0120  0003

0122  2819                      COL40_AREA S <2819h,0107h,10h,1>   ; 40x25, Brown FORE, Black BACK
0124  0107
0126  0010
0128  0001

012A  5019                      MONO_AREA  S <5019h,0007h,30h,7>   ; Monochrome, reverse video
012C  0007
012E  0030
0130  0007


                                ; NOTE: The standard BIOS ROM KEYBOARD interrupt routine is
                                ;         executed as a subroutine (using CALL DWORD PTR) if
                                ;         the interrupt was invoked to return a keystroke.  Any
                                ;         other execution of KEYBOARD_IO can be called as a
                                ;         simple inline FAR JMP instruction.  NOTE:  The CALL
                                ;         instruction (see just after INT_LOOP label below) uses
                                ;         the address stored here at KEY_CALL to KEYBOARD_IO.
0132                        KEY_CALL :
0132  EA                        DB 0EAH     ; Far JMP address to KEYBOARD interrupt
0133  0000 0000                 DW 0,0      ;
                            ;*****************************************************************
                            ;
                            ;      Procedure KEY_RTNE - Intercepts keyboard interrupt and deter-
                            ;              mines if the keystroke is one of the five SCREEN ones.
                            ;
                            ;*****************************************************************

0137                        KEY_RTNE:
                                ASSUME DS:CODE
0137  FB                        STI                             ; Turn on interrupts
0138  80 FC 00                  CMP  AH,0                       ; CALL as subroutine if keyfetch
013B  75 F5                     JNE  KEY_CALL                   ; Jump to KEYBOARD_IO if not
013D  1E                        PUSH DS                         ; Save DS and BX from destruction
013E  53                        PUSH BX                         ;
013F  51                        PUSH CX
0140  52                        PUSH DX
0141  06                        PUSH ES
0142  57                        PUSH DI
0143  8C CB                     MOV  BX,CS                      ; Move CS segment into DS
0145  8E DB                     MOV  DS,BX                      ;

0147                        INT_LOOP:
0147  9C                        PUSHF                           ; IBM keyboard proc expects interrupt call
0148  BB 0133 R                 MOV  BX,OFFSET KEY_CALL+1       ; Get address to ROM code for keyboard
014B  FF 1F                     CALL DWORD PTR [BX]             ; Call keyboard routine
014D  8B 1E 0112 R              MOV  BX,CUR_MODE                ; Get current mode address
0151  3B 06 010E R              CMP  AX,COL_MON                 ; See if COLOR<->MONO flip-flop key
0155  75 25                     JNE  TEST_FORE                  ; Exit if not
                                ; Otherwise, flip-flop screen mode
0157  3B 1E 0114 R              CMP  BX,MONO_SET                ; Are we looking at monochrome?
015B  74 0D                     JE   SET_COLOR                  ; Swap in color if yes
015D  83 3E 0114 R 00           CMP  MONO_SET,0                 ; See if monochrome monitor enabled
0162  74 14                     JE   NEXT_KEY                   ; Ignore command if not
0164  8B 1E 0114 R              MOV  BX,MONO_SET                ; Otherwise set up monochrome
0168  EB 0B                     JMP  SHORT DO_CHG               ;

016A                        SET_COLOR:
016A  83 3E 0116 R 00           CMP  COLOR_SET,0                ; See if COLOR monitor enabled
016F  74 07                     JE   NEXT_KEY                   ; Skip if not
0171  8B 1E 0116 R              MOV  BX,COLOR_SET               ; Set up for color

0175                        DO_CHG:
0175  E8 0201 R                 CALL SCREEN_CHG                 ; Implement screen change

0178                        NEXT_KEY:
0178  B4 00                     MOV  AH,0                       ; Set up to fetch keystroke
017A  EB CB                     JMP  INT_LOOP                   ; Fetch next key input

017C                        TEST_FORE:
017C  50                        PUSH AX                         ; Save registers.
017D  53                        PUSH BX                         ; See if in GRAPHICS mode
017E  B4 0F                     MOV  AH,CHK_MODE                ;
0180  CD 10                     INT  10H                        ;
0182  5B                        POP  BX                         ; Restore BX register
0183  3C 03                     CMP  AL,COLOR_ADPT              ; If between 0 and 3, not graf
```

Listing 1 continued on page 104

Listing 1 continued:

```
0185  7E 08               JLE  NOT_GRAF              ;
0187  3C 07               CMP  AL,MONO_MODE
0189  7D 04               JGE  NOT_GRAF              ;
018B  58                  POP  AX
018C  EB 6C 90            JMP  DONE                  ; If Color-Graphics mode, do not
                                                     ;   change modes.
018F                  NOT_GRAF:
018F  58                  POP  AX                    ; Restore AX
0190  3B 06 0108 R        CMP  AX,FORE_INC           ; Is this key to increment FORE?
0194  75 16               JNE  TEST_BACK             ; Skip if not
0196  3B 1E 0116 R        CMP  BX,COLOR_SET          ; See if currently using color
019A  75 2D               JNE  BW_FLOP               ; If not, go deal with B&W
019C  8B 47 02            MOV  AX,[BX].BF            ; Gets BACK in AL, FORE in AH
019F                  EQ_FORE:
019F  FE C0               INC  AL                    ; Increment FOREGROUND color
01A1  24 07               AND  AL,7                  ; Keep it within bounds
01A3  3A C4               CMP  AL,AH                 ; See if same as background
01A5  74 F8               JE   EQ_FORE               ; Increment again if yes
01A7  89 47 02            MOV  [BX].BF,AX            ; Save back to structure
01AA  EB C9               JMP  DO_CHG                ; Redraw screen

01AC                  TEST_BACK:
01AC  3B 06 010A R        CMP  AX,BACK_INC           ; Is this key to increment BACK?
01B0  75 21               JNE  TEST_REPAINT          ; Skip if not
01B2  3B 1E 0116 R        CMP  BX,COLOR_SET          ; See if currently using color
01B6  75 11               JNE  BW_FLOP               ; If not, go deal with B&W
01B8  8B 47 02            MOV  AX,[BX].BF            ; Gets BACK in AL, FORE in AH

01BB                  EQ_BACK:
01BB  FE C4               INC  AH                    ; Increment BACKGROUND color
01BD  80 E4 07            AND  AH,7                  ; Keep it within bounds
01C0  3A E0               CMP  AH,AL                 ; see if same as foreground
01C2  74 F7               JE   EQ_BACK               ; Increment again if yes
01C4  89 47 02            MOV  [BX].BF,AX            ; Save back to structure
01C7  EB AC               JMP  DO_CHG                ; Redraw screen

01C9                  BW_FLOP:         ; Flip-flop B&W monitor
01C9  8B 47 02            MOV  AX,[BX].BF            ; BACK in AH, FORE in AL
01CC  86 E0               XCHG AH,AL                 ; Swap
01CE  89 47 02            MOV  [BX].BF,AX            ; restore
01D1  EB A2               JMP  DO_CHG                ; Repaint screen

01D3                  TEST_REPAINT:
01D3  3B 06 0110 R        CMP  AX,REPAINT            ; Is this key to repaint screen?
01D7  74 9C               JE   DO_CHG                ; If yes, repaint

01D9                  TEST_80_40:
01D9  3B 06 010C R        CMP  AX,C80_40             ; Is the 80-40 flop key pressed?
01DD  75 1B               JNE  DONE                  ; Exit if not
01DF  81 FB 0122 R        CMP  BX,OFFSET COL40_AREA  ; Is current pointer area 40x25?
01E3  75 05               JNE  TSTB0                 ; Skip if not
01E5  BB 011A R           MOV  BX,OFFSET COL80_AREA  ; Otherwise, flip to 80x25
01E8  EB 09               JMP  SHORT SAVE_COL        ; Save to COLOR_SET

01EA                  TSTB0:
01EA  81 FB 011A R        CMP  BX,OFFSET COL80_AREA  ; Is current 80x25 color?
01EE  75 8B               JNE  NEXT_KEY              ; Ignore key if not
01F0  BB 0122 R           MOV  BX,OFFSET COL40_AREA  ;

01F3                  SAVE_COL:
01F3  89 1E 0116 R        MOV  COLOR_SET,BX          ; Save to COLOR_SET
01F7  E9 016A R           JMP  SET_COLOR             ; Implement

01FA                  DONE:
01FA  5F                  POP  DI
01FB  07                  POP  ES
01FC  5A                  POP  DX
01FD  59                  POP  CX
01FE  5B                  POP  BX                    ;
01FF  1F                  POP  DS
0200  CF                  IRET                       ; Return from interrupt
0201                  KEY ENDP      ; Done with main routine !!!

                      ;*********************************************************************
                      ;
                      ;      SCREEN_CHG - Changes current monitor screen mode
                      ;
                      ;             Inputs: BX points to current monitor structure
                      ;
                      ;*********************************************************************

0201                  SCREEN_CHG PROC NEAR
```

Listing 1 continued on page 106

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Listing 1 continued:

```
0201  B8 0000          MOV  AX,0                ; Get segment address to EQUIP_FLAG
0204  8E C0            MOV  ES,AX               ;    in RAM memory
0206  26: A1 0410      MOV  AX,ES:EQUIP_FLAG    ; Get set of EQUIP flags
020A  24 CF            AND  AL,0CFh             ; Get rid of current monitor flag
020C  0B 47 04         OR   AX,[BX].EQUIP       ; Set up new monitor flag
020F  26: A3 0410      MOV  ES:EQUIP_FLAG,AX    ; Save back in RAM
0213  89 1E 0112 R     MOV  CUR_MODE,BX         ; Indicate new mode
                       ; Now, set up attribute for foreground and background
0217  8B 57 02         MOV  DX,[BX].BF          ; Get both FORE and BACK in DX
021A  B1 04            MOV  CL,4                ; Shift count
021C  D2 E6            SHL  DH,CL               ; Shift BACK into upper nibble
021E  0A F2            OR   DH,DL               ; move FORE into lower nibble
0220  88 36 0118 R     MOV  SCRN_ATTR,DH        ; Save results
                       ; See if we need to reset monitor (switching to new monitor?)
0224  8B 47 06         MOV  AX,[BX].MODE        ; Get mode
0227  3A 06 0119 R     CMP  AL,SCRN_MODE        ; Compare with current mode
022B  74 05            JE   SET_ATTR            ; Skip if same
022D  A2 0119 R        MOV  SCRN_MODE,AL        ; Otherwise, save current mode
0230  CD 10            INT  10h                 ; And reset to new monitor

0232                 SET_ATTR:
                       ; Change attributes of current screen
0232  EB 0236 R        CALL CH_ATTR             ; Changes attributes
0235  C3               RET
0236                 SCREEN_CHG ENDP

                     ;************************************************************************
                     ;
                     ;     CH_ATTR - Repains active screen so that every character on
                     ;           current screen is displayed with the new attributes
                     ;
                     ;           Inputs : BX points to current monitor structure
                     ;
                     ;************************************************************************

0236                 CH_ATTR PROC NEAR
                         ; See if we need to draw in border for color mode
0236  81 FB 0114 R       CMP  BX,OFFSET MONO_SET ; In Color?
023A  74 0F              JE   NO_BORDER          ; Do not worry about border if not
023C  50                 PUSH AX                 ; Save registers
023D  53                 PUSH BX                 ;
023E  8B 5F 02           MOV  BX,[BX].BF         ; Get background color in BL
0241  8A DF              MOV  BL,BH              ;
0243  B7 00              MOV  BH,0               ; Select border coloring
0245  B4 0B              MOV  AH,11              ; Interface to Set Color Palette
0247  CD 10              INT  10H                ; Execute screen interrupt
0249  5B                 POP  BX                 ; Restore registers
024A  58                 POP  AX                 ;
024B                 NO_BORDER:
024B  8B 07              MOV  AX,[BX].CORNER     ; Get COL and ROW for current
024D  A3 028E R          MOV  CORNR,AX           ; Save in temporary
0250  B4 0F              MOV  AH,CHK_MODE        ; Get page number
0252  CD 10              INT  10h                ;
                         ; BH contains active page
0254  B4 03              MOV  AH,3               ; Save current cursor posn
0256  CD 10              INT  10h                ;
0258  52                 PUSH  DX                ; Save position on stack
0259  33 D2              XOR  DX,DX              ; Load DX with 0
025B  B9 0001            MOV  CX,1               ; Set up replication count
025E  8A 1E 0118 R       MOV  BL,SCRN_ATTR       ; Get current attribute

0262                 REP_ATTR:
0262  B4 02              MOV  AH,2               ; Set cursor position
0264  CD 10              INT  10h                ;
0266  B4 08              MOV  AH,8               ; Read next character
0268  CD 10              INT  10h                ;
                         ; AH contains current character attribute
026A  80 E4 88           AND  AH,88h             ; Get intensity bit
026D  80 E3 77           AND  BL,77h             ; Make sure attribute intensity off
0270  0A DC              OR   BL,AH              ; Combine to get current attribute
0272  B4 09              MOV  AH,9               ; Write out char with new attribute
0274  CD 10              INT  10h                ;
0276  FE C2              INC  DL                 ;
0278  3A 16 028F R       CMP  DL,TCOL            ; Are we done with this column?
027C  7E E4              JLE  REP_ATTR
027E  32 D2              XOR  DL,DL              ; Otherwise zero out DL
0280  FE C6              INC  DH                 ; Move to next row
0282  3A 36 028E R       CMP  DH,TROW            ; Done with screen?
0286  7E DA              JLE  REP_ATTR           ; Loop until done

0288  5A                 POP  DX                 ; Restore original cursor position
0289  B4 02              MOV  AH,2               ;
```

Listing 1 continued on page 108

Listing 1 continued:

```
028B  CD 10                       INT  10h                  ;
028D  C3                          RET
028E                         CORNR LABEL WORD
028E  00                     TROW  DB 0  ; Temporary store for ROW
028F  00                     TCOL  DB 0  ; temp store for COL
0290                    CH_ATTR ENDP

                        ;************************************************************************
                        ;
                        ;         SCR_RTNE - Replaces SCREEN interrupt so that it can intercept
                        ;                    B&W character writes and change attributes
                        ;
                        ;************************************************************************

0290                    SCR_RTNE PROC NEAR
                                  ASSUME DS:CODE
0290  FB                          STI
0291  1E                          PUSH DS               ; Save Data Segment register
0292  0E                          PUSH CS               ; Move CS segment into DS
0293  1F                          POP  DS               ;
0294  80 FC 06                    CMP  AH,6             ; Spot SCROLL UP and SCROLL DOWN calls
0297  7C 17                       JL   NORMAL_SCR       ;
0299  80 FC 07                    CMP  AH,7             ;
029C  7F 06                       JG   NOT_SCROLL       ;
029E                    SCROLL:
029E  E8 02B6 R                   CALL GET_CH           ; For scrolling, update attribute
02A1  EB 0D 90                    JMP  NORMAL_SCR       ; Now, execute scroll

02A4                    NOT_SCROLL:
02A4  80 FC 09                    CMP  AH,9             ; Check for 'WRITE ATTRIBUTE/CHAR' cmd
02A7  75 07                       JNE  NORMAL_SCR       ; Send out any other command as normal
02A9  86 FB                       XCHG BH,BL            ; Get attribute in BL
02AB  E8 02B6 R                   CALL GET_CH           ; Update attribute for command
02AE  86 FB                       XCHG BH,BL            ; Move attribute back to BH for cmd

02B0                    NORMAL_SCR:
02B0  1F                          POP  DS               ; Restore DS segment register
                                  ;
                                  ; NOTE: We are now ready to invoke the BIOS screen interrupt.
                                  ;        Since the ROM code includes an IRET interrupt return call,
                                  ;        all we need to do is to jump to the start of the ROM code
                                  ;        and all will be well.  Since the initialization code set
                                  ;        up the address to the screen interrupt code below, we can
                                  ;        set up a forced jump to that address.

02B1                    JMP_SCR:                        ; Address to SCREEN interrupt
02B1  EA                          DB 0EAH               ; Force a FAR JMP but do not set up dest-
02B2  0000 0000                   DW 0,0                ;   ination address at assembly time.
                                                        ;   (INIT routine will set this address)
02B6                    SCR_RTNE ENDP

                        ;************************************************************************
                        ;
                        ;         GET_CH - Subroutine replaces B&W character with current replacement
                        ;                  attributes and allows for Intensity bit setting
                        ;
                        ;         INPUTS : BH contains attribute to be modified
                        ;
                        ;************************************************************************

02B6                    GET_CH PROC NEAR
02B6  88 3E 02CE R                MOV  SAVECH,BH  ; Save character
02BA  80 E7 77                    AND  BH,77h     ; Remove intensity and blink bits
02BD  80 FF 07                    CMP  BH,BW_VAL  ; See if currently defined B&W value
02C0  8A 3E 02CE R                MOV  BH,SAVECH  ; Otherwise, modify to current attribute
02C4  75 07                       JNE  OUT        ; Exit if not
02C6  80 E7 88                    AND  BH,88h     ; Get rid of B&W part
02C9  0A 3E 0118 R                OR   BH,SCRN_ATTR; Move in current attribute part
02CD                    OUT:
02CD  C3                          RET             ; done

02CE  00                          SAVECH DB 0     ; Temporary character store
02CF                    GET_CH ENDP

02CF                    LASTONE:  ; All code after this label is freed to DOS use after
                                  ; initialization of the program.

                        ;************************************************************************
                        ;
                        ;         INIT_CODE - Code to load and initialize the SCREEN program...
                        ;                     sets up DOS to keep all code before 'LASTONE' label
                        ;                     safe from overlaying during system operation.
```

Listing 1 continued on page 110

Listing 1 continued:

```
                             ;
                             ;**************************************************************************

02CF  53 43 52 45 45 4E      COPYRT:  DB  'SCREEN  Version 1.20  Copyright 1983 Tim Field',13,10,'$'
      20 20 56 65 72 73
      69 6F 6E 20 31 2E
      32 30 20 20 43 6F
      70 79 72 69 67 68
      74 20 31 39 38 33
      20 54 69 6D 20 46
      69 65 6C 64 0D 0A
      24

0300                         INIT_CODE PROC NEAR

                                ; Initialize KEYBOARD intercept code
                                ASSUME  ES:KEYVECT                  ; 'VECTORS' is interrupt segment 0
0300  B8  ---- R                MOV  AX,KEYVECT                     ; Get address to interrupt vector
0303  8E C0                     MOV  ES,AX                          ; Save in ES
0305  26: A1 0058 R             MOV  AX,ES:KEYINT                   ; Get address to interrupt rtne
0309  BB 0133 R                 MOV  BX,OFFSET KEY_CALL+1           ; Address to place to save vector
030C  89 07                     MOV  [BX],AX                        ; Save interrupt address
030E  26: A1 005A R             MOV  AX,ES:KEYINT[2]                ; Get interrupt segment for rtne
0312  89 47 02                  MOV  [BX+2],AX                      ; Save it too
0315  26: C7 06 0058 R 0137 R   MOV  ES:KEYINT,OFFSET KEY_RTNE      ; Now, replace with own address
031C  8C C8                     MOV  AX,CS                          ; Save segment in interrupt vector
031E  26: A3 005A R             MOV  ES:KEYINT[2],AX                ;

                                ; Initialize SCREEN intercept code
                                ASSUME  ES:SCRVECT                  ; 'VECTORS' is interrupt segment 0
0322  B8  ---- R                MOV  AX,SCRVECT                     ; Get address to interrupt vector
0325  8E C0                     MOV  ES,AX                          ; Save in ES
0327  26: A1 0040 R             MOV  AX,ES:SCRINT                   ; Get address to interrupt rtne
032B  BB 02B2 R                 MOV  BX,OFFSET JMP_SCR+1            ; Address to place to save vector
032E  89 07                     MOV  [BX],AX                        ; Save interrupt address
0330  26: A1 0042 R             MOV  AX,ES:SCRINT[2]                ; Get interrupt segment for rtne
0334  89 47 02                  MOV  [BX+2],AX                      ; Save it too
0337  26: C7 06 0040 R 0290 R   MOV  ES:SCRINT,OFFSET SCR_RTNE      ; Now, replace with own address
033E  8C C8                     MOV  AX,CS                          ; Save segment in interrupt vector
0340  26: A3 0042 R             MOV  ES:SCRINT[2],AX                ;

                                ; Initialize screen
0344  8B 1E 0112 R              MOV  BX,CUR_MODE                    ; Set up initial mode
0348  E8 0201 R                 CALL SCREEN_CHG                     ; Initialize

                                ; Now, print out acknowledgement to user monitor and exit
034B  8C C8                     MOV  AX,CS                          ; Set up segment to this routine
034D  8E D8                     MOV  DS,AX                          ;
034F  BA 02CF R                 MOV  DX,OFFSET COPYRT               ; Now, print out copyright message
0352  B4 09                     MOV  AH,9                           ; DOS function to print string
0354  CD 21                     INT  21h                            ; Execute function interrupt
0356  BA 02CF R                 MOV  DX,OFFSET LASTONE              ; Save all code up to "LASTONE" label
0359  CD 27                     INT  27H                            ; No return needed.
035B                         INIT_CODE ENDP
035B                         CODE ENDS
                             END START
```

Text continued from page 100

izes the system display(s) according to the system's preset state.

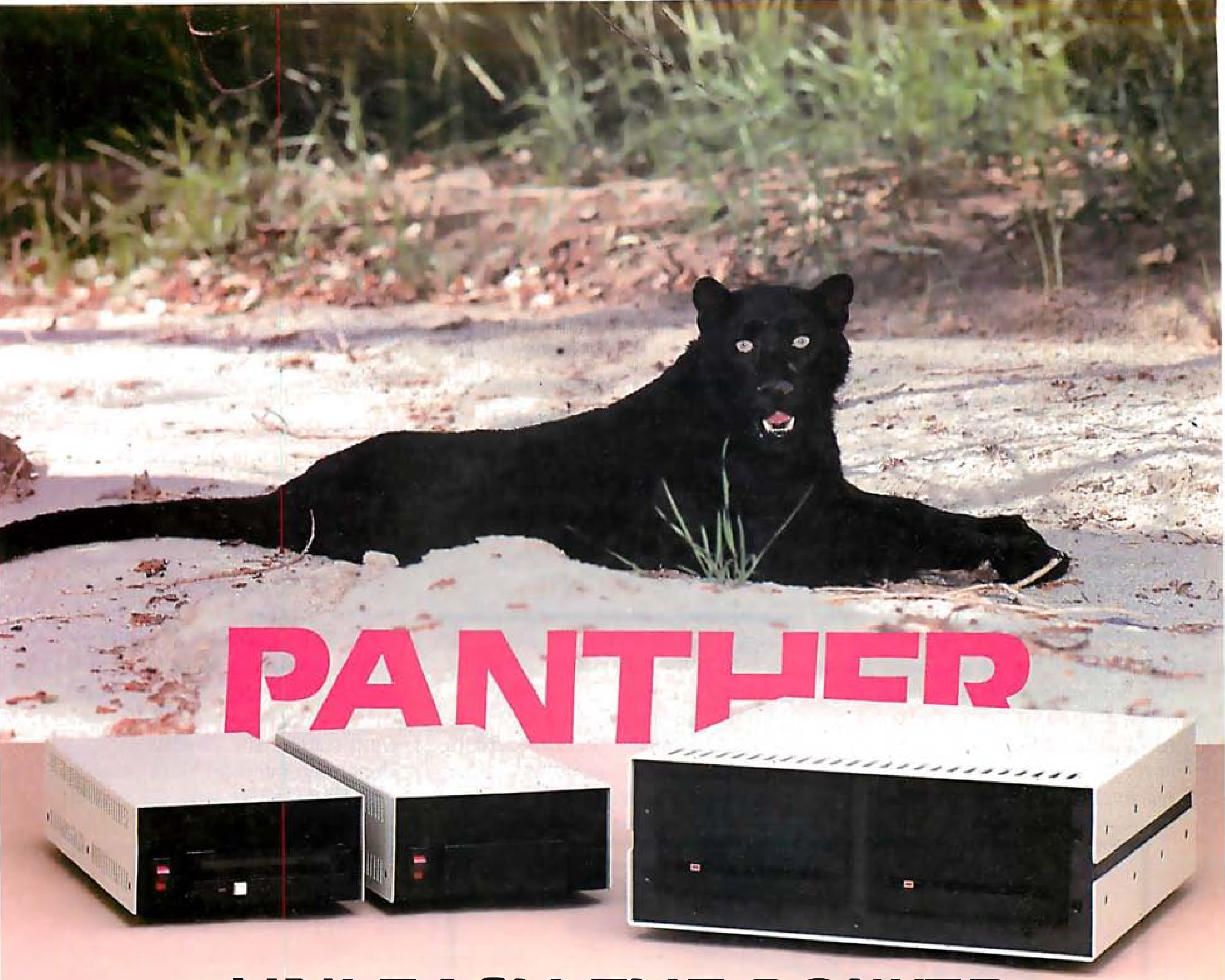
Screen then uses DOS to become resident in the system. When you subsequently execute other programs and DOS functions, Screen is not disturbed. It remains in the PC's RAM (random-access read/write memory), waiting for you to request one of its functions.

Screen Functions

You invoke each Screen function via one combined-keystroke entry. Figure 1 illustrates the use of the five functions.

You enter the keystrokes by holding down the Alt key and simultaneously pressing the specified function key. As soon as Screen detects these keystrokes, it implements the function requested.

The first two functions that are listed, <Alt F1> and <Alt F3>, increment or change the color of the foreground and background on a color monitor's screen. Eight colors are available for either area: black, blue, green, cyan, red, magenta, yellow, and white. When you invoke either of these two functions, the foreground or background changes from its present color to the next one in this list. The list wraps around so that



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the color choice after white goes back to black. The foreground or background of the display is actually "repainted" with whatever color is requested.

If you could choose the same colors for the foreground and background, the text display would be invisible. Thus, Screen does not fulfill such a request. Consequently, 56 color combinations are available for the foreground/background scheme of the PC color display. If you are using the monochrome monitor and invoke either of these functions, the display merely flips from reverse to normal video, or vice versa.

The <Alt F7> keystroke permits you to alternate between the color and monochome monitors, making either one active. For example, if all text and output is going to the color monitor, pressing <Alt F7> leaves that monitor unchanged and clears the monochrome monitor, making it active. Subsequent output then goes to the monochrome screen. Pressing <Alt F7> again reverses the process, reactivating the color monitor.

The <Alt F9> keystroke causes the active screen to be repainted with the currently specified attributes. This feature is needed after running certain DOS commands or applications programs that reset the screen to black and white. The DOS MODE command is an example.

Screen's Operation

The Screen program found in listing 1 is a 600-byte assembly-language program designed to take advantage of the PC's flexible-interrupt structure. It consists of three functional blocks: program initialization, screen interception, and keyboard interception. The program's initialization portion is found in the INIT_CODE subroutine. This routine serves three purposes: initiating execution of both the screen- and keyboard-intercept code, setting up the system display(s) in the default mode, and telling DOS that Screen is to remain resident in RAM.

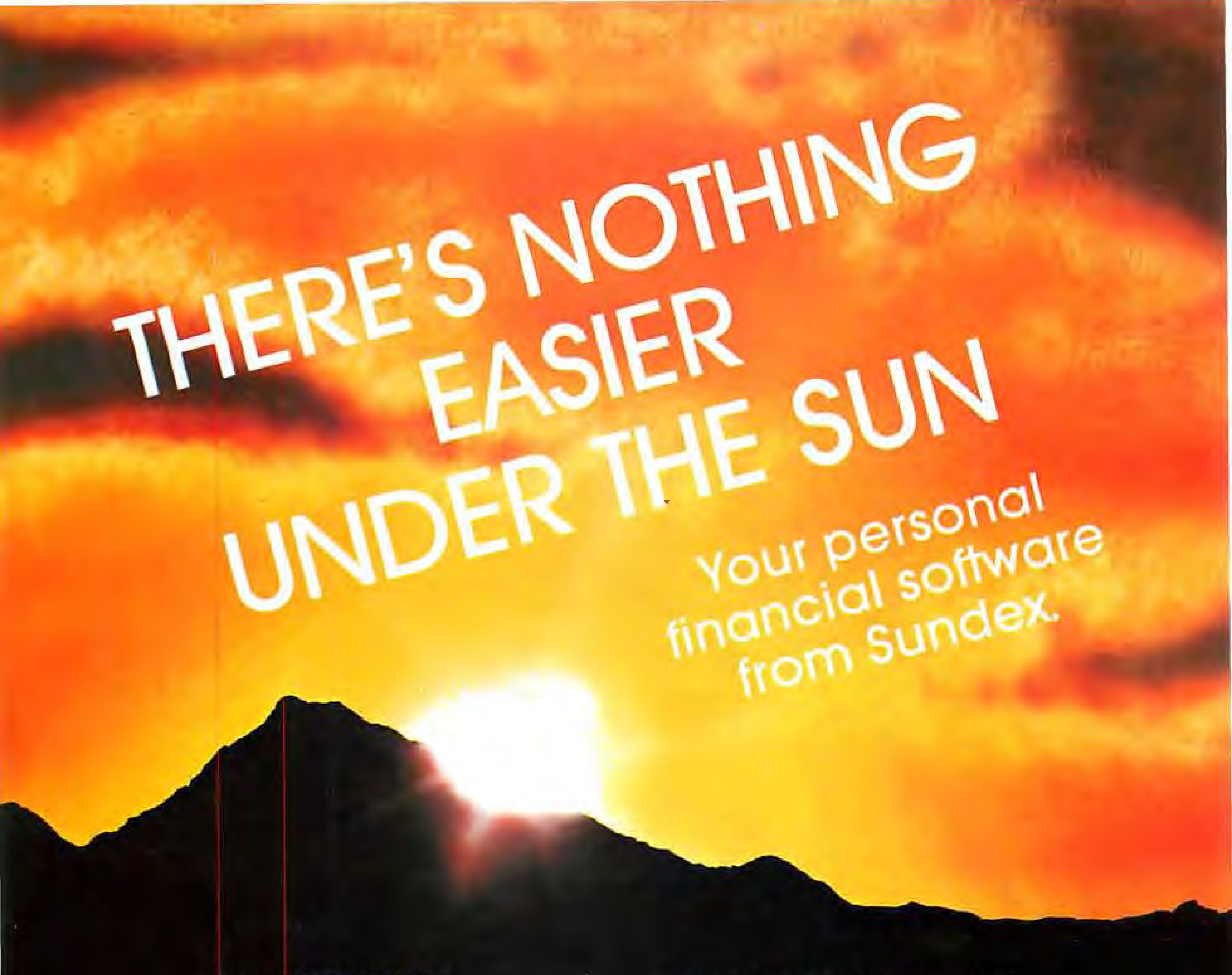
Screen consists of three functional blocks: program initialization, screen interception, and keyboard interception.

The two interception blocks perform the operations the program supports. The screen-interception segments actually intercept text characters as they are sent to either the color or monochrome screen and make the necessary alterations on their "attributes." (A character attribute specifies things about that character, such as color, and whether it is to be blinking or underlined.) Likewise, the keyboard-interception feature intercepts keystrokes received from the keyboard, watching for and executing Screen's five function keystrokes. The keyboard- and screen-intercept blocks are independent processes that share data structures and variables. The structures define the current state of the display.

The screen-intercept block consists of the SCR_RTNE and GET_CH subroutines in listing 1. This code intercepts any screen interrupts meant for the IBM BIOS screen handler (see "The IBM PC Screen Interrupt" on page 196) and checks to see whether text is being sent to one of the screens.

If text is being sent, SCR_RTNE examines the text-character attribute to see if it specifies a black-and-white character. If so, the attribute is replaced with the current Screen attribute for that display. For example, if Screen is currently displaying text with a white character on a blue background, any black-and-white text attribute is replaced with the white-on-blue attribute. The text character is then sent on to the BIOS screen driver for printing on the display.

The keyboard-intercept code includes the listing 1 subroutines KEY_RTNE, SCREEN_CHG, and CH_ATTR. The purpose of the functional block of code made up of these subroutines is to intercept any ROM (read-only memory) BIOS keyboard interrupts (see "The IBM PC Keyboard Interrupt" on page 114).



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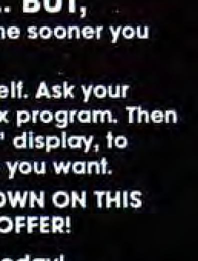

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The IBM PC Screen Interrupt

The IBM PC uses a memory-mapped approach to support adapters for the monochrome and color/graphics monitors, reserving two separate chunks of its 1-megabyte memory for the adapters. In text mode, the contents of each byte in those memory areas specify one character displayed on the screen. The monochrome adapter contains 4K bytes of RAM and begins at address B0000 hexadecimal. (All addresses to follow are hexadecimal.) The color/graphics card contains 16K bytes of RAM, beginning at B8000.

The obvious method of writing text to either monitor is by merely writing the appropriate ASCII (American National Standard Code for Information Interchange) values in one monitor's memory space. For example, if you move the value 65 to memory location B800:0000, the character "A" appears on the upper-left corner of the screen. This method of writing text can be extremely efficient, especially given the ability of the 8088 processor to do block moves, allowing you to write character strings to one of the displays using a single machine instruction.

If the PC's designers had simply left to each applications program the job of using this memory-mapped structure for accessing the displays, a number of problems would have occurred. For example, how does a program know which of the two monitors to write to? For that matter, how can the program determine whether the system has both monitors? (While this is easily determined, do we really want every program to have to embed the code needed to find out?) And what about the graphics capabilities of the color adapter; must each program check whether the display is in text mode or graphics mode?

This memory-mapped approach to writing text requires a hardware-specific solution. All programs written for the PC using this technique require that the memory-map space of both adapters remains unchanged. Furthermore, the specific hardware of the adapters must not change so that current display modes and other vital information can be determined from the display chips themselves.

Fortunately, the PC provides an alternative for interfacing to the display screens. The ROM BIOS code contains an interrupt handler called VIDEO_IO (INT 10), which performs a number of screen tasks for DOS and other application programs.

This interrupt handler provides an interface between programs and both displays, and the interface knows of only one active display at any given time. If the color monitor is currently active, then all output sent to VIDEO_IO is sent on the color screen; likewise, if the monochrome monitor is active, all output is sent there. If the system has only one display, that one is always active.

The VIDEO_IO interrupt handler provides numerous screen-oriented functions, including:

- *selecting the active monitor*
- *setting the mode of the color monitor (i.e., 40 by 25 characters vs. 80 by 25 characters and color vs. black and white)*
- *setting and reading the cursor position of the active monitor*
- *reading the light-pen position of the color monitor*
- *selecting the active display page of the color monitor*
- *scrolling the active page up or down*
- *reading/writing a character and attribute (the attribute of a character describes such features as color, underlining, etc.)*
- *performing simple graphics operations on the color monitor (for example, setting a color palette, read/write dot, etc.)*
- *checking the current mode of the active display*

Using the VIDEO_IO Interrupt

Screen intercepts any interrupt meant for VIDEO_IO. In other words, when a process executes the INT 10 instruction, SCR_RTNE gets control of the PC. SCR_RTNE checks to see whether the operation being requested of VIDEO_IO is a text-character write operation. If it's not, SCR_RTNE immediately executes VIDEO_IO. The result is that SCR_RTNE does not affect the PC's operation (except for the slight time delay required to determine what SCR_RTNE should do).

If, however, the operation requested is a text-character write operation, SCR_RTNE must act. It tests the attribute of the character being written, and if it determines that the attribute indicates a black-and-white character is being sent to VIDEO_IO, then SCR_RTNE simply replaces the black-and-white attribute with the attribute that is currently active in BASIC (white on blue, for example).

The character with the new attribute is then sent on to VIDEO_IO, and the result is a screen display of a different color. SCR_RTNE is careful not to change any other parts of the character attribute. For example, if the attribute signifies that the character is to be highlighted, this highlighting is not changed; the displayed character is highlighted in color.

Note what happens if you run Screen and then execute a program that uses the memory-mapped text output. Because text output does not come through VIDEO_IO, Screen never intercepts the characters. As a result, Screen has no effect on programs that use this technique for screen display.

KEY_RTNE, upon intercepting an interrupt, uses the BIOS keyboard handler to fetch the next keystroke, which is examined to see if it is one of the five keystrokes that invoke a Screen function.

If it is indeed a Screen function call, KEY_RTNE handles the request. The keystroke is then discarded, and the BIOS keyboard handler is used to fetch the next keystroke.

KEY_RTNE changes the data that the keyboard- and screen-intercept blocks share to reflect any change in state. When you invoke one of the Screen functions (by entering the appropriate keystroke), KEY_RTNE changes the visible current state of the display(s) and then reflects the new state in the shared data.

SCR_RTNE changes only the attributes of text characters being sent to the display. The shared data specifies which attributes are to be used as well as the monitor to which text is to be sent.

The data structures and variables

shared by the subroutines KEY__RTNE and SCR__RTNE are defined in listing 1. The basic structure is "S STRUC" and specifies the current state of each monitor. This structure is used three times—to define the states of the monochrome monitor (MONO__AREA), the 80-column color monitor (COL80__AREA), and the 40-column color monitor (COL40__AREA).

Program Flexibility

Note in listing 1 the five variables FORE__INC, BACK__INC, C80__40, COL__MON, and REPAINT. These variables contain the character codes for the keystrokes <Alt F1> to <Alt F9>, which are assigned to the five Screen functions.

By making these character-code variables, Screen makes it easy to

Screen's start-up state is a white-on-blue scheme in an 80-column mode.

reassign the functions to any keystrokes you want to use. For example, if one of your applications programs requires the use of the <Alt F1> keystroke, you can reassign the INCREMENT FOREGROUND operation to another key by replacing the <Alt F1> character code in FORE__INC.

Another feature that provides flexibility is the default or start-up state; as set up in listing 1, Screen initially uses a white-on-blue scheme with the color monitor in 80-column mode. You can change the default state by altering the appropriate variable at the front of the program listing.

Changes in Screen can be made by using either the DOS Debug utility or a program specifically designed for this purpose. For example, I use a menu-driven program called Install that allows safe and simple modification of Screen's keystrokes and default conditions.

Keyboard 'upt

The IBM PC actually use: two keyboard interrupts and associated ROM BIOS handlers. The first is KB__INT (INT 9). This routine communicates wit board's 8048 m essor to con

The transformation from scan to character code is quite complex. The state of such keys as the shift, Caps Lock, Alt, or Ctrl keys affects the resulting character code. I KB__INT checks for special ons, s h as the Ctrl-Alt-Del key combin t Screen func respon appropriately. (See "Using IBM's Marvelous Keyboard," May 1983 BYTE, page 402, for more information.)

The second keyboard interru BOARD IO is INT 16 h main fu heck th (bein 3__INT a key The n returned the process invoking t terrupt. KEYBOARD__IO can also be used to check the status of the keystroke buffer and return notice if some character is available.)

KB__INT receives this sca code and converts it to the appropriate character code, which it places in the keystroke buffer. Subseque (such as S or BA ons pro- m) want executes INT 16, D__IO. YBOAR eystroke buffer until de. The code is removed from the buffer and sent to the calling process.

Screen's keyboard intercept routine KEY__RTNE uses the KEYBOARD__IO interrupt han s set up receiv an IN yboard inte When it rec RTNE immediately executes KEYBOARD__IO as a subroutine, regaining control when KEYBOARD__IO returns with a key- e. KEY__R compares the troke return ose that are to the If a match is KEY__RTNE returns from the sending the keystroke it from KEYBOARD__IO back to the originating process. However, if KEY__RTNE finds a match, the appropriate Screen function is

Intercepting Interrupts

The initialization of Screen by INIT__CODE must perform two vital tasks. First, it must set up KEY__RTNE and SCR__RTNE to intercept the appropriate keyboard and screen interrupts. Second, it must supply those two subroutines with the addresses of the ROM interrupt handlers they replace so that Screen can use the ROM code.

The PC's interrupt structure makes it fairly simple to replace an interrupt-handler routine with one of your own design. (See "A Peek into the IBM PC," March 1983 BYTE, page 331, for a general discussion of this interrupt structure.)

INIT__CODE gets the addresses to the ROM interrupt handlers by looking into the appropriate slots in the interrupt vector table. These addresses are saved in storage areas in Screen for later use by KEY__RTNE and SCR__RTNE. INIT__CODE then moves the addresses of KEY__RTNE and SCR__RTNE into the interrupt vector table so they can intercept the appropriate interrupts.

It is interesting to look at how KEY__RTNE and SCR__RTNE use the saved addresses of the BIOS ROM keyboard- and screen-interrupt handlers. Two techniques are used to interface with the ROM code. The first technique executes the ROM code as a subroutine, allowing the caller to regain control after the ROM code has been completed. The second technique simply "jumps" to the ROM code as if it were in-line code, permitting the ROM code to return directly to the interrupt's origin.

For KEY__RTNE to examine the keystroke returned by the ROM keyboard interrupt handler, it must regain control when the ROM code is finished. It takes control by executing the ROM keyboard interrupt handler as a subroutine, using the standard CALL instruction.

When invoked as a subroutine, the interrupt handler executes and, when finished, returns via an IRET (interrupt return) instruction. KEY__RTNE must therefore perform a PUSHF (push flags) operation immediately prior to the FAR CALL subroutine call in order to account for the automatic POPF (pop flags) that the IRET does.

The keyboard- and screen-intercept blocks share data structures and variables.

SCR__RTNE completes its function of mapping a black-and-white text character into the appropriate character attribute before it executes the ROM screen-interrupt handler. Because SCR__RTNE need not regain control after the ROM code is finished, it can execute the ROM code as if it is in-line code, using a FAR JMP instruction. The IRET operation in the ROM code then returns directly to the origin of the interrupt.■

The Screen program discussed in this article is available assembled and ready to run on a standard IBM single-sided floppy disk, using PC-DOS 1.0, 1.10, or 2.0. Also inc
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Tim Field (Field Computer Products, 909 N. San Antonio Rd., Los Altos, CA 94022) is a software engineer and technical writer. He is the coauthor of Your IBM PC & XT *from Osborne/McGraw-Hill, due to be published this month.*

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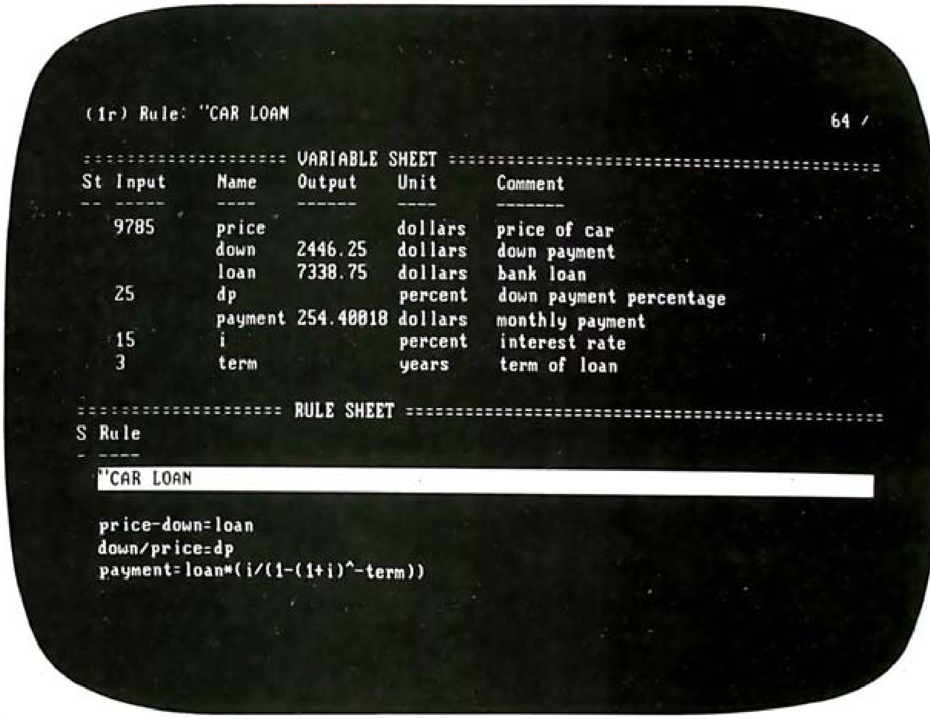

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Equation processing with TK!Solver, or problem solving made easy. The best way to understand what the TK!Solver program *is,* is to understand what it *does.* The following simple example is designed to do just that. If you're still a little in the dark after reading it, stop in at your local computer store for a very enlightening hands-on demonstration.

Begin by setting up your problem. The TK!Solver program lets you do it quickly, easily, and naturally. For example, a car costs $9785. What would be the monthly payment on a three-year loan if the down payment is 25% and the interest rate is 15%?

STEP 1. Formulate the necessary equations to solve your problem and enter them on the "Rule Sheet" simply by typing them in (as in the screen photo). For example: "price−down = loan."

STEP 2. Enter your known values the same way on the "Variable Sheet." For example: "9785" for price. You may also enter units and comments, if you want.*

STEP 3. Type the action command ("!" on your keyboard) to solve the problem.

STEP 4. TK!Solver displays the answer: the monthly payment is $254.40.

Backsolving, the heart of TK!Solver. Now that you've defined the problem and solved it, TK!Solver's unique backsolving ability also lets you think "backwards" to solve for any variable, regardless of its position in the equation. For example, if you can only afford a monthly payment of $200, you can re-solve the problem in terms of that constraint. The TK!Solver program will solve the problem, displaying your choice of a higher down payment, a longer loan term, or a lesser interest rate. This unique backsolving capability forms the basis of TK!Solver's remarkably flexible problem-solving ability.

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Also, as you can see from the example on the screen, TK!Solver deals not only with single variables, but with entire equations and sets of simultaneous equations. It also deals with much more complicated problems than this one. How complicated? That's up to you. What kinds of problems? That's up to you, too, but popular applications include finance, engineering, science, design, and education.

Other extremely useful and interesting things TK!Solver does. Aside from its basic problem-solving abilities, the TK!Solver program performs a number of pretty fancy tricks. Like: *Iterative Solving;* in which TK!Solver performs successive approximations of an answer when confronted with equations that cannot be solved directly, (like exp (x) = 2 – x • y and sin (x • y) = 3 – x – y). Like: *List Solving;* in which TK!Solver attacks complete lists of input values and solves them all, allowing you to examine numerous alternative solutions, and pick the one you like best. Like: *Tables and Graphs;* using the values you produced with the List Solver, the TK!Solver program will automatically produce tables and graphs of your data. You can look at your formatted output on the screen or send it to your printer with a single keystroke. And like: *Automatic Unit Conversion;* in which TK!Solver lets you formulate problems in one unit of measurement, and display answers in another. Very convenient what with all this talk about going metric.

The TK!Solver program also provides a wide variety of specialized business and mathematical functions like trig and log and net present value.

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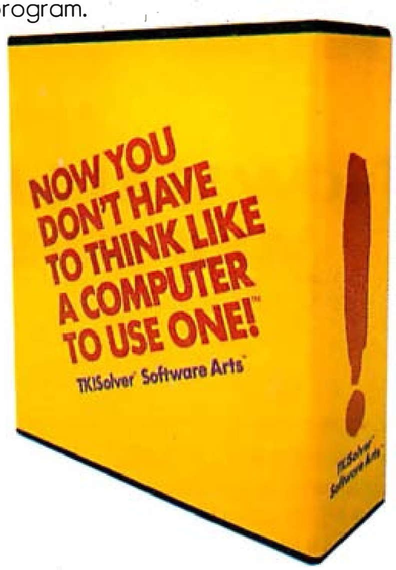

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POKEing Around in the IBM PC

Part 1: Accessing System and Hardware Facilities

by Hugh R. Howson

This two-part series demonstrates how you can use BASIC's PEEK and POKE commands to realize the speed and flexibility of machine-language code without sacrificing the convenience of a high-level language. Several short, general-purpose machine-language subroutines that allow BASIC programs access to the IBM Personal Computer's (PC's) system and hardware facilities illustrate the techniques involved. To lay the groundwork for the more detailed programming examples to be presented in Part 2 (next month), we will take a look now, in Part 1, at the PC's BIOS (basic input/output system) and registers in the PC's central processor.

The PEEK and POKE Commands

BASIC's PEEK and POKE functions form the magic window that gives us access to the PC's main memory. It's well worth investigating these functions in order to take advantage of the PC's modular systems software and to access some of the 8088 processor's powerful commands.

The PEEK and POKE commands operate as follows: the statement

X=PEEK(*n*)

assigns to the variable X the value stored in memory location *n*; similarly, the statement

POKE *n*,*m*

places the *m* into main memory at the location specified by *n*.

This description requires one minor clarification because of the method the 8088 uses to determine the absolute, or effective, memory address. The absolute address on which an instruction operates actually consists of two components: a segment address and an *offset* address, each 2 bytes (or 16 bits) long. The *n* is the offset address, used in the PEEK and POKE instructions; the DEF SEG statement can be used to define the segment address. If no segment address is defined, then that of the BASIC program is assumed.

Table 1 illustrates how an absolute memory address is formed from the segment and offset addresses. The segment address bits are shifted left 4 bit positions (equivalent to multiplying by 16) relative to the offset address bits. And then the two address components are added to yield the 20-bit absolute address, a format that permits an absolute address space of more than one million locations. Note that each segment address defines a 64K-byte address space, but one segment's address space may overlap another's, so segment addresses can assume any value that can be represented by the 16 bits of the segment address register.

Segment Address Bits	1000100010001000
Offset Address Bits	1000100010001000
Absolute Memory Address	10010001000100001000

Table 1: *The relationship between segment and offset address bits. The segment address bits are shifted left four bits relative to the offset address bits; then the segment and offset addresses are added to yield the absolute memory address. This technique permits an absolute address space of more than one million locations.*

Manipulating Data on Screen

These PEEK, POKE, and address concepts can be illustrated by a short program that scrolls up all data on a PC video display. Assuming use of the 80-column monochrome display adapter, all data displayed on the screen is stored in memory starting at segment address hexadecimal B000, offset address 0000 (all addresses to follow are hexadecimal). Each displayed character is represented by 2 single-byte memory locations: one location contains the byte specifying the characters and the second location stores the character's at-

Listing 1: *A BASIC program that shifts the PC's screen up one line at a time.*

```
10 DEF SEG = &HB000
20 FOR ROW = 0 TO 23
30   CURRENTROWFIRSTBYTE = ROW
     * 160
40   ROWBELOWFIRSTBYTE =
     CURRENTROWFIRSTBYTE + 160
50   FOR BYTE = 0 TO 159
60     BYTEBELOW =
       PEEK(ROWBELOWFIRSTBYTE +
       BYTE)
70     POKE (CURRENTROWFIRSTBYTE
       + BYTE), BYTEBELOW
80   NEXT BYTE
90 NEXT ROW
```

tribute byte (which indicates such conditions as a flashing character, reverse video, etc.). Therefore, a total of 160 bytes of memory are used for each 80-column line.

To move all text up one line, a program must move the 80-character per-row, 2-byte-per-character display a single byte at a time. For example, to move the left-hand character of the second row up to the first row, a program can use PEEK at the second-row, left-hand-character byte and then use POKE to move its value into the location corresponding to the left-hand character of the first row. The program in listing 1 accomplishes this task for the top 23 lines of the screen display, leaving the last line unchanged.

Listing 1 illustrates the convenience with which the segment address, B000, can be used to define the segment of memory dedicated to the screen, and it demonstrates how you can easily manipulate screen data using a BASIC program. However, if you actually run this program, you'll find that it's quite slow. That's one reason for investigating the BIOS, which can accomplish the same task with much greater speed and less effort.

Basic Input/Output System

The PC's BIOS is a set of subroutines stored in ROM that provides a standard interface between the user and all of the different input/output devices that may be attached to the system, including the screen, keyboard, printer, disk drives, and communications adapter. Each BIOS subroutine can be activated by a user interrupt. Each subroutine can perform several operations, which are selected by placing appropriate values in the 8088's registers before the interrupt occurs. The PC's documentation includes a complete listing of the BIOS subroutines. You do not need to be an assembly-language programmer to learn how to use them; each one is well documented. The comments at the beginning of each subroutine describe all actions that the subroutine performs and explain what values must be transferred between the user's program and the BIOS subroutine through the 8088's registers.

As a typical example, the comments at the beginning of the BIOS's video-I/O subroutine (included in Appendix A of the PC's *Technical Reference* manual) indicate that this subroutine can scroll any section of the screen up or down a certain number of lines. In addition, the comments indicate that it can perform such functions as placing the character at a specific location on the screen, determining the location of the cursor, and moving the cursor. The comments further indicate the parameters that the user must specify to select a desired action.

Table 2 summarizes the PC's BIOS functions and parameters; this table should prove more useful after you read the 8088's register descriptions later in this article.

The advantage of using the BIOS subroutines is that they include the logic to identify the physical characteristics of an active device. For example, the screen-manipulation (video-I/O) BIOS subroutine determines whether the screen is in text or graphics mode and whether the screen width is 40 or 80 characters, thus removing the burden of passing a lot of redundant information to the system. All of the subroutines have a similar structure, so if you learn how to use one, you can apply the same approach to others.

How can we use a BASIC program to access the BIOS video-I/O subroutine for our screen-scrolling task? Let's say that we would like to scroll a window on the screen up five lines and that the window starts at row 0, column 0 and ends at row 15, column 30. To pass these parameters to the BIOS, they must be placed in the appropriate registers defined in table 2. All of these registers are discussed later in this article, but for this screen-scrolling task we are concerned only with the four accumulator, or general, registers, AX, BX, CX, and DX.

Each of these registers consists of two bytes. When both bytes are taken together as one 16-bit word, then the X suffix in AX, BX, etc., is used. Each byte may also be treated separately, in which case the bytes are referred to as low byte or high byte, or more simply as AL and AH, BL and BH, and so on. Figure 1 illustrates this register configuration and the other 8088 registers discussed later in this article.

Now, to specify the screen-scrolling task, the table 2 entries shown in bold type indicate that we must load parameter values into these registers as follows:

AH (scroll direction: 6=up, 7=down)	=06
AL (number of lines)	=05
BH (blank-line attribute, normal=7)	=07
BL (not used for this task)	
CH (starting row)	=00
CL (starting column)	=00
DH (ending row, 15 decimal=0F) (hexadecimal)	=0F
DL (ending column, 30 decimal=1E) (hexadecimal)	=1E

These values can be loaded into the registers by a short subroutine written in machine language, which can be called when required from a BASIC program. The subroutine then initiates the necessary interrupt to activate the video-I/O BIOS, which completes the defined task.

A Screen-Scrolling Program

The following four machine-language instructions can move values into the AX, BX, CX, and DX registers:

B8, *low byte, high byte* (AX register)
BB, *low byte, high byte* (BX register)
B9, *low byte, high byte* (CX register)
BA, *low byte, high byte* (DX register)

DEVICE AND FUNCTION	AH	OTHER INPUT PARAMETERS	RESULTS RETURNED
VIDEO I/O-Interrupt 10			
set mode	0	[text mode] AL – mode value ((0 = 40 by 25 B/W; [text mode] 1 = 40 by 25 col; 2 = 80 by 25 B/W; 3 = 80 by 25 col; [graphics mode] 4 = 320 by 200 B/W; 5 = 320 by 200 col; 6 = 640 by 200 B/W)	
set cursor type	1	CH – bits 0–4, cursor start line CL bits 0–4, end line	
set cursor position	2	DH – row (starting at 0) DL – column (starting at 0) BH – page number	
read cursor position	3	BH – page number (must be 0 for graphics modes)	DH – row; DL – column CH,CL – cursor mode
read light-pen position	4	BH – page number	AH – status (0 = switch not down; 1 = valid value) DH,DL – row and column CH – raster line (0–199) BX – pixel column (0–319, 639)
select active display page	5	AL – new page value (text modes)	
scroll active page up	**6**	**AL – number of lines blank at bottom (0 = blank window) CH,DL – row, column of upper left scroll corner DH,DL – row, column of lower right corner BH – attribute to be used on blank line**	
scroll active page down	7	as above	
read attribute/character	8	BH – display page (text modes)	AH – attribute of character AL – character read
write character and attribute	9	AL – character to write BH – display page (text modes) BL – attribute or color CX – character repeat count	
write character (only)	10	BH – display page AL – character to write CX – count of times to repeat (max 1 row in graphics)	
set color palette	11	BH – color ID being set BL – color value to be used	
write dot (pixel)	12	AL – color value DX – row number CX – column number	
read dot (pixel)	13	DX – row number CX – column number	AL – dot value read
teletypewriter emulation	14	AL – character to write BH – display page in alpha mode BL – foreground color	
get current video state	15		AH – number of character columns AL – current mode BH – active display page
DISK SYSTEM–Interrupt 13			
reset disk system	0	AL – parameters for initialization	CY: 0 = successful, 1 = failed
get status from last operation	1	–	CY: 0 = successful, 1 = failed AL – system status
read sectors into memory	2	AL – number of sectors DH – head #; DL – drive # CH – track #; CL – sector # ES and BX – segment and offset addresses of data buffer	CY: 0 = successful, 1 = failed AH – operation status (0 = successful) AL – number of sectors actually read
write sectors onto disk	3	same as for read	same as for read
verify the desired sectors	4	same as for read	same as for read
format the desired track	5	same as for read The data buffer pointed at by ES, BX must contain four bytes for each sector, containing:track #, head #, sector #, bytes/sector (where 00 = 128, 01 = 256, 02 = 512, 03 = 1024)	

Table 2 continued on page 126

Table 2: *Basic input/output system (BIOS) functions. Those entries shown in boldface type apply to the screen-scrolling example described in the text. This information was condensed from Appendix A of the* Technical Reference *manual.*

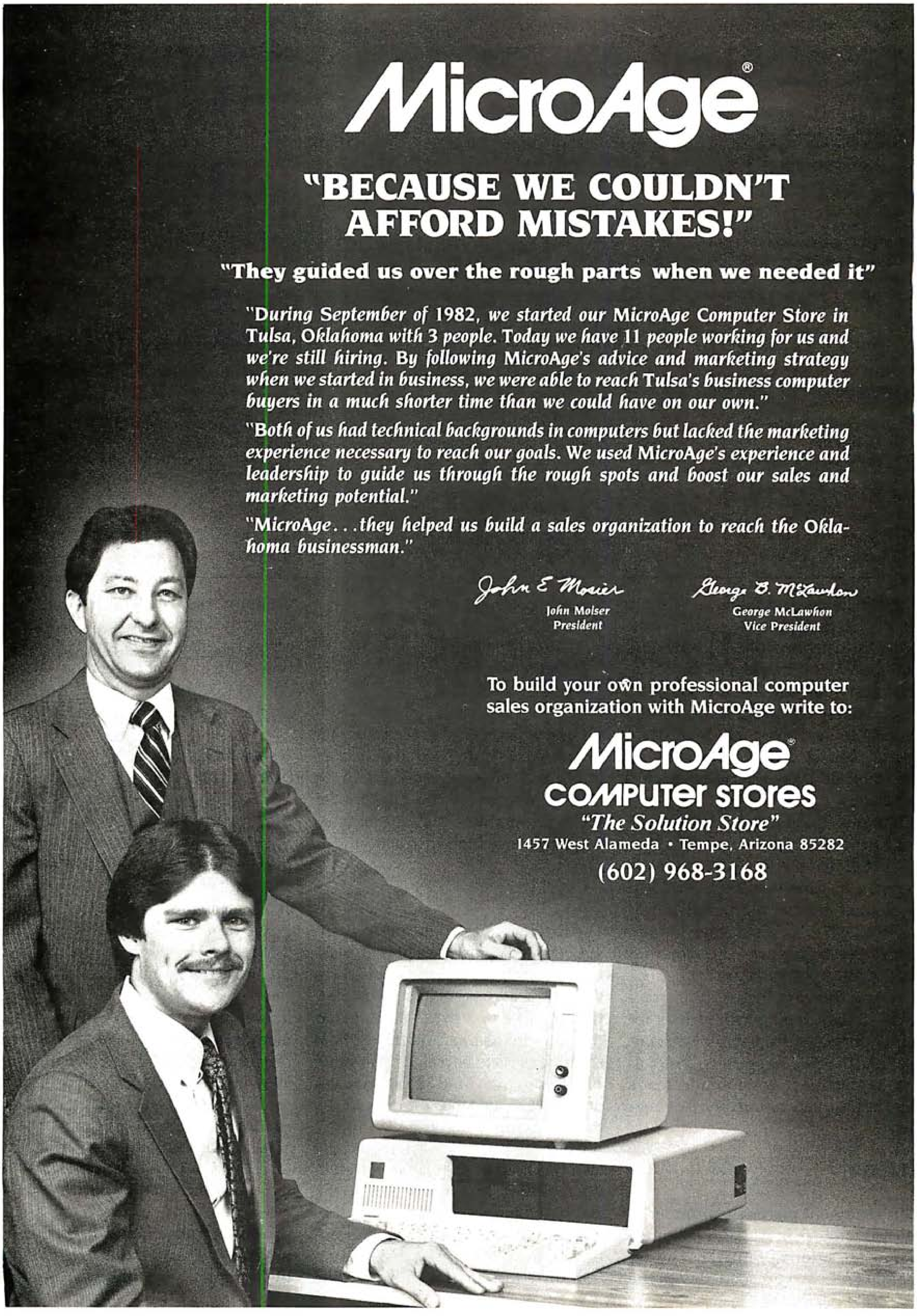

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Table 2 continued:

DEVICE AND FUNCTION	AH	OTHER INPUT PARAMETERS	RESULTS RETURNED
RS-232C I/O–Interrupt 14			
initialize all parameters	0	AL – parameters DX – select card	AX – status
send character	1	AL – character to send (preserved) DX – select card	AH – status
receive character	2	DX – select card	AH – status AL - character received
check status of port	3	–	AX – status
CASSETTE I/O–Interrupt 15			
turn cassette motor on	0		
turn cassette motor off	1		
read from cassette (in 256-byte blocks)	2	CX – count of bytes to read ES,BX – pointer to data buffer	CY: 0 = no error, 1 = error AH – error type for CY = 1 ES,BX – point to last byte + 1 DX – count of bytes actually read
write blocks to cassette	3	same as above	same as above
KEYBOARD I/O–Interrupt 16			
read next ASCII character	0		AH – scan code AL – character value
check if character available	1		Z(flag): 0 = code available, 1 = no code AX – code, if Z = 0
return current shift status	2		AL – status
PRINTER–Interrupt 17			
print character	0	AL – character to be printed DX – printer to be used (0 to 3)	AH – status: 1 = unsuccessful
initialize printer port	1	DX – printer to be initialized	AH – status
get printer status	2	DX – printer	AH – status

Each of these statements consists of an instruction plus two data bytes. Each instruction—B8, BB, B9, and BA—is a "load immediate data" instruction, meaning that the two bytes immediately following it are treated as data to be moved into the appropriate register. For example, the instruction B8 takes the two bytes immediately following it in memory and moves them directly into the AX register. Note that the first data byte is loaded into the low part of the AX register, AL, and that the second byte is loaded in the high part of the register, AH. The other three instructions operate in exactly the same way but apply to other registers.

We can thus use these four instructions to load the specific values required for our screen-scrolling example into the 8088's registers. The following statement, for example, loads the desired values into the AX register:

```
B8,05,06
```

This statement places the number of lines to scroll, 5, in AL, and the direction code, 6 for up, in AH. The remaining registers are loaded with the following statements:

```
BB,00,07 (for BX)
B9,00,00 (for CX)
BA,1E,0F (for DX)
```

Once we have loaded the values into the registers, we need to initiate an interrupt, advising the system to transfer control to the appropriate BIOS subroutine. This step requires the 2-byte machine instruction

```
CD,10
```

The first byte, CD, is the interrupt instruction that instructs the 8088 to look up a table of interrupt addresses to find the address of its next instruction. The second byte, 10, points to the entry in the interrupt table where the address is to be found. The value 10 refers to the video-I/O subroutine of the BIOS, as table 2 shows in the first bold subheading.

After the BIOS has completed the task specified by the values placed in the registers, it returns control to the machine-language subroutine that initiated the interrupt. That subroutine, in turn, requires a final instruction to return control to the BASIC program that called it. This instruction is the single byte CB, which completes the machine-language subroutine. So we can now turn our attention to loading and calling the subroutine from a BASIC program.

Using the Machine-Language Subroutine

We will use the approach discussed in Appendix C, "Machine Language Subroutines," of the IBM *BASIC* manual for loading and calling the subroutine. First, we must make space available for our machine-language program in memory, to ensure that it does not become embedded in the BASIC program. Normally, when the BASIC interpreter is being used, it is spread over all of the available memory space not used for systems programs, as illustrated in figure 2a, allowing no secure location in which to place the machine-language subroutine. To overcome this problem we can use the BASIC statement

```
CLEAR , &H8000
```

as the first statement of the BASIC program. This command instructs the interpreter to confine the amount

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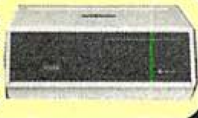

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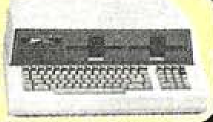

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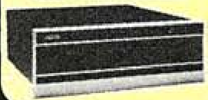

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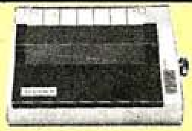

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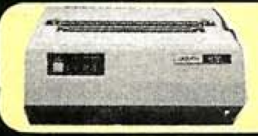

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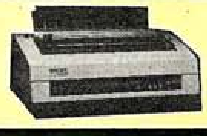


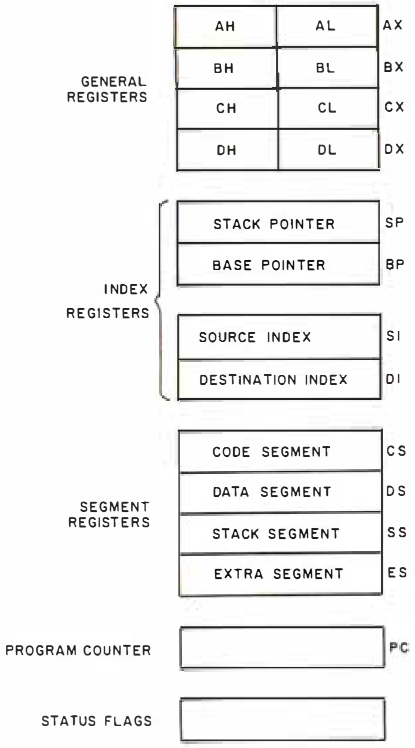


Figure 1: *The 8088 processor's registers.*

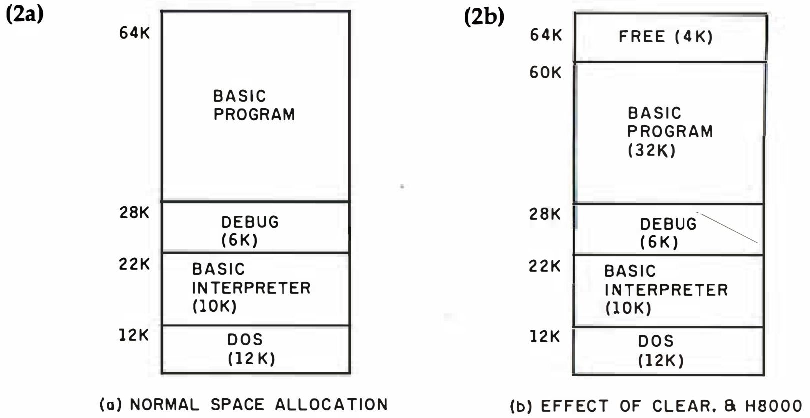


Figure 2: *Memory space allocation, showing the normal allocation (a) and the effect of the CLEAR, &H8000 (hexadecimal), statement (b).*

of memory space used for the BASIC program to 8000 (or 32K decimal) contiguous bytes of memory. The result of the &H8000 command is illustrated in figure 2b. The space available for the BASIC program is squeezed down to 32K bytes after the system programs, which require approximately 28K bytes, using a total of about 60K bytes of memory. The remaining 4K bytes at the top of memory are free for any other use and thus can hold our machine-language subroutine. (While this 4K-byte section is far more space than we require, it keeps the mathematics simple.) This free memory space can be addressed most easily by using the segment address 0F00, so that the addresses seem to start at 0000.

Once the memory space is allocated, loading the machine-language routine from BASIC is straightforward. As listing 2a illustrates, a loop can be used to read in each byte of the subroutine from a data statement. POKE places it directly into memory. Loading the machine-language subroutine is performed once, at the start of the program. Also, the subroutine must be given a variable name, so we have chosen SCREENSUB. It is assigned the value 0. This value represents the offset address within the segment of free memory where the first instruction of the subroutine is located. To initiate action of the subroutine, and through it the BIOS, the following two statements are required:

```
DEF SEG=&H0F00
CALL SCREENSUB
```

The action taken by the BIOS can be controlled by inserting different values for subroutine parameters, using a POKE, before calling the subroutine. To make this task easier, and to lessen the burden of remembering the technical details of the subroutine, variables can be defined and assigned the appropriate offset addresses or action codes as illustrated in listing 2b. Revised values can then be entered prior to calling the subroutine, as the following example illustrates:

```
DEF SEG=&H0F00
POKE SCREENACTIONCODE,
  SCROLLDOWN
POKE SCREENLINECODE, 8
CALL SCREENSUB
```

Debugging the Program

After the BASIC code that inserts the machine-language subroutine into memory has been written, it is a wise precaution to examine the subroutine to ensure that it does, in fact, represent the desired machine instructions. PC-DOS provides a debugging program, which is an excellent tool for both examining the subroutine and observing its operation, instruction by instruction. This may be done as follows:

1. Boot the PC-DOS and invoke the DEBUG facility with the following response to the system prompt:

   A>DEBUG BASICA.COM

   This statement invokes the DEBUG facility and instructs debug to load the BASIC interpreter as the program to be debugged.
2. Respond to the DEBUG prompt with:

   —G

   This character instructs DEBUG to "go" and run the BASIC interpreter.
3. Load your program as usual with BASIC and edit the program to insert a STOP statement after the machine language is poked into memory. Then run your program so that it places the subroutine into memory and then stops.
4. Terminate BASIC by entering:

   SYSTEM

   This command returns control back to DEBUG.
5. Ask DEBUG to give a listing of the

Listing 2a: *Loading the subroutine into memory.*

```
900 DEF SEG = &H0F00
902 FOR I = 0 TO 14
904   READ J
906   POKE I,J
908 NEXT I
910 DATA &HBB,&H05,&H06
912 DATA &HBB,&H00,&H07
914 DATA &HB9,&H00,&H00
916 DATA &HBA,&H1E,&H0F
918 DATA &HCD,&H10
920 DATA &HCB

922 SCREENSUB = 0
```

Listing 2b: *Declaring constant values.*

```
930 DIRECTION          =  2
932 NUMBEROFLINES      =  1
934 BLANKATTRIBUTE     =  5
936 STARTROW           =  8
938 STARTCOL           =  7
940 ENDROW             = 11
942 ENDCOL             = 10
944 SCROLLUP           =  6
946 SCROLLDOWN         =  7
```

Listing 3: *"Unassembled" listing of the machine-language subroutine loaded by the listing 2 BASIC statements.*

```
—u 0F00:0000
0F00:0000 B80506    MOV    AX,0605
0F00:0003 BB0000    MOV    BX,0007
0F00:0006 B90000    MOV    CX,0000
0F00:0009 BA1E0F    MOV    DX,0F1E
0F00:000C CD10      INT    10
0F00:000E CB        RET    L
```

machine-language program with the command:

—U 0F00:0000

This statement is the request to "unassemble" the machine-language instructions starting at memory segment 0F00, offset 0000, where the machine-language instructions have been placed.

The resulting listing gives the machine instructions and the equivalent assembly-language statements. Even if you are not an experienced assembly-language programmer, you should be able to examine this listing and to check that the subroutine is correctly represented. The subroutine developed above is illustrated in listing 3.

You can also use DEBUG to observe (or trace) the step-by-step execution of a machine-language subroutine, examining each transfer of values into and out of registers. As before, start with DOS to debug the program BASICA.COM. This time, to start BASIC use the command G followed by the memory address of the first machine-language instruction:

—G 0F00:0000

The effect of this command is that the DEBUG program inserts an interrupt instruction, CC, referred to as a breakpoint, at memory location 0F00:0000. When this instruction is then encountered during program execution, control is transferred back to debug by the interrupt. DEBUG then displays the register contents at the time of the interrupt and permits you to then trace the execution, instruction by instruction, from that point forward through the subroutine. This breakpoint function (a special debugging pseudoinstruction that stops execution), however, does not quite work when we use the POKE command in a machine-language program, as is the case with our screen-scrolling program.

The reason the breakpoint function doesn't work in this case is obvious (with a little reflection). After DEBUG places the CC instruction in memory and starts execution of BASIC and then your own program, your program will use POKE to substitute the first machine instruction in place of the breakpoint instruction. So the breakpoint disappears! This problem can easily be solved, fortunately, by including as the first instruction of your machine-language program the breakpoint command CC to trigger the DEBUG interrupt. Then, after you are satisfied that the subroutine works correctly, you can remove this instruction for normal operation.

This completes the introduction of the PC's BIOS and the development of a machine-language-interface subroutine to access the BIOS—specifically, the BIOS video-I/O functions—from a BASIC program. While it's not essential that you involve yourself in all of the technical details of debugging and tracing the operation of the subroutine, these details do provide a useful way of becoming familiar with the operation of the PC. In Part 2 we will extend the preceding program to provide a general interface with the BIOS so that you will be able to control all the I/O devices. First, however, let's review all of the BIOS subroutines and all of the 8088's registers to provide the necessary technical background.

Summary of BIOS Functions

The BIOS functions and the parameters for each function are summarized in table 2. These functions provide interfaces to the following devices: the communication port, the keyboard, the disk drives, the printer, video devices (both text and graphics), and the cassette.

Each of these subroutines is activated by an interrupt with an interrupt number (shown in table 2 beside the function name) to identify the routine desired. Each subroutine can perform several different operations, such as read a disk, write data to the disk, format a track, etc., selected by parameter values contained in the 8088's registers. Results from the operations, such as device status or data values, are returned through the same registers. Therefore, an interface subroutine that transfers values between a BASIC program and all of the registers can serve as a general-purpose access to the BIOS.

8088 Registers

Before developing our program, let's examine all of the 8088's registers, illustrated in figure 1. There are three groups of four registers, as illustrated. The four general registers, AX, BX, CX, and DX, which we've already considered, may be used to store or manipulate data or addresses. The four index registers normally contain offset addresses to point to memory locations of data to be acted on. The four segment registers contain segment addresses that are used in conjunction with the offset addresses to define the absolute memory address.

There are two additional registers. The program counter contains the offset address of the next instruction to be executed. The status, or flags,

THE BUFFER DID IT.

Who Stole The 1500 Letters From The Computer?

Let's just say you've got to send a letter to 1500 different people. Would you like to spend 22.5 hours* or 60 seconds of computer time?

With a garden-variety buffer, the computer has to mix, merge and send 1500 addresses and 1500 letters to the buffer. Trouble is, most buffers only store about 32 letters. So after 32 letters, the computer's down until the printer's done. Altogether, you're talking 22.5 hours.

In the case of our new (not to mention amazing) ShuffleBuffer, computer time is 60 seconds flat. Just give ShuffleBuffer one form letter and your address list, and it takes care of the mixing, the merging, and the printing. But that's not all ShuffleBuffer's stolen from the computer. Oh, no.

Who Changed and Rearranged The Facts?

Again, ShuffleBuffer's the culprit. You want to move paragraph #1 down where #3 is? Want to add a chart or picture? No problem. No mystery, either. Any buffer can give you FIFO, basic first-in, first-out printing. And some buffers offer By-Pass; the ability to interrupt long jobs for short ones. But only ShuffleBuffer has what we call Random Access Printing — the brains to move stored information around on its way to the printer. Something only a computer could do before. Comes in especially handy if you do lots of printing. Or lengthy manuscripts. Or voluminous green and white spread sheets. And by the way, ShuffleBuffer does store up to 128K of information and gives you a By-Pass mode, too.

And Who Spilled The Beans 239 Times?

Most buffers can't tell the printer to duplicate. If they can, they only offer a start/stop switch, which means you're the one who has to count to 239. Turn your back on your buffer, and your printer might shoot out a room full of copies. ShuffleBuffer, however, *does* control quantity. Tell it the amount, and it counts the copies. By itself.

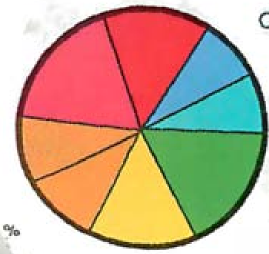
So, What's The Catch?

There isn't any. Sleuth around. You won't find another buffer that's as slick a character as this one. You also won't find one that's friendly with any parallel or serial computer/printer combination. This is the world's only universal buffer.

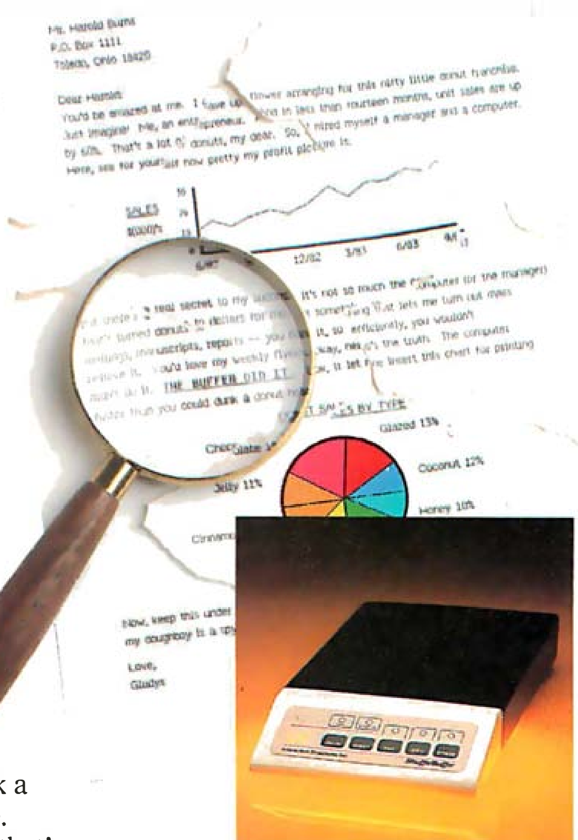
With a brain.

Who Wants You To Catch A ShuffleBuffer In Action?

You guessed it. We do. Just go to your local computer dealer and ask him to show you a ShuffleBuffer at work. Or, you can call us at (215) 667-1713, and we'll clue you in on all the facts directly.



* Based on an average 4000 character letter & 128K buffer.



ShuffleBuffer
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Circle 232 on inquiry card.

register indicates the system status (as described under the R (register) command in the DEBUG section of the PC-DOS manual).

The determination of absolute addresses is based on a standard relationship between the segment registers and the other registers, although this relationship can be overridden at any time by a program. The code-segment register (CS), in conjunction with the program counter (PC), defines the program-instruction area of memory. The data-segment register (DS) is used to define the segment of memory where data values are stored and is typically used with any of the accumulators, if they contain offset address values, or with the source index register (SI). The stack-segment register (SS) is used to define a segment in which to maintain a stack (which may contain return addresses for subroutines, iteration loops, etc.), and the top of the stack is pointed to by the stack pointer register (SP). The base pointer register (BP) is typically used to point to a specific entry in the stack also using the stack-segment register.

Finally, the extra-segment (ES) register is used in conjunction with the destination-index register (DI) to point to the destination addresses for moving data from any location in memory. The powerful MOV (move) instruction uses this destination address in conjunction with a source address provided by the data-segment register and the source index. MOV also enables bytes to be moved between any two locations in the main memory space. We will be using this instruction for a subroutine presented in Part 2.

While the machine instructions for these registers are for the most part straightforward, note that it is not possible to move data values directly into the segment registers. Instead, one approach, which we will use next month in Part 2, is to first move data into the AX register and then move the data from there to the segment register. ■

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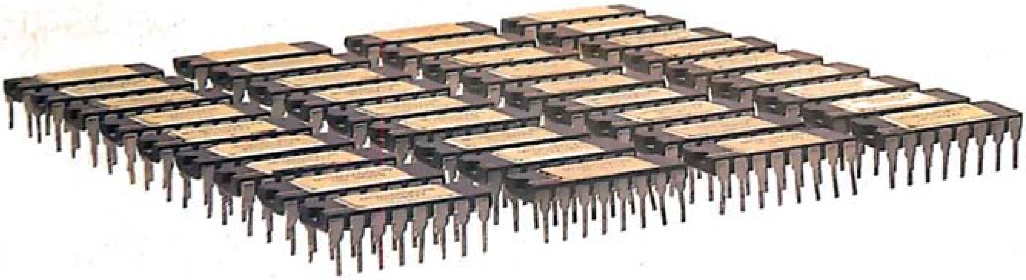
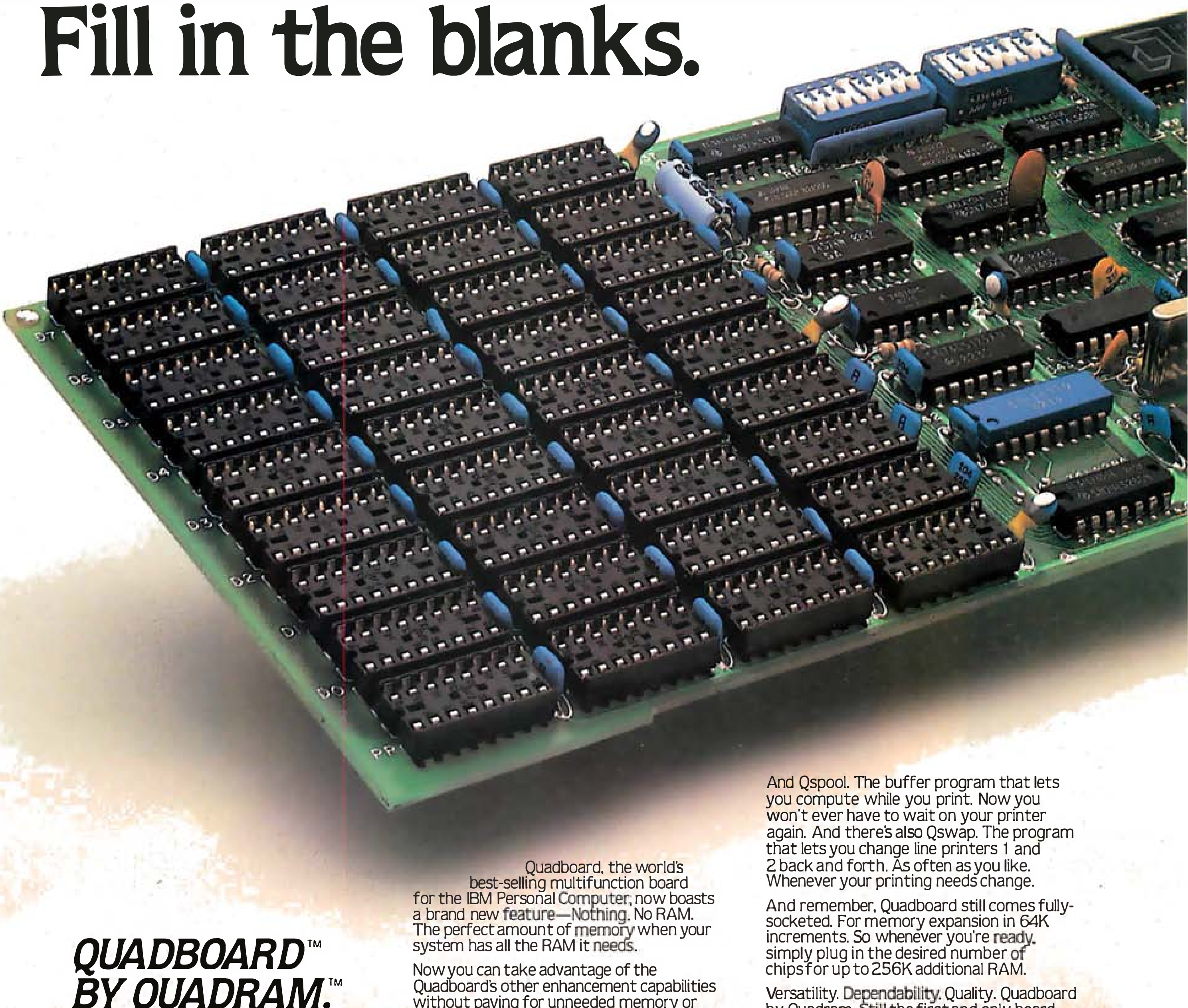


Fill in the blanks.



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Could 1,000,000 IBM PC Users Be Wrong?

IBM, the PC, and the Future

by Frank Gens and Chris Christiansen

In the early 1900s, IBM, then called the Computing-Tabulating-Recording Company (CTR), leaped from obscurity by automating the US census with a device known as the Tabulating Machine. In 1983, IBM appears poised to make another quantum leap by automating everyone from Fortune 500 executives to grade-school children. The vehicle for this revolution? The great-great-grandchild of the original CTR Tabulating Machine—the IBM Personal Computer.

Should IBM begin shipments of the Peanut this fall, the company will have shipped nearly 1 million of its Personal Computers (PCs) to large corporations, small businesses, professional offices, schools, and home users by the end of 1983. This is an impressive feat for a company that was not present in the personal computer market until a little over two years ago.

In this article we'll look at why the PC enjoys such wide market acceptance, the PC's profound effect on both "Big Blue" itself and the personal computer market as a whole, and the directions in which IBM will push its fastest growing product.

The PC's Impact on IBM

IBM's view of the PC has gone through a number of changes over the past three years. The PC was probably originally developed as a defensive product meant to keep other microcomputer suppliers from infiltrating IBM's large accounts. And, of course, it was intended as an experimental vehicle into new markets.

As the PC actually began to make a substantial contribution to the company's bottom line, the corporate office began to take notice. The potential strategic utility of the PC was studied, and IBM concluded that by encouraging proliferation of the PC in large corporate accounts, it could stimulate a grass-roots demand for its large computer systems through increased demands for communications networking, database access, and the necessary support. IBM decided to bring the PC into the mainstream of its product lines as the foundation upon which to build its advanced workstations/terminals.

On August 1, 1983, IBM formed a new manufacturing and development division—the Entry Systems Division (ESD), headquartered in Boca Raton, Florida. The division is responsible for a number of workstation products, including the PC and the PC XT.

Perhaps the most significant thing about IBM's formation of ESD is that it indicates just how pivotal a product IBM now considers the PC. ESD, essentially run by former PC product-management personnel, has responsibility for products formerly in IBM's Systems Products and Communications Products divisions. This makes it clear that the PC is assuming a position of importance in the corporation that may soon be second only to IBM's mainframe line.

Because the success of the PC thus far has been mainly a result of user enthusiasm, the formation of ESD raises an important question: how much more dominating a product in the personal computer market will the PC be with top-to-bottom corporate muscle behind it?

What's So Great About the PC?

For the past two years an ongoing debate has been taking place among personal computer users, vendors, industry analysts, and myriad others over the technical merits of the PC. These debates usually revolve around such issues as performance of the 8088 versus other microprocessors such as the Motorola 68000 or Intel's own 8086; the merits of MS-DOS versus CP/M-86, the UCSD p-System, Unix, C, and others; and the extent of special capabilities such as high-resolution color graphics.

The controversy surrounding these issues grows larger with the seemingly daily entry of new microcomputer vendors into the market with machines and operating systems that

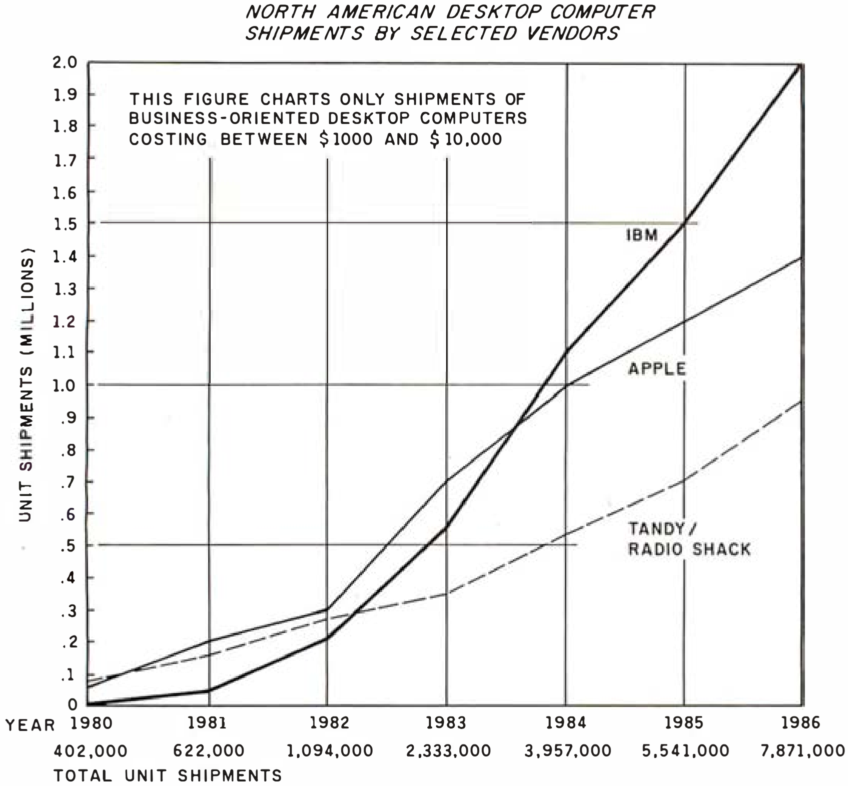


Figure 1: *This figure depicts the North American shipments of business-oriented desktop systems costing between $1000 and $10,000. While Tandy (Radio Shack) was an early leader in the personal computer market, it was eclipsed by Apple, whose market position is now threatened by IBM.*

reportedly take greater advantage of recent technological advances than the PC.

The Real Battle: Market Acceptance

The great irony, however, is that as the debate raged on through 1983, IBM quietly, but surely, began taking its position as the second leading vendor, number one being Apple Computer, in the over-$1000 market and is poised to take the leading spot in the home-oriented under-$1000 market. (See figure 1.)

In spite of the debate about the PC's technical merits, there can be no doubt that its market accomplishments are nothing short of spectacular. Since its introduction in September 1981, the PC has:

- taken IBM from a 0 percent share to number three in the market with an 18.8 percent share of 1982 shipments; by this year's end, it is expected that IBM will have attained the number two position with a 26 percent share
- established MS-DOS as the leading operating system for 16-bit personal computers
- established the Intel 8088/8086 microprocessor family as a personal computer industry standard
- garnered almost unparalleled support from third-party software and hardware vendors
- stimulated tremendous growth in the personal computer market—the corporate personal computer market has grown threefold from 1981 through 1983
- prodded other minicomputer and mainframe vendors—including Digital Equipment Corporation, Data General, Wang, Burroughs, and other companies—to enter the market
- revolutionized IBM's—and the industry's—view of personal computers; personal computers have taken on strategic importance for IBM and other large information system vendors
- changed many users' views of personal computers from novelties/toys to integral pieces in the corporate information system.

Technological Elegance: An Apparent Irrelevance

The PC's track record provides a dramatic demonstration that technological elegance and a leading price/performance position is almost irrelevant to market success. Indeed, our research indicates that the most important factors in the acceptance of any personal computer by end users are vendor recognition, applications software availability (vendor and third-party), a reputation for product reliability and support, moderately competitive pricing, and an assurance that the vendor won't disappear in the impending personal computer market shakeout.

For the novice personal computer buyer who craves a security blanket, vendor recognition, reputation, and stability are the most critical factors. For the experienced personal computer buyer, software and third-party hardware support are major purchase incentives. Moveover, these factors are also major selection criteria for personal computer retailers, who account for roughly two-thirds of all PC sales. With well over 150 personal computer manufacturers currently in the market and retailers providing shelf space for an average of only five or six products, satisfying retailers' selection criteria becomes at least as important as satisfying end users.

Our research indicates that with retailers, as with end users, technical characteristics play a relatively minor role in personal computer selection. Key selection criteria for retailers include support (documentation, training, service), margins and quantity discount schedules, and end-user preferences.

The PC as a Market Standard

IBM's success in the volatile personal computer market clearly shows that "me-too" technology is not a detriment to market acceptance and may in fact aid in market acceptance. The reason? Standards.

The PC has provided third-party vendors with stable, de facto standards upon which to design applications software and hardware enhancements, and the activity that the

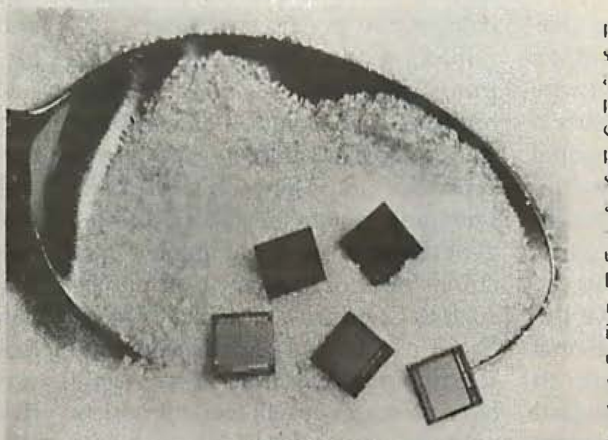
BYTE'S BITS

Welcome, IBM, to personal computing

With the announcement of the IBM 5100 system in a press release dated Sept. 9, 1975, personal computing gains an entry from the industry's production and service giant, IBM. The IBM 5100 is being marketed primarily as a *problem solver* for industrial, commercial and professional people — with the result that it is a very professional package at a premium price. But you will get a lot of function when you buy one of these computers — and you'll be able to call upon IBM's longstanding reputation for good service and customer handholding, the points which have led to the commendable success of IBM as a computer company.

What IBM engineers have done is to design a 50 lb-package of interactive personal computing which includes the following major features as standard items:

- System software is built-in, with access to BASIC and/or APL depending upon options purchased. These languages and the necessary monitor programs are hardwired into a read only memory.
- A video screen is built-in, with up to 1024 characters displayed in a 16-line by 64-character format.
- An interactive keyboard is standard, including the usual text entry section as well as a separate calculator style keypad. The keyboard has special function coding for all the APL and BASIC syntax elements.
- User memory starts at 16K bytes in the minimum configuration and can be expanded to 64K bytes (65,536).
- A magnetic tape cartridge storage device is standard. This is built into the unit, and becomes the primary method of storing user data and programs. It is also used to load IBM supplied programming packages. The cartridges for this device hold up to 204,000 characters of information.



You get all this function and professionalism from IBM by paying a high price. This machine is not intended to be a toy, although it would make an excellent one. It is intended as a production tool for people who presently use time sharing terminals, programmable calculators or other personal computers in daily work. Prices mentioned in the press release are:

- IBM 5100, processor . . . $8975 to $19,975, depending upon user memory (16K, 32K, 48K or 64K bytes) and language (APL or BASIC or both) options.
- IBM 5103 printer . . . $3,675 purchases an 80 cps 132-column dot matrix line printer.
- IBM 5106 Auxiliary tape unit . . . $2,300 purchases an additional tape cartridge drive to augment the functions of the built-in drive.
- "Problem Solver Library" software is available for a one time *rental* of $500 including a wide range of utility and applications software with interactive user sequences.

Miscellaneous features also available for the machine include a TV monitor output, the external I/O adaptor used with the 5103 and 5106 devices, a communications adaptor which makes the 5100 emulate an IBM 2741 communications terminal, and a carrying case.

As an IBM engineered product, you can expect a solidly built computer. If you are a business or professional person needing a high quality calculational and programming tool, then you should investigate the 5100 as an item of capital equipment — which you can incidentally use to program numerous BASIC games when you're not using it for business. But if your sole interest in the machine is as a luxury toy, you have to be moderately well off to purchase the IBM 5100 at its present price. ■

90

And we were there: BYTE's first mention of an IBM personal computer appeared in the December 1975 issue.

PC has stimulated in the third-party world has been spectacular. For example, we estimate that approximately 10 new PC products from both IBM and third-party vendors are announced daily. IBM estimated that, as of mid-1983, at least 3000 hardware and software products from 2500 vendors were available for the PC, compared with 1250 products in mid-1982. And this number is expected to grow to more than 6000 by the end of 1984.

We've also estimated that approximately 2000 applications packages run under the IBM operating system, PC-DOS, which is actually Microsoft's MS-DOS in disguise. When compared to an estimated 3000 Apple, 3000 Tandy, 5000 CP/M, and 2000 other applications running under various other operating systems, the MS-DOS application library is small. But it is important to note that MS-DOS has been in common use for only two years, and software "hits" such as Lotus Development Corporations's 1-2-3 are developed primarily for MS-DOS environments. (These figures are for nongame applications.)

In other words, MS-DOS is currently the fastest growing of the leading operating systems. We expect that by late 1984 or early 1985, MS-DOS will have the largest library of applications.

Helping or Hindering?

How does the PC affect the personal computer industry? IBM's stimulation of third-party hardware and software development exerts a stabilizing influence on the personal computer market. But is this stabilization good or bad for the industry at large? Will de facto standardization around the PC architecture limit the development of new alternative designs? In five years, will the personal computer market be saddled with an aging and nearly obsolete standard architecture, much as the mainframe market is tied to IBM's S/370 architecture?

Clearly, the PC stimulated software development for the MS-DOS operating system. Moreover, IBM's de facto standards provided the stable

(2a)

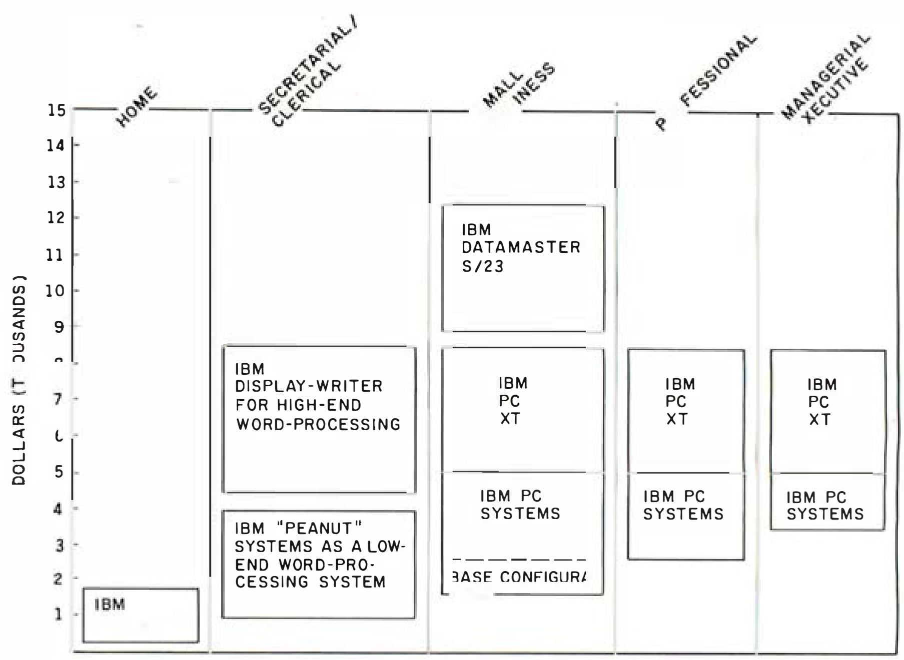


Figure 2: *Markets for the IBM PC and family in (a) 1983 and (b) 1986. Based on the IBM PC, this broad line of products will not be limited to the 8088/8086 chips from Intel but could include microprocessors from Motorola, National Semiconductor, and Harris.*

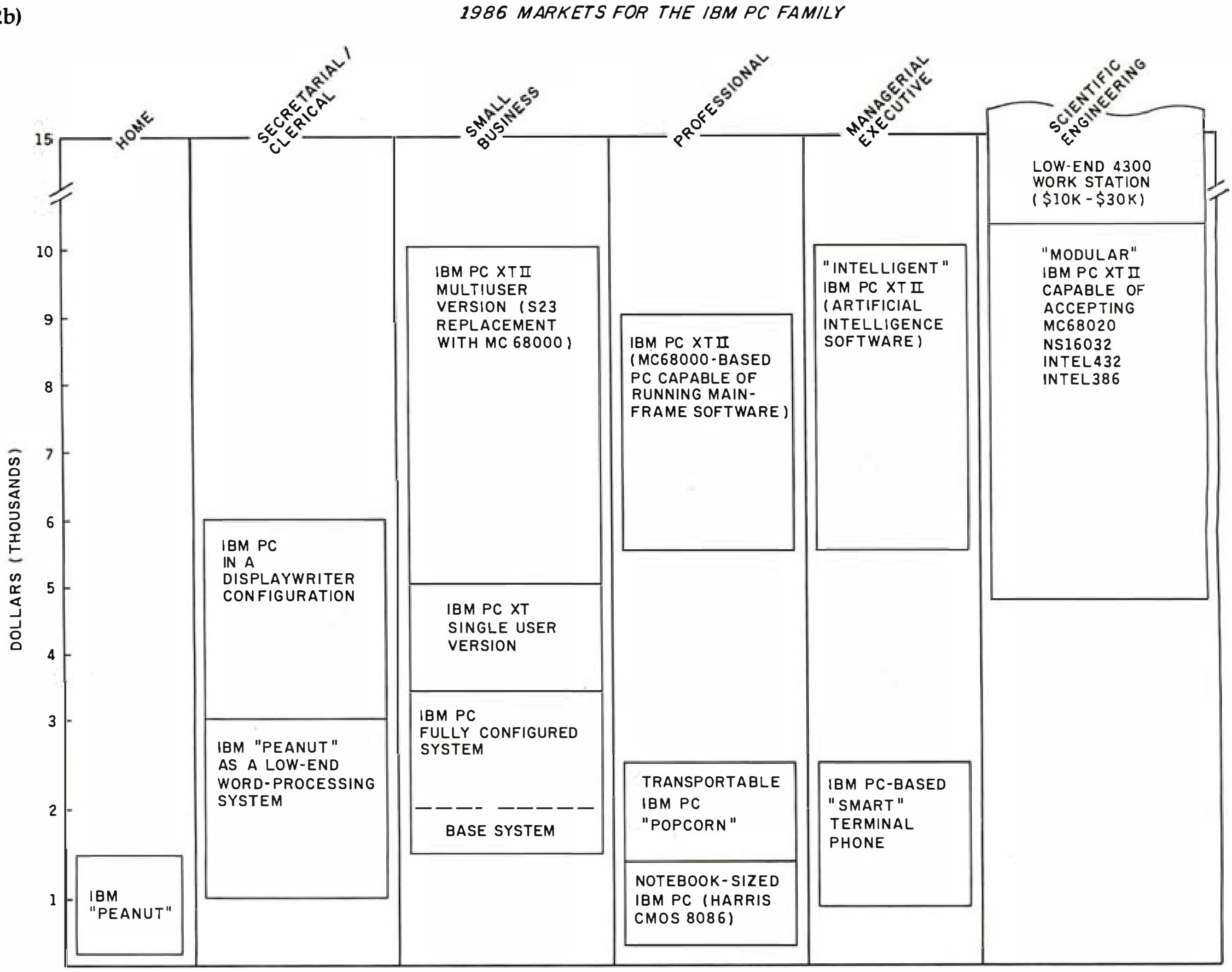
environment necessary for the costly development of products such as 1-2-3, Visicorp's Visi On, and Quarterdeck's DesQ, along with many other unannounced products. On the other hand, many software developers decided against working with operating systems such as the UCSD p-System, Pick, Oasis, TurboDOS, Unix, and others. In some cases, these operating systems offer features superior to MS-DOS, but they are not blessed with IBM's sanction and/or a competitive pricing structure.

IBM's effect in other personal computer marketplaces is also ambivalent. The evolution of a de facto standard based on Intel's 8088 microprocessor and Microsoft's MS-DOS operating system created an all-new generation of plug-compatible machines/manufacturers. Companies such as Compaq, Columbia, Corona, Eagle, Gavilan, Texas Instruments, Tandy, and reportedly even Apple have products or will focus products on these standards to take advantage of IBM's constrained production and deficiencies in the PC's hardware (such as a lack of monochrome graphics and the PC's awkward keyboard).

However, while IBM created a new IBM-compatible market for many small personal computer vendors, it also destroyed the market for some older machines. Traditional vendors such as North Star, Cromemco, Vector Graphic, and others are seeing their customers lured away by IBM and the IBM compatibles. While many of these vendors offer 8088- or even 68000-based machines, they are having a rough time competing for shelf space and users' attention in the face of advertising blitzes from IBM and its growing legions of compatible vendors.

Even third-party hardware vendors such as Tecmar and AST—which exist primarily to supply peripherals and enhancements for the PC—find IBM's presence in the personal computer market a mixed blessing. While IBM takes its time providing enhancements such as expansion slots, hard disks, and the like, third-party vendors thrive by filling the gaps in IBM's products. However, history shows that once third-party vendors pioneer and successfully market a new product or enhancement, IBM eventually—and inevitably—offers similar products. Memory boards, communication devices, color monitors, and hard disks are all good

(2b)



examples of this strategy.

The key to surviving as a third-party hardware supplier for the PC is continually keeping one step ahead of IBM. For example, a vendor producing hard disks or color monitors for the PC must continue to anticipate (or, better, stimulate) demand for other new hardware enhancements once IBM decides to offer those products itself. Such areas currently include mouse cursor controls, monochrome graphics boards, and high-resolution color graphics boards.

Future Directions for the PC

IBM has stated that the PC's modular architecture is designed to last five years—the standard depreciation period for office-automation equipment. This means several things:

First, IBM will stick with the PC's present 8088/8086-based architecture until at least 1986. For low-end products, the Intel 8088 will remain the processor of choice, but high-end models will offer Intel's 80186 and 80286 along with optional boards based on Motorola's 68000 and possibly National Semiconductor's NS16032. Figure 2 shows how the PC markets are expected to develop.

IBM will incorporate new technological developments through the modular addition of hardware, primarily through the use of coprocessors. For example, IBM will probably offer Intel's 80370 chip to enhance text processing by displaying 66 lines on a standard monitor. IBM has also mentioned Intel's 80270 chip to upgrade the PC's graphics capability. (You should remember that while the graphics chips from Texas Instruments and NEC may offer superior features, IBM owns a reported 13 percent share of Intel.) Because IBM does not intend to offer a full-page display or very high-resolution graphics, these areas represent real opportunities for third-party vendors.

The recent announcement of a math coprocessor, Intel's 8087, is the first implementation of IBM's strategy to use the PC as a "chassis" for multiple microprocessors/coprocessors. Still other chips such as Intel's 8089 (which fits into the same slot as the 8087) will increase the PC's speed by handling I/O (input/output) processing. The most exciting development, however, will come when a 68000 board from IBM is announced for the PC and the PC XT.

While that seems a contradiction of previous statements concerning IBM's commitment to Intel and the 8088/8086 architecture, it isn't really. IBM already sells a 68000-based product, the CS 9000. Developed by the IBM Laboratory Instruments division, the 9000 was recently offered to qualified value-added remarketers (VARs) and Hamilton-Avnet, an industrial distributor. In addition to high-level graphics and many other advanced features, this machine runs under a proprietary multiuser operating system similar to Bell Laboratories' Unix. Through VARs, this machine will be adapted to run Unix Version V and will be sold through retailers and systems houses (with IBM's blessing) as an alternative to Fortune Systems' 32:16, Digital Equipment Corporation's Professional Series and the Micro PDP-11, Data General's recently announced Desktop Generation Series, and Honeywell's Microsystem 6/10.

IBM took a beating in the minicomputer market several years ago, and revenge may be on its mind in the "super" microcomputer market. IBM's tacit endorsement of Unix further opens up this market to software developers, especially with the probable emphasis on Unix Version V and the agreement among Bell Laboratories and three prominent chip vendors—Intel, Motorola, and National Semiconductor. We believe that IBM may eventually offer an MC-68000-based board for the PC and future high-end PC models. Much like other personal computers that feature two or more different microprocessors (such as the Radio Shack Model 16 with a Z80 and an MC-68000), the PC will be able to run 8088/8086 or MC-68000 modes.

Furthermore, we believe that IBM will eventually offer an S/370 board that will run IBM mainframe software, most likely under the VM operating system. In fact, IBM already has implemented portions of the S/370 instruction set on MC-68000s.

New Models

Within the next six months, we expect IBM to introduce several new members of the PC family. By the time you read this, IBM finally should have plunged into the home personal computer market with the long-awaited "Peanut." The Peanut will cost $600 to $700 (base price), be transportable (weigh in the 10-pound range), and offer some compatibility with the PC and the PC XT.

This winter, IBM will introduce a high-end member of the PC family—the PC-3. The PC-3 will be priced between $7000 and $9000, be based on an Intel 8086-class chip (perhaps the 80286), and will functionally displace the IBM Datamaster. We expect that by the end of 1983, IBM will introduce a $2000 to $3000 *portable* personal computer.

Beyond these near-term product announcements, you can make a fairly good guess at what other personal computer products IBM is planning to introduce over the next 12 to 18 months by looking at the recent organizational changes within the company. In addition to the PC, the other products assigned to the new Entry Systems Division read like a list of products ripe for replacement by the PC or PC family members. These products include the Displaywriter, the Datamaster, and the 5280 Data Entry System. Each of these will be functionally replaced by PC follow-ons that are 8086-based and offer greater flexibility, particularly in regard to keyboard selection.

Another product included in the new division is the 5520, essentially a shared-logic word processor. The 5520 (or its successor) will play a key role as a cluster controller for IBM's PC products, especially in office environments.■

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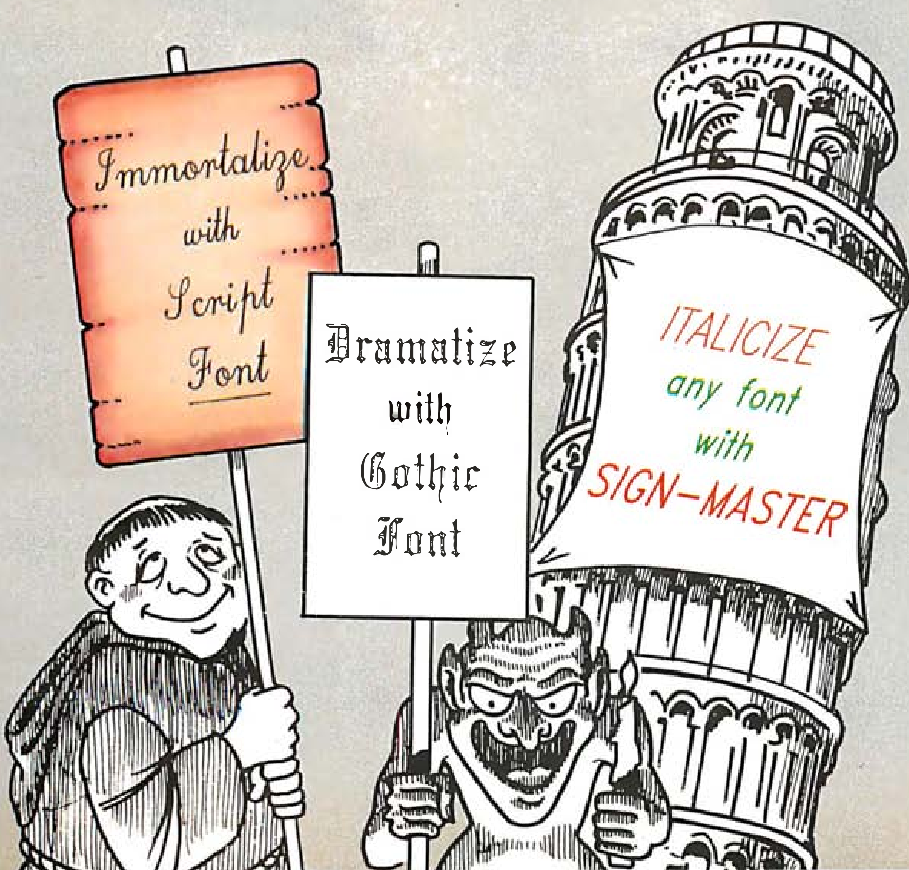
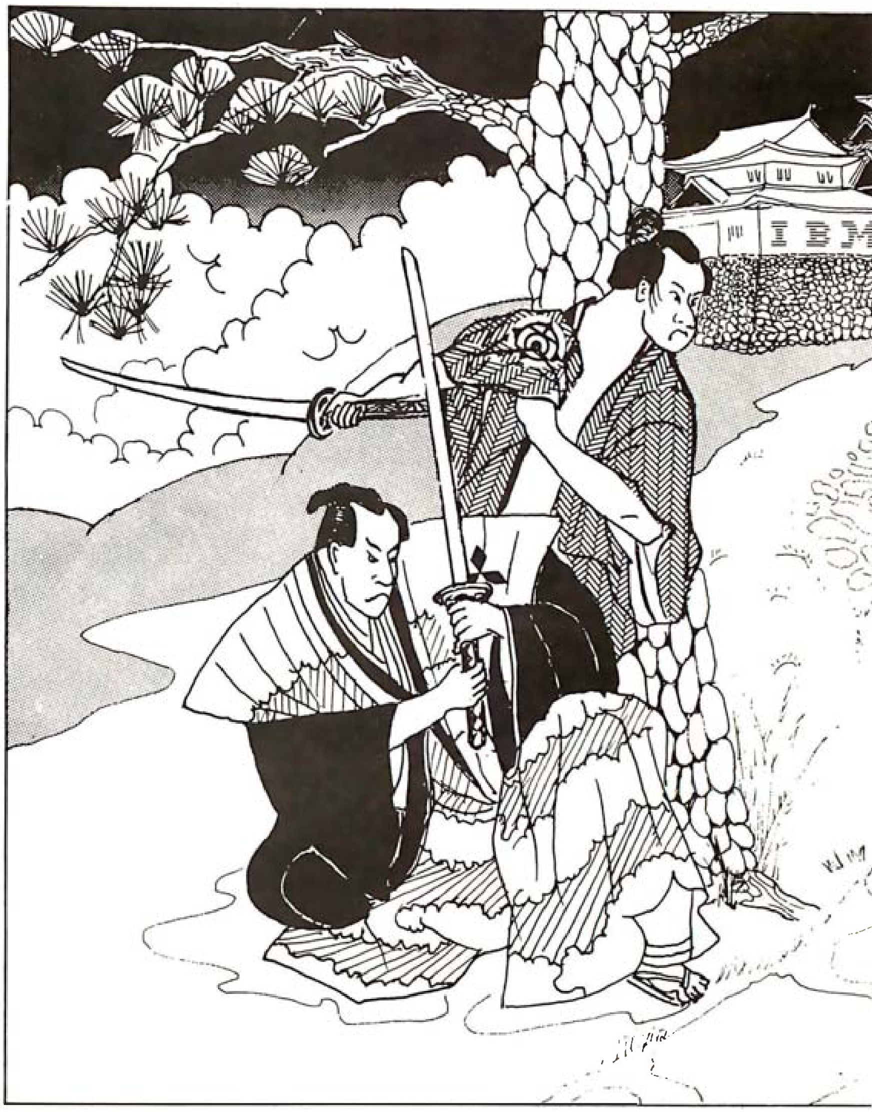


BIG BLUE GOES JAPANESE



by Richard Willis

Visitors to this year's National Computer Conference (NCC) in Anaheim were met with a kaleidoscope of new products out to exploit the microcomputer boom from every conceivable angle. But one product bound to have an enormous impact in its marketplace, a product with the IBM label, was tucked in a small niche of the Microsoft booth. A number of fiberglass pavilions were added in the Convention Center parking lot to accommodate all the NCC exhibitors, and an unusual May heat wave turned the unventilated shells into high-tech saunas. One sales rep cut the legs off his wool suit slacks, and many of the electronic marvels fizzled out in the heat. But IBM Japan's new 5550 Multistation was plugging along, quietly displaying a Japanese-language version of Multiplan developed by Microsoft for the machine. Although the system had been announced in Japan in mid-March, this was the first opportunity to get a good look at the hardware. And a pretty impressive look it was.

The 5550 system is not available in the US as of this writing. Little about it has been published in English. But if IBM Japan's extraordinarily broad plans for marketing the machine in Japan are any clue, we may soon see a similar machine here in America. The original IBM PC was released into a somewhat vaguely defined market, somewhere between hobbyists and small businessmen. Online communications capability was not a major selling point in early product literature. After 18 months and delivery of 300,000 units, there is no longer any doubt about who buys PCs and why. Small businesses do their bookkeeping and correspondence with PCs, and Merrill Lynch has ordered one for every broker

(Illustration © 1983 by Michael Nakayama.)

(12,000) in the company. IBM has legitimized the personal computer for business applications and catalyzed a multibillion-dollar market.

The real question now is where IBM goes from here. There is considerable speculation about the company's downscale plans, its move into the true home-computer market with the machine code-named "Peanut." But there is also a considerable gulf above the PC. The company's recently announced small business computer, the System/36, is priced in the $25,000-to-over-$100,000 range, with a per-user cost for a small system (say, four user terminals) of over $10,000 (the per-user cost drops with larger systems). And there is currently a strong demand from customers to put a reasonable amount of computing power at each workstation rather than running terminals (even intelligent terminals) from an expensive central processor. The company's Datamaster and Displaywriter systems are not designed for low-level networking (i.e., networking without a large central mainframe) or distributed database systems. And IBM does not support these capabilities in its PC.

The 5550 is just the product to meet these demands. Many desktop computer makers have taken to calling their products "workstations," but the 5550 is a true workstation. It is designed from the ground up to provide an easily accessible software environment for three major business applications: word processing; computation (spreadsheet, accounting, and the like); and online terminal communications. The machine packs a significant amount of computing power for the price: an 8086 microprocessor running at 8 MHz; 256 to 512K bytes of main RAM (random-access read/write memory); up to three 640K-byte floppy-disk drives, or one floppy disk and an 8.1-megabyte hard disk; 1024 by 768 dot graphics (with the large-format monochrome display); and fully supported communications interfaces. And the price: complete systems with software range from $5200 for a minimum configuration (256K-byte RAM, low-resolution character generation, two floppy disks, DOS, BASIC, word-processing software) to $10,000 for a top-of-the-line model (512K-byte RAM, hard and floppy disks, communications interface, software). Although these numbers are enhanced somewhat by the current overvaluation of the dollar with respect to the yen, they are clearly in the right ballpark for distributed office automation systems. The System/36 may be able to compete cost-wise in large network applications, but the 5550's powerful stand-alone capabilities make it an almost unbeatable bargain. The 5550 may well be the harbinger of workstations to come in the American market. Of course, this is mostly conjecture; IBM keeps its plans guarded in deafening silence.

The most distinctive features of the 5550 Multistation will most certainly not show up in the US; this machine offers unprecedented power in handling the Japanese language, including its thousands of pictographic *kanji* characters. Japanese computers have long been limited to using *kana*, the Japanese phonetic alphabet (see the text box on the *kana* keyboard on page 150), which is seriously handicapped in ordinary textual applications. The 5550, however, actually analyzes the semantics of a sentence and decides which *kanji* to insert for each word typed in *kana*. The operator merely supervises the process and clarifies any misunderstood words. In the past year or two, some Japanese stand-alone word processors and small computers have offered similar semiautomatic *kana*-to-*kanji* conversion. But the capability of this machine to provide high-performance word processing, as well as communications and personal com-

IBM Japan: A Chronicle of Shifting PC Strategy

The following is a translation by Richard Willis of an article that appeared in Nikkei Computer, *May 30, 1983, pages 54-55.*

IBM Japan's personal computer activities can be traced back seven years to the announcement of the IBM 5100 system in May 1976. The 5100 was a complete, integrated desktop system and included a 5-inch black-and-white display, a 3M-type cartridge-tape drive, and an APL keyboard. With this machine, IBM was aiming at the scientific and technical computation market, as well as small-scale measurement-and-control systems. An IEEE-488 parallel interface and an RS-232C serial interface were included.

The 5100 was also intended to function as an APL or BASIC language terminal with IBM's larger mainframes. Therefore, an APL interpreter and a BASIC interpreter were chosen as the system's resident languages. For generating graphs and diagrams, a library of APL graphics routines was included in the 5100's software library, with a wire dot-matrix printer performing the function of a printer/plotter.

In reexamining the 5100 in light of the current state of the art, several weaknesses stand out. The screen was quite small, there was no capability to use floppy disks, and the price was quite high, nearly 3 million yen [Translator's note: about $10,000 at 1976 exchange rates]. Having pointed out these shortcomings, we nonetheless can see many similarities between the 5100 and current PCs. Although the 5100 was not necessarily a commercial success, it should be said that it was a remarkable technological feat for an APL interpreter running on such a small machine to perform with sufficient speed to be of practical use.

In January of 1978, IBM announced the 5100's successor, the 5110. Its main differences from the 5100 were that it supported floppy-disk drives and used BASIC as its standard language, with APL as an option. Apart from these and a few other details, the fundamental configuration was the same as the 5100. Since that time, IBM has upgraded the machine's capabilities by selling a simple program-generator language called BRADS.

By this time, IBM had reached a turning point in its PC strategy. It had been expected that the APL capabilities of IBM's PC would be a major selling point, but instead, IBM began to modify its product line so that it would appear directly competitive, function for function, with American Hewlett-Packard's series of personal computers, which supported BASIC. This transformation should probably be viewed as a response to demands from the marketplace as well. Prior to this time, IBM's PC strategy seemed to be linked to their strategy of vigorously promoting the dissemination of APL. However, since the introduction of the 5100, the number of APL users had not grown to the extent forecast by IBM. The principal reason for this is generally felt to be the difficulty posed by APL's complex syntax. It is probably accurate to say that, faced with the strong demand for the BASIC language in the PC market at that time, IBM had no choice but to change its course.

IBM 5550: A Significant Departure from Past Practice

After the 5110, the complexion of IBM's PC changed, with subsequent machines displaying less of an orientation toward engineering applications and more toward business. The 5110's successor, the 5120, announced in February of 1980, was tailored almost entirely to business applications. Among other things, the IEEE-488 interface was dropped, and ISAM (indexed sequential-access method) file support was implemented. Before long, hardly anyone considered using the 5120 or its successor, the System/23, for engineering applications. The System/23 was given the model designation 5322, indicating that it was not considered to be a part of the 5100 product line. In looking at all this, one can see IBM's original PC strategy fading from the market, along with the 5110, and disappearing altogether with the introduction of the 5120. The 5120 was given a larger puting functions, in an under-$10,000 package will make it a formidable competitor in the red-hot Japanese market.

Not surprisingly, the other players in that market have started taking their shots at the giant. The 5550 system is not without its flaws. The word-processing software and the conventional computational software run under two different, incompatible operating systems. Even the character codes used by these two operating systems are different—one is based on EBCDIC (extended binary-coded-decimal interchange code), the other is the Japanese standard code—thus file sharing is currently not possible. The color display offers very good resolution (360 horizontal by 512 vertical addressable pixels), but only four colors are available in graphics mode (eight in character mode). These and other shortcomings are not escaping the notice of other Japanese computer manufacturers, who are working with altruistic fervor to inform the public.

But no one is betting heavily against the 5550's success. After less than six months on the market, it has already begun to spawn the same sort of mini-industry that has grown up around the American PC. A couple of independent magazines about the 5550 have premiered, and independent sales organizations are lining up to offer systems integration and programming support for the new machine. Several Japanese manufacturers will benefit as well. With the PC, IBM broke with tradition by procuring a number of major components from outside sources—chips from Intel, the system board assembled by SCI Systems Inc., drives from Tandon and MPI, and printers from Epson. IBM Japan is following suit. The 5550's system unit, including disk drives, is built by Matsushita Electric (makers of Panasonic equipment), the printer by Oki Electric (Okidata), and the keyboard by Alps (a major manufacturer of electromechanical devices). The current production rate of 2000/month is still fairly low, but that will undoubtedly change as the machine starts getting out into public view. There is much to be impressed with in the 5550 Multistation. Let's start with a fairly detailed look at the hardware.

Dissecting the Hardware

The physical configuration of the 5550 reflects the current emphasis on ergonomic design for workstations (see photo 1). The main system box is proportioned to fit to one side of the operator, thus enabling the display screen to be mounted in a lower, more comfortable position. The keyboard profile is the same as the original PC's, but the detached unit was made somewhat wider to accommodate 50 percent more keys. IBM also offers an adjustable, split-level desk and a tilt/swivel display mount to allow the user to set up the workstation to his or her own liking. This is all in marked contrast to the PC, which does not exactly blend in with a working desktop environment.

Examining the main system unit (model number 5551), the first thing that strikes someone with an electronics background is the quality and density of the packaging. The original PC, even with disk and display controllers and the inevitable multifunction expansion board, is wide open by comparison. Three densely packed circuit boards, a switching-mode power supply, up to three 5¼-inch floppy-disk drives (or one floppy disk and an 8.1-megabyte hard disk), and a five-slot expansion cage are mounted within the system unit case (slightly over 10 inches wide by 12 inches high by 16 inches deep). In overall construction, the inside looks more like a high-quality test instrument than a PC.

The system processing functions are spread over three 9- by 12-inch circuit boards: a microprocessor/memory board, a disk controller/clock board, and a video RAM board. There are two buses in the system unit, a main system bus (120 pins, .1-inch pitch), and a disk control bus (86 pins, .1-inch pitch). All three boards plug into the system bus, but only the disk controller board picks up the disk bus. The system bus is extended into the expansion cage by means of a full-width flex-circuit jumper cable, which has to perform some minor gymnastics to mate the horizontally mounted main motherboard to the vertically mounted expansion cage backplane. The disk control bus and the power harness are also carried on flex-circuits; with the exception of the two leads from the lithium battery that sustains the real-time clock, there is not a wire to be seen in the package.

The microprocessor/memory board is a multilayer board of extremely high density containing an Intel i8086-2 16-bit microprocessor running at 8 MHz. Though both the i8088 used in IBM's American PC and the 8086 used here are 16-bit processors

9-inch screen, and its overall configuration resembled the System/23 rather than the 5110.

There would seem to be little or no relation between the recently announced IBM 5550 and the 5100 or System/23 product lines. [Translator's note: the model number of the American PC is 5150.] The 5100's distinguishing feature was its APL orientation, while the System/23 was an office computer. With the 5550, though, IBM is aiming at the so-called workstation concept. The user need not have any special programming skill in order to tap the capabilities built into the machine; the three software functions provided by IBM (as touted in the company's "one machine, three roles" slogan) can be mastered with little difficulty.

IBM's main operating system for this machine is Japanese Language DOS, developed by the American company Microsoft. Since IBM's expertise in software has been a major selling point of its computers, it is quite a departure for it to have relied on an outside company in this case. However, even IBM Japan now admits quite frankly that it is changing course. "The era of relying solely on in-house software development has ended." It should probably be noted that this comment was limited to the world of general-purpose, microprocessor-based personal computers. In the PC field, even mighty IBM is subject to this handicap.

Photo 1: *The IBM 5550 Multistation. (Photo courtesy of IBM.)*

(i.e., their internal registers and arithmetic/logic units operate on 16-bit words), the 8088 has only an 8-bit system bus and must perform memory and I/O (input/output) operations a half-word at a time. The 8086 has a full 16-bit system bus that allows a substantial increase in speed, especially with programs that involve frequent branching or I/O operations. This is even more important in the case of Japanese-character I/O because 2 bytes of data are required to represent each *kanji* character in the standard Japanese digital code (see the text box "The Japanese Answer to ASCII" on page 156). The full-width system bus plus the higher clock rate (8 MHz versus 4.77 MHz for the PC's 8088) give the 5550 as much as two or three times the processor instruction rate of the PC, depending on the instruction being executed. Of course, your mileage may differ; overall system performance also depends on the amount of system overhead the processor has to perform and the efficiency of the software. The Japanese computer magazine *Oh!55* ran benchmark programs on the 5550, the PC, and several competing Japanese models. For a 3000-sample Simpson's rule integration of y = sin(x), the 5550 running its BASIC interpreter under Japanese Language DOS was about 1.75 times faster than the PC running BASIC under MS-DOS 1.1. A 50-element bubble sort ran over twice as fast on the 5550 (and, not surprisingly, 36 times as fast with 5550 compiled Pascal). Some other results of these benchmark tests will be quoted later on.

The 5550, like the PC, has an empty position designated for an i8087 numeric data coprocessor. There's no socket installed, so presumably the upgrade is intended to be done at the factory or service center. IBM Japan makes no mention of the 8087 in its literature; again like the PC, any IBM support of the 8087 is "somewhere downstream, maybe." However, several Japanese computer magazines have reported the existence of the empty chip position, so there will undoubtedly be a number of independent houses offering upgrade packages.

The 8086 is supported by 16K bytes of bootstrap and self-diagnostic routines in ROM (read-only memory). Unlike the PC, which uses 8K bytes of ROM BIOS (basic I/O system) and 32K bytes of ROM BASIC, the 5550's BIOS and BASIC must be loaded from disk. The BIOS handles the interfaces with keyboard, display controller, (including character-font cache management), disk controller, and printer.

Other inhabitants of the microprocessor/memory board include an i8237 DMA (direct-memory access) controller, an i8253 programmable timer, an i8259 interrupt controller, and an i8284 clock generator, the same complement of support chips used in the PC. Memory consists of thirty-six 4164-type 64K-bit dynamic RAMS, providing a total of 256K bytes of on-board memory plus parity. As if all that weren't enough, the board is encrusted with 102 (yes, 102!) small- and medium-scale Schottky TTL (transistor-transistor logic) chips (TI's), for a total chip count of 146, not including resistor networks, caps, crystal, printer and keyboard connectors, test panel, and so forth. This is one packed board.

By comparison, the PC has slightly fewer than 100 chips installed on roughly the same amount of real estate, and that's with a full bank of 16K-bit RAMs. It appears, among other things, that the I/O functions handled in the PC by the i8255 programmable peripheral interface have here been executed in random logic. There are no custom arrays in evidence. It will be interesting to see what kind of field failure rate IBM experiences on such a complex board. However, because the microprocessor/memory function is contained on a pluggable unit instead of on a motherboard, maintenance and upgrading should be relatively easy.

The second of the big boards in the 5550 is the disk controller card. The first version of this board is somewhat less congested, with "only" three LSI (large-scale integration), 51 support Schottky chips, and one hybrid (vs. one LSI, 25 TTL, and 4 hybrids on the PC's disk-controller card). The controller chip used is the NEC μPD765, and a Hitachi HA-16632 VFO chip handles data separation. IBM has begun to supply the 5550 with a universal disk-controller card that includes a Winchester interface, even if no hard disk is ordered. With this board installed, the system's disk complement can be upgraded at any time.

The unit can accommodate one,

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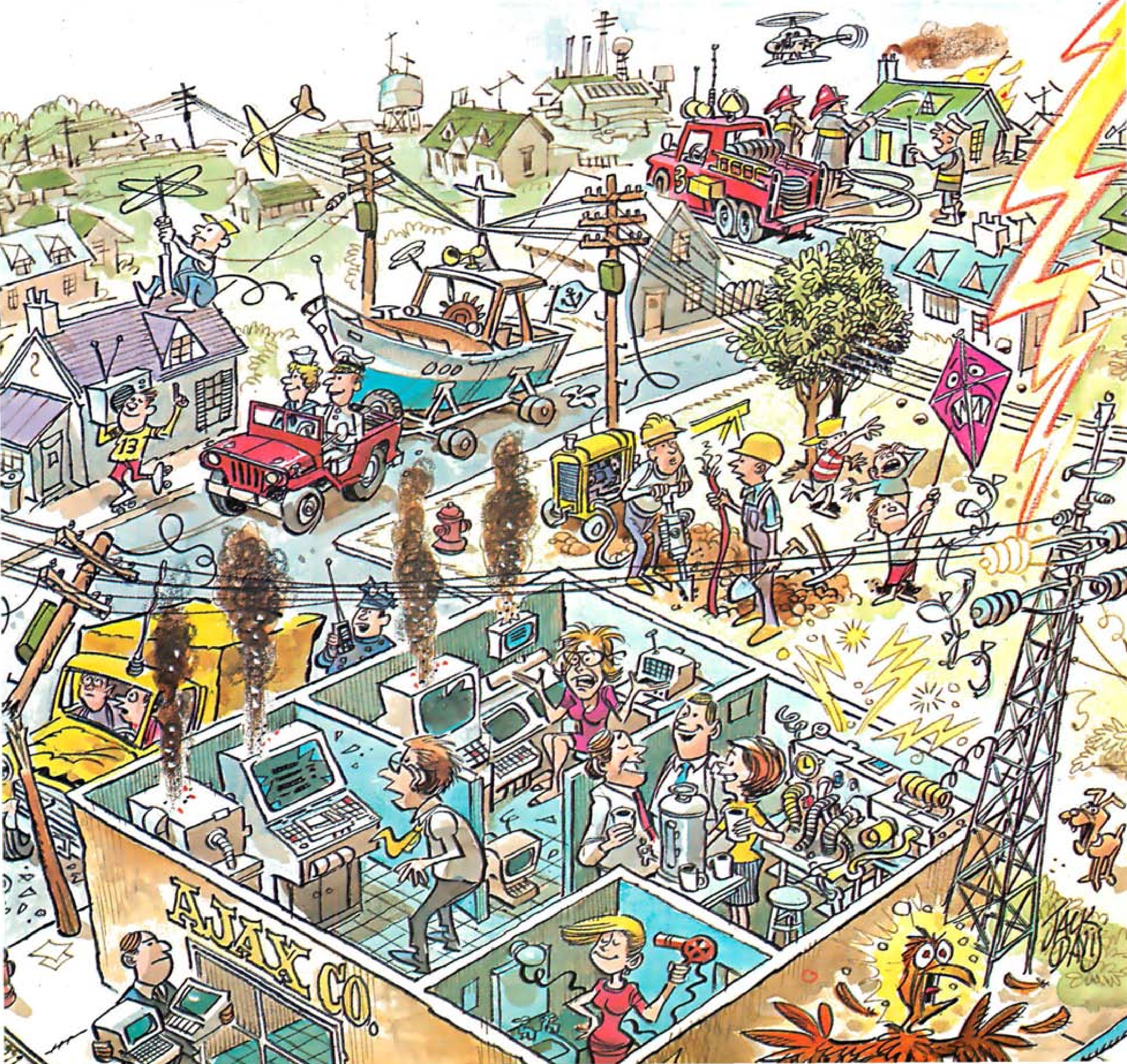


two, or three of the narrow-profile double-sided double-density, 80-track floppies, although the heavy dependence of the system on font libraries severely limits the capabilities of a single disk system. The use of high-density 5¼-inch floppy disks instead of 8-inch disks is somewhat surprising given the strong business orientation of the system. The IBM 8-inch format is still the most widely accepted standard among current Japanese business computers. By going with the smaller floppy disks, IBM may have been aiming to reach more of the individual personal-computer enthusiasts, while at the same time not putting too much pressure on its own System/34 and System/36 small-business computers; the new machine gives these more expensive systems a run for their money. In fact, IBM Japan has taken to using the term "Very Small Business Computer" (VSBC) to characterize the new product line.

The system can also be configured with one hard disk and one floppy disk, but IBM is not scheduled to start shipping hard disks until December. The disks simply plug in from the front of the cabinet; there are no harnesses to wrestle with (see figure 1). Thus, there should be quite a bit of competition, both in capacity and in price, with IBM's 10-megabyte (8.1 megabytes "available to user") unit, which adds about $2200 to the system price.

The video RAM board, another tightly packed module, includes a 6845-type video controller, a pair of 6116-type 2K by 8-bit CMOS (complementary metal-oxide semiconductor) RAM buffers used by the controller, up to 256K bytes of video RAM in the form of 4164-type dynamic RAMS, a hybrid clock generator, and 110 TTL support chips—again, a total of 146 chips. The function of this module will be described

The Japanese *Kana* Keyboard

The Japanese are fortunate to have a phonetic alphabet, or syllabary, in which to write their language; they are not limited, as the Chinese are, to a purely pictographic writing system. This Japanese alphabet is called the *kana* syllabary. There are 46 different *kana* characters, each expressing a simple sound such as "oh" or "ku" or "shi." You can immediately see that a word like *Yokohama* would be written with four *kana*, *yo-ko-ha-ma*. With the addition of diacritical marks (used like the tilde in Spanish) and subscripted characters, slightly more than a hundred different *kana* forms, one for each possible syllable in the Japanese language, can be constructed.

You might ask why the Japanese continue to struggle with thousands of *kanji* (pictographic) characters when they have the phonetic writing system available. The answer lies in the scarcity of syllables in Japanese. A hundred-odd syllables isn't much to work with in building an entire vocabulary. Of course, if you are willing to accept very long words, there are plenty of unambiguous combinations that can be created. But the Japanese already have the problem of long verb conjugation endings; they prefer to keep the roots of nouns and verbs fairly short, usually about two syllables. The result is that there are thousands of synonyms in Japanese; almost any word you name has at least one or two synonyms, and some have a dozen. Not surprisingly, this can cause all sorts of problems in communication. The native listener can usually tell from the context which meaning is intended, but it is very common for a speaker to have to go back and clarify certain words in a conversation. This situation would not be acceptable in written communication; in print you must be able to convey information clearly and unambiguously. Thus, the Japanese must continue to use the *kanji*, each of which carries a specific root meaning, to put their language on paper.

There is no reason, however, why

ん (n)	わ (wa)	ら (ra)	や (ya)	ま (ma)	は (ha)	な (na)	た (ta)	さ (sa)	か (ka)	あ (a)
		り (ri)		み (mi)	ひ (hi)	に (ni)	ち (chi)	し (shi)	き (ki)	い (i)
		る (ru)	ゆ (yu)	む (mu)	ふ (fu)	ぬ (nu)	つ (tsu)	す (su)	く (ku)	う (u)
		れ (re)		め (me)	へ (he)	ね (ne)	て (te)	せ (se)	け (ke)	え (e)
	を (wo)	ろ (ro)	よ (yo)	も (mo)	ほ (ho)	の (no)	と (to)	そ (so)	こ (ko)	お (o)

The traditional arrangement of Japanese kana (in this case the hiragana set) into a matrix of vowel and consonant sounds.

in detail later.

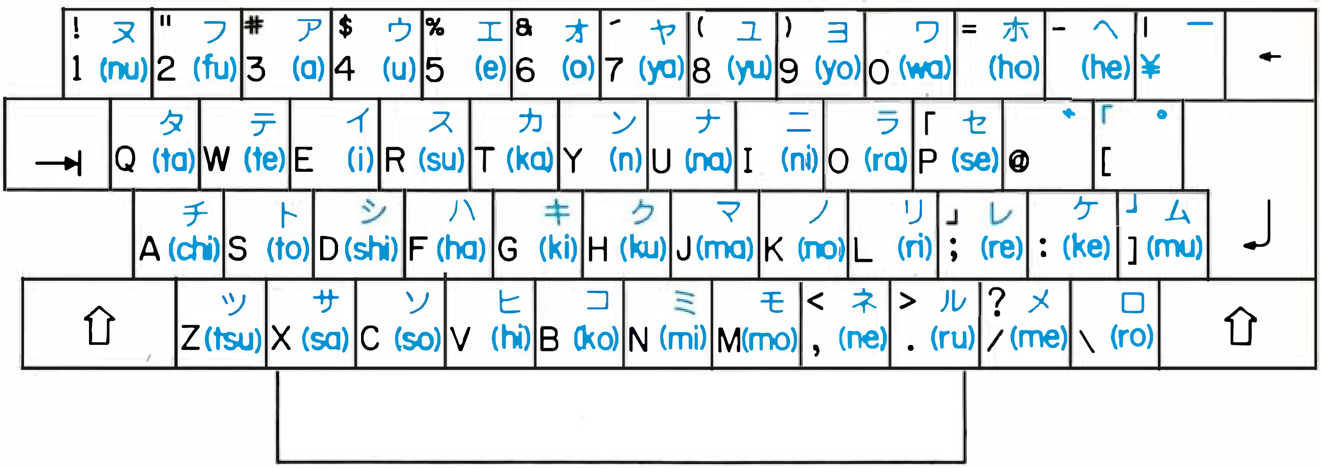
The switching-mode power supply, also a pluggable module, slides into the base of the cabinet and mates with the flex circuit power harness through a beefy connector. The fact that the boards, drives, and power supply are all replaceable modules shows the strong emphasis IBM put on reliability and maintainability in designing the system. Actually, the best feature of the power supply is that the switch is mounted to be accessible at the front of the system unit. Total power dissipation in the package is rated at approximately 230 watts, so the logic and drives probably use about 140 to 180 watts. A fan in the power-supply module cools the entire chassis.

An optional five-slot expansion cage holds the optional memory and interface boards. The cage's backplane board plugs into a connector bearing the main system bus; the whole cage can be added or replaced in the field. There are four optional boards currently available. Up to two memory-expansion boards of 128K bytes each can be added, for a maximum system memory capacity of 512K bytes. These memory modules go for about $375, which is a bargain compared to IBM's prices for PC expansion memory. (But then, who buys their PC expansion memory from IBM?) Communications adapters available include an asynchronous serial adapter (RS-232C) and a BSC/SDLC (Binary Synchronous Communication/Synchronous Data Link Control) adapter. Extensive software support is being readied for the latter interface, including a 3270 Kanji Terminal emulator, a package to support the BSC3741 protocols, and another package for the 3770 RJE (remote job entry) terminal protocol. IBM is vigorously promoting its networking and communications capabilities, hoping to convince a

documents cannot be entered into the computer in *kana* and then be converted to *kanji*, as long as the author supervises the conversion. So the Japanese have established two standard keyboard arrangements for the *kana*. The first arrangement, shown at left, is based on the 1000-year-old arrangement of the *kana* called the *go-ju-on-zu*, or "50-sound chart." You can see there is a logical pattern to this way of arranging syllables. In fact, the Japanese tend to view their syllabary more as a matrix than as a linear alphabet, so this is the most natural way of arranging the keys.

However, it's very difficult to touch-type on five rows of keys, thus the *go-ju-on-zu* style of keyboard is only available as an option on a few computers. The Japanese instead have adopted a version of the Western QWERTY keyboard, with the 46 *kana* plus supplementary marks spread over all four rows of keys (see below). Although most people don't touch-type the fourth row of the QWERTY keyboard too well, it's still easier to use a four-row keyboard than a five-row. You can observe that there is at least a suggestion of the original matrix of sounds preserved in this standard layout (even the QWERTY arrangement is not totally randomized). A few of the lesser used characters have been relegated to the top row or to the extreme right, but most of the fourth row characters get plenty of use. This is the keyboard you will see most often in Japan.

You may also have noticed that the Japanese characters in these two examples are not the same. The Japanese actually have two complete sets of *kana*, the *hiragana* shown in the first example, and the *katakana* in the second. These two character sets have much different roles in Japanese writing, but for all intents and purposes they are precise parallels of each other. The only difference is that a few subscriptable characters have been added to *katakana* to help approximate some of the foreign words that can't be sounded intelligibly with Japanese syllables. Most Japanese computer keyboards are labeled in *katakana*; the IBM 5550 offers the QWERTY-style keyboard in either *hiragana* or *katakana*, with *hiragana* being the standard for Japanese-language word processing. This style of Japanese keyboard has at least two shift functions—one to switch to the other *kana* set, and one to switch to the roman alphabet. The Japanese in their writing make extensive use of Western names, acronyms, numbers, and even slang, so they must be able to access our alphabet as well as their own.



Japanese katakana arranged on a QWERTY-style keyboard. The phonetic reading of each character is included for reference only.

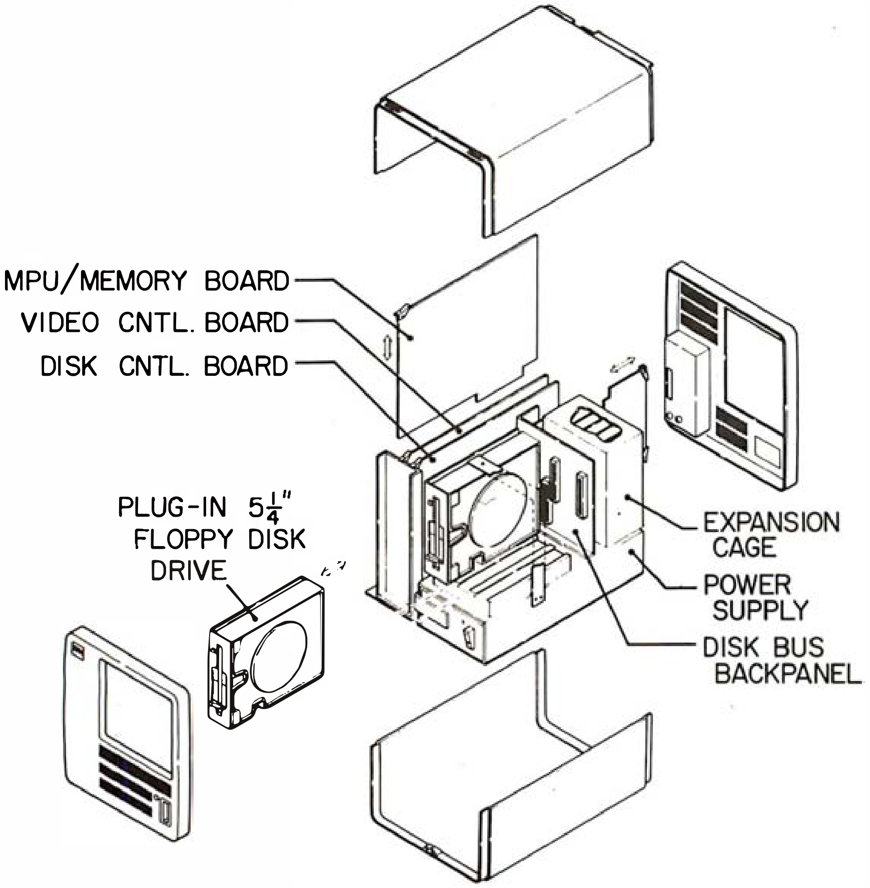


Figure 1: *Exploded view of the IBM 5550 system unit. Five option boards may be installed in the expansion cage. A hard-disk drive may be substituted for the two right-most floppy-disk drives. (Figure courtesy of IBM.)*

number of its major users to install 5550s in place of the 3270 or other networks they now operate. In such applications, IBM Japan seems to hold a clear advantage over its Japanese competitors.

The heavy emphasis on system networking applications is perhaps the clearest hint that we may see a similarly targeted machine for the US market before long. Independent Japanese computer journals and IBM's Japanese publications are reporting an extensive array of system configurations for which IBM is touting the new machine or for which it is preparing support. Although the Japanese still lag behind the US in data networking, at least in terms of installed base, they are putting a much greater national priority on data-communications facilities and will probably lead the world in this pivotal technology within a few years. IBM's Japanese subsidiary clearly intends to play a major role in this development.

The Keyboard Runneth Over

The most vociferously criticized feature of IBM's American PC is its keyboard—with good reason. IBM says its preliminary market studies showed that people encountering computers for the first time tend to be intimidated by large arrays of obscure function keys. So a simple, uncluttered keyboard layout was adopted; unfortunately, this layout manages to intimidate any typist who ever grew up with the Selectric. Even a novice quickly comes to curse the miniscule Shift and Return keys, the unlighted shift locks, and the 2 by 5 vertical array of function keys cleverly prompted by a 1 by 10 horizontal array of screen labels. IBM has shown little sympathy regarding these complaints. In fact, the company now says that the PC-style keyboard will become the standard on new generations of Displaywriter and small office computer products. Pity the poor secretaries.

By contrast, the 5550's keyboard (designated 5556) is anything but austere, as can be seen in figure 2. If anything, the pendulum has swung to the other extreme. With 124 keys, compared to the PC's 83, it weighs in with one of the most complex keyboards of any small computer, Japanese or otherwise. Some of the typing keys represent up to four different characters, and there are additional legends on the front of many keys. Given the multifunction character of the machine, it's hard to see how the keyboard could be significantly simplified. Changeable key overlays seem like an excellent idea, but machines using them haven't been overly successful in the market. And menu-driven software is great for a novice but tends to slow down an experienced operator. Besides, a complex-looking keyboard may not be as much of an impediment in the hard-charging technology culture of Japan.

Many of the typing complaints noted above have in fact been alleviated in this new layout. IBM has followed the JIS (Japanese Industrial Standard) *kana* keyboard layout (see the text box on page 150), which has nice large Shift and Return keys and no annoying symbol key intruding between the Z and the Shift. The shift locks aren't lighted, but the software displays the shift status—*hiragana*, *katakana*, roman, roman caps lock—on the top or bottom line of the display. The normal space bar has been split into five keys: a space, two *kana*-to-*kanji* conversion control keys, and two shifts. This is a little awkward for typing text in roman, but Japanese text does not use spaces between words, thus it is not a significant problem.

To the right of the typing keys is a block of word-processing function keys, quite similar to the Wang format used by many American small computers (except IBM's): cursor control cross, three page-flipping keys, Insert, Delete, Copy, and Move. Farther right is a 10-key pad with Enter and math function keys.

Unfortunately, the organization of the remaining 34 keys is based more on geometrical symmetry than on logical categories. The key block at

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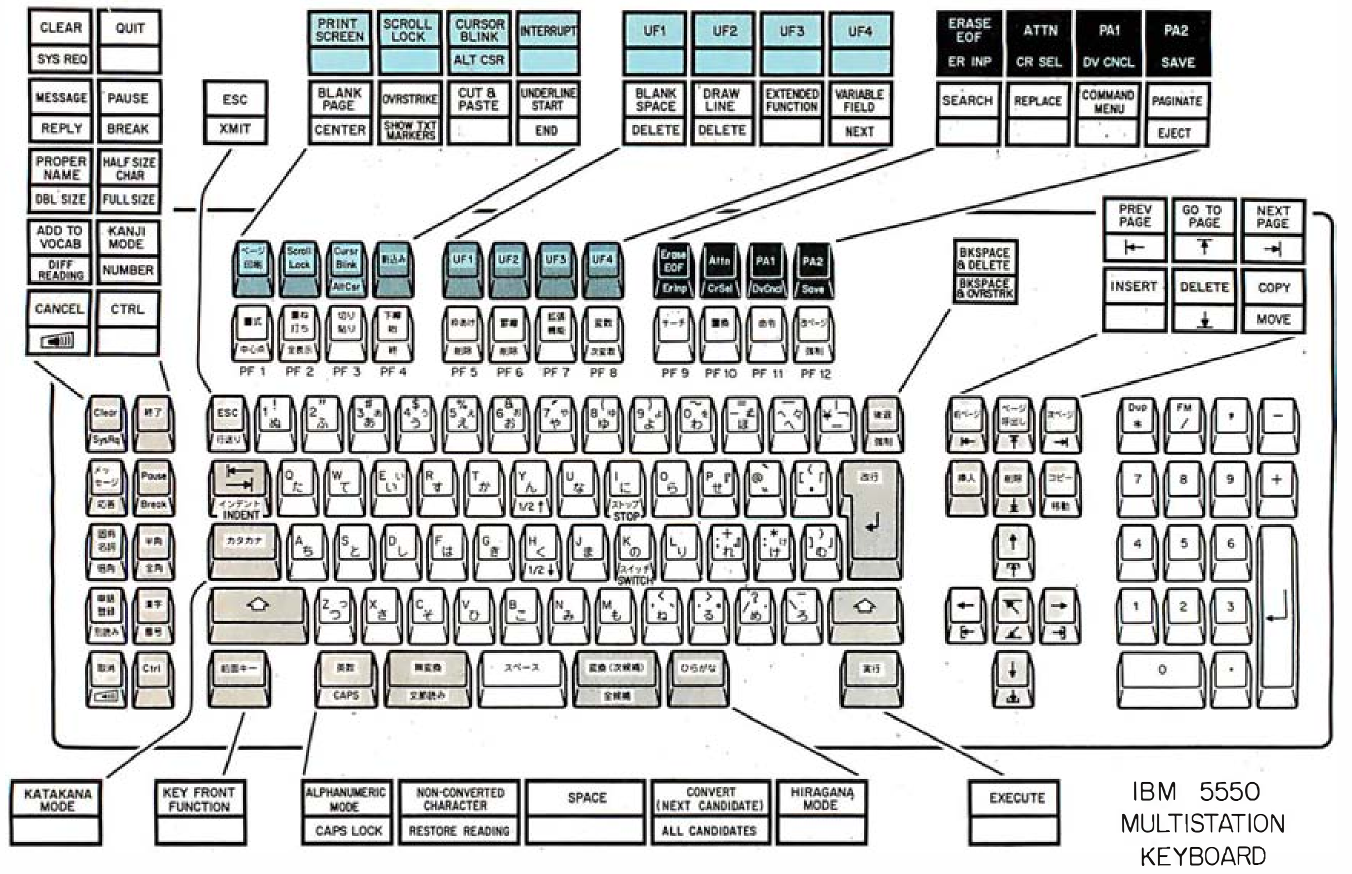

Figure 2: *The layout of the 5550 system keyboard, with translations of the legends of the function keys. The keys marked in blue are dedicated to word-processing operations.*

the left includes system-control functions such as Cntl, Quit, Break, and Cancel, plus some keys to initiate half-size or double-size character entry, a key to flag characters used in proper names (a real problem in Japanese), and some additional *kana*-to-*kanji* conversion control keys.

The same mix of functions is evident in the three blocks of control keys arrayed along the top of the keyboard. Format-control keys and other word-processing function keys are color-coded and arrayed in the lower row of 12 keys; communications and other miscellaneous keys reside in the upper row. But there is not the strong logical subgrouping there should be in a keyboard of such complexity. Keyboard designers must learn to make geometry and logic work together, rather than choosing one over the other. Perhaps the best example of a well-balanced keyboard is the HASCI (human applications standard computer interface) keyboard on the Epson QX-10 (see the October, November, and December 1982 BYTE). However, the IBM keyboard has many more functions to control, and the Epson is highly menu-oriented; the keyboard design challenge is yet to be mastered.

The feel of the 5550 keyboard is quite different from the mechanical break-over of the PC's keyboard. The new key touch is better suited to fast typing. The system speaker, mounted in the keyboard housing, gives an audible click at each key make. The volume of the click is adjustable. This is an excellent approach to keyboard feedback.

Like the PC, the 5550's keyboard connects to the system unit via a coiled cord. An internal microprocessor in the keyboard module scans the keys and sends key make/break information to the main proce sor in a serial format. The housing is of the same configuration as the PC's but is 3 inches wider.

IBM is offering three keyboard options with the 5550. The standard key layout is best suited for word-processing and personal-computing functions. One optional layout is available with four key legends altered for use with 3270 emulation software. IBM has shown a third keyboard, one with 125 keys, that is quite different from the standard layout and is designed to look like the keyboard of the 3270 Kanji Terminal.

Of *Kanji* Fonts and Printer Dots and Pixel RAM and Screens

The system used for handling the display screen and printer is surely the most interesting aspect of this machine. The Japanese *kanji* characters are much more complex than any Western alphabet and therefore need more pixels to portray them intelligibly. The American PC's monochrome display adapter generates roman characters of exceptional quality with a 7- by 11-pixel matrix (in a 9 by 14 space). By comparison, *kanji* characters displayed in a 16- by 16-pixel matrix are passable at best

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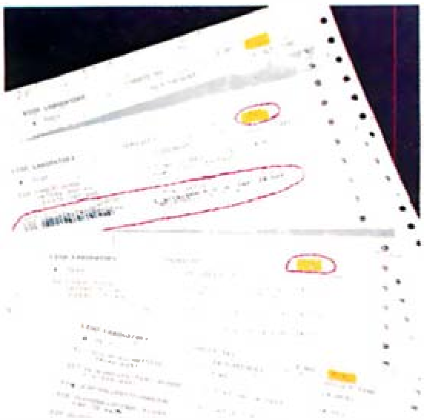

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The Japanese Answer to ASCII

Most Westerners can only be awed at the complexity of written language in the Orient. The pictographic/ideographic writing system that originated in China more than 2500 years ago involves thousands of intricately stroked characters. Although some simplification has been achieved in this century, the system still presents a formidable obstacle to communication, especially in the current electronic age. Most of the difficulties that have arisen in processing these languages by computer involve the entry of text into the machine and the display and printout of results. How do you design a keyboard to handle 2000 to 3000 different characters? What about a Chinese "selectric" typeball?

Fortunately, once the purely mechanical obstacles of input and output have been overcome, data can be dealt with in a routine way. A computer doesn't care what character set its 1s and 0s represent as long as all the humans involved agree on a standard code. In Japan, as in America, there are two such standards: IBM's and everyone else's. In the US, IBM's EBCDIC (extended binary-coded-decimal interchange code), which evolved from punch-card formats (remember keypunch?), is used in all IBM computers down to and including the System/34 and Displaywriter. Most computers from other companies, as well as IBM's PC, use ASCII to represent character data. ASCII is also the standard for intercomputer communication. Because there are only 128 (or 256) possible codes involved, it is little trouble for IBM's computers to convert to ASCII when communicating with the outside world; thus the dual standard does not cause any serious problems.

In Japan, though, there are a lot more characters to worry about. The Japan Standards Association, Japan's counterpart to ANSI (American National Standards Institute), has identified 3418 Japanese *kanji* characters as "primary *kanji*," and another 3384 as "secondary *kanji*." To put this in perspective, a Japanese student is expected to know 881 *kanji* by the end of the sixth grade and 2000 by the time he graduates from high school. A fairly literate college graduate is able to read about 3400 characters. By using these characters individually, or by combining two (or occasionally three) different characters, the tens of thousands of Japanese words can be represented. Secondary *kanji* include obsolete or historical *kanji*, characters used only in proper names, and so forth.

In addition to the *kanji*, there are two sets of *kana* characters (which act as a sort of phonetic "alphabet" for Japanese), plus Arabic numbers, Roman, Greek, and Cyrillic alphabets, and graphics symbols represented in the JIS standard, a total of 453 non-*kanji* characters. Because the Japanese had to go to 2 bytes per character anyway, they figured they might as well establish a code for every character that might ever be needed. Actually, only 7 bits of each byte are used for coding; the eighth bit is reserved for parity. There are 2^{14} or 16,384 possible codes that can be handled by the JIS format; of these, slightly more than half are used for actual characters, and the rest are reserved for control codes. A small segment of the JIS primary *kanji* code is shown at right.

IBM's *kanji* code, an "extension" of EBCDIC (like Texas is an extension of El Paso), actually predates the JIS code. IBM made an extensive commitment to the Japanese market in the sixties, back when Japanese electronic producers were still concentrating on stereos and TVs. An enormous amount of effort was expended over the years to develop Japanese-language interfacing capability for IBM's mainframes. Consequently, the IBM 3270 Kanji Terminal is still the standard online terminal in Japan. For more than a decade, IBM's Tokyo Scientific Center has been conducting research into Japanese-language programming systems for small computers. The 5550's word-processing software, which features semantic-sensitive *kana*-to-*kanji* conversion and utilizes EBCDIC-coded *kanji* characters, is a product of this research.

On the other hand, software developed for the 5550 by outside sources typically uses a variant of the JIS *kanji* code. This variant code differs from the JIS code only in that characters and control codes have been separated into different sectors. Microsoft's Japanese-language version of Multiplan and other 5550 software use this variant, and it has been adopted by virtually every Japanese microcomputer maker as a standard for personal computers. Thus there are two dissimilar data codes used in 5550 system software, a rather disturbing schizophrenia with symptoms that include the incapability to share data files between personal-computing and word-processing functions. IBM Japan is not currently offering a utility to convert between these two data environments. This incompatibility has been blown into a major issue by IBM's competitors and other critics. Many commentators have expressed serious doubts about the viability of the system on the basis of its disjointed data and file formats. In Japanese business etiquette, saying "I have serious doubts about your approach" is tantamount to saying "You must be out of your mind." IBM Japan will probably have to address this file-conversion problem eventually.

The fact that the characters of the Japanese language need a multibyte code for representation in a computer points up the importance of the 16-bit microprocessor "threshold" to the Japanese. Now that powerful, inexpensive 16-bit systems are entering the market, the Japanese will be able, for the first time, to interact with personal computers in their native language. The current small-computer "software gap" between the U S and Japan may get a lot narrower in the near future.

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but certainly not as intelligible as even 5- by 7-pixel roman characters. IBM's 5550 offers 16- by 16-pixel *kanji* with its 12-inch monochrome and 14-inch color displays, and 24- by 24-pixel *kanji* with its 15-inch monochrome display. The 24 by 24 representation is pretty good; Japanese characters are traditionally produced by strokes of a small brush pen, so the slight fuzziness in a 24 by 24 digitization gives the characters a somewhat quaint, arguably pleasing appearance.

However, even a 16- by 16-pixel

2nd byte							第2バイト b7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
							b6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
							b5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
							b4	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
							b3	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
							b2	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
1st byte							b1	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
第1バイト							点															
b7	b6	b5	b4	b3	b2	b1	区	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
0	1	0	0	0	0	1	1	(SP)	、	。	，	．	・	：	；	？	！	゛	゜	´	｀	¨
0	1	0	0	0	1	0	2	◆	□	■	△	▲	▽	▼	※	〒	→	←	↑	↓	〓	
0	1	0	0	0	1	1	3															
0	1	0	0	1	0	0	4	ぁ	あ	ぃ	い	ぅ	う	ぇ	え	ぉ	お	か	が	き	ぎ	く
0	1	0	0	1	0	1	5	ァ	ア	ィ	イ	ゥ	ウ	ェ	エ	ォ	オ	カ	ガ	キ	ギ	ク
0	1	0	0	1	1	0	6	Α	Β	Γ	Δ	Ε	Ζ	Η	Θ	Ι	Κ	Λ	Μ	Ν	Ξ	Ο
0	1	0	0	1	1	1	7	А	Б	В	Г	Д	Е	Ё					К		М	Н
0	1	0	1	0	0	0	8															
0	1	0	1	0	0	1	9															
0	1	0	1	0	1	0	10															
0	1	0	1	0	1	1	11															
0	1	0	1	1	0	0	12															
0	1	0	1	1	0	1	13															
0	1	0	1	1	1	0	14															
0	1	0	1	1	1	1	15															
0	1	1	0	0	0	0	16	亜	唖	娃	阿	哀	愛	挨	姶	逢	葵	茜	穐	悪	握	渥
0	1	1	0	0	0	1	17	院	陰	隠	韻	吋	右	宇	烏	羽	迂	雨	卯	鵜	窺	丑
0	1	1	0	0	1	0	18	押	旺	横	欧	殴	王	翁	襖	鴬	鴎	黄	岡	沖	荻	億
0	1	1	0	0	1	1	19	魁	晦	械	海	灰	界	皆	絵	芥	蟹	開	階	貝	凱	劾
0	1	1	0	1	0	0	20	粥	刈	苅	瓦	乾	侃	冠	寒	刊	勘	勧	巻	喚	堪	姦
0	1	1	0	1	0	1	21	機	帰	毅	気	汽	畿	祈	季	稀	紀	徽	規	記	貴	起
0	1	1	0	1	1	0	22	供	侠	僑	兇	競	共	凶	協	匡	卿	叫	喬	境	峡	強
0	1	1	0	1	1	1	23	掘	窟	沓	靴	轡	窪	熊	隈	粂	栗	繰	桑	鍬	勲	君
0	1	1	1	0	0	0	24	検	権	牽	犬	献	研	硯	絹	県	肩	見	謙	賢	軒	遣
0	1	1	1	0	0	1	25	后	喉	坑	垢	好	孔	孝	宏	工	巧	巷	幸	広	庚	康
0	1	1	1	0	1	0	26	此	頃	今	困	坤	墾	婚	恨	懇	昏	昆	根	梱	混	痕
0	1	1	1	0	1	1	27	察	拶	撮	擦	札	殺	薩	雑	皐	鯖	捌	錆	鮫	皿	晒
0	1	1	1	1	0	0	28	次	滋	治	爾	璽	痔	磁	示	而	耳	自	蒔	辞	汐	鹿

		漢字番号	JIS区点	連続CODE	内部CODE	IBM異体関係
7	[illegible]	6484	5388	5231	9B98	（本）
11	淆	7541	6234	6023	9FC0	（本）
14	雑	2698	2708	2707	8E47	（新）
.	襍	9121	8023	7704	E8B5	（本）
.	雜	9863	8024	7705	E8B6	（旧）
15	糅	8367	6882	6635	E2F0	（本）
16	駁	10054	8148	7823	E96F	（本）
17	襍	9121	8023	7704	E8B5	（本）
18	雜	9863	8024	7705	E8B6	（旧）
まじわる						
4	爻	7779	6411	6188	E0A9	（本）
6	交	1934	2482	2499	8CF0	（本）
ます						
4	升	3655	3003	2984	8FA1	（本）
	斗	3715	3745	3684	936C	（本）
5	加	1439	1835	1888	89C1	（本）
6	舛	4033	3304	3267	9143	（本）
8	枅	7138	5938	5745	9E65	（本）
.	枡	3464	4381	4284	9691	（俗）
10	倍	2756	3960	3887	947B	（本）
	枡	3464	4381	4284	9691	（俗）
	益	1908	1755	1814	8976	（新）
.	益	8058				（旧）
11	培	3500	3961	3888	947C	（本）
	曽	2399	3330	3293	915D	（俗）
12	曾	4454	3329	3292	915C	（本）
.	曽	2399	3330	3293	915D	（俗）
13	溢	4721	1678	1743	88EC	（本）
14	増	1613	3393	3356	919D	（新）
.	增	6282				（旧）
23	鱒	5062	4380	4283	9690	（本）
まず						
6	先	1954	3272	3241	90E6	（本）
まずしい						
11	貧	3491	4147	4062	956E	（本）
16	窶	8260	6764	6523	E280	（本）
ますます						
10	益	1908	1755	1814	8976	（新）
.	益	8058				（旧）
14	増	1613	3393	3356	919D	（新）

Examples of Japanese digital kanji codes. At left is a chart of the JIS primary kanji code chart. At right is an excerpt from a 475-page code book that IBM provides with the system. Beside each kanji are (from left) a character sequence number, the JIS kanji code, the EBCDIC-based IBM code, and the Japanese microcomputer code convention. Notice that the third kanji listed in the table has a JIS code of 2708. If you look at row 27, column 8 of the chart, you will find that same character. The characters in the chart are arranged phonetically. (Chart courtesy of IBM.)

matrix for the 3418 JIS primary *kanji* (see "The Japanese Answer to ASCII" on page 156) would take up more than 109K bytes of ROM—that's fourteen 2764s. The 24 by 24 font would eat up forty-two 2764s. Some Japanese small computers do use ROM font storage, and the Japanese have put a high priority on developing very dense ROMs (a half-megabit ROM is close to production). However, the 5550 keeps the character fonts on floppy disk and brings whichever fonts are needed into a cache buffer that occupies all or part of the video RAM. The same disk-based fonts are used for both the display and the printer. Thus, if you buy the small monochrome or the color display, you must settle for a 16- by 16-dot printout; with the 15-inch monochrome display, you can have 24- by 24-pixel *kanji* on both the screen and the printer.

The display adapter card provides 256K bytes of video RAM. How this RAM is utilized depends on the operational mode. In character mode, the entire video RAM is used for the *kanji* font cache. A separate 2K-byte RAM is used as a character buffer, and another for an attribute buffer. In character mode, the screen can display 25 lines of 40 *kanji* or full-width *kana*, or 25 lines of 80 roman characters or condensed *kana*. (Actually, it's 25 by 41 and 25 by 82 with a dead position at the lower right of the screen, but most operational programs use only 40/80 columns.) Because the *kanji* are physically twice as wide on the screen as the alphanumeric characters and require a 16-bit instead of an 8-bit code to designate them, there is a rather tricky one-to-one correspondence maintained between the contents of the character buffer and the contents of the screen.

When an operating program wants to write a *kanji* on the screen, the BIOS first checks to see if the necessary font is already contained in the font cache buffer; if not, it is loaded from disk. Then the appropriate location of the character buffer, either 1 or 2 bytes, is loaded with a code that points, via a table of vectors, to the location in the font cache at which the desired font is stored. Any video attributes (such as underline, blink, reverse video, and one of eight colors in the case of a color monitor) are loaded into the corresponding location of the attribute buffer. This novel combination of a character buffer containing references to code font locations (rather than the actual character codes like ASCII) and a large font cache play the same role as a normal character buffer and font ROM would in a conventional video display. The CRT (cathode-ray tube) controller chip accesses the character buffer one position at a time, the font address is referenced, and the pixel pattern is fetched and pipelined for display. The display refresh rate is approximately 72 to 76 interlaced half-frames per second (it varies with display model and mode). This refresh rate corresponds to a pixel rate of about 40 MHz for the 15-inch display.

The juggling of character fonts in the video RAM is also a little tricky but will not normally require a great deal of disk access. Perhaps half of the characters on a typical page of Japanese text will be one of the 100 or so *kana*, and over three-fourths of the remainder will be from a group of 1000 or so heavily used *kanji*. Slightly more than 2000 different fonts can be stored in the font cache; if the most common characters are brought in at the beginning, only a handful will need to be added along the way. Of course, because all typing is done initially in *kana*, the screen responds to the typist's input immediately. Only the *kana*-to-*kanji* conversion process may be delayed by disk access.

In graphics mode, the operation is somewhat different. The first third of

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the video RAM is used as a screen bitmap, and the remainder for the font cache. (In character mode, the *kanji* fonts and surrounding blank spaces (24 by 24 pixels in a 26 by 29 box) are loosely packed into 128 bytes per character. In graphics mode, the fonts are tightly packed into 72 bytes. Thus, even though the bitmap uses the first third of the video RAM in graphics mode, the remainder can still hold more than 2000 character fonts.) The graphics programs perform the normal dot-addressable graphics operations within the bitmap and can fetch character fonts from the cache, alter their size or orientation, and deposit them in the map as desired. For color graphics, the system used is very similar to the original PC's. The horizontal resolution is halved, from 720 by 512 to 360 by 512, and two contiguous bits in the bitmap are used to control each addressable dot, which allows four colors to be displayed. One of these colors is the background, so you actually get only three active colors. However, you do have a choice of what those colors are.

Although the 5550 strikes an excellent balance among its many capabilities, it is not really a strong graphics machine in comparison to more specialized systems. Though its resolution is very high for monochrome, and above average for color, the use of the 6845 controller chip and processor-controlled bitmap graphics severely limits its speed for certain types of operations. In the previously mentioned benchmark tests, the NEC-9801, another 8086-based personal computer, completed an 1100-line star, programmed in BASIC, in just 6 seconds, compared to almost 2 minutes for the 5550. In most other respects, the 9801 was comparable to the 5550 within a factor of about 1.5 either way. The NEC machine uses that company's μPD7220 graphics controller chip, one of the hottest on the market; the chip has hardware line generation and other state-of-the-art features. By going with the tried-and-true 6845, the same controller used in the American PC, IBM passed up a lot of graphics power it could have tapped for applications such as CAD (computer-aided design), opting instead for better character-handling performance. For the majority of office-oriented graphics applications, however, the system is more than adequate.

The printer used with the 5550 system is a very dense wire dot-matrix type made by Oki Electric. The unit is configured much differently from Okidata's American-market printers. Their top-of-the-line Pacemark 2410 produces some of the best correspondence-quality print of any dot-matrix machine; it uses a nine-magnet print head and generates a 17- by 9-dot matrix by taking two passes at each line, displacing the paper a half dot between passes. By contrast, both the 16- by 16-dot and 24- by 24-dot character matrixes generated by the 5550's printers (designated 5553-A01 and 5553-B01, respectively) are created in a single pass. These printers have full-resolution printheads, using 18 or 24 magnets. The print wires are skewed so that the tiny dots (11 mil and 8 mil, respectively) overlap slightly.

The print pattern is determined by dot information sent to the printer by the system unit. The printed character font is the same as the displayed font; there is no internal character generation in the printer. As a result, the printer can produce an extensive range of styles limited only by the software. The word-processing software, for example, supports half-width, normal, and double-width printing of roman characters and *kana* and normal and double-width printing of *kanji*. And because the pixel matrix is square, it is simple to rotate the characters to print Japanese text in the traditional fashion, vertical columns proceeding from right to left. The printer also supports the same dot-addressable graphics utilities used for display-screen graphics. Some examples of the 24- by 24-dot characters display and printout are shown in figure 3. The print speed is 60 *kanji* characters per second for the 16- by 16-dot printer and 40 *kanji* per second for the 24- by 24-dot version.

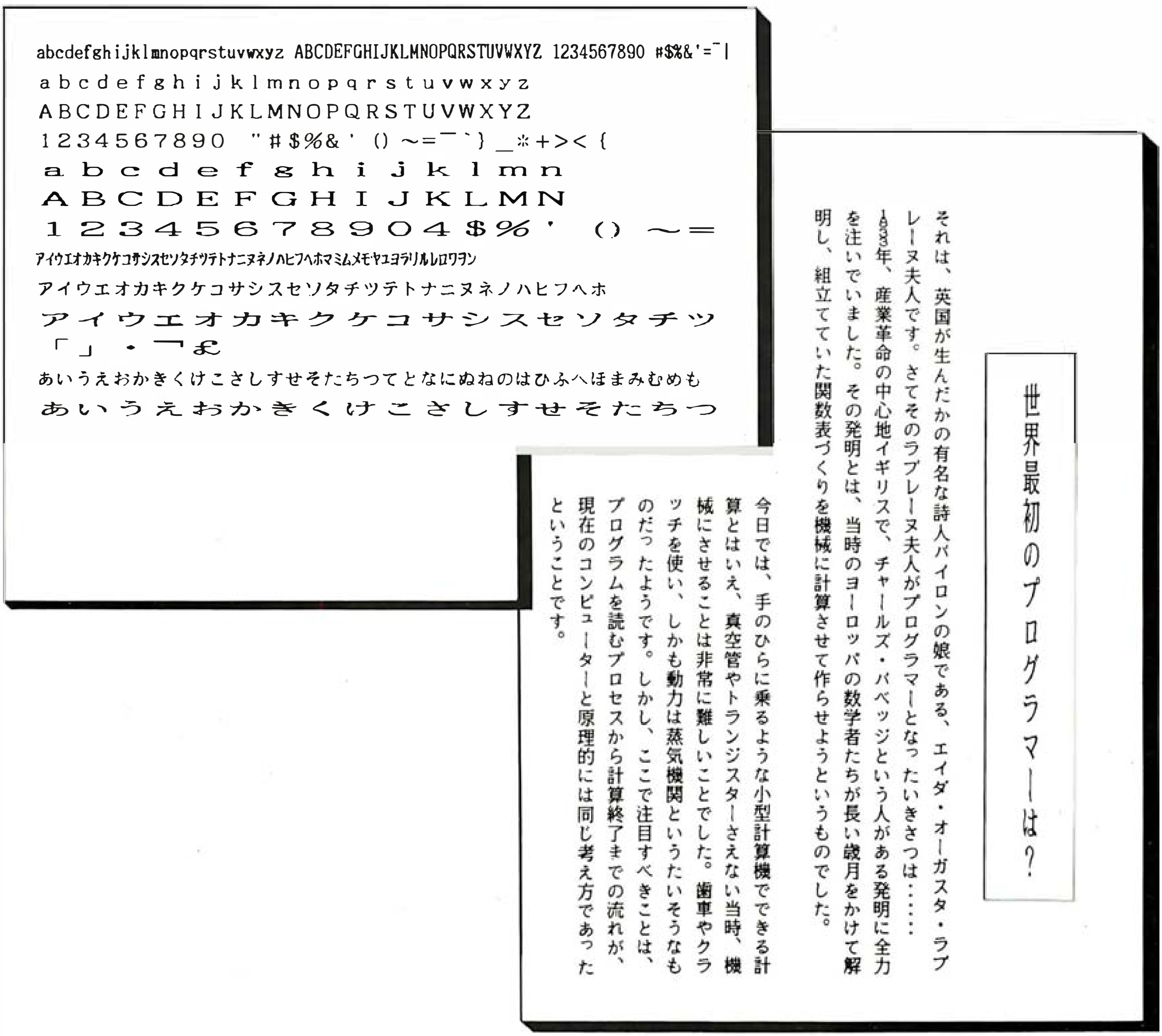

Figure 3: *Examples of the 5550 system's displays and printouts. At upper left is an example of textual material displayed on a screen by the Japanese-language word-processing function. At upper right is a screen display from Microsoft's Japanese version of Multiplan. Below are examples of horizontal and vertical printout modes. All examples were produced in the 24- by 24-bit font. (Material courtesy of IBM.)*

Product	Price	Availability
5551 System Unit, 256K-byte RAM, one 640K-byte 5¼-inch floppy disk:		
with 16- by 16-dot characters, for monochrome display	$2560	now
with 24- by 24-dot characters, for monochrome display	$3230	now
with 16- by 16-dot characters, for color display	$2605	now
5551 System Unit, 256K-byte RAM, one 8.1-megabyte hard disk, one 640K-byte 5¼-inch floppy disk:		
with 16- by 16-dot characters, for monochrome display	$4745	12/83
with 24- by 24-dot characters, for monochrome display	$5415	12/83
with 16- by 16-dot characters, for color display	$4790	12/83
System unit options:		
board cage	$125	now
128K-byte memory expansion board	$375	now
additional 640K-byte 5¼-inch floppy-disk drive	$417	now
SDLC/BSC communications adapter	$417	now
asynchronous communications adapter	$250	now
magnetic stripe reader adapter	$313	now
5553 Printer:		
for 16- by 16-dot characters and dot-addressable graphics	$1120	now
for 24- by 24-dot characters and dot-addressable graphics	$1313	now
5557 Printer:		
heavy-duty printer for multipart forms	$5625	12/83
5555 Display:		
12-inch monochrome for 16- by 16-dot characters	$250	now
15-inch monochrome for 24- by 24-dot characters	$605	now
14-inch color for 16- by 16-dot characters	$915	12/83
5556 Keyboard (three versions available):		
Japanese-language word processing and personal computing	$200	now
Japanese-language word processing and 3270 emulation	$200	now
3270 *katakana* keyboard format	$200	now
Japanese-Language Business/Personal Computing Software:		
Japanese-Language DOS/Basic Interpreter/Font-16 (16- by 16-dot) (JIS primary *kanji*)	$125	now
Same as above, with Font-24 (24- by 24-dot)	$125	now
Font-16 for IBM supplementary characters and JIS secondary *kanji*	$83	now
Font-24 for IBM supplementary characters and JIS secondary *kanji*	$83	now
Macro-Assembler	$125	now
BASIC compiler	$250	now
COBOL compiler	$625	now
FORTRAN compiler	$333	now
Pascal compiler	$250	now
Multiplan	$166	now
Multitool Chart	$166	12/83
Multitool File	$208	12/83
Sort/Merge program	$208	now
BSC 3741 communications utility	$158	now
SNA/SDLC 3770 RJE utility	$125	now
Japanese-Language Word-Processing Software:		
Document program	$417	now
Dictionary/Font-16 (extended character set)	$105	now
Dictionary/Font-24 (basic character set)	$105	now
Font-24 (extended character set)	$83	now
Japanese-Language Online Terminal Software:		
3270 *kanji* emulation/Font-16 (extended character set)	$250	now
3270 *kanji* emulation/Font-24 (extended character set)	$250	now

Table 1: *A price list. The 5550 is not yet available in the US, thus no US prices are quoted by IBM. The numbers listed in this table and quoted in the text are direct conversions from the Japanese price list, using an exchange rate of 240 yen to the dollar. Because it is widely agreed that the yen is currently undervalued with respect to the dollar by about 20 percent, the numbers above should probably be increased somewhat to get an accurate picture of the system's real cost to the potential Japanese customer.*

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The Software

The 5550 comes to market with an extensive repertoire of IBM-sponsored software. First and foremost are the packages that support the workstation task environments (word-processing and communications-terminal functions). The powerful word-processing software, developed by IBM, costs $525 to $600 for the Bunshō (Document) program and font libraries and gives the machine capabilities comparable to IBM's American Displaywriter system. The communications adapter and the three programs to support it (3270 Kanji Terminal emulator, BSC3741 communications utility, and 3770 RJE utility) will be available soon. The word-processing program and the *kanji* terminal emulator run under a special dedicated operating system developed by IBM and resident on the program disks.

The personal-computing functions, the BSC3741 utility, and the 3770 RJE utility run under Japanese Language DOS, Microsoft's Japanese version of MS-DOS. Several general applications packages and programming languages developed by Microsoft are available, including Multiplan spreadsheet; Multitool Chart and Multitool File are slated for December. (Interestingly, IBM has priced the Japanese version of Multiplan $100 less than the English version.) Interpreter BASIC, 8086 Macro-Assembler, FORTRAN, and Pascal are available now, and BASIC and COBOL compilers were scheduled for October release. The existing literature does not mention any specific applications software, such as accounting packages, that might be offered by IBM later on. But Ashton-Tate has developed a version of dBASE II for the 5550, and there is a file communicator called D-COM that enables the 5550 to exchange data with other popular Japanese microcomputers. And if the American PC is any precedent, the market should soon be flooded with 5550 software. ■

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Acknowledgment

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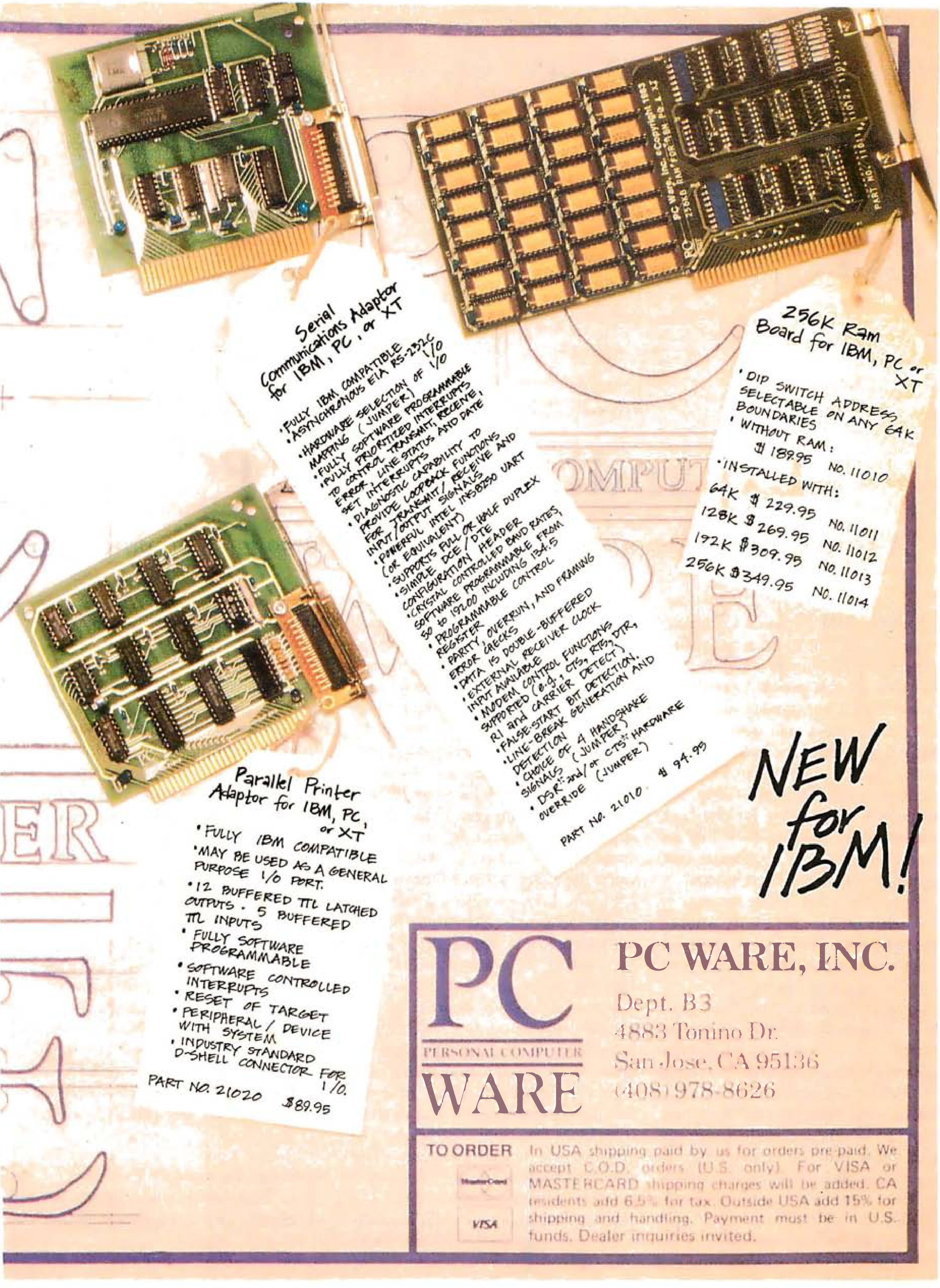


Circle 354 for Apple Products. Circle 355 for IBM Products.

Expanding on the PC

A survey of expansion boards for the IBM Personal Computer

by Mark J. Welch

Both the IBM Personal Computer and PC compatibles offer many features computer users want, but no one system can please everybody. Rather than try to predict which features most users will want and include those under the basic machine price, the PC and many PC compatibles include expansion slots. The result is a lower price for the basic machine plus greater flexibility for users who want to customize configurations to meet their needs.

Expansion slots, made famous by the Apple II, let you install printed-circuit boards to perform functions not provided by the computer's standard hardware.

Some of the add-on boards—disk-drive controllers, memory-expansion boards, and printer and communications interfaces—appeal to large numbers of computer buyers. Other boards—for prototyping, programming EPROMs (erasable programmable read-only memory chips), or converting analog signals for storage by the computer—target a much smaller percentage of PC and PC-compatible owners. Still, with these machines fast approaching the mark of 1 million units sold, a small percentage represents a very large number of users. Obviously, a substantial market for expansion boards, including dozens with distinct functions, exists.

Tables on the following pages provide detailed information about expansion boards produced by 107 different manufacturers. The tables organize the boards by their functions and list entries in alphabetical order by manufacturer within each category. (The exception is table 17, which lists miscellaneous boards alphabetically by function.) A separate listing of manufacturers' addresses begins on page 178.

Some expansion boards defy a simple description or are so unlike other boards that we couldn't include them in our survey listing. For example, Quadram Corp. offers a unique expansion board that enables the IBM Personal Computer to emulate an Apple computer. The $680 Quadlink board includes a 6502 processor and 64K bytes of RAM and can run most Apple II or II Plus software. According to Quadram, users can run programs concurrently in Apple and IBM modes, switching between the two at any time.

Quadlink won't run software written exclusively for the Apple IIe or software that uses a "half-track" copy-protect scheme, but it *will run* most other Apple software, including high-resolution graphics. Quadlink includes a game port that can be used in either IBM or Apple mode and can access other ports and expansion boards in the IBM PC.

The Futurex Encryptor, from Jones Futurex Inc., is a data-encryption board. The board encrypts, or translates, data into special codes that can be translated only by the Encryptor board. Data can thus be hidden from unauthorized users or can be transmitted to another IBM PC equipped with the board without risk of eavesdropping. Five versions of the Encryptor, ranging from $300 to $600, are available for the IBM PC.

Modular Expansion Boards

Two expansion-board suppliers let you choose any combination of features and upgrade already purchased boards by selling modular expansion boards. The boards plug into a standard expansion slot, and modules that perform particular functions then plug into the boards.

Maynard Electronics' Sandstar Multifunction card, with room for up to six modules, costs $110. The Sandstar Memory card, with room for up to 576K bytes of RAM (random-access read/write memory) and three modules, sells for $230. The Sandstar Disk Controller Card, for $265, includes either two 5¼-inch and two 8-inch disk-drive controllers or four 5¼-inch controllers, plus room for three modules. A clock/calendar module costs $85 more. Other available modules are a parallel port ($75), a serial port ($105), and a game adapter ($60).

Arby's Combination Board costs $110 and can be expanded with a $90 clock/calendar module, a $105 serial-port module, and a $75 parallel-port module, allowing up to six modules in all.

Take time to consider what you want from your IBM PC, and then carefully research the available products to determine which ones best meet your requirements. The information given here should get you started. With luck, you may find that the PC of your dreams is just an expansion board away. ■

Mark J. Welch is a BYTE staff writer. He can be reached at 70 Main St., Peterborough, NH 03458.

A Key to the Tables

Because the tables accompanying this article cover a number of boards and their characteristics, some items are necessarily abbreviated. The following explanations of column headings and comments are therefore provided to help you get the most information from the tables.

A/D Lines: *How many analog-to-digital conversion lines are on the board, if any?*

Board Name: *Some expansion boards may have more than one name, while others may use the same name for several variations of the same board.*

Clock: *A clock/calendar with battery backup is on the board.*

D/A Lines: *How many digital-to-analog conversion lines are on the board, if any?*

Digital I/O Lines: *If the board can be used for special input/output functions, how many single-bit lines can be connected? These I/O lines can be used to transfer single-bit (on or off) information or to transmit or receive bytes of information in parallel.*

E/EPROM Capability: *The board can be used to program EPROMs or EEPROMs.*

Game Port: *A standard game controller port is included.*

IEEE-488 Interface Included: *A standard IEEE-488 port—also known as a GPIB (general-purpose interface bus) port—is included.*

Manufacturer's Name: *Addresses are in a separate list beginning on page 178.*

Modem Included: *A modem is included on the board.*

N.A.: *Information was not available.*

Parallel Ports: *How many standard Centronics-type parallel printer ports are there on the board, if any?*

Price: *Manufacturer's suggested retail price for the board with the options and memory indicated. Although prices are listed for boards with 64K, 128K, 192K, 256K, 512K, and 1024K bytes of memory, some boards are available in other configurations (usually multiples of 64K).*

Print Spooler: *Software is included permitting part of the memory to be used as a print buffer.*

Prototyping: *The board can be used to design and revise prototype versions of an expansion board. This is useful for creating boards with features not available from any company or for trying sample layouts of a board you plan to mass-produce and sell.*

Prototype Size: *The size of the expansion board, usually about 13 by 4 inches. Some boards are smaller to save money or to fit into the PC XT's smaller slots.*

RAM Disk: *Software is included (at no extra charge) permitting the extra memory to be used as if it were a disk drive.*

Serial Ports: *How many RS-232C serial interface ports (for printers, modems, and other communications uses) are included on the board?*

Manufacturer	Board Name	Serial Port	Parallel Port	Price	Comments
Automated Business Machines	CP/M-80 Adapter			$545	
Byad	DS2	1		$760	CP/M included
Byad	DS1			$660	CP/M included
California Computer Systems	Z/Plus	1		$875	CP/M 2.2 included; with 192K bytes, $995
Gateway Communications	PC-LNIM			$595	allows CP/M or networking
Microdisk	1-DOS			$850	allows CP/M to run under PC-DOS; has print-spooler capability
Microlog	Baby Blue			$600	has RAM-disk capability
Personal Data Systems	Pack-Z80	1		$450	
Quality Computer Services	Big Blue	1	1	$595	has a clock

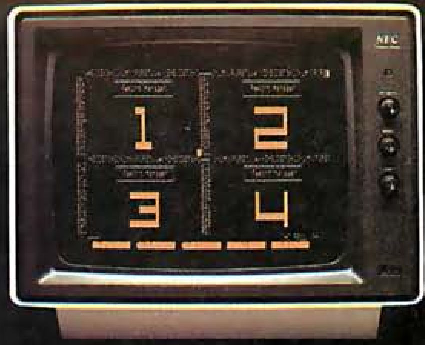
Table 1: *Z80 coprocessors (all include 64K bytes of RAM). The Z80 replaces the PC's standard 8088 processor as the central processor, letting you use both CP/M-80 software, which runs on the Z80, and standard IBM PC software, which runs on the 8088. Be sure to find out whether buying a particular board gets you the CP/M operating system or merely lets you use CP/M-based software.*

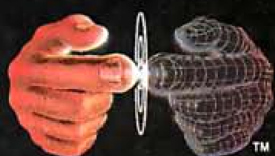
Manufacturer	Board Name	RAM Disk	Print Spooler	0K-byte Price	32K-byte Price	64K-byte Price	128K-byte Price
AST Research	MP Series Memory Expansion	•	•			$295	$395
Alpha Byte Computer Products	Memory Expansion						
Apparat	Memory Card	•				$189	
Applied Business Computer	Mega Board AI-1512					$295	$385
Apstek	AIM-256			$199		$269	$339
Arby	Expansion Memory			$230		$295	
Automated Business Machines	Memory Expansion Modules					$329	
Bitstream	Memory Boards			$129		$169	$229
Chintronics	M-192 Memory						
Computer Technology Innovations	IRM Memory Boards					$199	$299
Datamac Computer Systems	DM Memory Expansion Boards					$395	$590
Davong Systems	DSI Memory Boards					$265	$408
Daystar Systems	UltraRAM						
Hammond Computer Products	PC/RAM Stack						
Hammond Computer Products	PC/RAM Pack					$495	
IDE Associates	IDEA Memory Card					$245	$320
IBM	32K Memory Expansion				$325		
Intermedia Systems	Memory Expansion Modules						
Macrolink	Memory Board					$375	$475
Maynard Electronics	MEM Memory Expansion Modules			$210		$305	$410
Memory Technologies	Versa-RAM	•	•	$259		$339	$419
Micro Express	Memory Boards					$299	$450
Micro Match	MM64 Memory Expansion Boards					$145	$200
Micro Network	High Density Memory						
Micro Synergy	Pro Series RAM			$195		$275	$350
Microlog	L'il Red RAM Plus	•				$249	$299
Microsoft	RAMCard	•				$495	$695
Microtek	HAL Series	•	•			$299	
PC²	MEM Memory Boards						
Professional Data Systems	Memory Boards					$189	$289
Pure Data	Memory Expansion RAM Card						
Quadram	Memory Expansion Board					$275	
RGB Systems	Mile RAM					$650	$720
RGB Systems	Error-Correcting RAM						
Raytronics	Fleximem			$229			
STB Systems	I 64/192		•			$294	
Semidisk System	Semidisk I						
Semidisk System	Semidisk II	•					
Sigma Designs	Memory Boards					$295	$445
Sigma Designs	SDI64					$150	
Tecmar	RAM/ROM Board			$195			
Tecmar	Forget-Me-Not CMOS				$995		
Tecmar	Dynamic Memory					$289	$369
VR Data Corp.	IBM PC RAM			$699		$799	$899
Vista Computer	Maxicard	•				$349	$449
Wesper Microsystems	Wizard PC Memory Card			$250		$322	$545
Zobek	Memory Board						
Personal Data Systems	Pack-RAM					$225	$335
Tall Tree Systems	JRAM	•	•				
Super Computer	Supermemory					$295	

Table 2: *Memory boards. Although most IBM PCs contain 64K bytes of RAM, many popular applications programs require more memory. The solution comes from memory-expansion boards available with 64K to 1024K bytes (1 megabyte) of RAM, usually in multiples of 64K.*

192K-byte Price	256K-byte Price	384K-byte Price	512K-byte Price	1024K-byte Price	Comments
$495	$595				
	$345		$579		
$475	$565	$745	$925		
$409	$479				
	$745				
$289	$349				
$259					
$399	$449				
$785	$980				
$552	$696				
	$695		$895		
			$1195		
	$995				
$385	$445				
	$299				
$575	$675				
$510	$615				
$499	$579	$739	$899		
	$750				
$255	$305				
		$400			
$425	$525		$825		
$349	$399				
$895	$1095				
	$799				
	$499		$799		
	$529				
$425					
$790	$860				
$999					error-correcting capability
					EPROM capability
$470					error-correcting capability
			$1495	$2350	
			$1795	$2650	
$595	$695				
					EPROM capability
					battery backup
$439	$489				
$999					error-correcting capability
$549	$649	$849	$1049		
$695	$845				
	$335				
$445					
			$800		
					EPROM capability

Circle 326 on inquiry card. →





Manufacturer	Board Name	Price	8-inch-disk Interface	5¼-inch-disk Interface	Comments
Arby	Disk Adapter	$275		•	
Arby	Disk Adapter	$395	•		includes parallel port
Computer Technology Innovations	IC5/8C	$175	•	•	
Maynard Electronics	Floppy Drive Controller	$275		•	includes parallel port
Maynard Electronics	Floppy Drive Controller	$285		•	includes serial port
Paso Com	Professional IV Series	$495	•	•	also includes hard-disk interface
Sigma Designs	Disk Drive Adapter	$265		•	includes clock
Tecmar	Floppy 5/8 Adapter	$495	•	•	
Vista Computer	Disk Master	$299	•	•	also includes 3½-inch-disk interface

Table 3: *Disk-drive controllers. If you use a disk drive, you need a disk-drive controller.*

Manufacturer	Board Name	Serial Ports	Parallel Ports	Price	Comments
Control Systems	Serial/Parallel Interface	2	2	$300	4 PROM sockets
Jack Strick & Associates	Parallel/Serial Controller	1	1	$225	
Paso Com	Professional III Series	1	1	$495	
Paso Com	Professional II Series	1		$159	has game port and clock
Tecmar	Scribe Tender	2	1	$195	
Tecmar	2nd Mate	2	2	$295	
Tecmar	Scribe Master	3		$495	24 digital I/O lines

Table 4: *Multiple interface boards such as these offer both parallel and serial ports (see tables 6 and 13).*

Manufacturer	Board Name	Memory (bytes)	Parallel Ports	Color	Price	Comments
California Computer Systems	Supervision	N.A.			$800	132 by 44 text format on monochrome display
Conographic	Cono Color	128K		•	$895	16 colors in 640- by 400-pixel format
Control Systems	Artist I	512K		•	$3195	1024- by 1024-pixel format
Control Systems	Artist II	512K		•	$1595	640 by 400 pixels
Hercules Computer Technology	Graphics Card	64K			$499	replaces IBM board; 720 by 348 pixels
IBM	Color/Graphics Adapter	N.A.		•	$244	
Orchid Technology	MGA Graphics Controller	64K			$395	requires IBM monochrome card; 720 by 350 pixels
Plantronics	Colorplus	N.A.	1	•	$475	320 by 200 pixels in 16 colors; 640 by 200 pixels in 4 colors
Quadram	Quadcolor	32K		•	$295	16 colors, 640 by 200 pixels
Scion	PC640 Professional Color Graphics	N.A.		•	$1595	16 colors, 640 by 480 pixels
Syntec	Professional Graphics Generator	N.A.		•	$7000	overlays; 512 by 512 pixels, 16 colors
Tecmar	Graphics Master	128K		•	$695	up to 720 by 700 pixels
USI Computer Products	Multi Display Card	32K		•	$449	

Table 5: *Advanced graphics boards allow higher resolution or color graphics for the IBM PC; some boards include special software or allow use of a light pen or other special input devices. Currently, few software programs make use of the high-resolution graphics or color provided by these boards. Until that situation changes, you may have to buy software from the graphics-board vendor or write it yourself.*

Manufacturer	Board Name	Parallel Ports	Price
Control Systems	Parallel Interface Adapter	1	$105
GM Enterprises	Parallel I/O Adapter	1	$149
IBM	Printer Adapter	1	$150
Quadram	IPIC	1	$110
Super Computer	Parallel Printer	1	$75

Table 6: *Parallel boards. Parallel (or "Centronics-compatible") ports enable the IBM PC to interface with one or perhaps several parallel printers.*

Manufacturer	Board Name	Price
Apparat	Clock/Calendar	$99
Quadram	Chronograph	$110
Tecmar	Time Master	$135

Table 7: *Clocks with battery backup. These enable the PC to keep continuous track of the date and time and are helpful for sending electronic mail and for automatically inserting the date in a form letter.*

Manufacturer	Board Name	Memory (bytes)	Clock	Serial Ports	Parallel Ports	Price
Apparat	Print Spooler	64K			1	$319
Periphex	I-Queue	64K	•			$495
Super Computer	Superbuffer	64K				$395
Wesper Microsystems	Wizard-Spooler S/P	16K		1	1	$349
Wesper Microsystems	Wizard-Spooler P	16K			1	$289

Table 8: *Print-spooler boards combine printer ports and memory to provide a buffer (or spooler) that stores in a section of memory data that is to be printed. This lets the PC continue with other work while the printer is still printing. The boards listed here can only be used as buffers. Boards that include software for print spooling are listed in tables 2, 14, and 15.*

Manufacturer	Board Name	Price	Prototype Size (inches)
AST Research	WW-68 Wire-wrap Card	$75	N.A.
Advanced Computer Products	Prototype Card	$69	13.2 by 4
Apparat	Prototype Card	$29.95	8.1 by 3.9
Automated Business Machines	Development Card	$49	N.A.
GM Enterprises	Prototype Board	$25	8.1 by 3.9
IBM	Prototype Card	$45	N.A.
Micro Match	MM77-1 Prototyping Board	$45	N.A.
Sigma Designs	SDI Miniproto	$25	N.A.
Sigma Designs	SDI Proto	$45	N.A.
Super Computer	Prototyping Board	$45	N.A.
Tecmar	Protozoa	$45	42 square
Vector Electronic	Universal Wiring	$24.26 to $39	13.2 by 4.2

Table 9: *Prototype boards help you create your own specialized IBM PC board.*

Circle 327 on inquiry card. →

Manufacturer	Board Name	Memory (bytes)	Parallel Ports	Price	Digital I/O lines
GM Enterprises	ParlePC Speech Synthesizer	N.A.	1	$199	24
Street Electronics	Echo PC Speech Synthesizer	16K		$225	
Tecmar	Speech Master	N.A.		$395	

Table 10: *Speech synthesizers. If you want your PC to talk back to you, then a speech-synthesizer board is the answer. Some boards include speakers, but some don't.*

Manufacturer	Board Name	Price
Apparat	PROM Blaster	$129
Super Computer	Superblaster	$225
Tecmar	E + EEPROM Programmer/Reader	$495

Table 11: *EPROM and EEPROM programming boards make it easier to program erasable and electrically erasable programmable ROMs.*

Manufacturer	Board Name	Price	Prototyping
AST Research	Extender	$55	
Advanced Computer Products	Extender Card	$40	
Micro Match	MM39-1 Extender	$35	
Personal Computer Products	Card Extender	$50	
Tecmar	Extender Card	$80	•
Vector Electronic	3690-22 Extender	$22.35	

Table 12: *Extenders. When testing a homemade expansion board, an extender board is a handy option. It effectively ''lifts'' a card slot above the PC's case by plugging into an expansion slot and providing an identical connector on top.*

Manufacturer	Board Name	Serial Ports	Price
AST Research	CC-232 Advanced Communication	2	$295
Computer Technology Innovations	ISCDA-0	2	$125
Control Systems	4 Serial I/O Ports	4	$395
Control Systems	Hostess Multiuser Host A	8	$795
Datamac Computer Systems	DMS-1	1	$139
Datamac Computer Systems	DMS-2	2	$199
IBM	Asynchronous Communication Adapter	1	$120
PC²	COMM-1	1	$85
PC²	COMM-1	2	$115
Personal Systems Technology	Asynchronous Communication Ports	2	$165
Personal Systems Technology	Asynchronous Communication Ports	1	$125
Quadram	RS-232C Asynchronous Adapter	1	$110
Zen/Tek	Dual COM Card	2	$120
Zen/Tek	Z-COM Card	1	$100
Zobek	2SP	2	$165

Table 13: *Serial boards. A serial interface permits communication to a modem, a printer, or another computer. Serial ports are also known as RS-232C or asynchronous ports. (For boards offering both serial and parallel ports, see table 4.)*

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Manufacturer	Board Name	Print Spooler	Clock	Serial Ports	Parallel Ports	Game Port	0K-byte Price
AST Research	Combo Plus	•	•	1	1		
AST Research	Megaplus II	•	•	1			
AST Research	Six Pack Plus	•	•	1	1		
Anatron	Multifunction RAM	•	•	2	1		
Amdek	Multiple Adapter Interface				1		
Applied Business Computer	Mega A+	•	•	2	1		
Apstek	AIC-256		•	1	1		$299
Chrislin Industries	CI-PCM+			1			
Computer Technology Innovations	IMF-APGC		•	1	1	•	
Computer Technology Innovations	ISC5A			1			
Datamac Computer Systems	Combo Board			1			
Davong Systems	ASYNC + RAM			2			
Daystar Systems	Ultra55		•	2	1	•	
Easitech	Easiboard II	•	•	2	1		$350
Easitech	Easiboard	•	•	1	1		$325
IDE Associates	IDEA Plus	•	•	1	1		
Indigo Data Systems	PC Multipak	•	•	1			$297
Intermedia Systems	Memory Expansion Module			2			
MK Research	RAM Card with RS-232C			1			$179
Maynard Electronics	Memory Board with Serial Ports			2			$370
Memory Technologies	Versa-RAM Plus II	•	•				
Memory Technologies	Versa-RAM Plus II	•	•	1	1		
Memory Technologies	Versa-RAM Plus II	•	•		1		
Memory Technologies	Versa-RAM Plus	•		2	1		$299
Memory Technologies	Versa-RAM Plus II	•	•	1			
Micro Network	Combination Memory Board		•	1	1		
Micro Synergy	Pro Series 5		•	1	1	•	$395
Micro Synergy	Pro Series 3			1	1		$275
Microcomputer Business Industries	Monte Carlo GT		•	1	1	•	
Microcomputer Business Industries	Monte Carlo Quatro		•	1	1		
Microcomputer Business International	MegaRAM			2			
Microtek	HAL (parallel and serial ports)	•		1	1		
Microtek	Tele-buffer PC	•	•		1		
Paso Com	Professional I Series			1	1		
Personal Data Systems	Pack-RAM+Combo Card		•	1	1		
Personal Systems Technology	Time-Spectrum		•	1			
Quadram	QuadRAM 512+			1			
Quadram	Quadboard		•	1	1		
Quadram	Quadboard II		•	2			
Raytronics	RAMPLUS Multifunction		•	1	1		$319
STB Systems	RIO Plus	•	•	1	1	•	
STB Systems	RIO	•		1	1	•	
STB Systems	Super RIO	•	•	2	1	•	
Seattle Computer	RAM+			1			$220
Seattle Computer	RAM+3 with Memory		•	1	1		$320
Sigma Designs	System Support+Memory		•	1	1	•	$295
Sigma Designs	System Support Card Stack			1			
Starware	Tenley Board		•				
Tava	Trump Card			1		•	
Tecmar	1st Mate		•	1	1		$319
Universal Micro	Clock/Memory		•				
Vista Computer	Multicard		•	1	1		
Zen/Tek	Memory	•		1	1		

Table 14: *Multifunction boards with memory. By combining many capabilities, these boards help you get the most use from the PC's five expansion slots. (For multifunction boards* without *memory, see table 15.)*

64K-byte Price	128K-byte Price	192K-byte Price	256K-byte Price	384K-byte Price	512K-byte Price	Comments
$395	$495	$595	$695			
$395	$495	$595	$695	$970	$1090	game, parallel, and extra serial ports $50 each
$395	$495	$595	$695	$895		game port $50 extra
$395			$595			
	$799					includes monochrome adapter
$325	$415	$505	$595			
$369	$439	$509	$579			
$445	$495	$545	$595		$795	includes memory battery backup
$495	$585	$675	$750			
$265	$355	$445	$520			
$550						
$385	$580	$736	$892			
			$595	$795		EPROM capability
$420			$620			
$395			$595			
$395	$470	$530	$595			
$365	$432	$499	$565			
			$749		$1095	
$99					$579	
$465	$570	$680	$785			
$429	$509	$589	$669			
$479	$559	$639	$719			
$455	$535	$615	$695			
$369	$439	$509	$579			
$455	$535	$615	$695			
				$645		modem included
$475	$550	$625	$695			
$360	$445	$520	$595			
$425	$505	$575	$645			
$375	$440	$510	$575			
$300			$500			
$499			$999			
$699			$1199			auto-dial/auto-answer programmable modem
$295	$375	$455	$535			
$495	$615	$735	$855			
$395	$485	$575	$665	$930	$1100	extra serial port and/or parallel port optional
$325			$550		$895	
$395			$595			
$395			$595			
$389	$459	$529	$599			
$475			$739	$899		includes hard-disk interface
$395		$572	$659			includes hard-disk interface
$475		$649	$739		$1336	includes hard-disk interface
$295	$370	$445	$520			
$395	$470	$545	$620			
$575			$875			
$195			$595			
$445						
			$499		$699	
$389	$469	$539	$589			
$398	$488	$578	$668			
$399	$499	$599	$699			
$395	$485	$575	$665		$1025	available with extra serial port instead of parallel port

Manufacturers' Addresses

Advanced Computer Products
1310B East Edinger Ave.
Santa Ana, CA 92705
(714) 558-8813

ALL Computers Inc.
110 Bloor St. W, Suite 501
Toronto, Ontario,
Canada M5S 2W7
(416) 960-0111

Alpha Byte Computer Products
31245 La Baya Dr.
Westlake Village, CA 91362
(213) 706-0333

Amdek Corp.
2201 Lively Blvd.
Elk Grove Village, IL 60007
(312) 364-1180

Anatron
202 West Bennett St.
Saline, MI 48176
(800) 521-0521, (313) 429-2678

Apparat Inc.
4401 South Tamarac Pkwy.
Denver, CO 80237
(303) 741-1778

Applied Business Computer Co.
330 East Orangethorpe Ave., Suite C
Placentia, CA 92670
(714) 993-1101

Apstek Inc.
2636 Walnut Hill Ln., Suite 335
Dallas, TX 75229
(214) 357-5288

Arby Corp.
1617A Massachusetts Ave.
Cambridge, MA 02138
(617) 864-5058

AST Research Inc.
2372 Morse Ave.
Irvine, CA 92714
(714) 540-1333

Automated Business Machines Inc.
29352 Avocet Ln.
South Laguna, CA 92677
(714) 859-6531

Bitstream Inc.
POB 809
Loxahatchee, FL 33470
(305) 798-0025

Byad Inc.
101 Liong Dr.
Barrington, IL 60010
(312) 539-4922

Cactus Technology Inc.
3024 North 33rd Dr.
Phoenix, AZ 85017
(602) 269-2440

California Computer Systems
250 Caribbean Dr.
Sunnyvale, CA 94086
(408) 734-5811

Manufacturer	Board Name	RAM Disk	Print Spooler	Clock	Serial Ports	Parallel Ports	Game Port	Price
AST Research	I/O Plus II	•	•	•	1			$165
Apparat	Combo Card			•	1	1	•	$189
Applied Business Computer	I/O A+	•	•	•	2	1	•	$225
Apstek	SIC-1			•	1			$149
Apstek	PIC-1			•		1		$149
Automated Business Machines	Omni-board			•	2	1	•	$485
Easitech	Easistart	•	•	•	1			$350
M & R Enterprises	Sup'r Access I				7			$695
Maynard Electronics	Floppy Controller							$195
Micro Network	Combination Peripheral				1			$400
Personal Data Systems	Pack-Combo			•	1	1		$245
Personal Data Systems	Pack-Combo			•	1			$175
Personal Systems Technology	Timeport			•	1	1		$225
Personal Systems Technology	Uniport			•		1		$155
RGB Systems	Three in One Board				2		•	$289
STB Systems	Super I/O	•	•	•	1	1	•	$249
STB Systems	STB I/O		•		2	1	•	$279
Seattle Computer	RAM+3			•	1	1		$210
Tecmar	Lab Master			•		3		$995
Vista Computer	PC Clock I/O			•	1	1		$210
Vista Computer	PC Master			•	2	1	•	$449
Vista Computer	PC Expander			•	2	1	•	$349
Vista Computer	PC Extender			•	2	1		$249
Vista Computer	PC Extender Plus			•	1	1	•	$299
Vista Computer	PC Extender + Voice			•	2	1	•	$399
Ziatech	ZT1488 GPIB Controller			•				$485

Table 15: *Multifunction boards without memory. (For multifunction boards* with *memory, see table 14.)*

Cermetek Microelectronics Inc.
1308 Borregas Ave.
Sunnyvale, CA 94089
(408) 734-8150

Chintronics Co.
19 Longmeadow Rd.
Chelmsford, MA 01824
(617) 256-7862

Chrislin Industries Inc.
31352 Via Colinas
Westlake Village, CA 91362
(213) 991-2254

Computer Technology Innovations
965 West Maude Ave.
Sunnyvale, CA 94086
(408) 245-4256

Conographic Corp.
2268 Golden Circle
Newport Beach, CA 92660
(714) 642-6778

Control Systems
2855 Anthony Ln.
Minneapolis, MN 55418
(612) 789-2421

Datamac Computer Systems
680 Almanor Ave.
Sunnyvale, CA 94086
(408) 735-0323

Data Translation
100 Locke Dr.
Marlborough, MA 01752
(617) 481-3700

Davong Systems Inc.
217 Humboldt Court
Sunnyvale, CA 94086
(408) 734-4900

Daystar Systems Inc.
10511 Church Rd., Suite A
Dallas, TX 75238-9990
(214) 341-8136

Easitech Corp.
2215 Perimeter Park, Suite 22
Atlanta, GA 30341
(404) 452-7576

Flagstaff Engineering
2820 West Darleen
Flagstaff, AZ 86001
(602) 774-5188

Force Technology Corp.
POB 20955, Almaden Valley Sta.
San Jose, CA 95160
(408) 268-3359

Gateway Communications Inc.
16782 Red Hill Ave.
Irvine, CA 92714
(714) 261-0762

Giltronix Inc.
3780 Fabian Way
Palo Alto, CA 94303
(415) 493-1300

GM Enterprises Inc.
485 East Granville Ave.
Roselle, IL 60172
(312) 893-1171

Hammond Computer Products Inc.
3800 Crossbend Pl.
Plano, TX 75023
(214) 596-0130

Hayes Microcomputer Products Inc.
5963 Peachtree Industrial Blvd.
Norcross, GA 30092
(404) 449-8791

Hercules Computer Technology
2550 Ninth St., Suite 210
Berkeley, CA 94547
(415) 654-2476

IBM Corp. System Products Division
POB 1328
Boca Raton, FL 33432
(800) 447-4700

IDE Associates
7 Oak Park Dr.
Bedford, MA 01803
(617) 275-4430

Indigo Data Systems Inc.
100 East Nasa Road One, Suite 107
Webster, TX 77598
(713) 488-8186

Information Technologies Inc.
7850 East Evans Rd.
Scottsdale, AZ 85260
(602) 998-1033

Intelligent Technologies International Corp.
151 University Ave.
Palo Alto, CA 94301
(415) 328-2411

Intermedia Systems
10601 South DeAnza Blvd.
Cupertino, CA 95014
(408) 996-0900

Jones Futurex Inc.
9700 Fair Oaks Blvd., Suite G
Fair Oaks, CA 95628
(916) 966-6836

Lifeboat Associates
1651 Third Ave.
New York, NY 10028
(212) 860-0300

Macrolink Inc.
1150 East Stanford Court
Anaheim, CA 92805
(800) 854-3332, (714) 634-8080

Manufacturers' Addresses continued on page 180

Comments
game, parallel, or extra serial ports, $50 each
fits small slots of PC XT version
fits small slots of PC XT version
monochrome adapter
includes 1200-bps modem
includes 5¼-inch-disk interface
includes 5¼-inch and hard-disk interfaces
extra serial port, $50; EPROM capability
includes hard-disk interface
includes hard-disk interface
16 A/D lines, 2 D/A lines, 24 digital I/O lines
includes speech synthesizer, hard-disk interface
includes speech synthesizer
includes IEEE-488 interface

Manufacturer	Board Name	Serial Ports	Parallel Ports	Price	Comments
Automated Business Machines	Telephone Receptionist Adapter			$995	auto-dial/auto-answer, 300/1200 bps, speech synthesizer
Cactus Technology	PC-COM-300			$349	
Cermetek Microelectronics	Info-Mate 212A PC			$495	auto-dial/auto-answer, 300/1200 bps
Hayes Microcomputer Products	Smartmodem 1200B			$599	
Micro Network	Advanced Communications Board			$895	
Micrólog	Baby Talk	1	1	$895	includes Z80 coprocessor, 64K bytes, clock
Microperipheral	PConnection	1		$279	auto-dial/auto-answer, speaker, clock
Pacific Coast Peripherals	Communication Utility	1	1	$349	
SSM Microcomputer Products	PC Modemcard			$349	300 bps, $549 for 300/1200 bps
Tecmar	3rd Mate	1	2	$445	
Tecmar	Modem 1200			$695	300/1200 bps
Tecmar	Modem 300			$295	300 bps
Intelligent Technologies	PC Express	1		$895	

Table 16: *Integral-modem boards, like separate-unit modems, permit use of standard telephone lines for computer communications. Although the integral unit takes up one PC expansion slot, it requires no additional RS-232C port, cables, or desk space.*

Manufacturers' Addresses continued:

Maynard Electronics
400 East Semoran Blvd., Suite 207
Casselberry, FL 32707
(305) 331-6402

Memory Technologies Inc.
4343 Grand Prix Dr.
POB 508
Logansport, IN 46947
(800) 348-3377, (219) 722-1454

Microcomputer Business Industries Corp.
1019 8th St.
Golden, CO 80401
(303) 279-8438

Microcomputer Business International
POB 16115
Irvine, CA 92713
(714) 553-0133, (714) 727-0202

Microdisk
1422 Industrial Way
POB 1377
Gardnerville, NV 89410
(702) 782-8105

Micro Express
23392 Devonshire Dr.
Eltore, CA 92630
(714) 859-7575

Micro Interface Inc.
3111 South Valley View Blvd. #1-101
Las Vegas, NV 89102
(702) 871-3263

Microlog Inc.
222 Route 59
Suffern, NY 10901
(914) 368-0353

Micro Match
10049 Commerce Ave.
Tujunga, CA 91042
(213) 353-5929

Micro Network Corp.
511 11th Ave., Suite 429
Minneapolis, MN 55415
(612) 333-4303

Microperipheral Corp.
2643 151st Place NE
Redmond, WA 98052
(206) 881-7544

Microsoft Corp.
10700 Northup Way
Bellevue, WA 98004
(206) 828-8080

Micro Synergy
187 Ulmerton Rd.
Largo, FL 33544
(813) 535-6655

Microtek Inc.
4750 Viewridge Ave.
San Diego, CA 92123
(800) 854-1081, (619) 569-0900

Microware
POB 79
Kingston, MA 02364
(617) 746-7341

MK Research
17842 Irvine Blvd., Suite 122
Tustin, CA 92680
(714) 731-5201

Mountain Computer
300 El Pueblo Rd.
Scotts Valley, CA 95066
(408) 438-6650

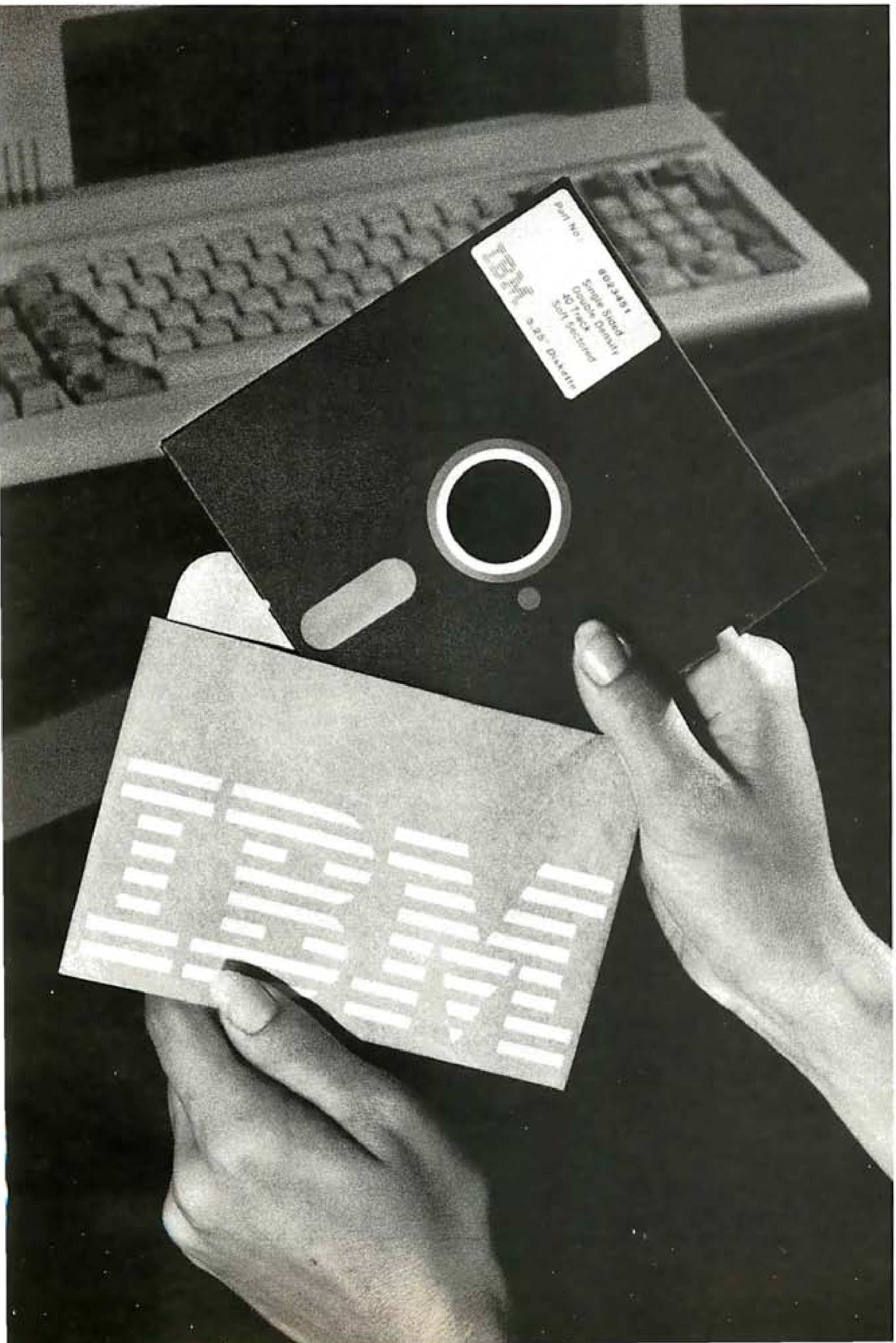
M & R Enterprises
910 George St.
Santa Clara, CA 95050
(408) 980-0160

National Instruments
12109 Technology Blvd.
Austin, TX 78727
(800) 531-5066, (512) 250-9119

Orchid Technology
47790 Westinghouse Dr.
Fremont, CA 94539
(415) 490-8586

Manufacturers' Addresses continued on page 182

Sleeves of Tyvek® protect your data investment better than paper. Here's why:



1. TYVEK* spunbonded olefin has more than twice the strength of good quality paper.

2. TYVEK does not lint.

3. TYVEK is smooth and nonabrasive.

4. TYVEK is chemically clean ... has a neutral pH.

5. TYVEK reduces static problems.

6. TYVEK is unaffected by water.

With TYVEK, you don't have to compromise on any important sleeve criteria. You get it all. That's why TYVEK is still the best way to protect your diskettes.

For more information, write: Du Pont Company, Room X40133, Wilmington, DE 19898.

*Du Pont registered trademark.
DuPont makes TYVEK, not sleeves.

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Circle 160 on inquiry card.

Manufacturers' Addresses continued:

Pacific Coast Peripherals
3480 Granada Ave., Suite 224
Santa Clara, CA 95051
(408) 247-1720

Paso Com
POB 2603
Mission Viejo, CA 92690
(714) 552-0130

PC²
595 Testoria Ave.
Sunnyvale, CA 94086
(408) 735-0323

Periphex Inc.
149 Palmer Rd.
Southbury, CT 06488
(800) 221-0732, (203) 264-7937

Personal Computer Products
1400 Coleman Ave., Suite C-18
Santa Clara, CA 95050
(408) 988-0164

Personal Data Systems Inc.
1110 Wrigley Way
Milpitas, CA 95035
(408) 262-7880

Personal Systems Technology Inc.
15801 Rockfield, Suite A
Irvine, CA 92714

Plantronics Division
Frederick Electronics
7630 Hayward Rd.
POB 502
Frederick, MD 21701-0502
(301) 662-5901

Professional Data Systems Inc.
2630 Walnut Ave., Suite H
Tustin, CA 92680
(800) 854-8428, (714) 730-7207

Pure Data Ltd.
950 Denison St., Unit 17
Markham, Ontario,
Canada L3R 3K5
(416) 498-1616

Quadram Corp.
4355 International Blvd.
Norcross, GA 30093
(404) 923-6666

Quality Computer Services
178 Main St.
Metuchen, NJ 08840
(800) 631-5944, (201) 548-2135

Raytronics
4901 Morena Blvd., Bldg. 900
San Diego, CA 92117
(800) 854-1085, (619) 270-4000

RGB Systems
3375 Woodward Ave.
Santa Clara, CA 94050
(408) 748-0400

Scion Corp.
12310 Pinecrest Rd.
Reston, VA 22091
(703) 476-6100

Seattle Computer
1114 Industry Dr.
Seattle, WA 98188
(800) 426-8936, (206) 575-1830

Semidisk System
POB GG
Beaverton, OR 97075
(503) 642-3100

Sigma Designs Inc.
3866 Eastwood Circle
POB 3765
Santa Clara, CA 95055
(408) 496-0536

SSM Microcomputer Products Inc.
2190 Paragon Dr.
San Jose, CA 95131
(408) 946-7400

Starware
1701 K Street NW, Suite 800
Washington, DC 20006
(202) 466-7351

STB Systems Inc.
1701 North Greenville, Suite 703
Richardson, TX 75075
(214) 234-8750

Street Electronics Corp.
1140 Mark Ave.
Carpinteria, CA 93013
(805) 684-4593

Jack Strick & Associates
949 South Southlake Dr.
Hollywood, FL 33019
(305) 925-7004

Super Computer Inc.
1710 East Newport Circle, Suite P
Santa Ana, CA 92705
(714) 540-1880

Symtec
15933 West 8 Mile
Detroit, MI 48235
(313) 272-2950

Tall Tree Systems
1036 Los Altos Ave.
Los Altos, CA 94022
(415) 941-5500

Tava Corp.
1711 Corinthian Way, Suite 1011
Newport Beach, CA 92660
(714) 261-0200

Tecmar Inc.
6225 Cochran Rd.
Cleveland, OH 44139
(216) 349-0600

Universal Micro Inc.
6302 Odana Rd.
Madison, WI 53719
(608) 274-6100

USI Computer Products
71 Park Ln.
Brisbane, CA 94005
(415) 468-4900

Vector Electronic Co. Inc.
12460 Gladstone Ave.
Sylmar, CA 91342
(213) 365-9661

Vista Computer Co. Inc.
1317 East Edinger
Santa Clara, CA 92705
(714) 953-0523

VR Data Corp.
777 Henderson Blvd., N-6
Folcraft, PA 19032
(800) 345-8102, (215) 461-5300

Wesper Microsystems
14321 Myford Rd.
Tustin, CA 92680
(800) 854-8737, (714) 730-6250

Zen/Tek Corp.
455 Whitepine Dr.
Salt Lake City, UT 84107
(801) 263-3925

Ziatech Corp.
3433 Roberts Ln.
San Luis Obispo, CA 93401
(805) 541-0488

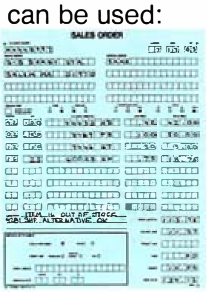
Zobek
7343 J. Ronson Rd.
San Diego, CA 92111
(714) 571-6971

Board Type	Manufacturer	Board Name	Price	Comments
analog/digital interface	Data Translation	DT2801	$1195	16 A/D,2 D/A,16 digital I/O lines; clock
analog/digital interface	Data Translation	DT2805	$1295	16 A/D,2 D/A,16 digital I/O lines; clock
BSR X10 interface	Automated Business Machines	BSR-X10 Adapter	$215	
BSR X10 interface	Tecmar	Device Master	$245	includes clock
bus analyzer	Personal Computer Products	Bus Analyzer	$295	
communications	Information Technologies	Linkup	$795	auto-dial/auto-answer (no modem); includes two serial ports
communications	Personal Data Systems	Pack-Comm	$495	
communications coprocessor	Personal Systems Technology	DCPI-88 Communications Processor	$695	includes 8088, 64K bytes, two serial ports
controller/sensor	Tecmar	Distance Tender	$495	allows sensors to measure distance
digital/analog interface	Tecmar	DADIO	$395	4 D/A, 24 digital I/O lines
digital/analog interface	Tecmar	Lab Tender	$495	32 A/D,16 D/A,24 digital I/O lines
digital I/O	Tecmar	Base Board	$345	96 digital I/O lines
emulator	Personal Systems Technology	3278-Coax	$395	provides 3278-terminal emulation
game controller	IBM	Game Control Adapter	$55	
GPIB/IEEE-488 interface	National Instruments	GPIB-PC	$385	includes IEEE-488 interface
hard-disk interface	Tecmar	Winchester Share System Adapter	$395	allows four PCs to share one hard disk
modular multifunction	Arby	Combination Board	$110	
motor controller	Tecmar	Stepper Motor Controller	$495	CY512 interface; includes four serial ports
network interface	Davong Systems	Multilink Network Card	$595	compatible with ARCNET and Xerox network protocols
network interface	Orchid Technology	PC-net Adapter Card	$695	requires 128K bytes
network interface	Tecmar	Ethernet Link	$950	
PAL programmer	Force Technology	PAL Programmer	$995	programs 20- to 24-pin PAL chips
speech digitizer	Mountain Computer	Supertalker II	$350	includes 32K bytes
speech recording/playback	Flagstaff Engineering	Voice Connection	$179	digitize message, playback, auto-dial/auto-answer
VCR controller	Tecmar	VCR Controller	$495	controls videocassette recorder
video digitizer	Tecmar	Video Van Gogh	$345	digitizes video-camera output
voice digitizer	Tecmar	Ethernet Companion	$695	
voice recognition	Tecmar	Voice Recognition	$995	software included, 200-word vocabulary; 8K-byte RAM

Table 17: *Miscellaneous boards.*

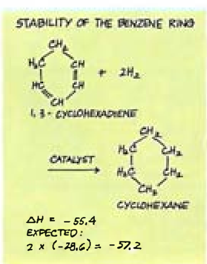
PENPAD® draws circles around a keyboard and a mouse.

Here are just a few ways PENPAD® can be used:

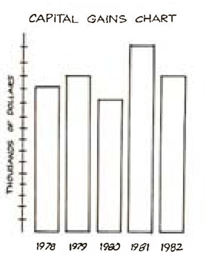


ORDER ENTRY

CONTROLS AT THE TOUCH OF A PEN



SCIENTIFIC EQUATIONS



INDUSTRIAL AND BUSINESS GRAPHICS

Only PENPAD® allows you to perform the functions of a keyboard, mouse and graphics tablet with a single, friendly means of input—a pen.

Only PENPAD® has Dynamic Character Recognition which converts your own handwriting into characters and displays them on the screen as if they were typed on a keyboard.

Only PENPAD® lets you compose text and graphics on the screen simultaneously. It combines the freehand capability of a multi-color high resolution graphics tablet with Dynamic Character Recognition and enables you to switch between text and freehand modes instantly.

Only PENPAD® puts the cursor in your hand at the point of your pen. Write anywhere or touch user-programmable function areas on the tablet. You can design function areas in any size or location on the pad and point to objects and icons at the touch of a pen.

Not only can PENPAD® draw circles around a keyboard and a mouse, it also lets you enter text by handprinting, select your own commands, use objects and icons, and sketch out rough ideas...all with one hand tied behind your back.

- PENPAD® works with most popular PC's like IBM, Apple, Wang, DEC, Seiko, and others.
- Software product developers call for special opportunities.

PENCEPT

Pencept, Inc. 39 Green Street, Waltham, Massachusetts 02154 □ Telephone: (617) 893-6390

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AND CHANGES MONTHLY

apple supply center

HARDWARE for Apple II/II+/IIe

• OVERSTOCK SPECIALS •
WHILE THEY LAST

FOR APPLE II/II+/IIe	LIST PRICE	OUR PRICE
★ALS Synergizer - Scalc - Condor (II -)	$ 749	$199
★ Axlon. 320KRAM DiskSystem (- ore)	$1000	$650
★CCS, Serial Interface 7710A (Set Baud)	$ 150	$ 99
★ComX. 16K RAM Card. 1Yr. Wty.. for II -	$ 179	$ 39
Microsoft. 16K RAMCard for II -	$ 100	$ 69
Saturn Systems.32K RAM Card for II -	$ 249	$169
64KRAMCard for II -	$ 425	$299
128K RAMCard for II -	$ 599	$399
Silicon Valley, Word Handler	$ 250	$ 39
★ List Handler	$ 90	$ 35
Videx. Videoterm. 80 column card for II -	$ 345	$229

DISK DRIVES for APPLE II+/IIe

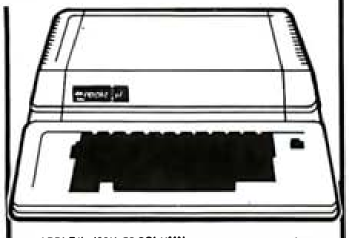
	★CENTRAL PT., Filer, Utility & Apple DOS	$ 20	$ 15
μ-SCI MICRO-SCI	A2,143KDiskDrive	$ 479	$ 219
	A2ControllerCard	$ 100	$ 79
	★A40, 160K, Drive	$ 449	$ 299
	★A70,286K,Drive	$ 599	$ 299
	A40 A70Controller	$ 100	$ 79
Rana	Elite 1, 163K, 40TK	$ 379	$ 249
	Elite 2, 326K, 80 TK	$ 649	$ 399
	Elite3, 652K, 160TK	$ 849	$ 499
	EliteController	$ 145	$ 84
TEAC	✱143K Drive, 1/2 High	$ 379	$ 259
	Controller Card.	$ 89	$ 69
	✱Electronics by ComX		
VISTA	DiskPak V1200, 6MBBackupSys.	$1549	$1049
	★V1000 Dual 8", Std. Format	$2195	$ 995

VIDEO CARDS

★ALS, Smarterm II (+ ore)	$ 179	$139
ComX, 80col./64KAdder (IIe)	$ 295	$145
Videx, Videoterm80col. (+ ore)	$ 345	$229
★ UltraTerm (+ ore)	$ 379	$279
Soft Video Switch (II+)	$ 35	$ 25
Enhancer II (II+)	$ 149	$ 99
FunctionStrip (II+)	$ 79	$ 59
We Have Full Videx Line.	Call.	Up to 35% off.
Vista, Vision 80	$ 289	$199

MISCELLANEOUS

ALS, TheCP/MCardV3.0(+ ore)	$ 399	$299
Z-Card (+ ore)	$ 169	$129
Color II (+ ore)	$ 179	$139
ASTAR, RF Modulator, louse TV	$ 35	$ 25
★ CCS, Serial Interface 7710A	$ 150	$ 99
★ Central Point, Alaska Card (copier, + ore)	$ 130	$ 99
Eastside, Wild Card (copier, + ore)	$ 130	$ 99
Kensington, System Saver	$ 90	$ 65
KeyTronic, KB200 keyboard (II+)	$ 298	$219
★Koala, Graphics Pad	$ 125	$ 85
Market Microscope	$ 700	$525
Kraft, Joystick (ApII/II+)	$ 65	$ 49
Paddle (ApII/II+)	$ 50	$ 39
M&R, SupRfan (+ ore)	$ 50	$ 39
★Microsoft, Z80 Softcard (+ ore)	$ 345	$235
Z80 SoftcardPlus (+ ore)	$ 645	$459
Softcard Premium Pack (II+)	$ 695	$495
SoftcardPremiumPack (IIe)	$ 495	$395
Micro Tek, Dumpling 64, Buffer	$ 349	$269
★ Orange Micro, GrapplerPlus (eor +)	$ 175	$119
16K Buffer Board for Grappler +	$ 175	$119
Buffered Grappler +, 16K	$ 245	$179
2 Chip Kit for above for 64K	$ 28	$ 19
Paymar, LowerCaseChip (II +)	$ 50	$ 39
Practical Peripherals.		
MBP IIe 64K Par. (Epson Internal) (+/e)	$ 279	$209
MBSIIe32KSer. (Epson Internal) (+/e)	$ 219	$169
Microbuffer II+, 16K, (+ ore) Par/Ser (specify)	$ 259	$199
Microbuffer II+, 64K, (+ ore) Par/Ser (specify)	$ 349	$259
★PCPI, Appli-Card, 14 features 6Mhz	$ 375	$275
RH Electronics, Super Fan II	$ 75	$ 59
★ Saturn Systems, Accelerator II	$ 599	$449
SSM, A10 II, Serial/Para Interface	$ 225	$169
TG Products, Game Paddles (II +)	$ 40	$ 29
Joystick (II+)	$ 60	$ 45
Select-A-Port (II +)	$ 60	$ 45
TrakBall (II+)	$ 65	$ 44
Videx, PSIO, Para/Ser Interface	$ 229	$169



APPLE IIe 128K, 80 COLUMN	$1,295
APPLE IIe, STARTER SYS. BY APPLE (Sys. A) 64K and 80 column, Disk II with controller, Apple Monitor III, Monitor Stand	$1,650
APPLE IIe STARTER SYSTEM BY CONROY-LA POINTE [SYSTEM B] 128K and 80 column, 1 Micro-Sci Drive with controller, Filer, Utility and DOS 3.3 Diskette, Zenith 12" Green Monitor, RF Modulator (for color TV), Game Paddles, Game w/color graphics and sound, 20 Blank Diskettes	$1,650

WARRANTY:
Limited warranty is 100% Parts & Labor for 90 days by us.

RAM EXPANSION

		LIST PRICE	OUR PRICE
★ ComX, for IIe, 80 col./64KAdderCard		$ 295	$109
★ ComX, RAMCard, 1 Yr. Wty. (II+)	16K	$ 179	$ 39
★ ALS, ADDRam (II+)	16K	$ 100	$ 59
★Microsoft, RAMCard (II+)	16K	$ 100	$ 69
★SaturnSystems, RAM Card (II+)	32K	$ 249	$169
RAMCard (II+)	64K	$ 425	$299
RAMCard (II+)	128K	$ 599	$399
★ Axlon RAM Disk System (+ ore)	320K	$1000	$650

SOFTWARE on disk for Apple II/II+/IIe

BUSINESS

Applied Soft Tech., VersaForm	$ 389	$259
Artsci. MagicWindow II NEW!	$ 150	$ 99
Ashton-Tate, dBase II (Req CP/M 80)	$ 700	$395
Financial Planner (Req CP/M 80)	$ 700	$395
Friday (Requires CP/M80)	$ 295	$199
BPISystems, GL, AR, AP, PRorINV, each	$ 395	$295
Broderbund, Bank StreetWriter	$ 70	$ 47
Continental, GL, AR, APorPRea	$ 250	$165
HomeAccountant	$ 75	$ 49
FCM	$ 100	$ 68
Dow Jones, Market Analyzer	$ 350	$275
Market Manager	$ 300	$235
Fox & Geller, Quickcode (for dBase II)	$ 295	$185
dGraph (for dBaseII)	$ 295	$185
dUtility (for dBaseII)	$ 99	$ 66
Hayden, Pie Writer (Specify 80col. board)	$ 150	$ 99
Howard Soft, Real EstateAnalyzer II	$ 195	$129
TaxPreparer	$ 225	$149
LJK, Letter Perfect w/Mail Merge	$ 150	$ 99
★ Micro Craft, (requires Z80 CP/M-Card)		
Verdict or Billkeeper	$ 995	$469
Micro Lab, Tax Manager	$ 180	$119
Micro Pro, (all require Z80-CP/M Card)		
★ WordStar w Applicard & CP/M SPECIAL	$ 495	$325
WordStar - Training Manual SPECIAL	$ 495	$239
MailMerge SPECIAL	$ 250	$129
SpellStar SPECIAL	$ 250	$129
★ WordStarProfessional, 4Pak SPECIAL	$ 895	$429
Microsoft, Multi-Plan (CP/M or Apple DOS)	$ 275	$199
Financial, Multitool (CP/M or DOS)	$ 100	$ 75
Budget, Multitool (CP/M or DOS)	$ 150	$115
Osborne/C.P. Soft, (Disk and Book) (Stat., Bus. & Math)		
Some Common Basic Programs (75 each)	$ 100	$ 49
Practical Basic Programs (40 each)	$ 100	$ 49
Peachtree, Requires CP/M & MBasic, 40 columns.		
Series 40 GL & AR & AP, all 3	$ 595	$365
Series40 Inv. or Payroll, each	$ 400	$275
Series 9 Text & Spell & Mail, all 3	$ 595	$395
Perfect, PerfectWriter	$ 495	$149
Perfect Speller	$ 295	$ 99
PerfectWriter/Speller 2 Pak	$ 695	$199
PerfectFiler	$ 595	$259
Quark, Word Juggler (IIe)	$ 239	$179
Lexicheck IIe (use w/Juggler)	$ 149	$ 99
Sensible, Sens. Speller, specify 80 Col. Brd.	$ 125	$ 85
Sierra/On-Line, ScreenWriter II	$ 130	$ 89
The Dictionary NEW!	$ 100	$ 69
General Manager II NEW!	$ 230	$155
★Silicon Valley, WordHandler	$ 250	$ 39
★ List Handler	$ 90	$ 35
Sof. Sys., Executive Secretary	$ 250	$169
Executive Speller	$ 75	$ 55

BUSINESS

Software Publishing, PFS: File	$ 125	$ 84
(specify + ore) PFS: Report	$ 125	$ 84
PFS: Graph	$ 125	$ 84
Stoneware, DB Master Version 4.0	$ 229	$229
DBUtility for II	$ 99	$ 69
Videx, Applewriter II preboot disk	$ 20	$ 15
Visicalc 80 col. preboot disk	$ 50	$ 39
VisiCorp/Personal Software.		
Visicalc 3.3	$ 250	$169
Visicalc Enhanced (IIe) NEW!	$ 250	$169
VisiFile or VisiDex, each	$ 250	$169

UTILITY & SYSTEM

Beagle, UtilityCity	$ 30	$ 22
DOSBoss	$ 24	$ 18
Apple Mechanic	$ 30	$ 22
Central Point, Filer, DOS3.3 and Utility	$ 20	$ 15
★ Copy II Plus (bitcopier)	$ 40	$ 35
Einstein, Compiler, for ApplesoftBASIC	$ 129	$ 85
Epson, GraphicsDump	$ 15	$ 9
Insoft, GraFORTH by Paul Lutus	$ 75	$ 59
Microsoft, A.L.D.S.	$ 125	$ 75
Cobol80	$ 750	$559
Fortran80	$ 195	$149
Complete Line in Stock		
★Omega, Locksmith (bit copier)	$ 100	$ 75
Penguin, Comp. Grphcs. Sys. NEW!	$ 70	$ 53
Graphics Magician NEW!	$ 60	$ 41
Phoenix, Zoom Grafix	$ 40	$ 34
Quality, Bag of Tricks NEW!	$ 40	$ 29
Saturn Systems, VC-Expand	$ 100	$ 49
VC-Expand80	$ 125	$ 69
Sensible, Back it Up. (bitcopier)	$ 60	$ 49

HOME & EDUCATIONAL

Broderbund, Choplifter	$ 35	$ 26
BudgeCo, Pinball Constr. Set	$ 40	$ 27
★Continental, Home Accountant	$ 75	$ 49
Datamost, Aztec or Zaxxon, each	$ 40	$ 27
Edu-Ware, (Large Inventory)	Call	Call
Einstein, Memory Trainer	Call	Call
Hayden, Sargon II (Chess)	$ 35	$ 29
Infocom, Zork I, II, or III, or Starcross, each	$ 40	$ 27
Lightning, Mastertype	$ 40	$ 27
Micro Lab, Miner 2049er	$ 40	$ 27
Sierra On-Line, Ultima II	$ 60	$ 40
Sir-Tech, Wizardry	$ 50	$ 39
Spinnaker, Kindercomp	$ 30	$ 20
Sub Logic, Flight Simulation	$ 34	$ 25
Pinball	$ 35	$ 25
Terrapin, Logo	$ 150	$ 99

OTHER BRANDS AND PROGRAMS IN STOCK. CALL.

DISKETTES

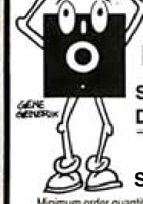
CDC, 100 each, SS,DD,48T (Apple, IBM)	$ 550	$ 179
10 each, SS,DD,48T (Apple, IBM)	$ 55	$ 19
100 each, DS,DD,48T, (IBM,H/P)	$ 750	$ 295
10 each, DS,DD,48T (IBM,H/P)	$ 75	$ 35
DYSAN, 10 each, (Apple, etc.)	$ 69	$ 39
10 each, 48T (IBM,H/P, etc.)	$ 89	$ 49
MAXELL, 10 each, MD-1, SS,DD	$ 55	$ 29
10 each, MD2-D, DSDD	$ 75	$ 39
VERBATIM, 10 each, Verex, SSSD	$ 40	$ 21
10 each, MD525-01, SSSD	$ 49	$ 25
10 each, DD34, DSDD	$ 84	$ 45
10 each, Optima, DSDD	$ 121	$ 65

GENERIK™ DISKETTES – AS LOW AS $1

100 each SS,DD,35 Track (Apple, Atari)	$ 415	$ 130
1000 each SS,SD,35 Track (Apple, Atari)	$4150	$ 995
100 each DS,DD,40 Track (IBM,H/P)	$ 626	$ 170
1000 each DS,DD,40 Track (IBM, H/P)	$6260	$1400

W/jackets, no labels, top quality. 90 day limited warranty by us.

NO HASSLE MONEY BACK GUARANTEE ON GENERIK'S



GENERIK™ DISKETTES
SS SD $1.00 Each
DS DD $1.40 Each

CDC
SS SD $1.79 Each

Minimum order quantities apply. See above. Money back guarantee is by COMX Corporation not us.

MONITORS AND ACCESSORIES

★AMDEK, 12" Green, #300G	$ 200	$ 135
★ 12" Amber, #300A	$ 210	$ 149
★ 12" Amber, 310A for IBM-PC	$ 230	$ 159
★ 13" Color I, Composite	$ 379	$ 289
★ 13" Color II, RGB, Hi Res	$ 529	$ 439
★ 13" Color III, RGB, (Ap. II, III)	$ 479	$ 399
DVM, Color II or III to Apple II-F	$ 199	$ 175
NEC, 12" Green, Model JB1201M	$ 249	$ 159
12" Color, Composite, JC1215M	$ 400	$ 299
12" Color, RGB, IBM Model JC 1203	$ 699	$ 569
PRINCETON, RGB Hi Res, HX-12	$ 795	$ 539
★QUADRAM, Quadchrome 12" RGB Color	$ 795	$ 499
Quadscreen 17", 968 x 512	$1995	$1595
SANYO, 9" Green, Model DM5109	$ 200	$ 139
12" Green, Model DM8112CX	$ 260	$ 199
ZENITH, 12" Green, Model ZVM121	$ 150	$ 89

MODEMS AND ACCESSORIES

ANCHOR, Signalman MKI Modem (RS232)	$ 99	$ 75
HAYES, IBM-PC Smartmodem 1200 B	$ 599	$ 439
IBM-PC Smartcom II Software	$ 119	$ 89
StackChronograph (RS-232)	$ 249	$ 189
Stack Smartmodem 300 (RS-232)	$ 289	$ 225
Smartmodem 1200 (RS-232)	$ 699	$ 535
Micromodem 100 (S-100 bus)	$ 399	$ 275
Micromodem II (for the Apple II)	$ 379	$ 275
Apple Terminal Program	$ 100	$ 65
IBM-PC to Modem Cable	$ 39	$ 29
NOVATION, Applecat II Modem 300 BAUD	$ 389	$ 269
212 Apple Cat, 1200 BAUD	$ 725	$ 599
Cat	$ 189	$ 139
D-Cat	$ 199	$ 159
J-Cat	$ 149	$ 109
212 Auto Cal	$ 695	$ 579
Smart Cat 103/212	$ 595	$ 435
Apple Cat II	$ 389	$ 269
212 Apple Cal	$ 725	$ 595
SSM, Transcend I for Apple II DataComm.	$ 89	$ 69
ModemCard for the Apple II	$ 299	$ 259
Transmodem 1200 (110/300/1200)	$ 695	$ 559

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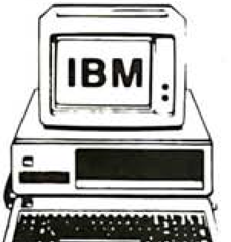

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Installable Device Drivers for PC-DOS 2.0

The latest version of the IBM PC's DOS provides support for device drivers

by Tim Field

Support for device drivers is one of the most significant new features provided by Microsoft's PC-DOS 2.0. In addition to other significant improvements over earlier versions, this release incorporates powerful new commands into the DOS as well as BASIC. In this article I'll define a device driver, explain its importance, and show how it works with the IBM PC.

The DOS (disk operating system) enhancements visible to the average user represent only the tip of the iceberg; much of the real power added to PC-DOS can be appreciated only by hardware and software designers. As those designers take advantage of PC-DOS 2.0's flexibility, we can expect to see new products that will work only with this and subsequent versions. These products will provide a major impetus for the average IBM PC user to abandon earlier versions of PC-DOS in favor of the latest release.

Devices and Drivers

A device is merely a piece of equipment that attaches to a computer. Some examples are printers, floppy- and hard-disk drives, monitors, and keyboards. You can even simulate devices; a RAM disk, for instance, appears to the PC as a disk drive, but it is actually a special program running in the computer's RAM (random-access read/write memory) that simulates the operation of a floppy-disk drive.

An interface is used to attach a device to the PC. The interface can be a standard type, such as an RS-232C or parallel port, or you can use one designed to work with a particular device, such as a keyboard. Either type of interface provides the necessary electronics to allow the PC and a device to communicate.

So far, so good. You know you need a device and an interface to plug it into the PC, but that combination is not sufficient. You must also provide the PC with the software required to "talk" with the device; that is, to perform input and output (I/O) operations on it.

Each device requires special signal and timing schemes to allow the PC's processor to communicate with it. Applications programs running on the computer don't provide such software routines, which can sometimes be quite complex; these programs must be able to perform specific tasks, though, such as sending a character to the modem or reading the sector of a particular address on drive A. What is needed, then, is a set of general-purpose software routines that match the high-level needs of applications programs with the low-level requirements of the hardware interfaces. These software interfaces are called device drivers.

It is one of the main tasks of the operating system to provide the support that applications programs need to use the devices attached to the computer system. Thus, the responsibility for supplying and supporting device drivers falls in the realm of DOS functions.

One device driver that comes with the PC is the parallel-printer driver. That code is stored in the system's ROM (read-only memory) and interfaces system software with the parallel interface port.

A program running on the PC does not get involved with how characters are printed out; it's the printer's responsibility to actually print out text characters. A program requests that a string of characters be printed out, and the printer device driver handles that request, receiving characters from a program and converting them into the 1s and 0s that the parallel interface card requires. The interface then takes these binary values and converts them into appropriate electrical signals, which are sent to the printer through cabling. The printer converts these signals back into characters, which are then printed out.

Without the device driver, each software program that required the use of the printer would have to provide the appropriate signals for the parallel adapter. But because most programs require the use of many devices (usually at least a keyboard, monitor, disk drive, and printer), general-purpose device drivers prove most efficient; they supply the highest level of software support possible.

The internal activities of device drivers are invisible to applications programs. Yet when you run an applications program or a DOS command, the device drivers work with that program to accomplish the requested task. The device-driver concept provides an additional benefit:

it helps make programs device-independent. In other words, the driver ensures that the program need not get involved with a particular device's idiosyncrasies; it works directly with the device-driver interface.

For example, the signals and timing schemes required to communicate with a floppy-disk drive differ from those required for a fixed-disk drive. A high-level device interface, however, permits an applications program to read or write to either type of drive identically.

Device Drivers in PC-DOS 2.0

The IBM PC provides two levels of device drivers. At the low end is the BIOS (basic input/output system) ROM (read-only memory) interface, which makes a set of simple device interfaces available to assembly-language programs. The PC-DOS interface, however, provides device drivers of a somewhat higher level. The DOS contains a set of functions that enables a program to access a number of useful operations, including the device operations. The DOS device drivers (or device functions) actually use the BIOS drivers to accomplish portions of their work. The DOS drivers' higher level provides them with greater flexibility than those in BIOS.

Using earlier versions of PC-DOS, applications programmers had to specially rig (or "kludge") device drivers to work with the DOS. This was often accomplished at the BIOS interface level. And although the drivers worked, they were not standard ones, nor were they easy to implement.

PC-DOS 2.0, however, permits programmers to create installable device drivers at the DOS-interface level in a standard way. These new drivers can either define a new device type to be used on the PC or replace an old device driver. For example, a device driver can be added to support an intelligent pen plotter, or the PC's standard keyboard device driver can be replaced by a new driver that looks for input not only from the keyboard but also from a mouse device.

Normally written in assembly language, an installable device driver is assembled and linked into a .COM file. It makes its corresponding device available to any program using the standard DOS function calls. You install a device driver in PC-DOS by copying the .COM file onto the system disk and creating a special file called CONFIG.SYS, which is merely a text file (created using Edlin or a text editor) into which you add the command line:

DEVICE=driver.COM

(where the word "driver" is replaced by the name of the device driver). You must complete this process for each device driver you install.

The installation process is then accomplished at system start-up. When the PC is turned on, or whenever a system reset is issued (via the Ctrl-Alt-Del key sequence), PC-DOS performs a number of tasks before it issues the system prompt and waits for user input. One of those tasks is to configure the system as instructed through the CONFIG.SYS file, which includes installing any specified device drivers. Figure 1 outlines these activities. For a more detailed discussion of the inner workings of device drivers and their installation process, see "A Peek into PC-DOS Device Drivers" on page 190.

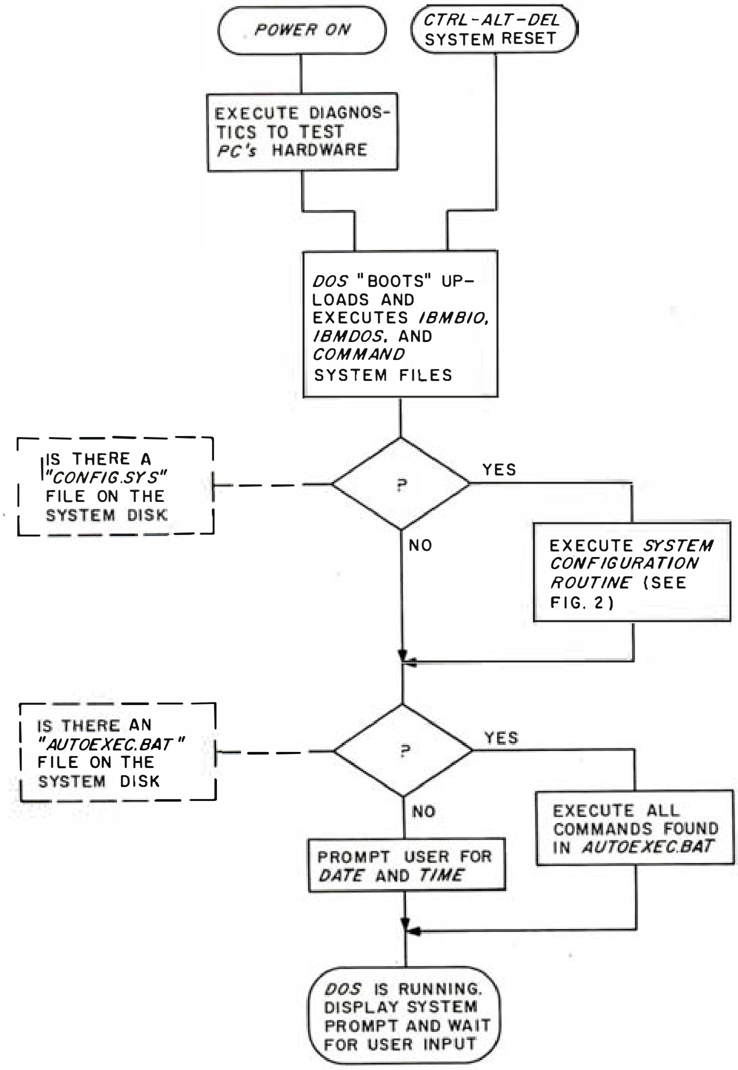

Figure 1: *This flowchart outlines the tasks the DOS performs before it issues the system prompt and waits for user input.*

Device Categories

The types of devices that the PC recognizes fall into two categories: character devices and block devices.

A character device performs input and output in a serial manner—character by character. For example, a

A Peek into DOS Device Drivers

Let's take a look at the implementation of device drivers in PC-DOS 2.0. As discussed in the main text, the PC uses two types of devices: character and block. The device-driver format is structured in such a way that the same approach is used for either type of device.

An assembly-language program designed to work as a device driver consists of three user-defined parts: a device header, a strategy routine, and an interrupt routine.

The Device Header

The device header is an 18-byte block found at the beginning of a device driver. This header is used by the DOS to install and identify a particular driver. The header is broken into the following five components:

Next Device Header Field *(4 bytes): This is a pointer (offset followed by segment) used by the DOS to make a linked list of all of the installed device drivers. Both offset and segment addresses must be set to –1 by the assembler (unless you have more than one device driver in the file, in which case the pointers of each device header in the file should be set up in a linked list at assembly time, and the last driver in the list should be set to –1).*

Device Attribute *(2 bytes): This group of bits defines the type of device and some special attributes about that device. For example, one bit specifies whether it is a character or block device. Other bits indicate current clock device, current standard input device, and standard output device. (Standard input is generally the keyboard, standard output is the screen display. See the section on redirection of standard input/output in the PC-DOS manual for more information.)*

Device Strategy Pointer *(2 bytes): This is an offset into the device-driver segment to the strategy routine.*

Device Interrupt Pointer *(2 bytes): This is an offset into the device-driver segment to the interrupt routine.*

Device Name Field *(8 bytes): This field contains the device name for a character device. For a block device, the first byte of the field contains a count of the number of devices supported by the driver and the remaining 7 bytes are not used.*

The Strategy Routine

When the DOS receives a request for a device operation, it looks through its list of device drivers, searching for the driver specified by the request. When a match is found (i.e., when the device name matches the requested device), the DOS invokes that driver's strategy routine *at the address found in the device header.*

With PC-DOS 2.0, the strategy routine doesn't play a very important role. It simply queues up a device request and returns to the DOS. In future versions of the DOS, however, it could assist in such operations as priority-queued multitasking or time-sharing situations.

Interrupt Routine

Upon receiving control back from the strategy routine, the DOS invokes the driver's interrupt routine. *This routine provides all of the functionality for the driver—the code to execute the device-driver operations.*

Because there are many different tasks a device driver might perform for a given device, a standard mechanism is needed for the DOS to specify to any device the command to be executed. This mechanism takes the form of a request header.

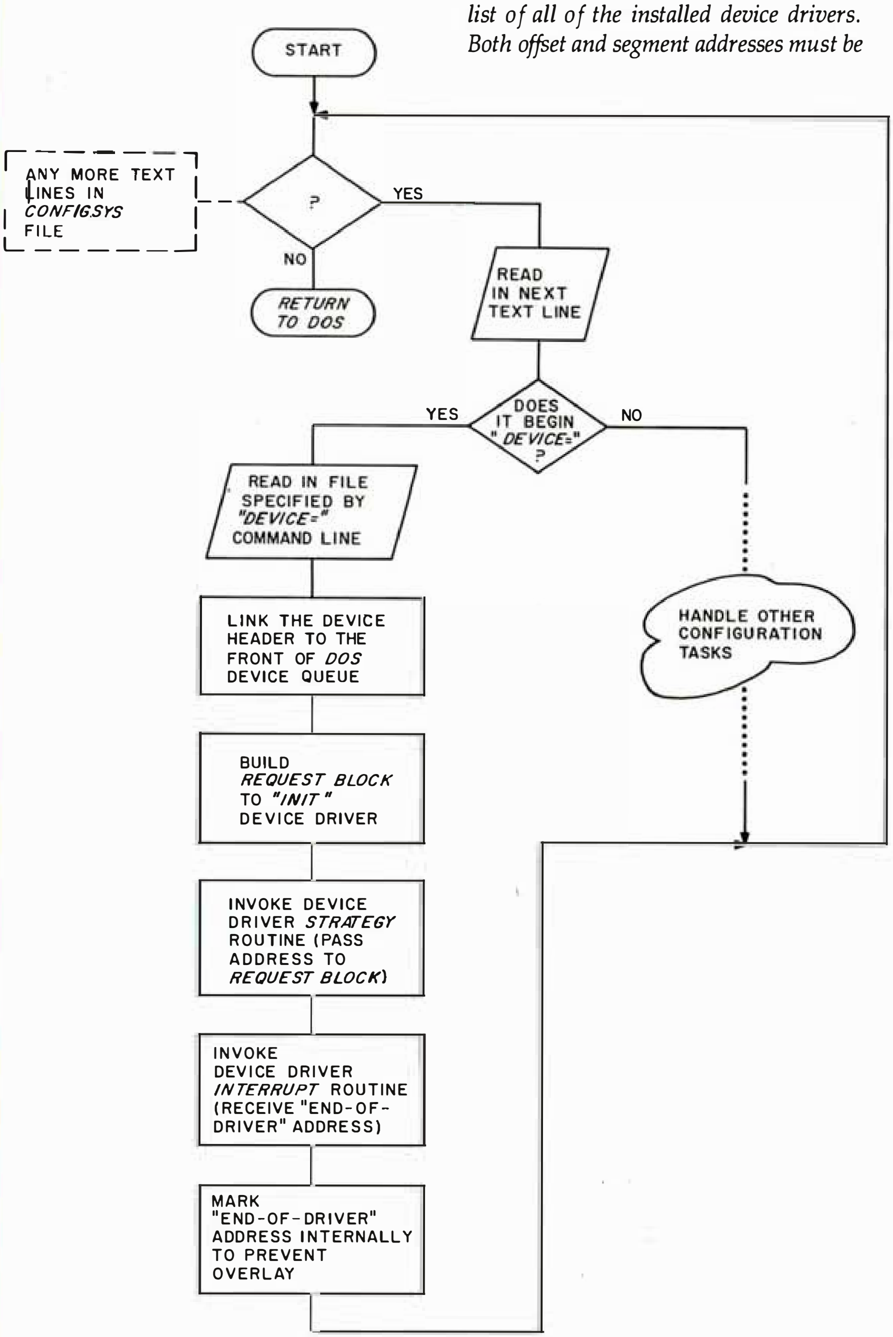

Figure 2: *A summary of the steps PC-DOS takes to install device drivers.*

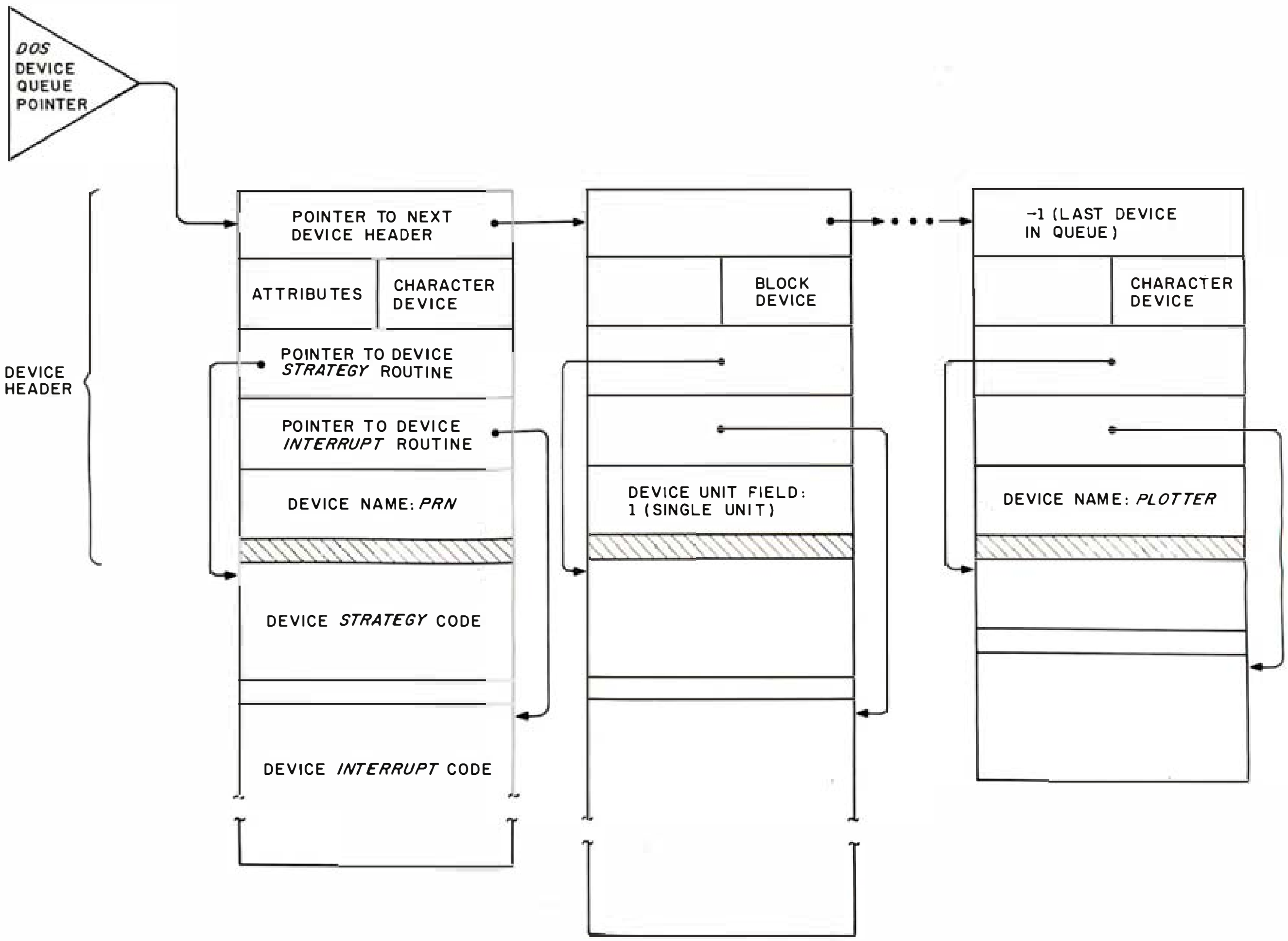

Figure 3: *Examples of several device drivers installed in DOS.*

A request header is a block of memory that the DOS sets up. A pointer to this header is passed to the device driver in the ES:BX register pairs during the strategy-routine call. The strategy routine saves this address.

When the interrupt routine receives control, it fetches the saved address to the request header and uses the contents of the header to determine the operation it is to perform. The request header contains the following data:

Request-Header Length *(1 byte).*

Unit Code *(1 byte): This byte specifies the subunit (for block devices only) that the requested operation should use.*

Command Code *(1 byte): This gives a value specifying the operation to be performed.*

Status *(2 bytes): This is a word set aside to allow the device driver to return the status of the operation to the DOS. A status word can indicate an "ERROR" (returning an 8-bit error code with the error indication), "BUSY" (used by an explicit status-function request), or "DONE" (which has no functional use in PC-DOS 2.0 but appears to be set aside for future uses such as multitasking or perhaps even multiprocessing).*

DOS Reserved Area *(8 bytes).*

Data Area *(variable length): This segment contains any data appropriate to the operation.*

Figure 2 outlines the PC-DOS procedure for installing device drivers. You specify which devices to install by including in the CONFIG.SYS file the command "DEVICE=device.COM" (replacing "device" with the device-driver filename) for each driver. Because CONFIG.SYS can contain other system-configuration commands, figure 2 includes a check for DEVICE= requests.

The DOS loads each device driver from the system disk into memory, adds it to the front of its list of device drivers, and executes the driver's INIT command. INIT will return to the DOS an end-of-driver address (actually the end of the device-driver code plus 1 byte). The DOS then reserves the area before this address, being careful not to overlay any other programs on the device driver.

Figure 3 shows the structure of multiple device drivers installed in PC-DOS; three drivers are portrayed. The first is a character device named PRN, which acts as the standard printer device. The second is a block device and thus is unnamed. The third is a character device called PLOTTER. Notice that the length of different device drivers can vary.

If the DOS installs yet another device driver in the scheme shown in figure 3, it will be placed in front of PRN. If it, too, is a character device with the name PRN, it effectively replaces the older one. Thus, any characters sent to PRN will use the first driver in the list with that name.

Command Code	Function Requested	Character Devices	Block Devices
0	INIT	•	•
1	MEDIA CHECK		•
2	BUILD BPB		•
3	IOCTL INPUT	•	•
4	INPUT (read)	•	•
5	NON DESTRUCTIVE INPUT NO WAIT	•	
6	INPUT STATUS	•	
7	INPUT FLUSH	•	
8	OUTPUT (write)	•	•
9	OUTPUT WITH VERIFY	•	•
10	OUTPUT STATUS	•	
11	OUTPUT FLUSH	•	
12	IOCTL OUTPUT	•	•

Table 1: *A list of device request codes, indicating whether they are used with character or block devices or both.*

Device Commands

There are 13 specific device operations (see table 1) that may be requested of a device driver in PC-DOS 2.0. Some of these are valid with both block and character devices; some are used only by one or the other.

The DOS requests a particular command by placing the appropriate command code into the request header. It is efficient for a device driver to set up a separate routine for each of the 13 operations using single entry and exit points to the driver. A standard jump table can be used to determine which routine to execute. (A jump table contains the entry addresses for each routine. The command code found in the header is used to index into the table and get the correct address.)

Each command is briefly described below. Refer to chapter 14 of the PC Disk Operating System *manual (Boca Raton, FL: IBM Corporation, 1983) for more information on these functions. It is helpful to look over the listing of the RAM drive at the end of chapter 14 to see how such things as the device header and jump table can be implemented. The device commands are:*

INIT—*This routine is executed once after system start-up. It allows the device driver to install itself and perform any necessary initialization tasks—including initializing devices, returning the driver's ending address to the DOS (so that the DOS knows where it is safe to load other programs without overwriting the driver), and returning an initial device status in the request header.*

MEDIA CHECK *(Block devices only): This command checks to see if the media (e.g., disk) has been changed.*

BUILD BPB *(Block devices only): The BPB (BIOS parameter block) is a 13-byte chunk of memory that describes the block device. It contains device-specific data such as number of bytes per sector and sectors per unit. The BPB is returned to the DOS.*

IOCTL INPUT/OUTPUT: *IOCTL (input/output control) is a mechanism that lets the DOS determine and change the status of a device* (not *the status of the device driver). For example, DOS might use IOCTL INPUT to determine the lines-per-inch setting of an intelligent printer and then change this with an IOCTL OUTPUT command.*

INPUT: *This command reads the data from the specified device (at a given address for block devices) and returns it to the DOS.*

NON DESTRUCTIVE INPUT NO WAIT *(Character devices only): This allows the DOS to check for data waiting to be read. For example, the DOS can use the command to check the keyboard buffer to see if any keys have been pressed. If the keyboard buffer is empty, a normal INPUT command to the keyboard will wait until a key is pressed. Sometimes it is desirable for a program to check first and ensure that it will not have to wait.*

INPUT/OUTPUT STATUS *(Character devices only): This command returns the status of the specified device.*

INPUT/OUTPUT FLUSH *(Character devices only): This terminates all pending device requests. For example, it might clear the keyboard buffer on an INPUT FLUSH or a printer buffer on an OUTPUT FLUSH.*

OUTPUT: *This command writes the data to the device (at the given address for block devices).*

OUTPUT WITH VERIFY: *This writes data to the device and then verifies that the operation has worked correctly.*

The device-driver mechanism is a straightforward implementation that is sufficiently general to support a large variety of devices. Several of its features hint at powerful things to come in later versions of PC-DOS. By using such a standard mechanism, the DOS gives users the capability to develop products now that will be easily integrated into future versions.

printer is a character device through which a string of characters is printed out; the printer device driver is called once for each character.

Character devices are given specific names. The standard ones have predefined names, such as CON (the system console, which uses the keyboard for input and the display screen for output), AUX and COM1 (the auxiliary communications port through which you can attach serial printers and modems), and PRN or LPT1 (the parallel-printer port). You can assign a new character device to a driver by giving that device the name of the device it is replacing. To attach a new character device to the PC, you give it a unique name.

A special character device, CLOCK$, can be defined to allow integration of a real-time clock into the PC for TIME and DATE operations. CLOCK$ provides a standard mechanism for integrating a battery-backup clock chip, contained on many multifunction boards, into the system.

The other type of device, the block device, is a mass-storage unit, such as a floppy, hard, or RAM disk. Instead of accomplishing data I/O one character at a time, a block device passes whole chunks (or blocks) of data in one shot. Usually, each block contains one disk sector (512 bytes) of data.

Unlike character devices, block devices are not specifically named. Instead, they are mapped via the drive letters (A, B, C, etc.) PC-DOS maps a new block device by internal-

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ly assigning it the next available drive letter and automatically maps a block-device operation to the appropriate device driver, which can support multiple devices of the same type.

For example, suppose you have two floppy-disk drives, A and B, and a fixed disk, C, and you want to add two RAM disks. You do so by defining one block-device driver with support for two disks. The DOS will use this device driver to initialize and add two RAM disks, D and E. Then when a program attempts to read or write to either D or E, the DOS will execute the device driver to perform the requested task.

DOS Support for Device Drivers

As mentioned earlier, PC-DOS automatically provides the necessary support for newly installed device drivers. When an applications program requests any DOS operation on a given device via a DOS I/O function call, the DOS determines which device driver is required and invokes it to perform the requested task.

Earlier versions of PC-DOS internal function calls also support 2.0's installable device drivers. An applications program designed with PC-DOS 1.1, for example, uses a function call to the DOS to invoke a disk-read operation. Under PC-DOS 2.0, the disk-read operation supports the device driver. You can thus run the applications program on the PC with a newly installed device without modifying the program. In fact, the program will not sense the change.

To remember all its device drivers, PC-DOS uses a linked list. At system start-up, as the DOS installs a new driver specified in the CONFIG.SYS file, it adds that device to the top of its list. When it later receives a request for a device I/O function, it starts at the head of the device list and searches through it for the device whose name matches the I/O request, then invokes the first device driver that matches the name requested. This technique allows you to replace any existing character devices by giving your device driver the same name as the device to be replaced.

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Two Sample Device Drivers

With the purchase of PC-DOS 2.0, you receive two device drivers. One is a character-device driver that enhances the capabilities of both your display and keyboard. The other is a block-device driver with a RAM disk for use with the PC. I will briefly describe each of these drivers and then look at the glaring problems each reveals about PC-DOS 2.0.

A New Console Driver

The PC-DOS 2.0 disk includes a file called ANSI.SYS, a character-device driver that replaces the standard console device (CON:) and enhances the capabilities of the display and keyboard. You can set up DOS to use this driver simply by creating a CONFIG.SYS file using Edlin and adding the line DEVICE=ANSI.SYS.

ANSI.SYS establishes the American National Standards Institute (ANSI) standard terminal-control sequences that allow applications to be moved between various terminals and personal computers. Any system using this standard will support the same console-control sequences.

This console device driver provides two basic capabilities. First, it allows you to reassign the meaning of any key on the keyboard, including using a single key to replace a string of keys. Second, it gives you direct cursor and attribute control of your display screen. It permits you, for example, to specify where on the screen the cursor is to move to.

The ANSI.SYS control commands are issued via the standard DOS screen and keyboard function calls 1, 2, 6, and 9. Basically, you first send a special sequence of characters to the screen or keyboard functions. These characters are then interpreted by the ANSI.SYS device driver, and the appropriate action is taken.

The IBM RAM Disk

In chapter 14 ("Installable Device Drivers") of the PC-DOS manual, IBM supplies an assembly-language listing of a block-device-driver implementation of a RAM disk. The listing can be typed in, assembled, and used with PC-DOS 2.0 as a single-sided, nine-sector-per-track (180K-byte) simulated disk drive.

IBM's main purpose in including the RAM-disk listing was for demonstration purposes. The code and comments help you to get a better feel for how a device driver is actually implemented. Furthermore, it provides a nice frame for setting up the code for your own drivers.

Note that this RAM driver is not found on the DOS disk. IBM left it up to you to enter and assemble the program. If you do not have an assembler, you can use Debug to set up the file. This task is very tedious at best.

Problems, Problems, Problems

These two device drivers do more than demonstrate the potential of installable device drivers, however. They also display some of the chaos found in PC-DOS 2.0—a most unfortunate and distressing situation. These two programs should be Microsoft's showcase, where it displays how well device drivers work. Instead, the programs spotlight some of the inconsistencies found in the latest version of the DOS.

ANSI.SYS pinpoints the most glaring deficiency of the whole device-driver setup on the PC; BASIC apparently does not use the standard DOS character functions and thus will not work with user-installed character-device drivers. (BASIC does, however, work with user-installed block-device drivers). The character I/O operations of BASIC (the screen, keyboard, printer, auxiliary port, etc.) normally use the lower-level BIOS ROM (read-only memory) device interfaces instead of the DOS function calls, thus nullifying any user-installed character device.

For example, ANSI.SYS can be used to replace the standard console device to allow you to assign any keystroke sequence to any key on the PC. The most obvious use of this feature is to assign commonly used strings of keystrokes to the function keys to make it easier to use an applications program. If that program is written in BASIC, however, the DOS console driver is bypassed and ANSI.SYS is useless.

The RAM-disk device driver demonstrates a less harmful yet still frustrating problem. At first the program seems to work beautifully. The DOS correctly installs the simulated drive, and you can use DIR to get a directory of the simulated disk. COPY works to move files from a floppy or fixed disk to the RAM drive, and COMP lets you compare them. Even BASIC uses the standard DOS function calls for block device I/O; you can thus use the RAM drive for reading and storing data and programs.

However, for some reason, the DISKCOPY and DISKCOMP commands do not work. Both indicate an "invalid drive" error and then halt. No methods I tried were able to coax the two DOS commands to perform with the RAM disk.

While these problems are not major catastrophes, they do indicate carelessness on the part of IBM and Microsoft for letting them through their quality-control checks. It appears that there will be limitations with user-created device drivers in this version of PC-DOS that may prevent the concept from being exploited to the fullest extent. However, easy fixes to this situation could be quickly forthcoming.

Conclusion

The device-driver capability of PC-DOS 2.0 gives it significantly more power than previous versions. This feature, along with some other special enhancements, should do much to spur the development of more powerful hardware and software options for the IBM PC.

All is not well with PC-DOS, however. As the discussion in the text box "Two Sample Device Drivers" (above) illustrates, the current implementation is suffering from some nontrivial problems. Note, though, that PC-DOS is in transition, quickly evolving from a system with limited capabilities to one with a flexible and powerful Unix-like structure. Each step forward will likely present a problem here and there, but the power of its enhancements far outweighs the troublesome areas. I look forward to the next revision of PC-DOS, fully expecting solutions to current problems, additional goodies, and, undoubtedly, some difficulties with its new features.■

Tim Field, a software engineer and technical writer, works for Field Computer Products (909 North San Antonio Rd., Los Altos, CA 94022).

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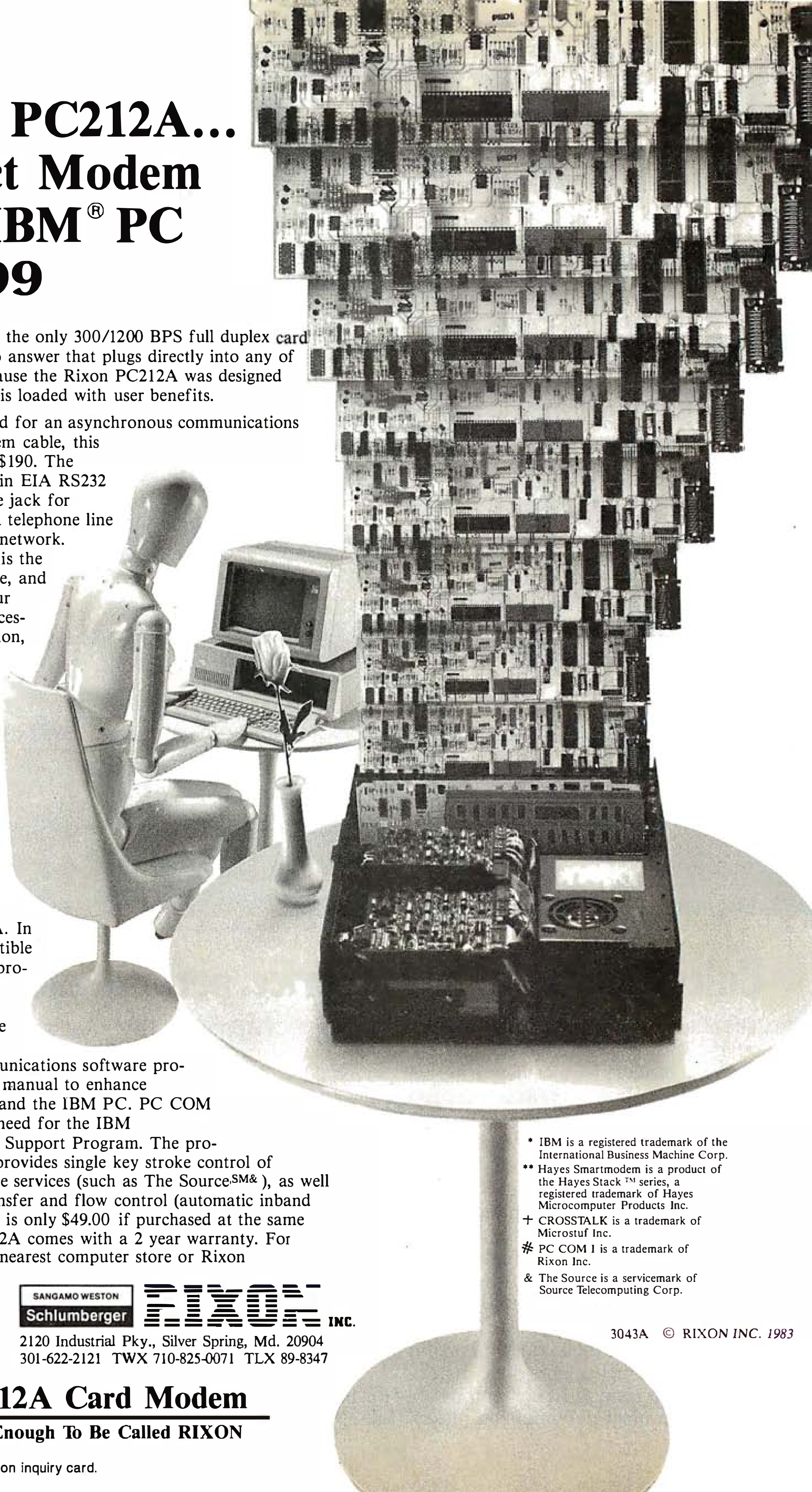

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A Communications Package for the IBM PC

With a little help from our friends, the Transend PC software evolved through several iterative design stages

by Richard K. Moore and Michael Geary

In the process of creating a communications software package at Small World Communications Inc., we discovered that a good package was the result of many factors. To us, the most surprising of these factors was the iterative product-development cycle that begins with design, continues with evaluation by users, and starts over again with a redesign based on user feedback. By letting our friends try out each intermediate version that resulted from such a cycle, we pruned those ideas that didn't work and expanded the ones people seemed comfortable with.

The result of our efforts is a product that was not so much designed as it was allowed to evolve. Called Transend PC (published under a licensing agreement by Transend Corporation of San Jose, California), it runs on the IBM Personal Computer (PC), a machine for which powerful, versatile code can be written. Many users would agree that most commercial software falls short of such a high performance level. This article describes the design decisions that resulted in a powerful product designed with ease of use in mind.

The Choice of Features

Our first step was to discover which communications functions personal computer owners needed most. To get this information, we looked at the products available on the market, but we learned more by asking users what they wanted to do and by looking at the experience of research centers such as Xerox PARC (Palo Alto Research Center). There seemed to be three distinct needs:

By trying out each intermediate version, Transend PC was not so much designed as it was allowed to evolve.

- the ability to send and receive short, informal messages (electronic mail)
- the ability to send and receive disk files
- the ability to access teleservices such as The Source or Dialog

But these functional requirements were only the tip of the iceberg. As we examined typical communications scenarios, we found that the actual communications process is the least of the user's worries. For example, with electronic mail, most of the user's time is spent with the local management of messages: creating, reading, editing, printing, filing, and retrieving them. In addition, for each person or service users wish to communicate with, they need to deal with such troublesome details as phone numbers, data rates, log-in codes, protocols, user IDs, and so on.

Our conclusion was that electronic mail should be the central focus in the product design. We wanted managers, secretaries, and clerks to feel comfortable using this communications device, even if they had no other occasion to use a personal computer. Our problem then became one of selecting a metaphor that would express the function of electronic mail.

```
            Open Basket ←F1 F2→  it from Transend   | Transend PC  (tm)
           Label Basket ←F3 F4→                     | TEST Version 1.0
          Print Summary ←F5 F6→                     |
           Print Basket ←F7 F8→ Be a Terminal       |
                        ←F9 F10 Send/Receive Mail   |
-----------------------------------------------------------------------
       Press a function |

[      IN       ]  [ ADDRESS BOOK  ]  [   SERVICES    ]  [   YOUR PC     ]
[      OUT      ]  [    SENT OK    ]  [     WASTE     ]  [               ]

[     Jeff      ]  [ Spec Changes  ]  [               ]  [ Byte Article  ]
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```

Figure 1: *Based on a desktop metaphor, Transend PC includes in, out, and sent baskets; phone numbers and access information reside in the services and address-book baskets. The wastebasket retains a copy of recently discarded messages. The lower 16 baskets serve as a simple filing system for electronic messages, which can be moved between baskets at will; printing and duplicating require only a single keystroke.* (**Editor's note:** *The figures accompanying this article are screen dumps from a monochrome display.*)

The Choice of Metaphors

In Visicorp's popular Visicalc package, the metaphor is simply a piece of ledger paper. That idea is strong enough to express the program's functionality while at the same time being simple and familiar to the intended audience. We, too, wanted a metaphor appropriate to our focus that was as powerful, yet as simple and familiar.

As did Apple with Lisa and Xerox with Star, we chose the desktop as our central metaphor. On our desktop is a collection of baskets in which the user can place messages and forms (figure 1). The forms describe the communications parameters for the people and services of interest to the user. We found this metaphor extremely powerful: the in-basket, outbasket, and wastebasket are immediately familiar and help establish the reality of the metaphor for the user. We introduced other baskets to provide needed system functions, and a number of nondedicated baskets are available so that users can create their own filing systems for messages.

We made a commitment to ourselves that we would maintain the chosen metaphor with dogged consistency. We wanted our users to believe that they really were working with paper and baskets and to encourage them to try unfamiliar tasks without fear. We wanted the illusion to be so reliable that users would have a clear expectation of the results of their actions, based on their real-world experience with paper and containers.

Our problem became one of selecting a metaphor appropriate to electronic mail.

The Choice of Machines

When we began work on this project, the IBM PC had just been introduced and had not much force in the marketplace. We were considering doing communications-package versions for the Apple II or for CP/M, and when we began work on an initial prototype, an IBM PC was loaned to us by a friend. He had an educated hunch that this machine was to have an immense impact on the market and wanted to be sure we were getting on the bandwagon.

We had no way of knowing how correct his prediction would turn out to be, but our experience with the PC was favorable from the start. We found it a superb development vehicle that incorporated several lessons from earlier machines. The large memory capacity, the elaborate keyboard, and the extensive monochrome character set all contributed to an environment in which we had the freedom to effectively communicate our metaphor to the user. Most important, however, was IBM's decision (borrowed from Apple) to offer "open system architecture." Opening up the machine to third-party hardware and software vendors is what made the product an instant hit within the industry and with customers.

Taking Advantage of the PC's Architecture

With so much machine at our disposal, we had to decide which features were appropriate to our needs. We decided early, for example, to ignore the possibilities of color and bit-mapped graphics and develop instead the potential of the monochrome graphics set. We chose this route for three reasons: text mode is much faster than graphics mode, the monochrome screen's appearance is more attractive than IBM's graphics display, and a text-mode version can run on all installed machines. We have been very happy with this choice and have found the character graphics capabilities sufficient for our needs.

The PC keyboard is both a blessing and a curse. The large number of keys provides many ways to invoke commands, support scrolling, and permit optimized data-entry—such amplitude is a blessing to the user-interface designer. But the curse is on the first-time user who must navigate the sea of keys: he needs to distinguish among four left-pointing-arrow keys, to remember whether he pressed one of the three Lock keys, and to remember the meaning of the 10 function keys. We set out to simplify the keyboard through appropriate use of graphics on the screen.

In the top region of each of our screens is a control panel (figure 2). The left part of the control panel shows a map of the 10 function keys together with the menu of the cur-

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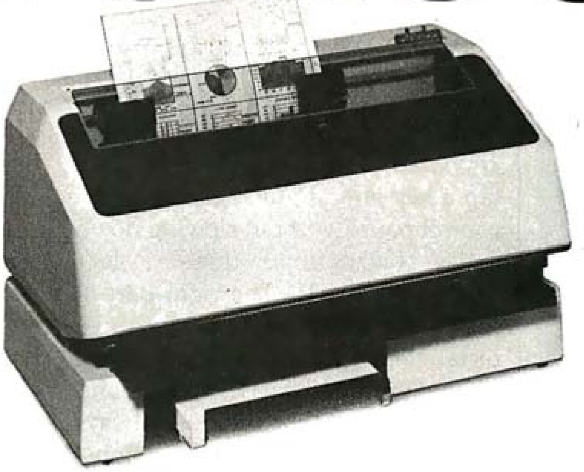

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```
        Revise List ←F1 F2→ Save Message          | Transend PC  (tm)
   Test Interpreter ←F3 F4→ Restore Original      | TEST Version 1.0
      Print Message ←F5 F6→ Insert ¶              |
                    ←F7 F8→                       | Caps
      ← Delete Word ←F9 F10 Delete Word →         | Lock
------------------------------------------------------------------------
     Grey ← deletes errors;      Home End ↑ ↓ PgUp PgDn scroll
------------------------------------------------------------------------
  Subject:[Word-Processor Design      ]

 ¶SIMPLE APPROACH
 ¶The goal is to be as easy to use as a typewriter.  Informal messages
  don't need multiple columns, footnotes, pagination control or font-change
  commands, so we don't need lots of comands or control characters.


▶¶SUPPORT FOR LOCK KE▪YS                                                  ◀
```

Figure 2: *The large rectangle at the top of the screen, bounded above and below by double lines, is the user control panel. The control panel furnishes the tools and information the user needs to manipulate the desktop environment. The control panel's top portion maps the 10 function keys onto a menu of available commands; the lower control-panel line suggests actions appropriate to the current state of the desktop.*

rently available commands. The function-key map is laid out in two vertical columns, exactly mimicking the keyboard. This layout lets the user tap a key after a quick glance at the control panel, without slowing down to say, "I want option three . . . let's see, where is F3?" The right part of the control panel has space for three rectangles, which can display Shift Lock, Num (Numeric) Lock, and Scroll Lock so that the user always knows the state of those functions. As a final touch, references to keys in our help messages use graphics whenever possible.

After continuous refining, we have perfected these screen aids to the point that first-time users of Transend PC have very little trouble using the keyboard.

Users Know What They Want

Having analyzed the machine and chosen the metaphor, we thought the project would then proceed according to the classic paradigm: analyze the problem, design a solution, and implement the design.

We dutifully proceeded to outline which commands would be needed on each screen and what mechanism the user would employ to select operands for the commands. When we had our prototype running, we sat a friend down at the machine and asked her to try to use it. First she asked, "What do I do now?" We said, "Choose a function key, of course." The pattern continued—at each step her assumptions and interpretations were different than we had planned.

Then we let another friend try the system, hoping that the first person was atypical. No such luck. We learned that each person very quickly creates an idea of what the machine is trying to do. Wherever two interpretations of the screen are possible, the user draws the wrong one (or, more often, invents a third). We wanted the user to adapt to our metaphor, so we had to make the metaphor totally clear and unambiguous at every step.

This goal turned out to be very costly to pursue. At each stage of refinement, the ambiguities uncovered were more subtle—maintaining the user illusion took an ever greater sleight of screen.

How Many Screens?

As the user interface began to take shape, the first issue was how many different screens to have and how much information to put on each one. In many menu-driven software products, the labyrinth of screens is so formidable that "Where am I?" and "How do I get back to where I was?" are the usual questions asked by the inexperienced user. In an attempt to keep the user out of such traps, we

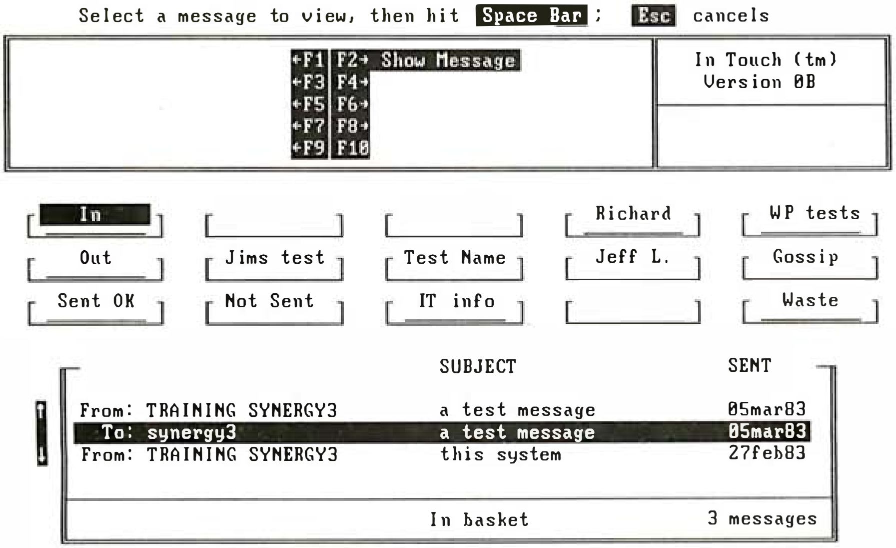


Figure 3: *This early screen version got the cold shoulder from users. The help line at the top was universally ignored. The open basket at the bottom was not seen as a blow-up of the selected basket, but rather as a different basket. Users never knew what to expect from the scroll keys. The crowded screen also had the effect of limiting the number of baskets and messages that could be displayed.*

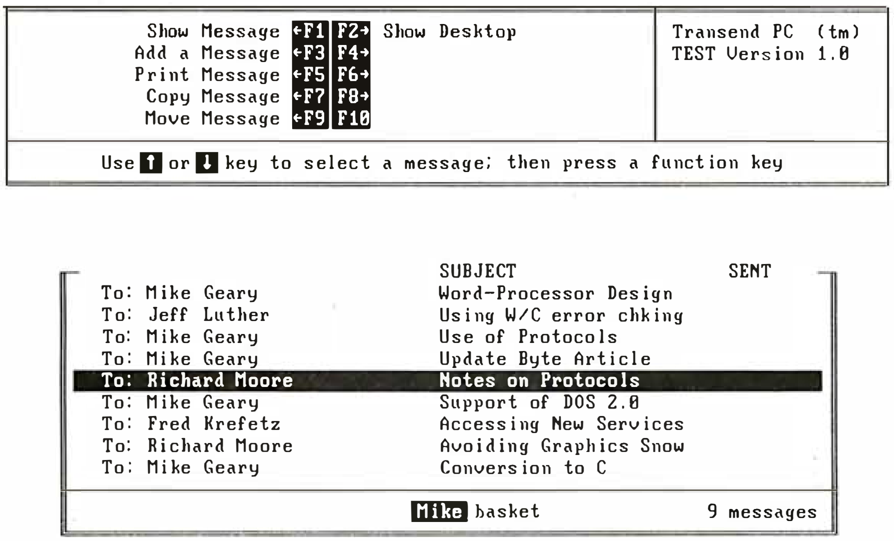


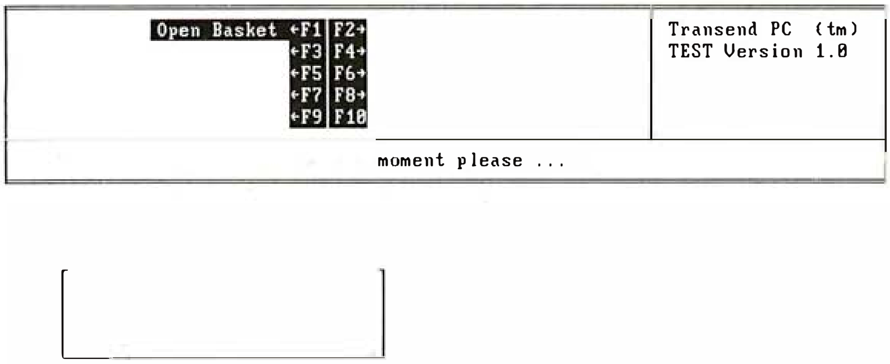
Figure 4: *By devoting an entire screen to the display of a basket's contents, we could show more messages than we could using the figure 3 screen. Moreover, we could simplify scrolling for the user.*

packed as much information as possible into our screens.

In figure 3, you can see an early attempt at a main screen. Below the control panel each of the baskets is shown, with an expanded view of the selected basket. The expanded view shows a scrollable list of the messages in that basket. This screen seems to make a lot of sense. Users can look at the contents of one basket without losing the global context. Users, however, were confused by the clutter of images, and they couldn't predict what the effect of using the scroll arrows would be. Sometimes the arrows would select a basket; at other times they would cause the message list to scroll.

In response to user confusion, we replaced the main screen with the two screens in figures 1 and 4. The two-screen approach did reduce confusion, and users learned their way around each of these screens more quickly. The transition between the screens now became the point of confusion. The OPEN BASKET command would cause the array of baskets to be replaced by a blown-up

(5a)



(5b)

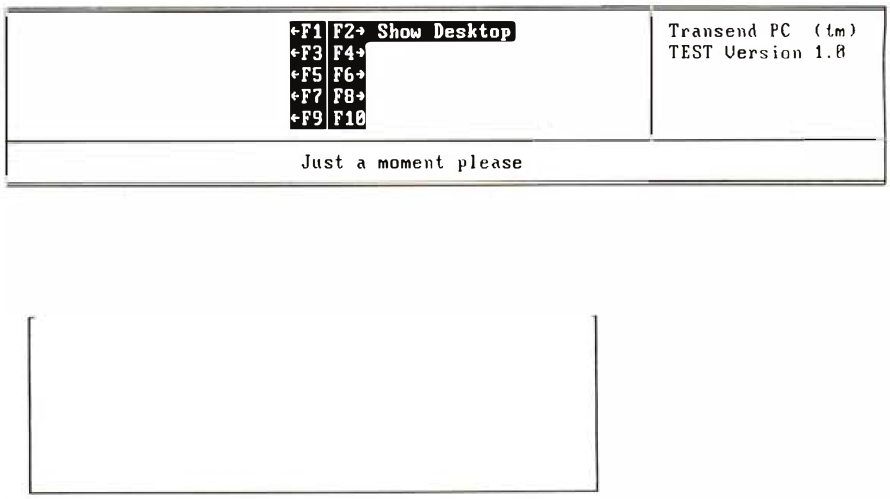


Figure 5: *Simple outline animation provides continuity between the screens in figures 1 and 4. Compare this screen to figure 1's, and note how this kind of animation, captured here successively in parts a and b, makes a basket appear to grow.*

view of the selected basket. One of our friends tried this and commented, "Well, what do we have now?" We pointed out that the blown-up basket came from his selected basket, and he said, "Oh, of course." But others who test-drove the system had the same initial confusion when the screen changed. We were in a quandary—the combined screen was too cluttered, and the separate screens seemed unconnected. Could we build a bridge between the two screens?

Animation with Character Graphics

What we wanted was some way to make the screen transition easier for the user to understand. We looked again at our metaphor. In real life, a basket can appear to get bigger (or come closer) only by passing through intermediate sizes (or distances). But animation, popular on bit-mapped screens, was impractical on a character-oriented screen—or so we had assumed. We experimented a little and found that *simple* outline animation was both practical and effective. We introduced an animated sequence to show the basket opening out from the desktop array, as shown in figure 5. Not only did this simple animation remove the confusion, but our friends responded with actual pleasure at our fidelity to the metaphor. Could a productivity-oriented software package actually be fun to use? Transend PC seemed to have edged beyond being merely nonhostile into the realm of being truly friendly.

Simple animation was so successful in solving the open-basket problem that we couldn't avoid the implication that this kind of animation should be used wherever a screen transition needed clarification. There

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```
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            ←F3 F4→                     | TEST Version 1.0
            ←F5 F6→                     |
            ←F7 F8→                     |
            ←F9 F10                     |
Use ↑ or ↓ to select a name, then hit Space Bar ;   Esc cancels

                                 7 entries in Address Book
                                 Name                    Service

 From:     ??                    Bill & Liz              Transend PC
 To:    ←----------------------→ Fred Krefetz            OnTyme
 Attach:                         Gregg Williams          The Source
 Subject:[                       Jeff Luther             OnTyme
                                 Mike Geary              OnTyme
                                 PCUG Bulletin Board     Other host
                                 Richard Moore           OnTyme
```

Figure 6: *The Transend PC address book contains an entry for each electronic correspondent.*

```
Revise Entry ←F1 F2→ Show Basket        | Transend PC  (tm)
             ←F3 F4→ Discard Entry      | TEST Version 1.0
 Print Entry ←F5 F6→                    |
  Look Above ←F7 F8→                    |
  Look Below ←F9 F10                    |
     Home End ↑ ↓ PgUp PgDn scroll text for viewing

                    A D D R E S S   B O O K

 This form describes a person or computer that you communicate with.

 Name:  Fred Krefetz              (to send messages "To")

↑ Where do we reach this person or computer:                        ↑

↓ On an electronic mail service:                                    ↓
     OnTyme
     The Source

 Direct dial to:
      Another PC using Transend/PC
      Another PC using a different communications program
```

Figure 7: *An example of an address-book form.*

were many such transitions, and handling each one of them was long and tedious work. Sometimes, waiting for a compilation in the middle of the night, we had to ask ourselves whether we were in charge of the user interface or if it was leading us by the nose. As refinement continued, even slighter user annoyances came to our attention.

Reassuring Sounds

Often, users couldn't tell whether their commands were being processed, if they were supposed to hit another function key, or whether the program had received their most recent request. We found that a few judiciously placed beeps and chirps let users know that the machine was listening and, indeed, was responding. Our biggest surprise was that we didn't get any feedback from friends after sound was introduced. We thought they would say, "Oh, how neat, you're using sound." But they were so accustomed to sound from computer games that they proceeded merrily along, knowing the computer was following them, not conscious of why they were so sure.

The Help Line

Even though we made each part of the system as easily understandable as we could, we found that a prompt, or help line, was needed on the screen at all times. We put the help line at the most prominent place on the screen—the very top. Unfortunately, users didn't notice it. We had to keep reminding them to look

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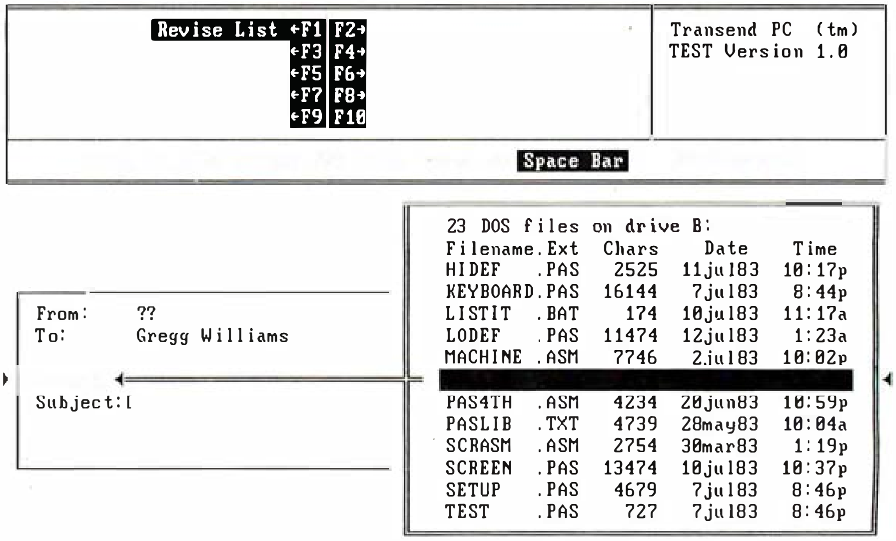

Figure 8: *When mail is being sent between PCs, disk files can be sent along as attachments.*

at the top of the screen. We finally moved the help line to the bottom of the control panel. The user's eye is then forced to cross over the help line when moving from the function-key menu to the main screen.

Transend PC Features

The result of Transend PC's iterative design process is a product that fills a wide range of communications needs. Consider, for example, some of its message-exchange capabilities. Its address book (figure 6) contains an entry for each correspondent. When you're ready to send a message, you simply pick the names you want from a list of entries—Transend PC automatically copies them into its message header. When the message is later transmitted, the full address-book entry is used to route messages to their destination.

The forms within the address book are of variable length, depending on how the correspondent is to be reached (figure 7). For someone who has a mailbox on an electronic-mail service, you need only supply the mailbox name (ID). To dial direct, you must supply the phone number and the characteristics of the modem you are dialing.

When mail is being sent directly between PCs, any disk file can be sent along as an attachment to the message (figure 8). Both the message and the file are sent with a protocol that eliminates data errors. Files are attached to messages via the same kind of lookup window used for address-book access. In Transend PC, we have tried to minimize the number of user-interface concepts by applying each technique in as many contexts as possible.

A Continuing Process

We expect that the process of extending and refining the product and its user interface will continue even after its initial publication. For example, future plans include porting the product to other popular machines (so that diverse machines can easily communicate with one another) and integrating it with local-area networks and in-house mainframes. And, relative to product refinements, it will be only after groups of people are using Transend PC to communicate with each other daily that the next level of subtle concerns will emerge. Fortunately, our software base is flexible—having bent under the wind of so many changes, it seems to accept new requirements without snapping.■

Richard K. Moore worked at Xerox PARC and Tymshare and participated in the development of Xerox's Star and Apple's Lisa before cofounding Small World Communications (10311 S. DeAnza Blvd., Suite 4, Cupertino, CA 95014) with Michael Geary.

Michael Geary was an employee and later a consultant to Tymshare before cofounding Small World Communications. He is the principal designer of the Transend PC and is experienced in the use of mini- and microcomputers to access communications and mainframe services.

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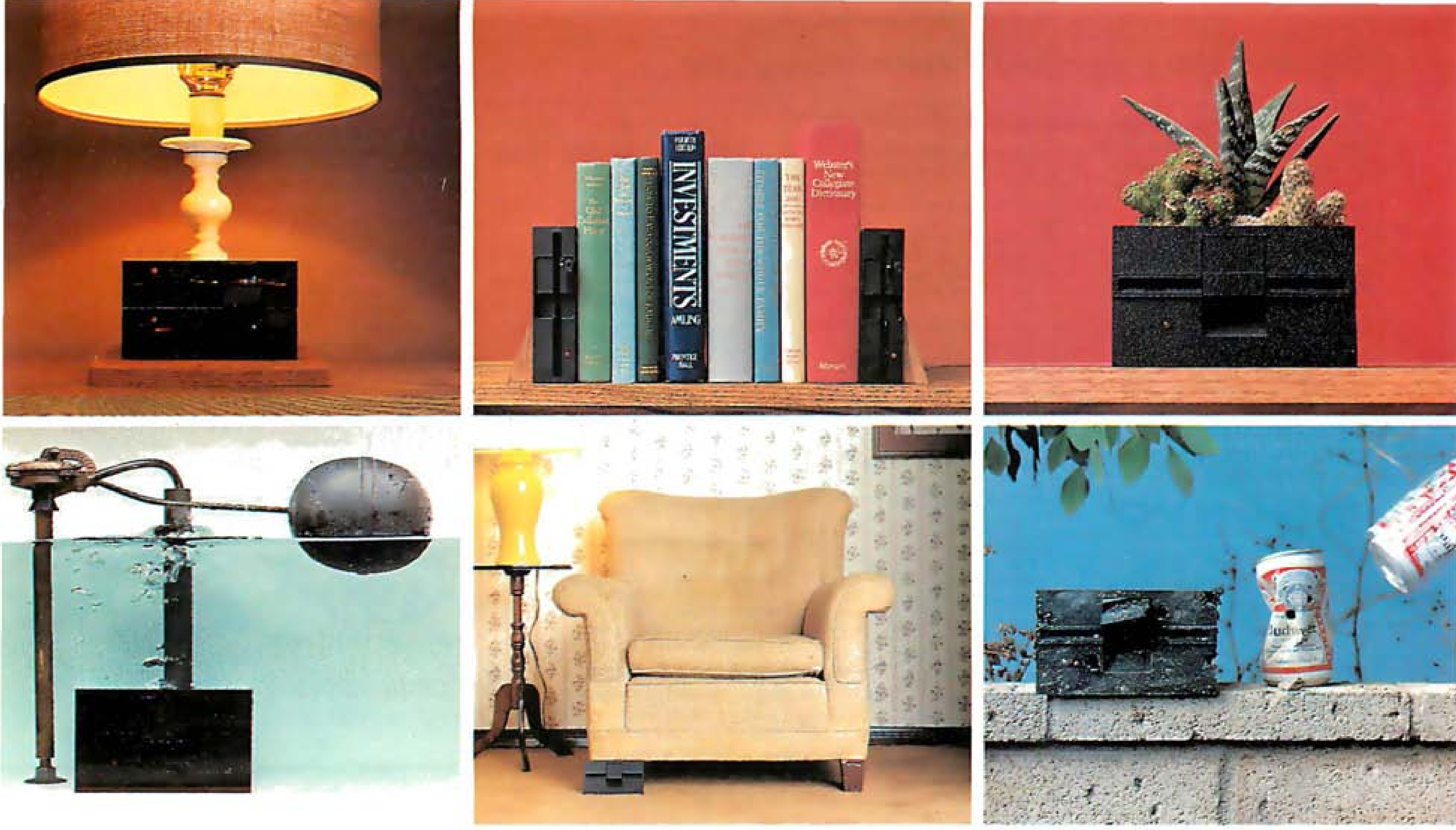

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A Graphics Editor for the IBM PC

Glyphe makes drawing with the PC's graphics characters productive and enjoyable

by Charles B. Duff

One of the most attractive features of the IBM Personal Computer (PC) is its complete graphics character set. The computer's designers made a wise decision in assigning a graphics character to virtually every code not used by the standard set of printing ASCII (American National Standard Code for Information Interchange) characters. Unfortunately, they provided no convenient means of generating these characters from the keyboard or printing them. Glyphe, a graphics editor, simplifies use of the PC's extensive graphics capabilities.

The problem of printing the graphics characters has been addressed by developers of printer-driver replacements for the PC (see Tim Field's article, "A Peek into the IBM PC," March 1983 BYTE, page 331). Generating graphics from the computer's keyboard, however, involves at best hitting the Ctrl key and another key; or at worst, using a four-key combination involving the Alt key and the number pad. This constraint is intolerable if you're in the midst of a creative project and can't remember the key combinations you need.

I discovered this drawback when I first tried to use the PC to create flowcharts and diagrams. I hoped to produce an image on the machine, store it on disk, and later build a new image by editing the original rather than starting over. I also wanted to use an existing word processor rather than burden the world (and my brain) with yet another homemade editor. So I fired up Wordstar and entered a sequence that in BASIC would have generated a graphics symbol. Nothing happened. Because Wordstar uses the high-order bits in some characters as an internal formatting flag, it accepts only ASCII codes lower than 128. Most of the PC's graphics, however, occupy the codes from 128 and above and have the high-order bit turned on.

Thus, I was confronted with the prospect of having to write an editor in BASIC before I could use that wonderful graphics set that includes algebraic, foreign-language, and block graphics as well as useful symbols for screen formatting and creating charts and tables. After a little examination, however, the problem didn't seem too discouraging.

The PC's BASIC environment, which was created by Microsoft, provides the most powerful integral screen-mode editing feature I have ever used. Keys are used to move the cursor to a point in a listing where a change is required, and the change is made over old text. Although many of the keys on the PC's keyboard are intended for use in full-screen editing, they are not fully exploited in the BASIC editor. Cursor-control codes that enable a program to detect the use of cursor keys and update the cursor's position on the display are provided, however, making the task of writing a screen editor for the PC simpler than it would be for other systems.

Glyphe is the result of my attempt to make drawing with the PC's graphics characters fun as well as efficient. The editor has seen plenty of use in a production environment and benefits from an iterative redesign based on user comments. The pro-

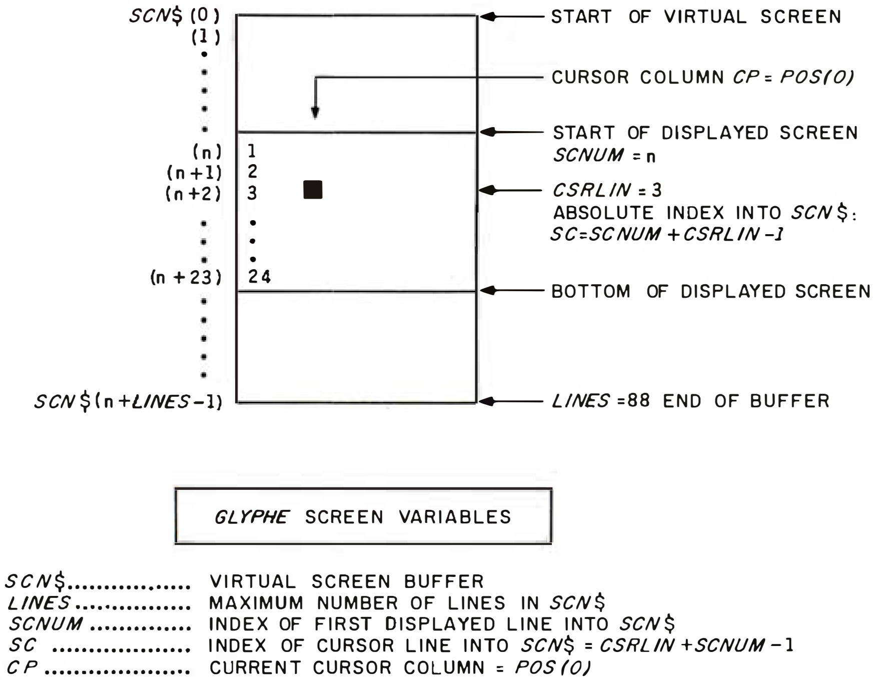

Figure 1: *With this screen-handling information, you can always know the location of the cursor in the screen buffer.*

gram for this graphics editor is provided in listing 1 on page 220.

I set four goals to guide Glyphe's design:

1. The PC's keyboard must be used as fully and logically as possible to provide maximum function with minimal keystrokes.
2. Use of the editor should be simple enough to learn in an hour or less.
3. The software design should be modular to promote easy modification and adaptation to user needs.
4. Glyphe should be easy and efficient to employ for a variety of graphics tasks including creation of flowcharts, tables, graphs, and use of algebraic symbols.

Functional Design

The following list comprises my set of the minimum functions a useful editor must have.

- four cursor movement keys
- the most useful graphics characters for a given application available via one keystroke
- modeless character insert and delete
- frame scrolling (16 lines at a time)
- line copy and move
- a "memory key" that reenters the last character typed
- indicators of the line and column of the cursor's location
- single-keystroke access to frequently used primitives, such as boxes and diamonds in a flowcharting application
- the capability of saving work to disk
- the capability of abandoning edit (with verification)
- the capability to print during editing
- a "graphics mode" in which all keys produce graphics instead of ASCII characters
- full use of the PC's user function keys

These features would maximize utility while minimizing programming time and complexity. For instance, single-keystroke primitives provide a much higher payoff for the work involved than a block-move function would. Of course, an extensible design would allow such a function to be added later if it proved worthwhile.

File Design and Data Structures

My first step was choosing a file structure that would support permanent disk storage of edit files. Random-access files have certain advantages over those accessed sequentially, but they are somewhat more complex to use. Performance is better using random access, particularly when you want to retrieve a given record, because you can access files without reading through all the previous records. Access by record number would permit an extension of Glyphe to include reading or writing sections of files by line number ranges. I decided to use random-access files with 80-byte records as Glyphe's method of permanent storage. This format provides good results with the DOS TYPE command when you must view an image file without using the editor, for example, setting up a batch file to do printing.

Designing an editor screen buffer can be a complex task if you attempt to optimize use of memory and/or insert time. Optimizing memory generally involves a method of space compression, such as replacing a string of blank spaces with a byte that indicates the number of spaces. An even more efficient method involves text-compression algorithms.

Optimizing line-insert time is best accomplished by minimizing the amount of text that must physically be moved in the buffer. The best way to do this is to store lines in a linked list, which means storing each line in a fixed location in the buffer and keeping its address in another set of variables. When the order of lines changes, the address variables, or pointers, are merely updated to reflect the new order. This procedure is much more efficient than actually moving the text.

Accomplishing either of these techniques for optimizing use of the buffer in BASIC is less than straightforward and hardly necessary if you are dealing with a small number of lines. Because my goal was to make the program as simple as possible, I elected to keep the size of the image file relatively small: graphics applica-

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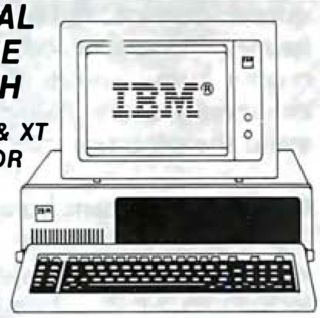

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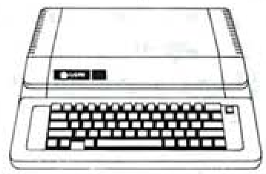

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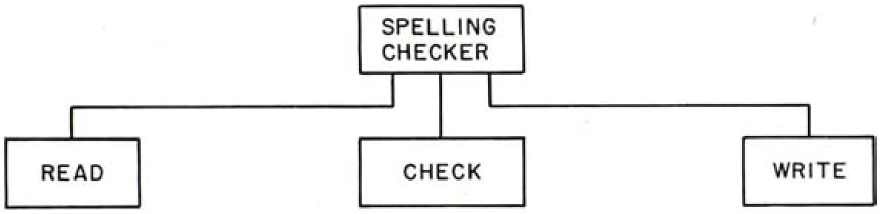

Figure 2: *This diagram is an example of a "source, transform, sink" problem structure. The main module calls the three subordinates in order from left to right, repeating the process until the input is exhausted.*

tions aren't likely to require a very large file anyway. The buffer can then be an exact image of the screen as it would appear at any point in the file, which simplifies the entire program.

Using the following screen-handling information (detailed in figure 1), you can always determine the cursor's position in the screen buffer:

- the correspondence between the first line in the screen and the screen buffer
- the current cursor column (1-80)
- the current cursor line (1-24)
- the maximum number of lines in the buffer

In addition to the basic screen-handling data structures, I defined string arrays that would hold the graphics primitives that the application required. BOX$, DIAM$, and CRT$ define a process box, a decision diamond, and a screen symbol, respectively. A brief subroutine could then be written to appropriately copy each type of primitive to the screen buffer.

Another data structure is the string buffer PIK$. I needed a means of moving and copying lines and developed the functions Pick and Drop. Pick provides a nondestructive copy of the line the cursor is currently on into a buffer. By moving the cursor and hitting the Drop key, you can then drop (insert) the buffer anywhere. It remains intact and can therefore be dropped any number of times. This feature is extremely useful when you're building tables or charts, which tend to involve many similar lines stacked on top of each other. Pick and Drop, together with Line Delete, provide a flexible yet simple function set.

A Modular Software Design

The purpose of using modular design is to minimize maintenance and extension activities—the most costly portions of a program's life cycle. To the extent that such a design makes a program more comprehensible and error-free, it also reduces the effort required to support these inevitable activities. One of the most significant factors in making a software product comprehensible is the way it is partitioned; that is, how effectively it is divided into less complex parts. Our minds deal with complexity by creating hierarchical structures into which new information can be placed, thus enabling a complex set of facts to be grouped under, and replaced at some level, by a single piece of information. Modular design attempts to exploit this tendency by setting up in a system explicit hierarchies that the mind can assimilate more easily than it can an unstructured list of details.

The goal of such design is to create a set of modules that exhibits four basic characteristics: (1) Each module ideally performs one function appropriate to the level of the decomposition, providing what is known as functional integrity, (2) each module is minimally coupled via external data structures to other modules. Update access to a given datum should therefore be restricted to as few modules as possible. In languages with a local variable concept, such as C or Pascal, this criterion is much easier to enforce than in BASIC because all BASIC variables are global (accessible to any routine by name), (3) the size of a module should be roughly a printed page or less, depending on the program's complexity, and (4) within the module, the flow of control should be confined to the patterns that comprise a structured-programming approach: sequence, decision, and iteration. Minimizing the number and obscurity of control paths within the module enhances a user's ability to understand the program.

Glyphe's Program Structure

In order to make Glyphe easily extensible, I applied modular-design techniques to its structure. Small modules with high functional integrity prove inherently more adaptable to other uses. In some cases, though, the modules in Glyphe seemed too small; because subroutine linkage slows down the computer, the effort to minimize module size must be balanced by also restricting the number of subroutines. But I planned to compile the code anyway and felt that the calling overhead was justified by the benefits of restricting module size.

Another essential feature of good software design is that the structure of the code should map the structure of the problem it is solving. This does not mean that a program that tracks elephant mating patterns should contain big modules that bump into each other a lot. Rather, this method is based on an abstraction of problems into broad classes amenable to a common method of analysis.

Consider the following situation, which illustrates this structuring technique. You decide to write a program to read documents you have created, check them against a dictionary, and mark misspelled words. This problem (outlined in figure 2) is a repetitive execution of three sequential steps: read the next word, check its spelling, and write an indication of whether it is right or wrong. A system designer might term this a "source, transform, sink" kind of problem, which is a fancy way of saying that this procedure involves taking something in, transforming it into something else, and then placing it somewhere. Most problems lend themselves to this type of treatment.

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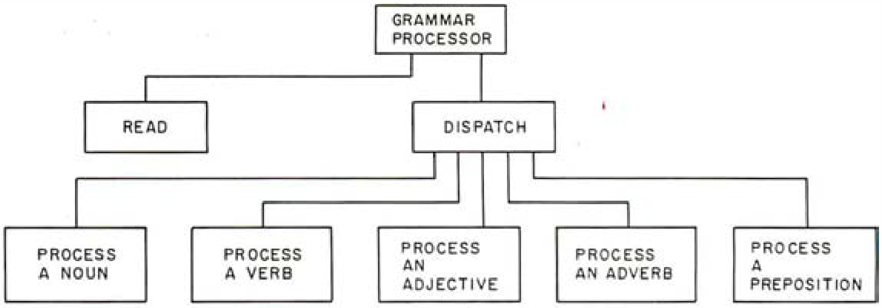


Figure 3: *An example of transactional processing. The program takes different paths for each type of input data.*

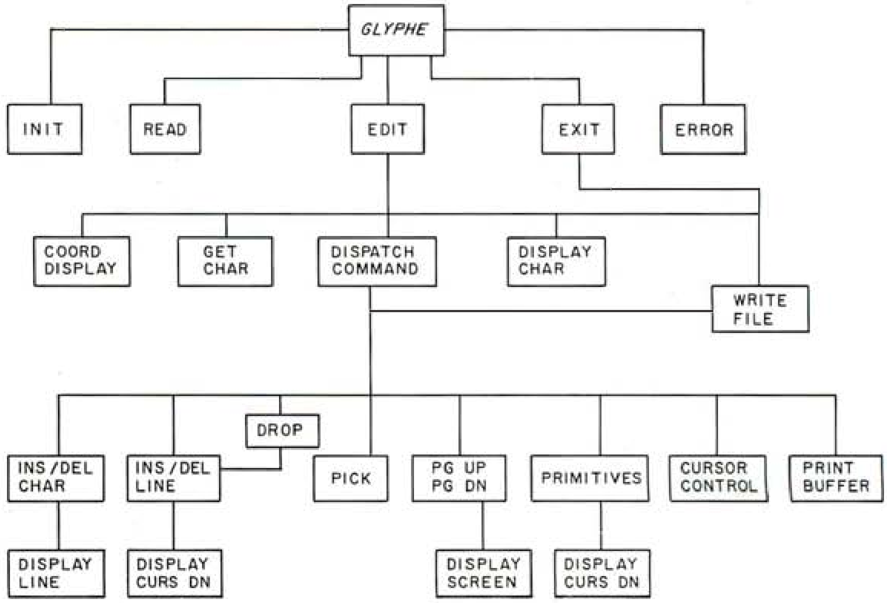
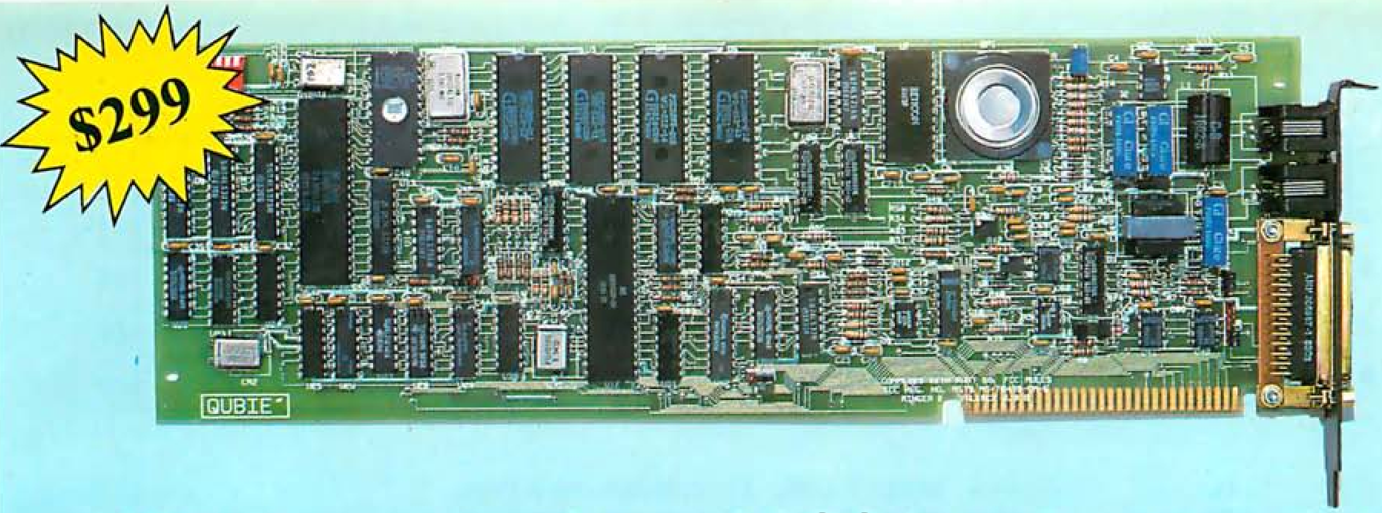


Figure 4: *The hierarchy of Glyphe modules.*

with your spelling checker and want it to act on each word differently, depending on whether the word is a noun, verb, adjective, adverb, or preposition. The spelling program you were using was process-driven: it performed one particular process (checking spelling) for each word. Your new program, however, is data-driven: it bases the type of processing it does on the data it reads. A transactional problem of this sort does not operate sequentially. Instead, it is characterized by a dispatcher that calls one of several service tasks, depending on the transaction indicated by the input data (see figure 3).

An editor typically demonstrates both of these structural patterns. At the highest level, it consists of these sequential modules: read a file, modify the file's information (edit), and write the file. (Although this outline oversimplifies the actual process of file-handling, it does describe the high-level function of an editor.)

Figure 4 illustrates the decomposition of the edit module into subordinates—the first point at which the program structure becomes transactional. The edit module calls a routine to get a character and then must decide whether the input is a printable character (ASCII/graphics) or a command character, such as a function key. If the character is a command, it gets passed to a dispatcher that determines its validity, calls the proper subroutines to service it, and then returns to get another character from the keyboard (see figure 5). A few routines are called by more than one command service routine; Display Line is an example. Making these functions modular usually results in a very compact and easily understood service routine and



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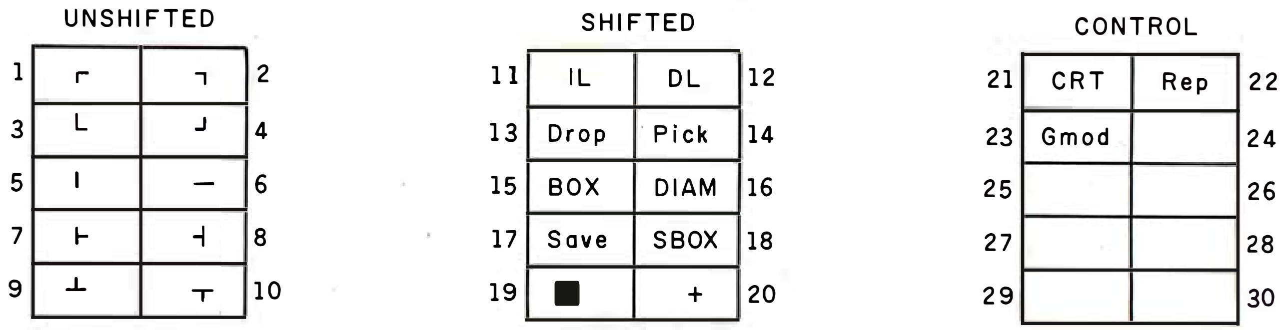

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DL	→ DELETE LINE AT CURSOR POSITION
Drop	→ INSERT THE CONTENTS OF THE PICK BUFFER AT CURSOR
Pick	→ MAKE THE CURRENT LINE THE PICK BUFFER
BOX	→ GENERATE A FLOWCHART PROCESS BOX
DIAM	→ GENERATE A FLOWCHART DECISION DIAMOND
SBOX	→ GENERATE A SMALL BOX
CRT	→ GENERATE A SCREEN SYMBOL
Rep	→ REPEAT THE LAST CHARACTER ENTERED
Gmod	→ TOGGLE GRAPHICS/NORMAL MODE

OTHER EDITING KEYS

Pg Up	→ MOVE 16 LINES TOWARD TOP OF FILE
Pg Dn	→ MOVE 16 LINES TOWARD BOTTOM OF FILE
Ins	→ INSERT A SPACE IN THE CURRENT LINE (NO WRAP)
Del	→ DELETE A CHARACTER FROM THE CURRENT LINE
Home	→ MOVE TO UPPER LEFT CORNER OF SCREEN
shift PrtSc	→ PRINT THE CURRENT SCREEN
Ctrl-PrtSc	→ PRINT THE ENTIRE BUFFER
arrows	→ MOVE THE CURSOR
Esc	→ EXITS *GLYPHE* WITHOUT SAVING WORK
End	→ WRITES TO DISK AND LEAVES *GLYPHE*

Figure 5: *An explanation of how function and editing keys are used in Glyphe.*

facilitates adding new routines because most of the necessary housekeeping can be done via calls to previously defined modules.

Program Logic

The logic of Glyphe can best be understood by dividing the Glyphe code (listing 1) into the following sections:

1. initialization and file open (lines 2-570)
2. keyboard read and dispatcher (lines 610-1530)
3. file save, exit to DOS (lines 1550-1710)
4. command service subroutines (lines 1730-5070)
5. error handler (lines 0000-20040)

1. Initialization and file open: The DEFINT statement in line 10 is used to improve performance and space utilization because Glyphe does not need floating-point variables. Error trapping is set up to avoid dropping into DOS in the event of a printer timeout, and the arrays are defined and initialized. COORD$ is a coordinate line that is always displayed on the 25th line as a reference for the slave cursor, which always indicates the current cursor column. Distinctive graphics mark five- and 10-column intervals as well as screen center. The primitives BOX$, CRT$, and DIAM$ are loaded with the proper graphics characters in lines 170-344, then the screen is cleared and prompts are issued for the input and output files. If an input file is specified, it is opened as a random file with a record length of 80 bytes.

Many editors permit a user to read parts of files for inclusion in another file, write parts of the edited file to other files, and perform these functions at any time in the editing process. I looked at several file-handling schemes in other editors and decided that the most powerful facility they shared was the capability to provide independent input and output file specifications. With this feature, you can either edit an existing file in place or use it as a template for a new file that possesses characteristics of the original one. In a graphics editor, this capability is particularly important. For example, you could create a graphics template for a status report on a project, then use the template

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Fields Per Record	32	384
Key Fields Per File	7	10
Number of Files Simultaneously Accessible	2	10
Number of Screens Per Program	Limited by system memory	Limited only by system storage
Data Dictionary	No	Yes

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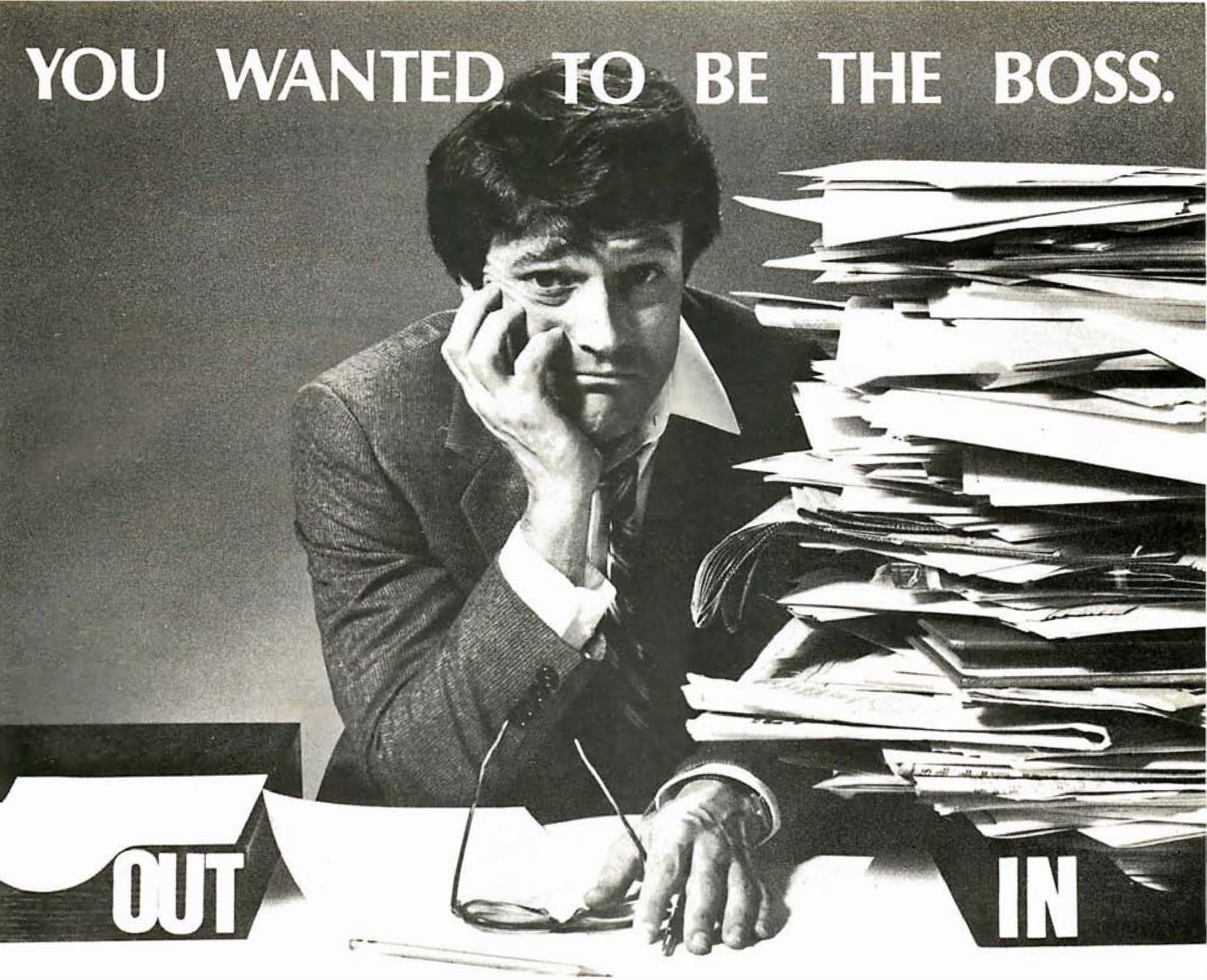
Listing 1: *Glyphe, a character graphics editor for the IBM Personal Computer.*

```
2 REM ===========================================
3 REM * GLYPHE - a character graphics editor for the IBM PC
4 REM * Requirements - one disk drive, monochrome or
5 REM * color display. A modified printer driver is
6 REM * needed to print the PC's character graphics.
7 REM * Author - Charles B. Duff   03/06/83
8 REM ===========================================
10 DEFINT A-Z:ON ERROR GOTO 20000
30 FOR I=1 TO 10:KEY I,"":NEXT          ' Turn off function key definitions
50 KEY OFF                              ' Erase 25th line key help display
70 DIM SCN$(88)
90 PIK$=SPACE$(80)                      ' pick buffer
100 TOF$=CHR$(12):LPI8$=CHR$(27)+"0":LPI6$=CHR$(27)+"2"   ' codes for MX-80
110 DIM DIAM$(10),BOX$(5),CRT$(6),SBOX$(4)  ' diamond,box and screen figures
150 COORD$="····o····1····o····2····o····3····o····"+CHR$(127)+"····o····5····o·
···6····o····7····o····"
170 DIAM$(1)="     ⅄"      :BOX$(1)="┌─────────┴─────────┐":SBOX$(1)="┌─────┴─────┐"
190 DIAM$(2)="    / \"     :BOX$(2)="│                   │":SBOX$(2)="│           │"
210 DIAM$(3)="   /   \"    :BOX$(3)="│                   │":SBOX$(3)="│           │"
230 DIAM$(4)="  /     \"   :BOX$(4)="│                   │":SBOX$(4)="└───────────┘"
250 DIAM$(5)="<         >" :BOX$(5)="└─────────┬─────────┘":
270 DIAM$(6)="  \     /"   :CRT$(1)="┌┬─────────────────┬┐"
290 DIAM$(7)="   \   /"    :CRT$(2)="││                 ││"
310 DIAM$(8)="    \ /"     :CRT$(3)="││                 ││"
330 DIAM$(9)="     Y"      :CRT$(4)="││                 ││"
340 NU$=CHR$(0):            CRT$(5)="││                 ││"
344                         CRT$(6)="└┴─────────────────┴┘"
346 LINES=88  ' max lines in editor: 88= 1 printed page at 8 lpi
350 REM =====================================
370 REM * Prompt for files and enter main edit loop
390 REM =====================================
400 CLS:PRINT "              GLYPHE (c) Copyright 1983, Charles B. Duff"
404 PRINT:PRINT:
410 FILES:PRINT:PRINT:INPUT "Input Image file";IM$
430 INPUT "Output image file";OM$:CLS
440 IF OM$="" THEN OM$=IM$: IF OM$="" THEN CLOSE:END   ' output defaults to in
450 IF IM$="" THEN 570         ' if no entry don't open input file
470 OPEN IM$ AS #1 LEN=80:IF LOF(1)=0 THEN CLOSE:GOTO 570  ' open input
490 FIELD #1,80 AS IL$         ' 80-char text field
510 FOR LIN=1 TO LINES         ' fill buffer
530  GET #1,LIN:SCN$(LIN)=IL$
550 NEXT LIN
570 GMODE=FALSE:SCOLD=1:SCNUM=1:GOSUB 1730       ' display the first page
590 LOCATE 1,1,1                  ' home and turn on the cursor
610 GOSUB 2270                    ' print slave cursor in 25th line
630 A$=INKEY$:IF A$="" THEN 630   ' get a character
650 IF LEN(A$)=2 THEN 710         ' if function or special key
660 IF A$=CHR$(27) THEN GOSUB 3690:GOTO 610
670 IF A$=CHR$(13) AND CSRLIN=24 THEN GOSUB 3470:GOTO 610 ' scroll
680 IF A$=CHR$(9) AND POS(0)<72 THEN LOCATE CSRLIN,POS(0)+8:GOTO 610
690 GOSUB 3770:PRINT A$;:OA$=A$:GOTO 610   ' update buffer,display and loop
710 AV=ASC(MID$(A$,2,1))                   ' get ascii value of 2nd char
712 REM ===========================================
730 IF AV<71 THEN 1120 ELSE IF (AV>83 AND AV<115) THEN 1320  ' if function key
750 ON AV-70 GOTO 810,830,870,610,930,610,950,610,1550,970,1090,1050,1010
790 GOTO 610
810 LOCATE 1,1:GOTO 610                               ' home
830 IF CSRLIN>1 THEN LOCATE CSRLIN-1,POS(0):GOTO 610   ' up arrow
850 GOTO 610
870 SCOLD=SCNUM: IF SCNUM>16 THEN SCNUM=SCNUM-16 ELSE SCNUM=1  ' Pg Up
890 GOSUB 1730:GOTO 610                      ' display new page
930 PRINT CHR$(29);:GOTO 610                 ' left arrow
950 PRINT CHR$(28);:GOTO 610                 ' right arrow
970 IF CSRLIN<24 THEN LOCATE CSRLIN+1,POS(0):GOTO 610  ' down arrow
990 GOTO 610
1010 GOSUB 2370:GOSUB 2550   ' delete a character
1030 GOTO 610
1050 GOSUB 2690:GOSUB 2550  ' insert char
1070 GOTO 610
1090 SCOLD=SCNUM:IF SCNUM<LINES-38 THEN SCNUM=SCNUM+16 ELSE SCNUM=LINES-23
1110 GOSUB 1730:GOTO 610     ' Pg Dn - display new page
1112 REM ==============================================
1120 IF AV<59 THEN 610       ' this section handles F1-10
1130 ON AV-58 GOTO 1140,1160,1180,1200,1220,1240,1260,1280,1300,1310
1132 GOTO 610
1140 A$="┌":GOTO 690      ' FC 1-10 are graphics characters
1160 A$="┐":GOTO 690      ' for building tables, graphs, etc
1180 A$="└":GOTO 690
1200 A$="┘":GOTO 690
1220 A$="│":GOTO 690
1240 A$="─":GOTO 690
1260 A$="├":GOTO 690
1280 A$="┤":GOTO 690
1300 A$="┴":GOTO 690
1310 A$="┬":GOTO 690
1314 REM ==============================================
1320 IF AV>93 THEN 1480     ' this section handles F11-20
1322 ON AV-83 GOTO 1328,1330,1350,1370,1390,1410,1430,1450,1460,1470
1328 INSLIN=CSRLIN+SCNUM-1:GOSUB 3210:SCN$(INSLIN)=SPACE$(80):GOSUB 3890:GOTO 61
0                                ' insert line
1330 GOSUB 3310:GOSUB 3890:GOTO 610 ' delete line
1350 GOSUB 3090:GOTO 610  ' drop
1370 GOSUB 2930:GOTO 610  ' pick
1390 GOSUB 4010:GOTO 610  ' box
1410 GOSUB 4210:GOTO 610  ' diamond
```

Listing 1 continued on page 222



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to create a complete report every week. The approach I used in Glyphe was to prompt at program start-up for input and output files. If the user responds to the input prompt with a carriage return (CR), presumably no input open is needed, and the buffer is initially blank. A response of CR to the output prompt implies that the same file will be used for both purposes, and such a response to both prompts ends the program. After this initial session, no further file specification is permitted. Any SAVE command will result in the current contents of the screen buffer being written to the output file. This arrangement is flexible and simple to implement.

Next, the screen is cleared, and the input file is read. The first 24 lines of the file are displayed with a call to 2270, the screen-display primitive. The cursor is turned on and placed in the upper left-hand corner of the screen with a LOCATE 1,1,1 statement, and the edit session is ready to begin.

2. Keyboard read and dispatcher: Line 630 polls the keyboard with INKEY$ to determine whether a key has been pressed, then loops if it hasn't. Distinguishing printable characters from function keys and special keys is made easier by the way INKEY$ is implemented. All of the keys on the PC with special functions, such as Pg Up, Home, and the function keys, cause INKEY$ to return with a string length of 2. The first character in the string is null, and the second indicates which key was pressed. Line 650 thus determines whether the keyboard input is a printable character; if it is not, the character is sent to line 710 to be processed as a possible command. If the character is printable, two checks must be made before it can be printed: ESC is used as a quit-without-save command; it causes a prompt to this effect to be issued. A carriage return causes a single-line scroll when issued on the 24th line. If these checks fail, the character is printed, the slave cursor is updated, and another character is read.

If the input was a possible command rather than a printable charac-

Listing 1 continued:

```
1430 GOSUB 1570:GOTO 610    save to disk
1450 GOSUB 5200:GOTO 610    small box
1460 A$="■":GOTO 690
1470 A$="+":GOTO 690
1472 REM ==============================================
1480 IF AV>103 THEN 1520        ' this section handles F21-30
1484 ON AV-93 GOTO 1490,1500,1510   ' room for expansion
1486 GOTO 610
1490 GOSUB 4510:GOTO 610        ' crt screen figure
1500 A$=OA$:GOTO 650            ' F22 remembers last key pressed
1510 GMODE= NOT GMODE:GOTO 610 ' toggle graphics mode
1518 REM ========================================
1520 IF AV=114 THEN GOSUB 5000:GOTO 610    ' Ctrl-Prt Sc
1530 GOTO 610
1550 GOSUB 1570:COLOR 7,0:CLS:END       ' End was pressed - save and exit
1570 OPEN OM$ AS #2 LEN=80  ' write image to disk
1590 FIELD #2,80 AS OL$                 ' open random output file recl=80
1610 FOR LIN=1 TO LINES
1630  LSET OL$=SCN$(LIN)
1650  PUT #2,LIN
1670 NEXT LIN
1690 CLOSE 2:RETURN
1710 END
1712 REM ************************************
1720 REM * Begin subroutine code
1730 REM ===================================
1750 REM * Display screen given by SCNUM
1770 REM ===================================
1790 CP=POS(0):CL=CSRLIN      pickup cursor column and line
1810 CLS:GOSUB 2190
1830 FOR SCL=1 TO 23
1850  LOCATE SCL,1,0:PRINT SCN$(SCNUM+SCL-1);
1870 NEXT SCL
1890 LOCATE 24,1:PRINT MID$(SCN$(SCNUM+23),1,79);
1910 LOCATE CL,CP,1:RETURN             restore cursor and return
2130 REM ==========================================
2150 REM * Print coordinates on the 25th line
2170 REM ==========================================
2190 LOCATE 25,1:PRINT COORD$;
2210 RETURN
2230 REM ===========================================
2250 REM * Print slave cursor at current column, and current line indicator
2270 REM ===========================================
2290 NCP=POS(0):NL=CSRLIN:LOCATE 25,CP,0:PRINT MID$(COORD$,CP,1);
2310 IF NCP<80 THEN LOCATE 25,NCP,0:COLOR 8,7:PRINT CHR$(127);
2330 LOCATE 25,1:PRINT USING "##";NL+SCNUM-1;:COLOR 7,0
2350 LOCATE NL,NCP,1:CP=NCP:RETURN
2370 REM ====================================
2390 REM * Delete a character from the current line
2410 REM ====================================
2430 SC=SCNUM+CSRLIN-1:CP=POS(0)
2470 SCN$(SC)=LEFT$(SCN$(SC),CP-1)+RIGHT$(SCN$(SC),80-CP)+" "
2530 RETURN
2550 REM ==================================
2570 REM * Print the current line from screen buffer
2590 REM ==================================
2610 CP=POS(0):CL=CSRLIN
2630 SC=SCNUM+CL-1:IF CL=24 THEN 2670
2650 LOCATE CL,1,0:PRINT SCN$(SC);:LOCATE CL,CP,1:RETURN
2670 LOCATE 24,1,0:PRINT MID$(SCN$(SC),1,79);:LOCATE CL,CP,1:RETURN
2690 REM ====================================
2710 REM * Insert a space in current line
2730 REM ====================================
2750 SC=SCNUM+CSRLIN-1:CP=POS(0)
2790 SCN$(SC)=LEFT$(SCN$(SC),CP-1)+" "+MID$(SCN$(SC),CP,80-CP)
2870 RETURN
2890 REM =====================================
2910 REM * Pick a line from SCN$ to the pick buffer
2930 REM =====================================
3010 PIK$=SCN$(CSRLIN+SCNUM-1)
3030 RETURN
3050 REM ======================================
3070 REM * Drop a line to the screen (insert)
3090 REM ======================================
3110 SC=CSRLIN+SCNUM-1: IF SC>LINES THEN RETURN
3130 INSLIN=SC:GOSUB 3210
3150 SCN$(SC)=PIK$:GOSUB 3830:RETURN
3170 REM ======================================
3190 REM * Move lines down in scn$ for insert
3210 REM ======================================
3230 FOR LIN=LINES TO INSLIN+1 STEP -1
3250  SCN$(LIN)=SCN$(LIN-1)
3270 NEXT LIN
3290 RETURN
3310 REM ======================================
3330 REM * Delete a line from the screen
3350 REM ======================================
3370 SC=CSRLIN+SCNUM-1
3390 FOR LIN=SC TO LINES-1
3410  SCN$(LIN)=SCN$(LIN+1)
3430 NEXT LIN
3450 SCN$(LINES)=SPACE$(80):RETURN
3470 REM ======================================
3490 REM * Handle a scroll from a CR on line 24
3510 REM ======================================
3590 IF SCNUM >LINES-24 THEN LOCATE 24,1,1:RETURN
3610 PRINT A$;:LOCATE 24,1,0:PRINT MID$(SCN$(SCNUM+24),1,79);
3630 SCNUM=SCNUM+1:GOSUB 2270:LOCATE 24,1,1:RETURN
3650 REM ==================================
```

Listing 1 continued on page 224

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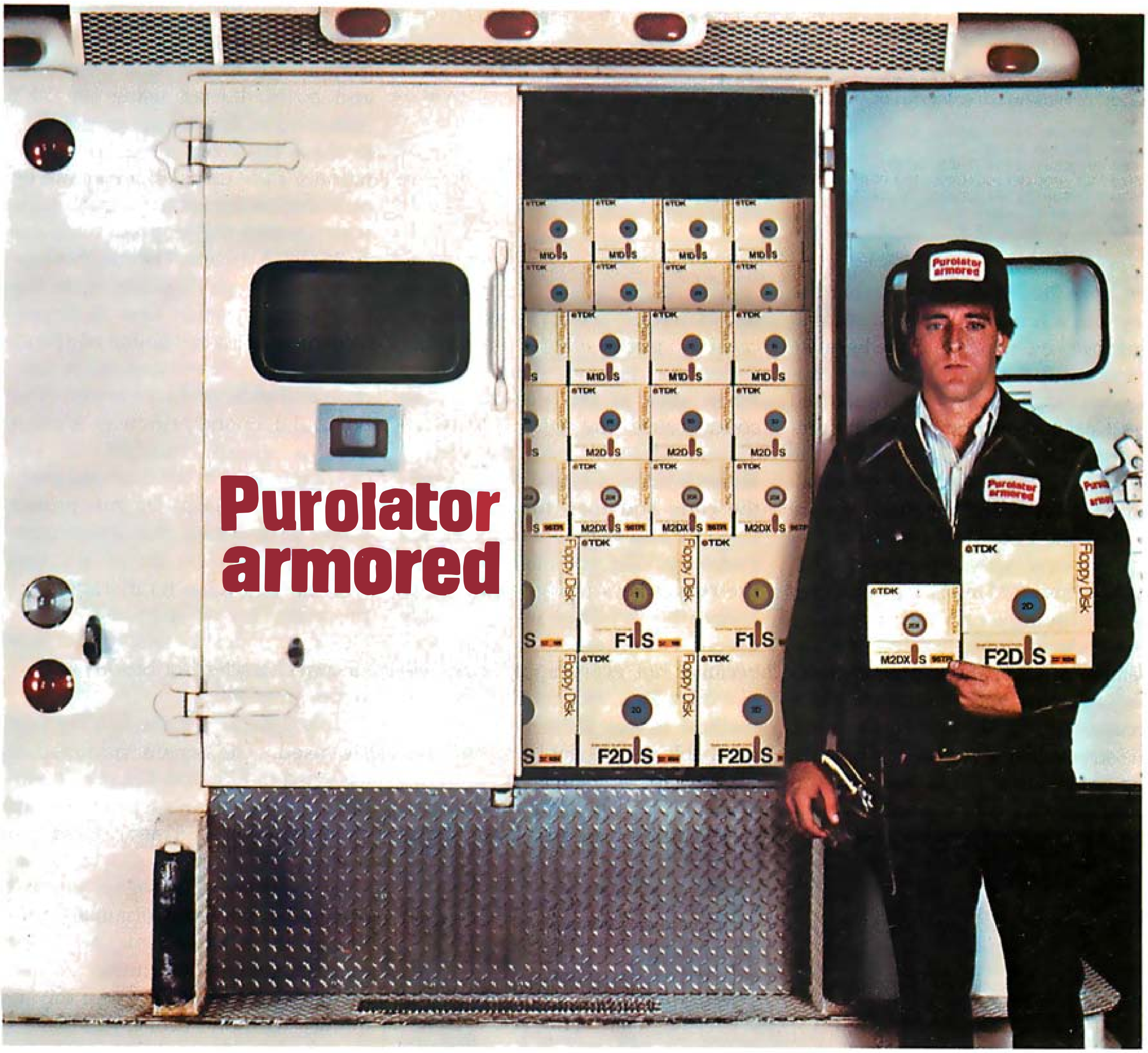
Listing 1 continued:

```
3670 REM * ESC to quit without save
3690 REM ===================================
3700 CP=POS(0):CL=CSRLIN                 save cursor position
3710 LOCATE 25,1:INPUT:"Quit without saving (Y/N)";ANS$
3730 IF ANS$="Y" OR ANS$="y" THEN CLS:END
3750 GOSUB 2170:LOCATE CL,CP:RETURN
3770 REM ====================================
3780 REM * Update buffer with character entered, and
3784 REM * handle a scroll if at 24,80 and not beyond
3786 REM * the end of the screen buffer. Add 127 to code if graphics mode.
3788 REM ========================================
3789 AV=ASC(A$):IF GMODE AND AV<>13 AND AV<>32 AND AV<127 THEN A$=CHR$(AV+127)
3790 IF A$<>CHR$(13) THEN MID$(SCN$(SCNUM+CSRLIN-1),POS(0),1)=A$
3800 IF CSRLIN<24 OR POS(0)<80  THEN RETURN
3804 IF SCNUM>LINES-24 THEN RETURN
3806 SCNUM=SCNUM+1:RETURN
3810 RETURN
3830 REM ====================================
3850 REM * Print screen from current line down
3870 REM ====================================
3890 CP=POS(0):CL=CSRLIN:
3910 FOR LIN=CL TO 23
3930  LOCATE LIN,1:PRINT SCN$(SCNUM+LIN-1);
3950 NEXT LIN
3970 LOCATE 24,1:PRINT MID$(SCN$(SCNUM+23),1,79);
3990 LOCATE CL,CP:RETURN
4010 REM ======================================
4030 REM * Print a box with top center at cursor
4050 REM ======================================
4070 SC=SCNUM+CSRLIN-1:
4090  IF POS(0)<(LEN(BOX$(1))/2)+1 THEN RETURN
4110  CP=POS(0)-(LEN(BOX$(1))/2)
4130 FOR LIN=1 TO 5:IF SC+LIN-1=LINES+1 THEN 4190
4150  MID$(SCN$(SC+LIN-1),CP,LEN(BOX$(1)))=BOX$(LIN)
4170 NEXT LIN
4190 GOSUB 3870:RETURN
4210 REM =======================================
4230 REM * Print a diamond with top at cursor
4250 REM =======================================
4270 SC=SCNUM+CSRLIN-1
4290  IF POS(0)<LEN(DIAM$(5))/2 THEN RETURN
4310  CP=POS(0)-(LEN(DIAM$(5))/2)
4330 FOR LIN=1 TO 9:IF SC+LIN-1=LINES+1 THEN 4390
4350  MID$(SCN$(SC+LIN-1),CP,LEN(DIAM$(5)))=DIAM$(LIN)
4370 NEXT LIN
4390 GOSUB 3870:RETURN
4510 REM ======================================
4530 REM * Print a crt screen with top center at cursor
4550 REM ======================================
4570 SC=SCNUM+CSRLIN-1
4590  IF POS(0)<(LEN(CRT$(1))/2)+1 THEN RETURN
4610  CP=POS(0)-(LEN(CRT$(1))/2)
4630 FOR LIN=1 TO 6:IF SC+LIN-1=LINES+1 THEN 4690
4650  MID$(SCN$(SC+LIN-1),CP,LEN(CRT$(1)))=CRT$(LIN)
4670 NEXT LIN
4690 GOSUB 3870:RETURN
5000 REM =====================================
5010 REM * Print the contents of the screen buffer
5020 REM * on the printer
5030 REM =====================================
5032 LPRINT LPI8$+TOF$;      ' (MX) set 8 lpi , top of form
5040 FOR LIN=1 TO LINES
5044  IF INKEY$="" THEN 5050
5046   CP=POS(0):CL=CSRLIN:LOCATE 25,1:INPUT;"Quit printing (Y/N)";ANS$
5048   GOSUB 2170:LOCATE CL,CP: IF ANS$="Y" OR ANS$="y" THEN 5070
5050  LPRINT SCN$(LIN);
5060 NEXT LIN
5070 LPRINT LPI6$;           ' RESTORE 6 LPI
5080 RETURN
5200 REM ======================================
5220 REM * Print a small box  with top center at cursor
5240 REM ======================================
5280 SC=SCNUM+CSRLIN-1
5300  IF POS(0)<(LEN(SBOX$(1))/2)+1 THEN RETURN      ' check if off screen
5320  CP=POS(0)-(LEN(SBOX$(1))/2)                     ' center it
5340 FOR LIN=1 TO 4:IF SC+LIN-1=LINES+1 THEN 4690
5360  MID$(SCN$(SC+LIN-1),CP,LEN(SBOX$(1)))=SBOX$(LIN)  ' store in scn$
5380 NEXT LIN
5400 GOSUB 3870:RETURN
20000 REM ====================================
20010 REM * Error handler
20020 REM ====================================
20030 IF ERL <> 5050 THEN 20200
20040  CP=POS(0):CL=CSRLIN:LOCATE 25,1:INPUT;"Printer error - quit printing (Y/N
)";ANS$
20050  GOSUB 2170:LOCATE CL,CP: IF ANS$="Y" OR ANS$="y" THEN RESUME 5080
20060  RESUME 5050
20200 IF ERL<>470 THEN 20400          ' input open errors
20220  CP=POS(0):CL=CSRLIN:LOCATE 25,1:INPUT;"Input open error - abort (Y/N)";AN
S$
20230  GOSUB 2170:LOCATE CL,CP: IF ANS$="Y" OR ANS$="y" THEN RESUME 570
20240  RESUME 470
20400 IF ERL<>530 THEN 20600          ' input read errors
20420  CP=POS(0):CL=CSRLIN:LOCATE 25,1:INPUT;"Input read error - abort (Y/N)";AN
S$
20430  GOSUB 2170:LOCATE CL,CP: IF ANS$="Y" OR ANS$="y" THEN RESUME 570
```

Listing 1 continued on page 226



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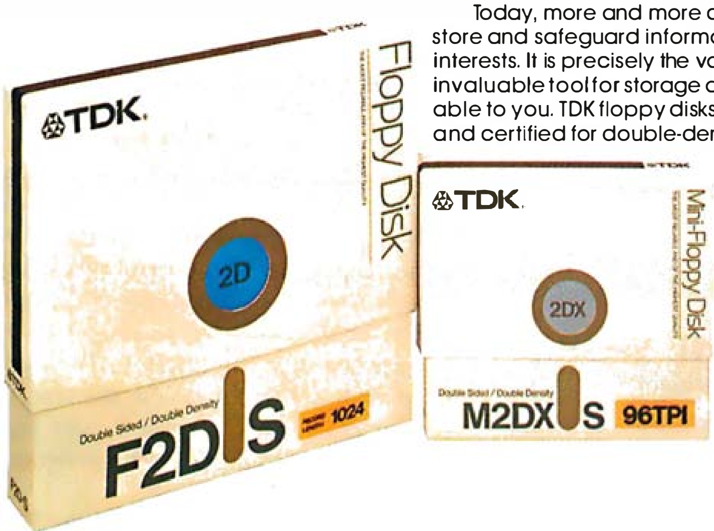

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Listing 1 continued:

```
20440  RESUME 530
20600 IF ERL<>1570 THEN 20800          ' output open errors
20620  CP=POS(0):CL=CSRLIN:LOCATE 25,1:INPUT;"Output open error - abort (Y/N)";A
NS$
20630  GOSUB 2170:LOCATE CL,CP:IF ANS$="Y" OR ANS$="y" THEN RESUME 1690
20640  RESUME 1570
20800 IF ERL<>1650 THEN 20900          ' output write errors
20820  CP=POS(0):CL=CSRLIN:LOCATE 25,1:INPUT;"Write error - abort (Y/N)":ANS$
20830  GOSUB 2170:LOCATE CL,CP:IF ANS$="Y" OR ANS$="y" THEN RESUME 1690
20840  RESUME 1650
20900 ON ERROR GOTO 0
```

ter, lines 710-750 decide whether the key was a function key or a special-purpose key, which is done because these groups are each assigned contiguous ranges and can be dispatched most easily with independent computed GOTOs. Line 750 handles the range from 71 through 83 (for special-purpose keys), and function keys are sent to line 1130. Most processing for the various special-purpose keys, such as Ins and Del, is accomplished with subroutine calls rather than in-line code in order to keep the dispatcher as small and simple as possible (a further encouragement to extensibility). Pg Up and Pg Dn scroll the screen 16 lines unless it's near the top or bottom of the buffer. The cursor control keys, which come in as two-character INKEY$ sequences, cause Glyphe to generate one of four codes that produce cursor control when sent to the display. These codes cause the cursor to wrap around when it's near the vertical screen borders; Glyphe simply sends the code and then finds out with CSRLIN and POS where the cursor ended up. Why, you might ask, don't the cursor keys just generate these codes directly? They were probably given two-character sequences because not every application will use them for cursor control, and this method makes them easily distinguishable as special-function keys. Or, perhaps, someone was just lazy.

Function keys 1-10 display the graphics characters that form lines and boxes. I tried using the KEY statement to directly assign graphics to these keys, but a bug in the PC monitor code turns off the eighth bit on strings assigned to function keys, which makes the graphics come out as ASCII characters. The four box corners are arranged logically as the top four keys. Function keys 11-20 perform most of the remaining edit functions, such as insert and delete line, drop and pick, and save to disk. The box and diamond primitives are also in this group. Incidentally, the characters used in the diamond primitive are translated by my printer driver to graphics that differ from those displayed on the PC's screen because the PC has no characters appropriate for a diamond figure. PR256 provides the ability to define custom characters for Epson's MX/FX Series printers.

Only three keys in the F21-30 group are used. The screen primitive is assigned to F21, and F22 is a "memory key" that always repeats the last character entered. This setup can be useful if you discover a graphics character you want to use again yet can't remember how you originally produced it. Also, if you have just entered one of the clumsy Alt sequences, this key can repeat the sequence with one stroke. F23 toggles the graphics mode, in which all the normal keys produce graphics symbols. This is done by simply adding 127 to the normal ASCII value of the key, putting that key into the graphics set. The resulting arrangement of symbols is less than optimal but easy to implement. The four combinations of mode keys that produce keyboard graphics are shown in figure 6.

3. *File save, exit to DOS:* Lines 1570-1690 save the buffer contents to the disk file previously specified as the output file. This procedure can be performed at any time with F17 (Shift F7). The normal exit is at line 1520, in response to the End key. The Buffer Write routine is called, the screen color is set back to normal, and the screen is cleared before the program ends.

4. *Command service subroutines:* The

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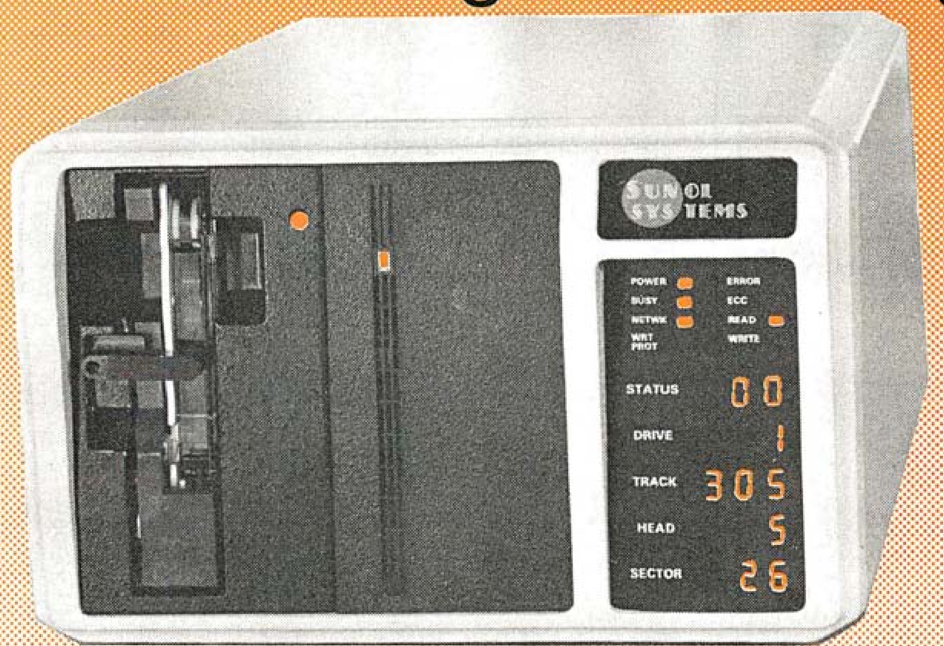

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Circle 447 on inquiry card.

subroutine library that does most of the work in Glyphe starts with line 1712. Several routines are used by the others as utilities: Display Screen displays the 24-line section of the buffer starting with SCNUM for Pg Up and Pg Dn. Print Coordinates refreshes the 25th line after a clear-screen operation. Print Slave Cursor updates the 25th-line information by providing current cursor position. Print Current Line refreshes the cursor's line from the buffer, and Print Screen from Current Line refreshes the display after a line insert or delete operation (because lines above the cursor do not change).

The Update Buffer routine is called whenever a printable character is entered, placing the character in the

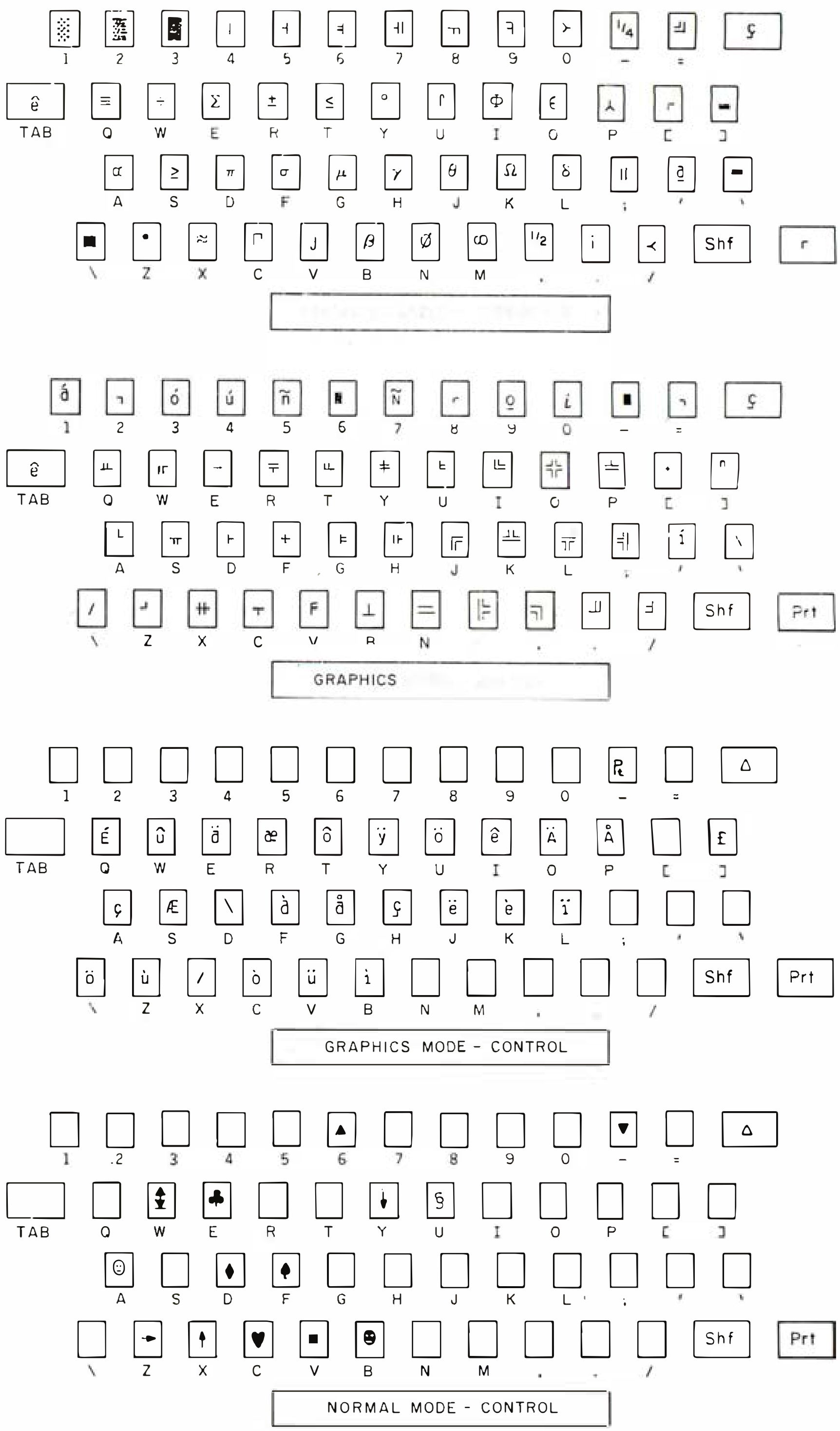

Figure 6: *Graphics can be generated in four different Glyphe keyboard modes.*

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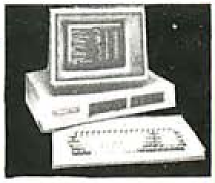

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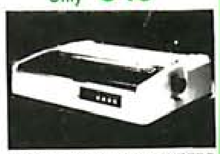

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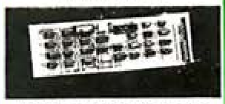

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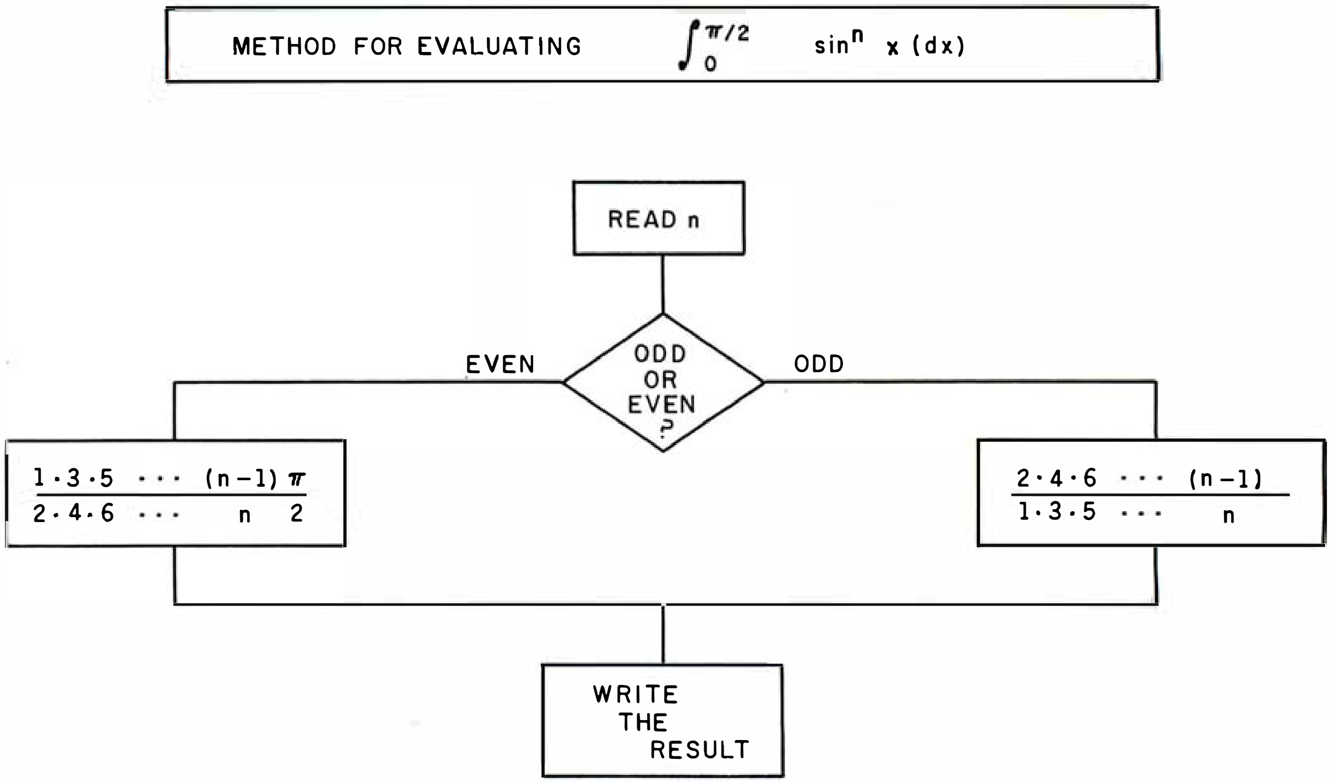


Figure 7: *This flowchart was prepared using Glyphe.*

buffer before it is displayed. Thus, the screen and the buffer are always current. This routine also acts as a filter during graphics mode, mapping each alphanumeric character to a graphics character.

One final routine that deserves mention is the Print Buffer subroutine at line 5000, called whenever Ctrl-PrtSc is hit. A formfeed character (TOF$) is sent to the printer, followed by a sequence that sets the printer at 8 lines per inch (LPI8$). The printer is set at this format because those graphics symbols that span the full width or length of the character and connect on the display will not connect on a printer set at 6 lines per inch. The parameters in Glyphe are set up to work with Epson printers; if you have a different type of printer or don't want form ejection, you can change them accordingly. Printing can be interrupted at any time by hitting a key; the routine polls INKEY$ after printing each line. The Esc key can be used to exit Glyphe without saving to disk and is protected by a prompt to avoid catastrophe.

5. *Error handler:* Printer and disk errors are possible during execution of Glyphe. When either occurs, the user is prompted to abort or retry the operation.

Enhancing Glyphe

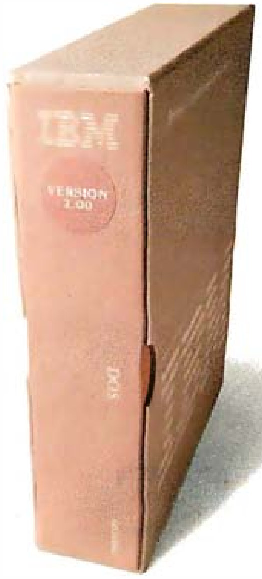
No two users of Glyphe will have the same expectations of what it should do for them (figure 7 provides one example). To adapt it to your special needs, you'll have to be creative. I did the groundwork, which I hope will encourage you to modify the program for your applications.

Here are some suggestions. You might want to set up a key to generate a string of keystrokes while editing. This capability could be added to Glyphe, or you could purchase a package that would do it (for example, Keynote, from Advanced Software Interface, 2655 Campus Dr., Suite 260, San Mateo, CA 94403. It costs $99.95). This feature would add incredible power and flexibility to Glyphe and allow dynamic definition of primitives and macro-like sequences. Another nice feature would be column-insert and -delete commands, which are a real lifesaver for work with tables. You can easily expand the buffer capacity of Glyphe by changing the LINES variable and the DIM SCN$ statement in line 70; this modification would probably be limited only by memory size. With a large buffer, a GOTO PAGE n command would be another asset.

Any number of other editing features, such as erase line, search for string, and set table tabs, could be easily added. And adding primitives and functions only requires placing new entries in the computed GOTO lists that point to the new routines, then returning to line 610 (690 if A$ must be printed). My only caveat: before you dive in, consider what changes provide the greatest capability for the least effort, and make sure your modifications support the clean, modular structure of the program so that you can easily add new features when your needs change. Have fun! ■

Charles B. Duff manages a line of educational and recreational software for Kriya Systems Inc.

An extended version of Glyphe is available from the author on a PC-DOS disk for $25. It includes a small character font editor for defining custom characters on Epson printers. Address orders and inquiries to Charles B. Duff in care of Kriya Systems Inc., 505 North Lakeshore Dr., Suite 5510, Chicago, IL 60611.



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Comparing the IBM PC and the TI PC

Although the two computers look similar, each has its own special features

by Bobbi Bullard

Photo 1: *The TI PC (top) and IBM PC (bottom) keyboards. Notice the larger number of keys on the TI PC keyboard (photo by Randy Bullard).*

A year and a half after the introduction of the IBM Personal Computer (PC), Texas Instruments entered the market with the TI Professional Computer. Obviously designed to compete with IBM's machine, the Professional Computer resembles the IBM PC in many ways and even provides some useful features that the IBM PC doesn't offer. However, because IBM's Personal Computer is firmly entrenched as the 16-bit microcomputer standard, computers that are not compatible with it, including the TI PC, will face a struggle in the marketplace.

Physical Appearance

Based on its physical characteristics, TI's computer appears to be another in a line of IBM clones. The IBM PC and the TI PC both measure about 6 inches high and a little less than 20 inches wide. Each has two disk drives inset in the front of its cabinet on the right and vents on the left. Detachable keyboards connect to the main unit via coiled cords, and both units sport separate cathode-ray tubes. Green screens and color monitors are available for both. Aside from the TI PC's color, which is slightly pinker than the IBM PC's beige, and TI's enlarged keyboard, the computers are strikingly similar.

The keyboards are their greatest physical difference. TI's keyboard is considerably larger, supporting more keys than does IBM's keyboard (see photo 1). The IBM PC uses the same keyboard IBM has used for years with various older and larger computers. The IBM keyboard, however, is far from perfect. For example, numeric-keypad keys double as cursor keys, which complicates any function that requires movement around the screen and numeric input. Placement of the return key has been criticized by users; the key is on the far side of the seldom-used squiggle key known as a tilde, instead of next to the quotation mark, where it is most easily reached. Anyone who learned to type on anything besides the IBM PC will find that the tilde is unnecessary and out of place. Moreover, because no lights indicate when the Num Lock and Caps Lock keys have been pressed, problems may arise. For example, a user can press an arrow key to move a cursor and instead produce numbers on the screen. The Caps Lock key causes similar headaches.

The people at TI, however, didn't make these errors when designing their keyboard. The typewriter section of the Professional Computer's keyboard follows the configuration of an IBM Selectric's keyboard (didn't the designers at IBM have access to this keyboard?). TI's key arrangement is also comfortable to use: cursor keys are separate from the numeric keypad, which provides numerous amenities. The numeric keypad has its own Enter key (which works the way the return key does), a tab and a space key, and keys for the numeric operands *, +, and =. The TI PC supports 12 function keys, as opposed to the IBM's 10. The extra function keys are seldom supported with software, though, because most of the programs provided were converted from software for the IBM PC. But it's nice to know they're available should you need them.

The feel of the two keyboards is also different. TI's uses a tactile-feedback system that feels light to the fingertips. It offers no resistance until the finger is halfway down, then the key lightly engages. Ergonomic research has shown that typing speed can be improved as much as 3 or 4 percent on this type of keyboard. The IBM keys, on the other hand, have a definite spring and click and produce a fair amount of noise. Users who are dedicated to the IBM computer are convinced that TI's keys are too light to the touch. But most people with access to both machines prefer the touch on the TI keyboard, and certainly no one has criticized TI's placement of keys.

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Configuration for the TI PC
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2 video-controller card (graphics board can clip on)
3
4
5

Disk controller is built in and parallel printer is attached to built-in parallel port

A Typical Slot
Configuration for the IBM PC
1 Disk-controller board
2 Monochrome adapter and parallel-printer port
3 Asynchronous/synchronous card
4
5

IBM PC with Green Screen
and Color Monitor
1 Disk-controller board
2 Monochrome adapter and parallel-printer port
3 Asynchronous/synchronous card
4 Color-graphics adapter
5

Table 1: *The IBM PC and the TI PC differ in the way their expansion slots are used.*

Hardware

TI had the advantage of seeing IBM's design and the opportunity to improve on it before going into production, and in many respects it did just that. However, in setting up the motherboard, TI failed to match IBM. IBM's newest release uses 4164 chips, providing 256K bytes of memory on the motherboard alone. TI, which has access to a wide array of chips from its own manufacturing facilities, instead incorporates 4116 chips in the Professional Computer, limiting motherboard memory to 64K bytes.

However, TI made more economical use of expansion slots than IBM did, as illustrated in table 1. IBM's slot design is not highly functional. In its aim to cater to all potential buyers, from the home user to the business professional, IBM included nothing in the basic computer configuration—everything must be added on. Although this configuration allows versatility, it also causes the expansion slots to fill up quickly. Using only IBM equipment (as opposed to third-party manufacturer's products), the slots are soon filled. One of the five slots is used for a disk-controller board, one for a green-screen/parallel-interface board, and one for the video controller. If additional memory is needed (more than the 256K bytes that can plug into the motherboard), another slot accommodates a memory board. And still another slot is for asynchronous/serial communications. However,

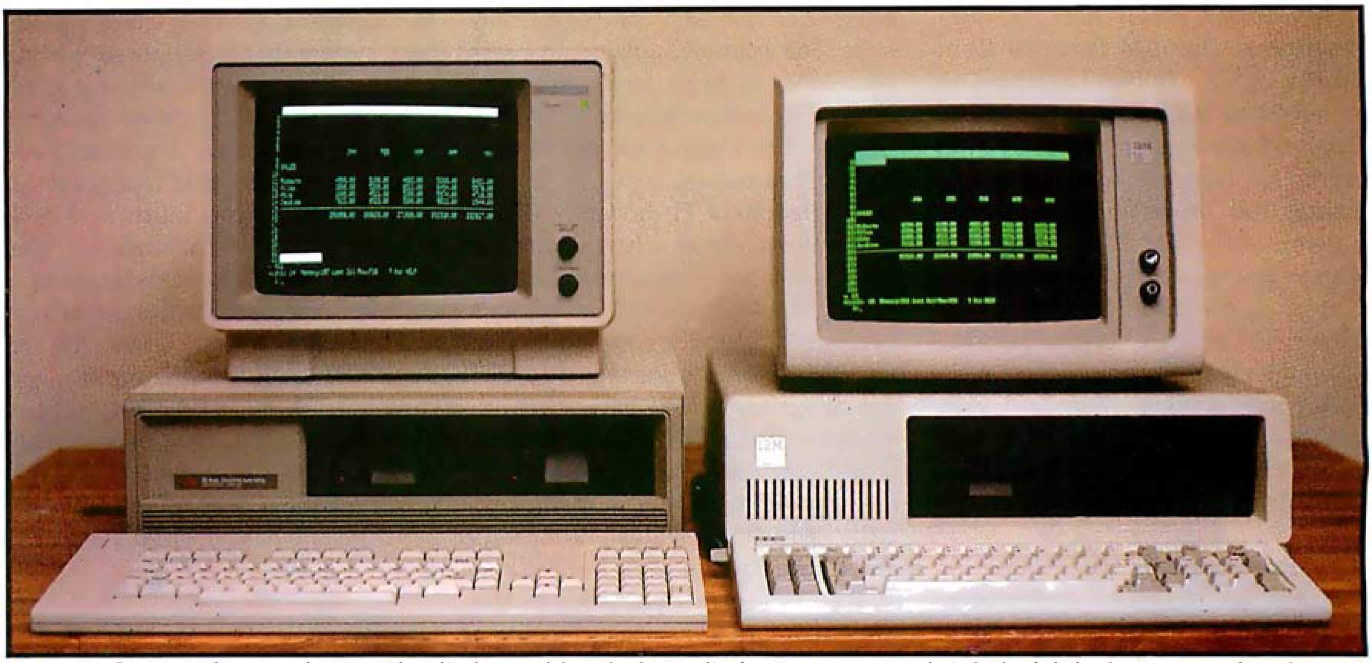

Photo 2: *Compare the TI and IBM video displays. Although the TI display is easier to read, it looks faded when compared to the IBM display. The contrast and brightness controls were adjusted on both screens to give the best picture (photo by Randy Bullard).*

third-party boards are available from other manufacturers that combine ports, memory, and other functions. In 1981, Seattle offered a memory/asynchronous board and Quadram introduced the first four-function board—with memory, a clock, a parallel port, and a serial port. These boards can help overcome the congestion problem in the IBM expansion slots.

The XT, IBM's newest offering on the PC market, is configured differently. It has an internal 10-megabyte hard-disk drive and comes with a serial port. Inside, it sports eight slots that are narrower than the slots on the IBM PC. This difference has limited manufacturers of peripherals somewhat but provides the XT with versatility the IBM PC lacks. The XT's slots, however, like the IBM PC's, are not economically arranged. One slot goes to a video board, one is for the hard-disk controller, and another handles the serial-port board. The slot for the serial-port board has different pinouts then do the other slots, so the serial board cannot be removed and replaced with a third-party manufacturer's multifunction board, thus limiting users options. If a color monitor for creating graphics and a green screen for producing text are added, two more expansion slots are filled; a video-controller board is required for each monitor.

For use of expansion slots, TI walks away with the honors. By labeling its computer a professional computer instead of a personal computer, TI made certain assumptions. For example, the company expects users to employ disk drives with its PC instead of cassette tapes. For this reason, TI included a disk drive and disk controller in the computer and thus freed an expansion slot from use. A built-in parallel port makes it unnecessary to use a slot for a parallel printer. Moreover, TI's green screen and color monitor run off the same board. And because the graphics board clips onto the video board, the two can share a slot. This makes it harder for third-party hardware manufacturers to make competitive color boards. (TI's color board is exceptional.)

Though the TI PC is advertised as providing five expansion slots, it actually has six; one of the slots has two plugs. Two small boards can be attached to it, one at each end. This configuration provides one of the boards access to a port at the back of the computer. The other board would have to be one that doesn't need an outlet—for example, a memory-expansion board.

Hard-Disk Drives

Both TI and IBM offer internal hard-disk drives. You can purchase the TI computer with one or two floppy disks and decide later to upgrade to a hard disk. But you must decide when you buy an IBM PC whether you require hard-disk storage; you cannot add hard-disk capability later. You could use another manufacturer's equipment on the IBM PC; however, you might encounter memory-address problems. Only the XT version comes with a hard disk.

The original TI hard disk stored only 5 megabytes. In an age when microcomputers are carrying a greater amount of the computer work load, 5 megabytes falls short. The IBM XT, however, has a 10-megabyte hard-disk drive and can connect to an expansion chassis to provide additional hard-disk storage. TI now has a 10-megabyte hard disk, but no DOS 2.0 is available for it, and DOS 1.1 cannot sector the hard disk or create directory volumes, making this disk's directory unwieldy.

The TI and the IBM units both come in a variety of configurations. TI, however, makes more peripherals than IBM does. The Dallas-based firm, for example, offers an internal modem with rates of 300 or 300/1200

Vector Interrupt Listing

Description	TI	IBM
Divide by zero	0	0
Single-step trap	1	1
Nonmaskable interrupt	2	2
Break (single-byte interrupt)	3	3
Overflow trap	4	4
Print screen	5	5E
Time of day	8	4E
Keyboard	9	n.l.
Keyboard mapping vector	n.l.	5B
Keyboard program pause key vector	n.l.	5C
Keyboard program break key vector	1B*	5D
*(Listed in IBM as user-supplied routine)		
Keyboard queueing vector	n.l.	5F
Disk interface	E	4D
Video	10	49
Communications	14	n.l.

Table 2: *A partial listing of interrupt vectors for the two computers. Using such a list, you could place an IBM- or TI-specific module at the beginning of your assembly-language program to set up variable names for the vectors and thus make the remaining code compatible. (n.l. stands for "not listed.")*

bits per second (bps); IBM has left the task of making peripherals to other manufacturers.

Screens

In its most obvious departure from the IBM design, TI chose not to support separate green-screen and color-screen boards. IBM offers a slow green-phosphor screen on a green monitor board; TI provides a green screen that runs off the same board as the color screen. TI's color board has higher resolution, a higher horizontal-scan rate, and less scatter than the IBM's color board and screen do. When a green screen is plugged into the IBM's color-monitor board, TI's screen is much clearer and easier to read. However, when TI's screen is placed beside an IBM green screen plugged into its own board, TI's screen looks faded (see photo 2). TI's screen appears to shimmer if it's placed within a few feet of an IBM screen, yet it doesn't shimmer around other computers and other computers don't experience this problem around the IBM PC. The cause of the shimmer is not apparent—it could be inadequate shielding on IBM's computer, inadequate shielding on TI's unit, or just poor grounding on the TI PC.

TI's bright color screen is clear and easy to read. It provides very high resolution—720 × 300 pixels (picture elements)—and its eight colors are vivid and distinct. Indeed, this screen has been compared favorably to CAD (computer-aided design) computers costing tens of thousands of dollars more than the TI PC. By comparison, the IBM PC has a resolution limit of 640 × 200 pixels and supports only four colors in this mode.

TI's color screen provides a superior scan rate. While the IBM PC's horizontal scan rate is around 15.4 kHz, TI's is 19.2 kHz. Although it provides better resolution and clarity, TI's board, though RGB (red-green-blue), does not have a standard output, and versatility is limited because large projection screens require alteration before they can be used.

TI's Voice-Recognition Interface

TI has touted its voice-recognition interface, and although this option may at first seem to be just a publicity gimmick, it does have some usable features. The interface has two characteristics. The first is that it permits the computer to recognize words. This feature attacks one intimidating aspect of computer use: dependence on the keyboard. Instead, a user speaks into a microphone that plugs into the RS-232C port. The computer recognizes about 100 words, even if they are embedded in sentences. It analyzes the voice of a user who speaks the requested words into the microphone four times and uses an average to produce a voice template.

The other advantage of the voice-recognition interface is that it permits the computer to store sound on disk, making the machine an intelligent telephone-answering device that can play different messages at different times.

Software Comparisons

It's unfortunate for software programmers and users that the TI and IBM machines are not compatible; software for the IBM PC (except for some BASIC programs) will not run on the TI PC, even though the two share the same type of microprocessor (the 8088). The reason? Their addresses and methods of numbering DOS BIOS (basic input/output system) calls are different (see table 2). The DOS BIOS calls perform the same functions on the two computers. For instance, "Print Screen" is a 5 on the IBM and 5E on the TI. This difference could be handled by assigning the DOS BIOS call numbers to a variable. Each PC would then require an initialization module that assigned correct numbers to the variable names.

Screen-handling techniques for the two computers also differ. For example, the IBM PC includes an attribute byte (display attributes include such characteristics as reverse video and blinking characters) that directly follows each character byte in the display buffer. With the TI PC, however, attributes are set via a separate latch, located at a different address in memory and not directly adjoining the character byte.

The green screen's video buffer on the IBM starts at the address B000 hexadecimal, and the color screen's video buffer begins at 8000 hexadecimal. TI's video buffer begins at DE000 hexadecimal, and the attribute latch is at DF800 hexadecimal.

Both computers set aside memory for the screen, yet the addresses for each are different. The IBM PC has an address of B000 hexadecimal or 8000 hexadecimal with 16K bytes of dynamic RAM. The last bytes are not

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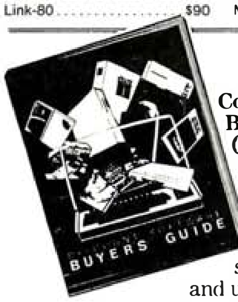

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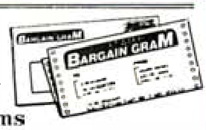

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actually used on the screen but are set aside for the screen as a hidden buffer. The TI computer, on the other hand, has the same amount of memory set aside, but as it places a character on the screen, it fills the memory buffer, and after the bottom of the screen is reached, text appears at the top, overwriting what was there. TI says this feature is meant to help scrolling, but software developers who have used these addresses as a hidden buffer say it forces them to rewrite code when transferring software from the IBM to the TI PC.

Compatibility in BASIC

Because both the TI and the IBM use MBASIC, many people expected that the two computers would be compatible. In fact, when BASIC programs written on the IBM were tried on the TI PC, many ran straight from one to the other. But, in some cases, odd things happened to the cursor; for instance, sometimes it disappeared. When cursor keys were needed, though, the TI PC's F11 and F12 keys could be used to control the horizontal motion of the cursor.

Most scan codes are the same for TI's MBASIC and IBM's version, PC BASIC, and the codes for the cursor key immediately follow the code for function keys on both computers, but because the TI PC has two extra function keys, its cursor-key scan codes begin two numbers higher.

The disappearing cursor on the TI is a result of the ineffective LOCATE command in TI's BASIC. The two computers' operating manuals say that their LOCATE commands should work the same way— "LOCATE x,y" should place a cursor at point x,y on the screen. However, on the TI PC, LOCATE used in conjunction with an INKEY statement causes the cursor to disappear. A PRINT statement immediately following LOCATE brings the cursor up at point x,y+1. And if you need a cursor on a screen full of text, TI's BASIC requires that you reprint what is already on the screen. One software developer solved this problem by printing a line under the location where the user is being directed. Producing such a character (which actually has to be printed in two pieces, with a left and a right underline) is certainly more involved than using a functioning LOCATE command.

The only other differences between TI's MBASIC and the IBM PC BASIC involve their color statements. The IBM PC has three parameters on the color statement that control foreground, background, and border colors. Each available color has an assigned number (which is documented in the BASIC manual). To control the blinking attribute, the number 16 must be added to the number for the chosen color. The color statement on the TI computer has four parameters. The fourth is an attribute code.

The IBM PC includes 48K bytes of ROM (read-only memory), which contains much of its BASIC. To provide similar capability, the TI PC employs extra code in RAM. TI's MBASIC thus needs a minimum of 128K bytes of memory to run, while the IBM 1.1 BASIC requires only 48K bytes. Once running, however, the two versions are similar. *Many IBM* BASIC programs will run on the TI with no alterations.

Programmers working in BASIC can easily convert their IBM programs for use on the TI PC using one of two methods. They can write a simple conversion program that will seek all LOCATE commands, and COLOR and INKEY statements, or they can use a text editor with a Search and Replace function.

Peachtree Software has taken advantage of the compatibility of the disk formats for the IBM PC, the TI PC, and two other computers by manufacturing one disk to run on all four computers. The programs, Peachtree 5000 and the Series 8 Accounting programs, are sold with a configurator disk that sets up a screen interpreter for each computer. Because of the video buffers in the TI and IBM PCs, the interpreter does not have to be called upon often, so the screen handling doesn't take much time. The attribute latch, or the second 8 bits of the character in the video buffer, must also be set up, and the configurator must address a few

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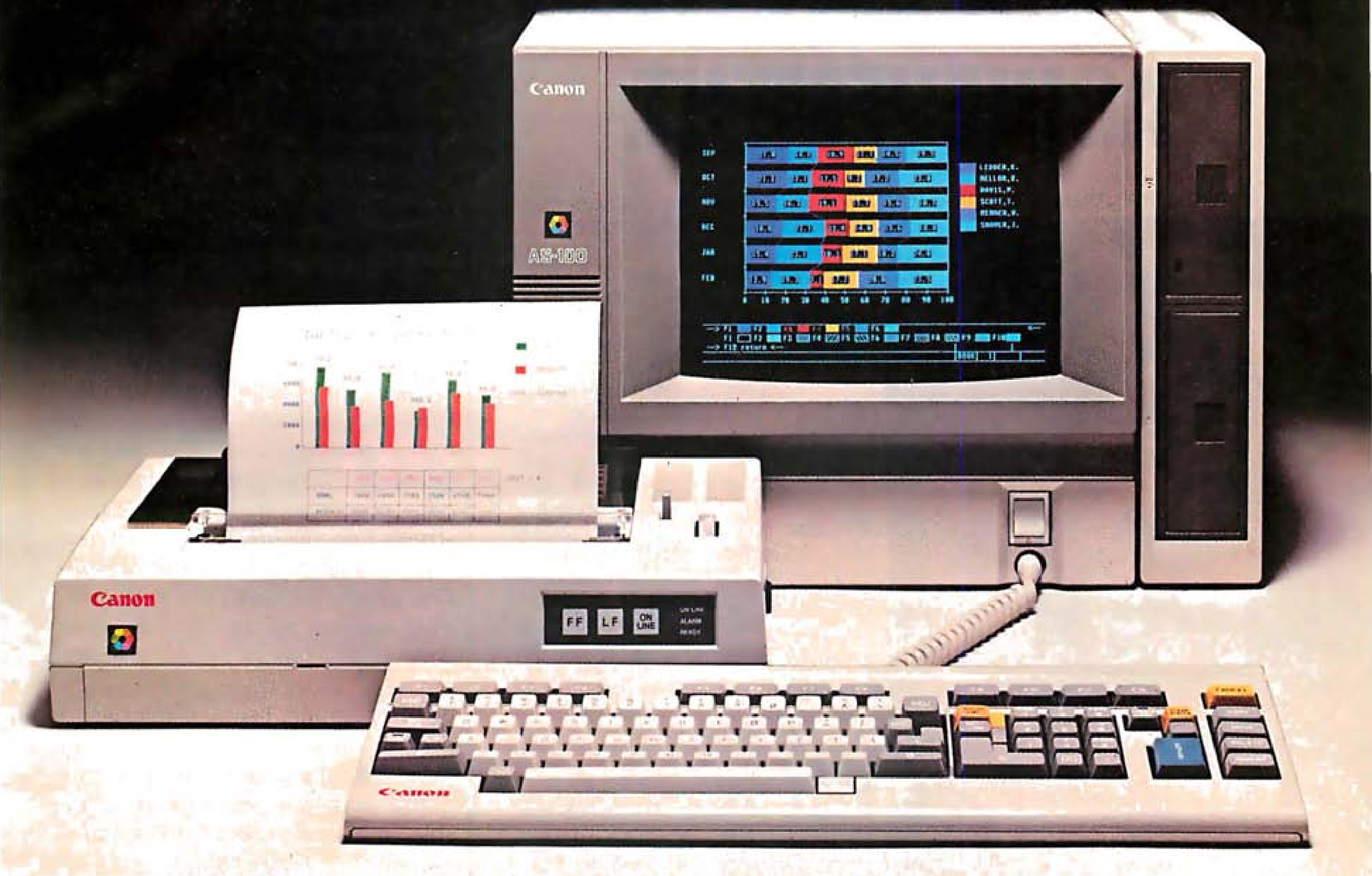

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other differences, but in general, the programs require little alteration to run on both the IBM and TI machines.

Benchmark Tests

Run-time speed is an important consideration when comparing computers, and matching the IBM PC against the TI PC produced interesting results. Tests conducted in the past used disks formatted for the IBM PC. Although the TI and the IBM can read each other's formats, their formats are different, and a program on an IBM-formatted disk runs more slowly on the TI PC than the same program on a TI-formatted disk. Consequently, these test results showed the TI to be considerably slower than the IBM. In our testing, however, we used only disks formatted for each respective machine.

To compare run times, we used a program called Cope from Antech of Roswell, Georgia. Cope is an electronic-spreadsheet program with trend analysis and goal seeking (which involves circular or reiterative references) built in. Each sheet constructs a BASIC program to solve the problems created on the spreadsheet. The program is available in a compiled version for the IBM PC, but Antech developers are waiting for Microsoft to fix the bugs in the TI's BASIC compiler before it compiles a version for the TI PC. The testing done on interpretive BASIC programs produces results in measurable numbers rather than milliseconds.

The first test used a program that read a screen full of information from disk in a disk-seek action and displayed it on the screen in a formatted fashion. The average time on the IBM PC was 21 and 30/100 seconds. The TI PC took an average of 19 and 26/100 seconds—demonstrating a 10 percent edge over the IBM machine.

The second test used a cost-justification model that reads data off a disk, performs calculations with the four major math functions, and writes results back to disk. The results showed dramatic differences, giving the TI PC a 30 percent advantage. The average time on the TI was

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MS DOS 2.0	$60	not available yet
10-megabyte hard disk for upgrade	available only with expansion chassis	$2300
Expansion chassis with 10-megabyte hard disk and eight expansion slots	$3390	not available

Table 3: *Price comparisons for the IBM PC and TI PC.*

2 minutes, 21 seconds; the average time for the IBM was 3 minutes, 26 seconds.

In formatting, however, the TI computer didn't fare as well. The TI format operation took an average of 1 minute, 10 seconds, while the IBM PC finished in only 39 seconds.

Available Software

For the prospective purchaser, software as well as speed is an important consideration. Regardless of its hardware features, a computer is only as good as the software that runs on it.

Because TI made its computer available to major software producers, the TI PC runs many of the best-selling programs. When it was introduced, the TI PC could run programs such as dBASE II, Wordstar, Supercalc, Multiplan, and Easywriter II. Some were sold under TI's name brand, some through independent publishers. TI made only a limited number of computers available for software-development, and only large-scale software companies were provided with a free computer.

Although converting IBM PC software for use on the TI PC is not difficult, it is time consuming. Most independent software authors with limited funds are waiting to see if the TI PC will take a large share of the market before purchasing or borrowing a computer to produce programs for it. Currently, more software is available for the IBM than there is for the TI PC.

Prices

TI competes with IBM by offering the Professional Computer at a lower price than IBM charges for its PC. For comparably equipped models (stocked with only their respective manufacturers' equipment), a TI PC costs almost a thousand dollars less than an IBM machine. Shortly after TI introduced its PC with a price lower than that of the IBM, IBM reduced its price. TI countered with an offer of free memory and later dropped its price again. However, TI does not as yet offer the option of buying third-party hardware, which can reduce the cost of a complete system. TI's options, such as extra memory, are as overpriced as the ones offered by IBM. Table 3 shows prices for comparably equipped models.

Summary

Deciding whether to buy the TI PC or the IBM PC boils down to use. If you know your needs and can meet them with existing software, and if you don't need a hard-disk drive immediately, you will do well to choose the TI PC. It is reasonably priced, runs commonly used software programs, and has a superior keyboard. It also runs faster than the IBM PC and can be upgraded for a hard-disk drive. By the time you need a hard-disk drive, the TI PC's 10-megabyte drive will probably have been released and DOS 2.0 will be available for hard disks.

On the other hand, you should choose the IBM PC if you currently need a hard-disk drive, if you need one of the thousands of programs available for the IBM but not for the TI PC, or if you don't know what your future needs will be and you want to leave yourself open for the newest, most innovative software and hardware.

There is no guarantee that IBM's software or hardware will be usable with TI PCs. Although the Professional Computer is a serviceable, nicely designed machine, whether TI can gain a market share, considering IBM's position in the market, remains to be seen.■

Bobbi Bullard currently writes a column for Computer Retails *and is manager of Computer HeadQuarters, 333 Peters St., Atlanta, GA 30313.*

Editor's Note:
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Meaning we've been approved by the manufacturers to sell their products. If you don't think that makes a difference, try getting some warranty work done once you've bought from an unauthorized dealer. You're stuck in a Catch-22. "Take it to your dealer," says the factory, but the "dealer" washed his hands of you the day that box was shipped. "It's got the manufacturer's warranty," he'll tell you, "so you deal with them."

It's called the Grey Market. And if you fall victim, you've only yourself to blame.

4 Let's Get Technical

Nothing's perfect, and we both know you may need service. So we've sent our technicians to school. They've been trained to do factory-authorized warranty and post-warranty repairs on C. Itoh, Epson, Okidata, Smith-Corona and Star-Micronics printers and the Franklin Ace 1000. And they've got the diplomas to prove it.

But school's not out yet. We're expanding our technical department even further, to include all the printers, modems and monitors we sell. If your purchase does have to go to the factory, we watch over it (we've dropped two product lines because the factory repairs took two months). At **THE BOTTOM LINE** we honor all the warranties, and even offer extended warranties on our own, so no matter what you buy, you're covered.

5 Professional Mail-Order

The Direct Marketing Association is a professional organization that rides herd on the business practices of mail-order marketers. **THE BOTTOM LINE** is proud to be a member. We subscribe to the DMA's guidelines for responsible advertising, billing, customer service and after-sale support. We urge you to look for the DMA symbol whenever you shop by mail, and use their Action Line (212-689-4977) should you encounter any trouble with a mail-order marketer, computer or otherwise. We think this organization deserves both business and consumer support.

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Plain talk about printers...

Dot Matrix Printers

There've been some big changes in IBM PC printer compatability. Okidata's new Plug-n-Play ROMs (see below) make a Microline 92 or 93 fully compatible with PC screen graphics. We expect that other printer manufacturers will offer similar upgrades shortly

EPSON

FX, RX & MX

The **FX-80** (160 cps) has a correspondence font, 10, 12 & 1/ cpi, italics, double-strike/width/ emphasis & dot graphics, plus a 2K buffer. Friction & pin feed is standard; the adjustable tractor is optional & cost extra. The **FX-100** the 136 column version & includ the adjustable tractor.

The **RX-80** & **RX-80 F/T** (100 cp: are upgraded versions of the MX Series.

RX-80	**$389.ε**
RX-80 F/T	**$499.88**
MX-100	**$669.88**
FX-80	**$569.88**
FX-80 Tractor	**$39.88**
FX-100	**$749.8**

C. Itoh's **Prowriter** has speed (12 cps), a buffer (1.5K), 10, 12, & 16 cp (plus a proportional font with correspondance quality) and dot graphics (160x144 dpi). One of our biggest sellers. The **Prowriter 2** has the same specs, but in a 136 column format.

Prowriter	**$3**
Prowriter 2	**$7**

STAR MICRON

Gemini 10X Delta 10/15

features 10, 12, 17 cpi, italics, a correspondance font, 120 x 144 dp graphics matrix & a 1K buffer. The **Gemini 10X** comes with friction/ tractor feed & uses plain spool ribbons. The **Gemini 15** is the 132

parallel *and* serial interfaces, 160 cps print speed. an 8K buffer, plu he standard fonts (10, 12 & 17 c dot graphics, friction/tractor feed and spool ribbons. The **Delta 15** 136 column version.

Gemini 10X	
Gemini 15	**$459.88**
Delta 10	**$529.88**
Delta 15	

OKIDATA

Microlin

The Microline 92 (80 col) & **93** (132 col) are ideal for word processing. They offer a 160 cps draf mode, a 40 cps correspondance mode, 10, 12 & 17 cpi (w/double-width), pin/friction feed (tractor is optional on the **92**) & dot-addressable graphics (120 x 144). Centronics parallel interface is standa the serial (RS-232C) interf optional.

A new PROM called **PC Plug-n Play** turns a **92** or a **93** into an I printer, with full screen dump capabilities. You will sacrafice a features (like 12 cpi) but the PR are worth it if total compatibility your goal.

The **Microline 82A** (80 col) & **83A** (132 col) are data crunchers, perio They print 120 cps, at 10 & 16 cpi (8 double-width). Dot-addr graphics are optional.

The **Microline 84** (132 col) is the Step 2 version, featuring 200 cps a 10, 12, & 17 cpi (w/double-width), a with a correspondance mode & dot addressable graphics. Pa serial (RS-232C) interfac available.

Microline 82A	**$389.88**
82A/92 Tractor	**$59.88**
Roll Paper Holder	**$49.88**
Microline 83A	**$5**
82A/83A Okigraph 1 Graphics ROM	**$**
Microline 92	**$4**
Microline 93	**$7**
92/93 IBM-PC Plug-n-Play Graphics ROM	**$49.88**
92/93 RS-232C Interface	**$99.88**
Microline 84	**$1024.88**
w/RS-232C Interface	**$11**

32

Diablo has now entered the do matrix printer market, and their ne **Series 32** (150 cps) looks very promising. It features 132 column, with 10 or 16 cpi, plus a near-letter quality font. It has all the sub/super-scripting features you'd expect, plus both dot & block graphics. We can't tell from the spec sheet, but we assume the **Series 32** is compatible.

MT-160 L MT-180 L

printer. The 10, 12, 17 & 20 cpi, plus correspondance font, makes the **MT-160 L** very versatile. It has both parallel & serial (RS-232C) interfaces, and the menu-driven installation from the control panel is easy to use. Friction and adjustable tractor feed are standard issue. Th **MT-180 L** is the 136 c version.

The **Spirit** (80 cps) is low cost draft printer. It has 10, 12 17 cpi fonts, friction & adjustable tractor feed, and a unique square-wire printhead that makes even dr printing a pleasure.

MT-160 L	
MT-180 L	

Printers,

Anadex

DP-9620	**$153**
DP-9625	**$168**
WP-6000	**$227**
IDS	
Prism 80	**$1079.88**
w/4-color	**$1439.88**
Prism 132	**$1239.88**
w/4-color	**$1669.88**
MicroPrism	**$569.88**
Inforunner	
Riteman	**$34**

Letter-Quality Printers

The new, low-speed letter-quality printers are making quality afforab And the high-speed models are coming down in price too. Still, get dot matrix printer for drafts & as

StarWriter PrintMaste

uses Diablo code, wheels & ri 10 or 12 pitch, 6, 8 & 1/48" lir space, plus 1/120" horizontal spacing—ideal for proportion modes. We've found the **Star Writer** exceptionally reliable.

The **Printmaster** has the same pecifications, but prints at 55 c

Starwriter Parallel	**$121**

with 10, 12 or 15 pitch, sub/super-script, underlining and *true* Diablo 1610 emulation making it compatible with most word processing software. It's friction fed, and it

same specs as the **EXP-550** slower and without page inje ractor.

EXP-550 (Parallel)	**$**
EXP-550 Tractor	**$**
EXP-500 (Parallel)	**$**

The new **2000** Series are slower (cps), but they've retained all t quality of the 3500/7700 Seri Uses the same thimbles & ribbons.

2010/2030	**$1049.**
2050	**$1199.88**
3530	**$1759.88**
3550	**$2009.88**

TP-1 Mes

The **Memory Correct** **senger** (the full name) is ideal for the home or small office. It combir he features of an electric typewri *and* a letter-quality printer. It eatures 12 cps, 3 pitches (10, 12 15), variable line spacing, 10.5' writing line, backspacing & auto correction. It comes complete parallel/serial i

The **TP-1** has pi) & underlini suprscript. The tr optional. (Specify you order.)

Memory Correct Messenger	
TP-1	

Other Letter Q Printers,

Comrex

CR-1	
CR-2	
Diablo	
620 (RS-232C)	
630 (PC)	
Qume	
Sprint 11+	

Monitors

USI

Pi Monitors

The **Pi-3**'s 20MHz bandwidth and sharp, clear phosphor make it our favorite. Comes in 9 or 12", & in green.
Pi-3 (12" amber) **$189.88**
Pi-4 (9" amber) **$159.88**

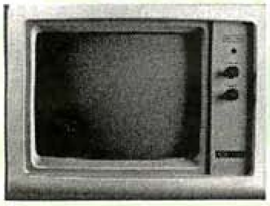
NEC

JB 1205M

A close second to the USI Pi Series. 18-20Mhz bandwidth and a crisp, clear amber display (or green).
JB1205M-A (12" amber) ... **$179.88**
JB1201M (12" green) **$179.88**

PRINCETON GRAPHICS

HX-12



The **HX-12** is one of the highest resolution RGBs available. 16 colors (using NEC's tube), 690 dots by 240 lines (480 non-interlaced) & 15MHz bandwidth. The case is identical to IBM's, & it comes with its own cable.
PGS HX-12 .... **$499.88**

QUADRAM

QuadChrome

The **QuadChrome** has the same spec's as the HX-12. Same price too.
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QUADRAM

QuadColor

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QuadColor .... **$CALL**

USR

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TECMAR

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DC HAYES

Smartmodems

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"Stack" Smartmodems
300 baud **$219.88**
300/1200 baud **$539.88**
1200B w/Softcom II **$459.88**

US ROBOTICS

Password

The **Password** is an originate/answer type modem. 0-300 & 1200 baud capability with auto dial/answer, auto mode/ speed select, full/half duplex (local echo),audio phone line monitor. Comes with an RS-232C cable (specify male or female DB-25), power supply & modular telephone cable.
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STANDARD MICROSYSTEMS

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Peripherals

AST RESEARCH

MegaPlus II

The **MegaPlus** has one RS-232C port, a parallel port, a clock & up to 256K RAM. An optional game and second serial port are also available. Comes with SuperDrive/Spooler software.

The **MegaPak** is a 128K or 256K piggy-back card that attaches to the MegaPlus & gives you additional memory to 256K.
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256K MegaPlus **$509.88**
128K MegaPak **$329.88**
256K MegaPak **$329.88**
RS-232C Port **$49.88**
Game Port **$49.88**

AST RESEARCH

SixPak Plus

The **Sixpak** holds up to 384K on the board. Added to a 256K motherboard, you've got 640K, the maximum addressable memory. **Sixpak** has an RS-232C port, parallel port, clock & SuperDrive/Spooler software. An optional game port is also available.
64K Sixpak **$289.88**
256K SixPak **$469.88**
384K SixPak **$659.88**
Game Port **$49.88**

AST I/O Plus II

The **I/O Plus II** has one parallel port, one RS-232C port, one game port & a clock. A second RS-232C port is optional.
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ConnectAll .... **$CALL**
RS-232C Port **$49.88**

QUADRAM

Quadboards

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Quadboard 64K **$279.88**
Quadboard 256K **$429.88**

QUAD 512+

Quad 512+s have a single RS-232C port on them, and sockets for up to 512K RAM. QuadSpool/Drive software is included.
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Quad 512+ (256K) **$439.88**
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TANDON

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Much more than just a voice output device, the Votrax PS System lets you mix either speech and sound effects or speech and music. A programmable master clock and 255 programmable frequencies give you unmatched control of speech and sound effects.

The Votrax PS System offers user expandable ROM for custom applications, user downloadable software capability and sound effects subroutines for easy user programming. Its programmable speech rate provides more natural rhythm, while 16 programmable amplitude levels give you greater control of word emphasis.

Actual size: 12.2" x 4.5" x 2.6"

Friendly to humans.

Designed to look like a printer to your computer, the Votrax PS System is extremely easy to use. It can be used in tandem with your printer without an additional interface card. Both serial and parallel ports come standard, allowing you to connect the Votrax PS System to virtually any computer. Speech, music and sound effects are only a PRINT statement away.

What to say after "Hello".

Businesses will appreciate spoken data transmission, narration of graphic displays and unmanned, oral product demonstrations. Spoken verification of data input will make computers much easier for the blind to use. School children can receive comprehensive computer instruction with voice textbooks as well as spoken drills and testing. And then, late at night, you can make those adventure games explode.

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- ☐ Simultaneous speech and sound effects or speech and music.
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- ☐ Serial and parallel interface standard.
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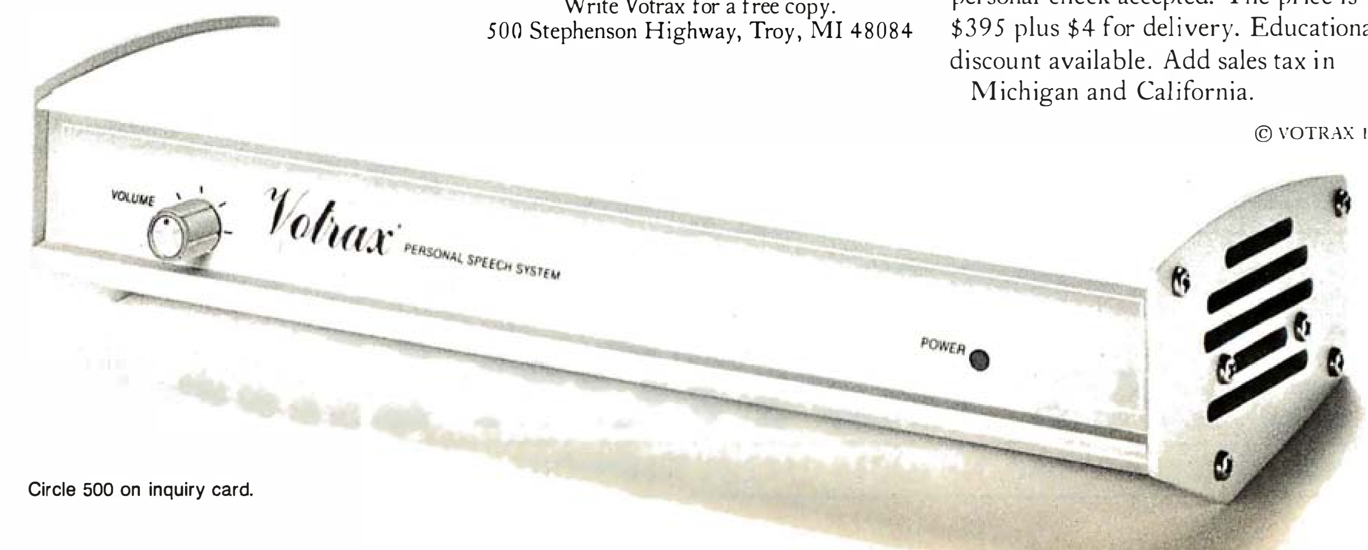

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Technical Aspects of IBM PC Compatibility

It takes more than an 8088 board to create a plug-compatible machine

by Charlie Montague, Dave Howse, Bob Mikkelsen, Don Rein, and Dick Mathews

In late 1981, IBM unveiled the IBM Personal Computer (PC), which included features that encouraged third-party software and hardware vendors to design compatible products. Unlike IBM's previous computers, the PC offers an open architecture and system software produced by Microsoft. Additionally, the company published technical specifications for the PC's hardware and software interfaces in its *Technical Reference Manual.*

Almost immediately following the introduction of the PC, it became obvious that the economic success of the machine, the promise of a large applications-software base, and the inclusion of the features noted above would combine to make the PC an industry standard. The opportunity for a PC-compatible computer was here.

To produce a compatible computer requires addressing a variety of issues that generally fall into two major categories: hardware compatibility and software compatibility. If both hardware and software products designed for the PC can run without modification on your new machine, you have a PC-compatible computer.

Hardware Aspects

Hardware compatibility divides into the areas of system architecture and physical interface. The architecture, or central processor and its I/O (input/output) and memory maps, obviously is of primary importance to the hardware/software interface.

The architecture of a compatible system must be either equivalent to, or a superset of, the IBM PC. Plug-compatible hardware achieves compatibility when the differences in implementation techniques remain transparent to installed hardware and software modules.

With the introduction of the PC, it became obvious that IBM had established a new microcomputer industry standard.

The first step is selection of a microprocessor compatible with the 8088. While Intel produces a family of microprocessors that are compatible with the 8088 at a machine-code level, important architectural differences affect compatibility at the system level. Specifically, these differences include variations in the data-bus structure, the hardware-interrupt interface, and the ability to interface to the 8087 numeric-data processor. System timing is also an important design consideration because many factors affect processor throughput, and changes to these factors often produce unpredictable effects. The processor reference-clock frequency affects the execution speed of the 8088 microprocessor. While changing the clock frequency yields predictable results with external events, a change in the data-bus width results in unpredictable changes in throughput. Obviously, the most compatible microprocessor is the 8088. (See the text box "Levels of PC Compatibility" on page 248 for a detailed description of the architectural differences and their effects on compatibility.)

Input and Output

Software modules must interface with hardware input and output registers. Because IBM released the internal register descriptions of the PC's I/O system to independent programmers, most applications software makes use of them. When you design a compatible machine, you can include any type of I/O devices provided that the command, status, and data registers appear exactly the same to the software. The processor makes decisions based on the status registers; a processor will make correct decisions if the status registers respond correctly to output commands. All register and bit addresses for both the status and command information must therefore correspond exactly with those used by the IBM PC.

Higher-level communication or data-transfer protocols depend on the hardware/software interface, thus requiring physical compatibility with the IBM PC I/O system. Any differences in the I/O devices must be transparent to both the software modules and to the user. For example, if a software module writes data to video memory, its location on the display device and its content must replicate what would appear on the PC.

Another essential area of compatibility, the floppy-disk drive and controller, becomes relatively easy to implement. Generally, the disk format must be compatible with the PC's, which requires a controller compatible with the NEC 765 or Intel 8272.

The keyboard may be the most maligned component of the IBM PC, but it is still important for compatibility. Obviously, the software and hardware interfaces to the keyboard must be compatible, but even adherence to the layout and appearance of the PC's keyboard becomes important because many applications programs refer to pictures of the IBM keyboard in their documentation. Fortunately, a number of suppliers of PC-compatible keyboards exist.

The final hardware-compatibility consideration takes into account the variety of expansion boards available for the PC. These add-on peripheral boards plug into a 62-pin expansion slot and the 8288 bus controller determines the electrical characteristics of the data transfer in response to status information from the 8088. The data transfer occurs in 8-bit bytes upon requests from the 8088 processor and the 8237 DMA (direct memory access) controller. Bus signals allow synchronization of the transfers by either the system-processor board or the expansion board. Other inputs to the bus connector allow the board to request service either by interrupt or DMA. Obviously, a compatible system must provide a PC-compatible bus interface to allow users access to the myriad of peripheral boards on the market. (See "Expanding on the IBM PC," page 168.)

Levels of PC Compatibility by Ronnie Ward

(Editor's note: Future Computing has done a large amount of research on the effect of the IBM PC on the microcomputer marketplace. One of its reports, released in the May 31, 1983, issue of the company's newsletter, *Future Views*, analyzes the field of IBM PC-compatible computers. The following information, excerpted from this issue, discusses various levels of PC compatibility as it is achieved by these machines. . . . **G.W.**)

Future Computing divides machines into four compatible categories:

1. Operationally compatible. *These computers should be able to run the top-selling software intended for the IBM PC. Their degree of software compatibility can be determined by the number of the three interface areas implemented (display, keyboard, and sound) and the correctness of the implementation. They should be able to use add-on boards designed for the IBM PC and read and write IBM PC disks (single- and double-sided). They provide the same user interface for software documentation compatibility and usefulness. The machines typically offer complementary features to the IBM PC. These features (which may include portability, monochrome display graphics, or a low price) attract buyers. Retail stores carry the products initially if the IBM PC is unavailable. These products are carried even if the IBM PC is sold in the same store. They sell well with the IBM PC because of their complementary features. They also serve as a backup to the store should something happen to hinder availability of the IBM PC. As shown in table 1, Future Computing Inc. categorizes several machines as operationally compatible.*

2. Functionally compatible. *These computers cannot run software intended for the IBM PC because of significant variations in their implementation of the three interface areas. Instead, the manufacturer or software publisher separately packages a different version of the top-selling IBM PC programs. This means that they can read/write* and *process information for IBM disks. The machines cannot use IBM add-on boards. Due to design differences in the three interface areas, they cannot move to become operationally compatible with the IBM PC. Moreover, the manufacturers of these machines do not want to become operationally compatible with the IBM PC. These products are positioned to sell against the IBM PC. The machines are priced competitively and offer functional advantages. The functions attract buyers. Retail stores carry these products instead of the IBM PC, or in addition to the IBM PC. Currently, only one machine, the Texas Instruments Professional, is considered by Future Computing Inc. to have the software base to be categorized as functionally compatible.*

3. Data compatible. *These machines do not run the top-selling software intended*

Software Compatibility

To establish software compatibility, three major areas were explored: ROM (read-only memory) compatibility, MS-DOS compatibility, and BASIC compatibility. You must start with the firmware located in ROM, sometimes referred to as the ROM BIOS (basic input/output system) or Bootstrap ROM. This software performs the system checkout and testing; the initialization of the memory, interrupt vectors, I/O, scratchpad, and flag values; the BIOS level interface via interrupt vectors for I/O manipulation; and the operating system bootstrap.

The first function, system checkout and testing, is normally not critical to any off-the-shelf software. Therefore, the degree of compatibility must assure only that the components and functional elements that are similar to the PC's are indeed present and tested. The more critical compatibility requirements occur with the initialization of the memory, interrupt vectors, I/O, scratchpad, and flags. IBM uses both a format and location criteria for the scratchpad and a flag *for the IBM PC, nor has the manufacturer separately packaged its own version of the top IBM PC software. Add-on boards designed for the IBM PC cannot be used. These machines can read or write IBM disks (sometimes), but in most cases, nothing can be done with the data transferred. They can move to become functionally compatible by releasing their own versions of the top-selling IBM programs. This would require significant effort on the manufacturer's part and close cooperation with software vendors. The most likely candidate machines to move in the next year are the NCR Decision Mate, the Wang PC, and the Zenith Z-100. Manufacturers of data-compatible machines do not necessarily want to become functionally compatible with the IBM PC. These machines are sold either in markets where they do not compete with the IBM PC, or they are positioned to coexist with the IBM PC in organizations with multiple personal computers.*

4. Incompatible. *These machines cannot exchange data disks with the IBM PC. Even if they could, they do not run the top-selling software available on the IBM PC. These machines use Intel 16-bit microprocessors, and some have implemented MS-DOS. The manufacturers of these machines have chosen not to be compatible at any level with the IBM PC. They are positioned to be sold in completely different markets and are included in Future Computing's non-IBM compatible forecast, which, by the way, is a very large market.*

Operationally Compatible	Functionally Compatible	Data Compatible	Incompatible
• uses 8088 microprocessor • runs top IBM PC labeled software • uses IBM peripheral cards • can read/write IBM disks (SSDD and DSDD) • same user interface for documentation, display, keyboard, sound	• uses 8088/8086 microprocessor • runs their own version of top IBM programs • cannot use IBM peripheral cards • can read/write IBM disks (SSDD and DSDD) • different user interface • cannot move to operationally compatible	• uses 8088/8086 microprocessor • may not run top IBM programs • cannot use IBM peripheral cards • can read and/or write IBM disks (SSDD and/or DSDD) • different user interface • can move to functionally compatible	• uses 8088/8086 microprocessor • may not run top IBM programs • cannot use IBM peripherals • cannot read/write IBM disks • can move to data compatible
Best: Columbia Data's MPC COMPAQ Better: Corona PC Dynalogic Hyperion Good: Eagle PC Seequa Chameleon	TI Professional	Datamac 1600 EAGLE 1600 Hitachi PC MAD-1 MTI P.E.C. NCR Decision Mate Olivetti M20 with 8086 card* Pronto Series 16* SORD M343* Wang PC Zenith Z-100 *According to product specifications	Altos 586 CDI Dot DEC Rainbow 100 Durango Poppy PBS Fujitsu Micro 16 Gavilan Grid Compass NABU 1600 NEC-APC ONYX 2000 SKS Personal Computer Sumicom 330 Televideo TS 1602/3 Victor 9000

Table 1: *The IBM PC-compatible categories.*

region that begins at <Seg> 0040 hexadecimal : <Offset> 0000 hexadecimal. The ROM BIOS interrupt vectors (INT 0 through INT 1FH) must be initialized to point to functions identical to the PC's.

The ROM BIOS also maintains control of the standard low-level hardware and peripheral interfacing required for I/O manipulation and parameter passing. The BIOS is essentially a collection of routines and tables accessible through the software-interrupt feature of the 8088. In designing a compatible machine, you must derive the functional definition of each BIOS entry point by studying the PC standard and performing exhaustive testing. IBM documents the input and output parameters of each function but no existing documentation specifies the resulting system behavior.

The last major function of the ROM BIOS is bootstrapping the operating system. Compatible bootstrapping requires reading sector #1 (512 bytes) on track #0 of head #0 into RAM memory at location <Seg> 0 : <Offset> 7C00 hexadecimal using ROM BIOS INT 13 hexadecimal. When this boot sector is in memory, control transfers to the boot address (0000:7C00).

MS-DOS and PC-DOS

Because PC-DOS and MS-DOS share the same origins, the quest for a compatible operating system isn't formidable. To successfully emulate PC-DOS, we at Columbia Data Products (CDP) provided a second BIOS and modified the MS-DOS source code. MS-DOS requires its own BIOS to provide a well-defined interface between the operating system and the hardware and peripherals. On the PC or a compatible, however, the PC/MS-DOS BIOS uses the ROM BIOS and its existing low-level drivers. Therefore, the machine-independent part of MS-DOS resides in RAM with the tailored MS-DOS BIOS. The resulting operating system behaves like PC-DOS. Because the same level of documentation is not made available for the PC-DOS BIOS as is for the ROM BIOS, you must resort to information from Microsoft's documentation and exhaustive testing for defining the tailored MS-DOS BIOS. The BIOS and the DOS reside in the memory area from <Seg> 0: <Offset> 600 hexadecimal to <Offset> 2E00 hexadecimal.

Even the size of MS-DOS becomes an important compatibility consideration. Most applications-software packages provide instructions for the initial program setup. Often, the setup procedure requires that you copy the operating system to the system-tracks portion of the program disk to make it bootable. If a compatible DOS is larger than PC-DOS, this procedure would overwrite data on the program disk. Therefore, the maximum disk BIOS size is 2K bytes.

In general, the Columbia Data Products implementation of MS-DOS 1.25 supports all PC-DOS function calls and performs all required actions. Furthermore, we incorporated software handshaking on Serial Communications Device #0 via <XON – XOFF>. Other extra functions include the redirection of parallel-printer data (nongraphics) to Serial Communications Device #0 and the inclusion of RAM-disk capability.

A BASIC interpreter (GW BASIC) from Microsoft, renamed BASICA for compatibility reasons, is compatible with IBM's Advanced-Disk BASIC. In IBM's implementation of BASIC, part of the interpreter resides in ROM, always available. Because of the high cost of fixing ROM bugs as well as the degree of difficulty in making GW BASIC compatible with BASICA, CDP chose to implement BASIC entirely in RAM.

Tailoring GW BASIC for compatibility involves purchasing and modifying Microsoft's sources as well as implementing a third BIOS. This task poses particularly difficult problems because most details of IBM's implementation can be determined only through testing. Most of the compatibility problems caused by having RAM-based BASICA instead of ROM-based BASICA can be overcome by simulating the IBM PC's environment. You accomplish this by loading different parts of the BASIC in different locations in RAM. A problem occurs, however, in that GW BASIC requires larger disk space than IBM's BASICA because part of IBM's BASIC already resides in ROM. When a software vendor's installation instructions include copying BASICA to the program disk, a RAM-based BASICA may not fit. Another related problem involves direct calls to the IBM BASIC ROM. Some software developers use routines and entry points located in IBM's BASIC ROM interpreter, making direct calls functional parts of software. These programs, needless to say, will not run on our (or any other) PC-compatible machine.

Testing for Compatibility

While product testing plays an important part in any product development program, it takes on new dimensions and increased importance when compatibility is involved. Besides assuring product quality and design feasibility, testing provides a yardstick for measuring the level of

compatibility with the IBM PC. The result to someone who buys our computer is that the software and hardware solutions offered for the IBM PC can be used on ours as well.

The goal for this compatibility testing is simple—test everything. When priorities must be set, the hottest-selling products are tested first. However, all commercially available products must eventually be tested.

Additions and Enhancements

If features are going to be added to a configuration, they must not affect compatibility. New features must not interfere in any way with existing or optional system components. Additional expansion slots, an external reset switch, a combination monochrome/color graphics board, a faster power-on sequence, and a ROM monitor with diagnostics and debugger cannot affect compatibility. In addition, compatibility cannot be sacrificed when software is bundled with the system. Nor can it be sacrificed when features that are optional on the IBM PC are made standard on the compatible computer.

Summary

Many important issues confront any manufacturer of a PC-compatible product. Even though IBM published the hardware and software interfaces for the PC, it is not a trivial task to build a compatible computer. Not only must all the hardware issues be addressed (IBM's *Technical Reference Manual* is neither complete nor totally accurate), but also all software issues, including DOS, DOS utilities, BASIC, and ROM-based software, must be addressed. In addition, with the introduction of the XT, IBM provides another subtly different standard to emulate. As IBM extends its PC product line, it will undoubtedly set new standards that all manufacturers of IBM-compatible products will be forced to emulate.■

This article was written by staffers at Columbia Data Products Inc. (9150 Rumsey Rd., Columbia, MD 21045): Charlie Montague, director of technical services; Dave Howse, hardware design manager; Bob Mikkelsen, program office manager; Don Rein, software engineering manager; and Dick Mathews, vice-president of planning and development.

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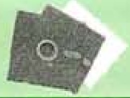

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The Making of the IBM PC

IBM sat back and watched the microcomputer market develop before jumping in and dominating the race

by Brian Camenker

Back in 1914, a banker persuaded three companies to combine and form the Computer-Tabulating-Recording Corporation. Thomas Watson Sr. was hired as the general manager; he renamed the company International Business Machines (IBM) in 1924, after starting a successful branch in Canada.

The world's number-one computer company now owns 11,000 patents and spent $3 billion on research and development last year. But IBM's 70-year success story can be explained in one word: marketing. Nobody does it better. This fascinating company is an example of institutionalized excellence. It has never had a layoff (even during the Great Depression), never failed to make a profit and grow internally, and, in its domestic operations, has never been unionized.

If you are one of the few who have been around computers from their beginnings, you may have found IBM's jump into the personal computer world something of a déjà-vu. Many people think that IBM was the first producer of commercial computers; however, a company called Remington Rand introduced the UNIVAC in 1951. IBM entered the market a full year later with a less advanced model, but within five years Big Blue's market share was 85 percent.

For one reason or another, when the minicomputer market appeared in the late 1960s and early 1970s, IBM failed to move into it, leaving the gap open for upstarts like Digital Equipment Corporation and Data General to make it big. Therefore, in the late 1970s, people were wondering if IBM would jump into microcomputers or let this open market slip by, too.

During a year of six- and seven-day work weeks, one IBM tradition after another was broken.

However, a company of 365,000 people as heavily layered in bureaucracy as IBM does not normally sprint along with the changing events. But when Apple Computer and Radio Shack proved the existence of this lucrative new market, IBM executives took notice. Time was of the essence, though, and IBM wondered, says retired chairman Frank T. Carey, "How do you make an elephant tap dance?"

Current Chairman John Opel elaborated on the problem, saying, "You have to have people free to act, or they become dependent. They don't have to be told; they have to be allowed." To remedy that, Opel has established separate entities—within IBM but emancipated from the bureaucracy—called Independent Business Units (IBUs). IBM acts as the venture capitalist, if you will, to these companies-within-the-company. *Fortune* magazine called it "How to start your own company without leaving IBM," and others have recognized it as a low-risk way to enter new markets. In the past four years 14 IBUs have been chartered. Some have prospered, but by far the most successful is the Entry Systems (Personal Computer) unit.

In July 1980, Philip D. Estridge, a division vice-president, was placed in charge of a 12-member team and given 12 months to create a competitive personal computer (see "IBM's Estridge," page 88). The team


Release

looked and listened to what was happening in the microcomputer market at that time and speculated on what future users' needs might be. During a year of six- and seven-day work weeks, the planners broke many IBM traditions—acts that are in many cases keys to the PC's present success.

The PC is built around Intel's 16-bit 8088 microprocessor. Although 8-bit computers were the fashion at the time, the design team wanted a computer that was powerful enough to "be used without too many changes for the next decade or so." Because the 8088 is cheaper to use than its older brother, the 8086, cost has been kept down.

The PC's open architecture philosophy was quite a contrast to the tight world of mainframes. IBM made all the technical specifications available to outside companies, opening a fountain of compatible software and hardware peripherals for the PC. In the microcomputer world, this serves to strengthen a company's market position. Even the operating system, PC-DOS (IBM's name for MS-DOS), is licensed from Microsoft.

But being in the IBM-peripheral business isn't as easy as it would seem. When the new version of the PC, the XT, came out in March 1983, the expansion slots were narrower.

Many of IBM's peripherals for the PC are bought outright from peripheral suppliers and simply given the IBM tag and sold through IBM's distribution channels with a hefty markup. Many customers have found that they can save hundreds of dollars by buying disk drives and memory chips directly from the manufacturer. Sometimes even computer stores stock items labeled both ways.

Independent Retailing Allowed

IBM has broken a tradition in marketing by letting independent retailers sell PCs. Again, direct selling is de rigueur in the mainframe realm, but it wouldn't really get the PC out to the general public. IBM studied Apple's successful methods of setting up networks with franchises such as Computerland and independents, emphasizing dealer support and customer education. This allows for broad-based distribution to the public. IBM also has its own product centers that handle PCs. In practice, the retailers sometimes find themselves competing with Big Blue for corporate customers. In addition, IBM's sales reps have a tendency to try to persuade customers to buy the higher-priced Displaywriter instead of PCs, once they're interested.

We can certainly speculate on where the PC may go from here. The PC-to-mainframe connection seems obvious. And earlier this year IBM bought 15 percent of Rolm Corporation, a manufacturer of telephone-switching networks. Recent investments such as this may be seen as part of IBM's long-awaited local-network scheme.■

Brian Camenker (133 Waban St., Newton, MA 02158) is a microcomputer consultant specializing in the IBM PC. He is a member of the Boston Computer Society and has done software reviews for its IBM PC magazine, PC REPORT. Recently, he and friends have formed a software company.

Concurrent CP/M

By permitting a 16-bit microcomputer to execute several processes that seem to occur simultaneously, this operating system efficiently uses computer and operator resources

by Joe Guzaitis

A growing sentiment at Digital Research can be expressed as

CCP/M : 16 :: CP/M : 8

that is, Concurrent CP/M is to 16-bit microcomputers as CP/M is to 8-bit machines. Bold stuff. But not really, when you consider that CP/M (control program for microcomputers) has come to dominate the 8-bit market.

But what exactly is concurrency, the major enhancement of this operating system? Concurrency does not allow two processes to occur at the same time in the same place, but it does permit many processes to occur sequentially in round-robin fashion in infinitesimal time slices, so that they seem to occur simultaneously in the same place. Therefore, although most systems spend a lot of time waiting for input from a person or process, Concurrent CP/M permits a computer to perform a task while waiting for input from another process.

Multitasking, multiprogramming, and concurrency allow as much of a system's resources as possible to perform useful work for as much of its operating time as possible. Concurrency increases throughput, which in turn results in increased efficiency and cost-effectiveness.

16-bit Advantages

Concurrent CP/M has the potential of stimulating the 16-bit microcomputer market the way Visicalc stimulated the early 8-bit field—by giving the world a powerful example of a microcomputer's capabilities.

Let's face it: 16-bit computers are not inherently faster or more versatile than 8-bit machines. In fact, an 8-bit computer can often run rings around a 16-bit machine. In addition, a wider variety of applications software is available for 8-bit computers than for 16-bit machines. Why spend the extra money for this new technology?

There are two good reasons. The first is memory. Getting an OUT OF MEMORY message in the middle of a program is a frustrating experience that nearly every computer user will encounter eventually. But this problem isn't insurmountable; there is usually a way to work around memory limitations.

A better reason to choose a 16-bit machine is concurrency. Its large memory requirements make its use within an 8-bit architecture impractical. Concurrent CP/M takes up as much as 90K bytes; 256K bytes are actually needed to make it useful.

How Concurrency Works

To understand how concurrency is possible, we can look at our work habits, which resemble a type of concurrent processing. For example, as I sit here at my word processor typing away, I break momentarily to jot down an appointment on my calendar, go back to typing, break away again to use my calculator, return to the keyboard, stop to look up a word in the dictionary, then go back to typing, all the while waiting for a phone call.

Breaks can be self-generated, such as those made to check a word in the dictionary, or they can be imposed from the outside. We work in an interrupt-driven manner, allowing phone calls, messages, or fellow workers' inquiries to tear us from the task at hand. Many users of Concurrent CP/M say that the operating system seems like a natural extension of the way they work because it enables them to switch among tasks without losing the thread of any of them.

Because it provides the capability for processes to seemingly execute simultaneously, Concurrent CP/M increases processing efficiency much the way online processing proved more efficient than batch processing. In batch processing, similar types of data are accumulated over a period of time and processed in one run. Online processing, on the other hand, allows a computer to appear to handle many sources of input simultaneously, then usually returns to the task's origin. Batch processing works serially; online processing allows another task to begin before the first is completed, and it appears to handle both processes at the same time.

Similarly, single-tasking operating systems must process sequentially, and multitasking systems such as Concurrent CP/M rapidly go from one process to another, appearing to perform many tasks at once. And, whereas single-tasking systems left the operator idle much of the time, waiting for a process to be completed, Concurrent CP/M has the machine waiting for the operator, ready to do more work. Concurrent processing involves one user at a time, who feeds various types of input into the processor via several virtual consoles, whereas online processing provides for many users at many consoles, all feeding into a central computer.

How Concurrency Looks to the User

The concept of virtual consoles helps some users understand concurrent processing but confuses others. The computer can be thought of as having only one actual console (the terminal) but several virtual consoles—equivalent consoles that can also interact with the central processor. The terminal can monitor one process at a time. A concurrent operating system allows a user to go from one process to another, switching to various virtual consoles to monitor different processes (see figure 1).

This procedure is analogous to the way a television user can switch from one channel to another, sequentially viewing several programs. Both the television and Concurrent CP/M permit screen switching. Use of a computer differs from that of a television, though, because a computer allows a user to interact with its programs, whereas a television does not (we will ignore those few cable-TV experiments that permit user participation).

Another way to think of concurrency is to picture a computer operator sitting among several computers, each running a different applications program. By swiveling around, the operator can interact with each application—use the output from one process to inform another, print one letter while writing another, and compile one program while editing another and debugging a third. With Concurrent CP/M, swiveling is replaced by a keystroke, which summons the program you want to monitor to the terminal screen.

Processes and Data Modes in CP/M

In Concurrent CP/M, we talk of processes more than programs. In this environment, a program is a static piece of code, and a process is what is executed. Whenever a program is loaded into memory, a process is created that involves code from the program, the operating system, and housekeeping data that indicates, for example, which virtual console to use. The operating system monitors the process, not the program.

There are two modes in which console output generated by a process can be handled: dynamic and buffered. Whatever task you have selected to be in the foreground directs its output to the console screen, and you monitor the virtual console assigned to that selected process on the terminal. You must set each virtual console to either dynamic or buffered mode so that the system knows how to handle console output in your absence.

However, a process not being monitored on the screen is considered to be in the background, and its output is not monitored. In dynamic mode, when you select a virtual console, you do not see the procedure as it happened; instead, you see the net results. For instance, if your word processor was performing a search-and-replace procedure in a lengthy file, you would return to see the strings replaced but would have missed the replacements as they occurred.

Output is handled differently in buffered mode. To return to our TV analogy, buffered mode works as though you had a videotape recorder connected to a channel you're not viewing, recording everything that was going on in your absence. When you return to that virtual console, it replays all the updates that happened on that console while you were away in the sequence and context in which they occurred.

Depending on the implementation, information on which mode you're in is usually available on the status line at the bottom of the screen. The status line also typically tells which virtual console is being displayed and the name of the process running and may also include information such as time of day, printer assigned to that console, and disk drive in use. As you switch screens, the status line changes, providing information for the next virtual console you want to monitor.

Shared Files

Another feature that Concurrent CP/M provides is a shared-file structure. By using BDOS calls programs can open files in one of three modes: locked, read only, and unlocked. Two or more concurrent processes can access the same file; that access is controlled by the file-access mode.

The locked mode is the default one. In that mode, a file can be opened only if no other process has that file open already. Once opened in locked mode, the file must be closed before any other process can open, access, or delete it. (An extended lock feature allows a process to keep the file locked after it's closed.)

If a file was opened in read-only mode, no process can write to it, but any process can read from it. But if a file was opened in unlocked mode, it can be read from or written to by any process.

For a process to access either a read-only or unlocked file, it must open the file in that mode. Record locks are also available in unlocked file mode to deny access to individual records within an otherwise unlocked file.

Advanced Features

As more software vendors realize the power of concurrency, applications programs will share common data structures that allow the packages to work interactively. Shared files give us a hint of what's possible. Other features that lend themselves to the interactive environment Concurrent CP/M affords are queue management and priority setting.

A queue, a line of items waiting for the processor's attention, is a way for one concurrent application to communicate with another. In other words, a process on one virtual console can be made to share data with a process on a different virtual console. Because queues operate entirely in RAM (random-access read/write memory), they work quickly and efficiently. Queues can be created,

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Video Quality	1	**5**	4	4	3
No. of attributes	5	**5**	5	2	5
Attribute method	2	**5**	2	4	2
Suitability for micros	2	**5**	3	5	3
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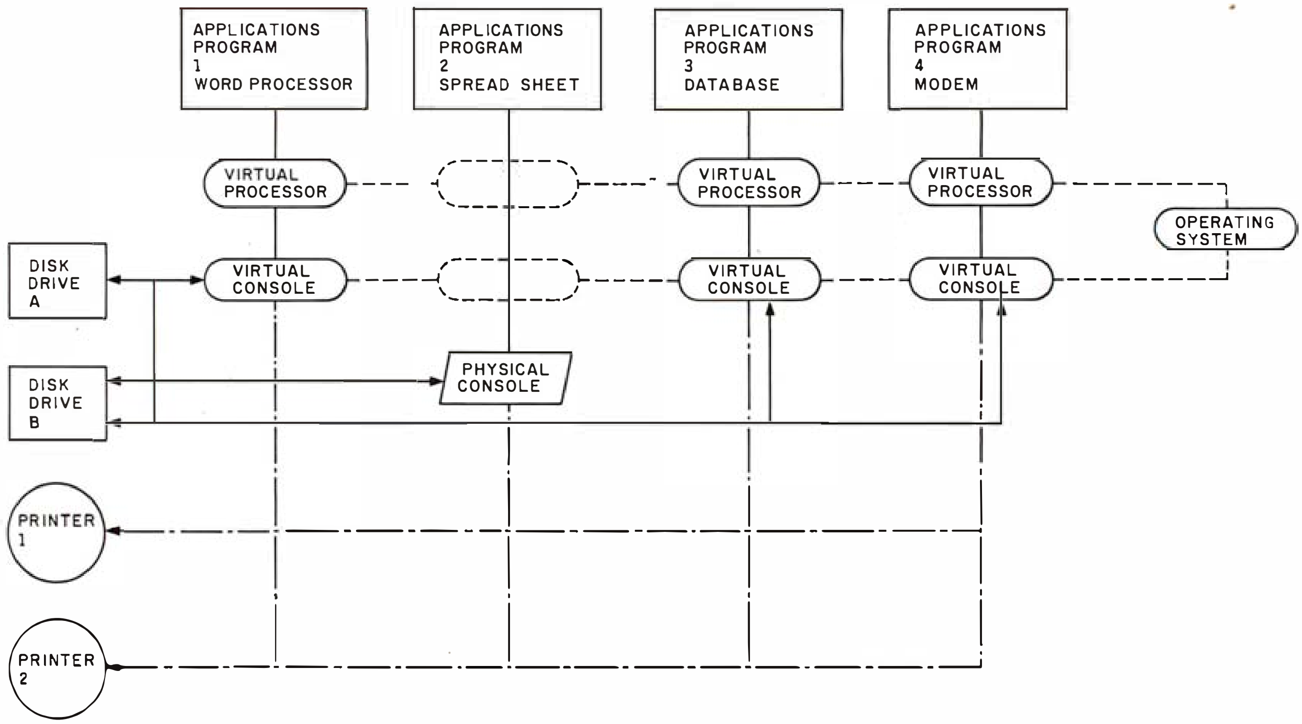

Figure 1: *This diagram illustrates a system where the terminal, or physical console, is monitoring a virtual console running an electronic-spreadsheet program.*

opened, closed, and deleted just as disk files can, and you can read or write to them on a conditional or unconditional basis. The data structures of the programs must be compatible, however, to allow for queue management.

Another advanced feature that concurrency permits is priority setting. Specifically, it allows you to set a priority level on each process so that important processes are not hindered by lesser ones. Because a system's processes all share the same central processor, they affect each other's operation. For instance, if your modem is attached to one console and is receiving data, you want to ensure that the data is not slowed down by work you're performing on another console. Moreover, because data integrity and telephone charges are involved, the task receiving the data demands top priority. Less important tasks can run more slowly.

To ensure that the more crucial task gets preferential handling, you need not use such tactics as postponing "saves" as you work in your word processor or stopping the compiler while data is being sent or received. The priority-setting capability lets you assign the reception of data priority over other processes. If the modem is using bits-per-second (bps) rates above 1200, other processes may slow down when the modem is receiving or sending data. A lower bps rate, however, should cause no problem.

Priority setting will probably be a standard feature of applications packages designed to run under Concurrent CP/M. Until those packages are available, however, it must be accomplished via a system-function call.

Another advanced capability that is also implemented through a system-function call is process detachment, which allows certain processes that need not be monitored, such as print spooling, to be detached from a virtual console and run unattended, thus freeing a virtual console for other tasks. Concurrent CP/M also provides the program logic for other features that do not actually reside in the operating system. Until they are made available in software packages, though, the only way to get them is to program them yourself. Those packages should also encourage software designers to standardize user interfaces because when users can rapidly switch back and forth among programs, the differences between software packages can affect operator efficiency.

Additional Benefits

Because printing can take a great deal of time and use little of the processor's power, many people invest in a hardware or software spooler, which allows printing to operate as a background task while another task is carried out in the foreground.

With concurrency, a spooler is unnecessary, because the operating system allows you to print a file from one virtual console while working on several others. Moreover, each virtual console can be assigned to a different printer, so you can print several files, each from a different console, on the same or different printers, while working with other programs. If two files are trying to print a file on the same printer, the first to begin printing "owns" the printer, and the other one must wait until the first is finished. During that time, all activity on the waiting console is suspended.

Communication is another task for which concurrency will prove useful. Linking many microcomputers in your organization can increase the efficiency of each operator because it makes available such features as

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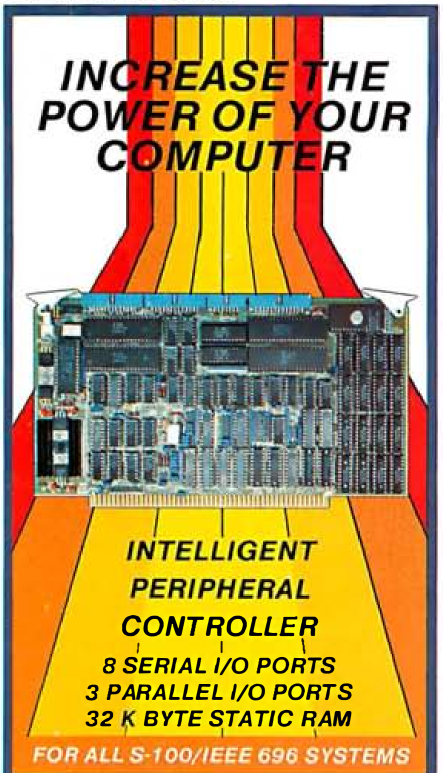

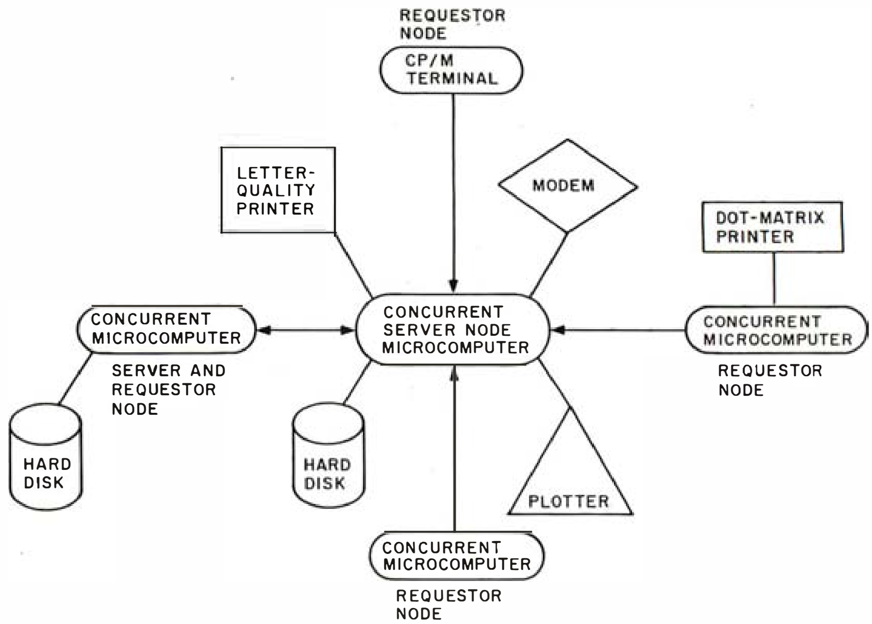

Figure 2: *CP/Net supports concurrent computers connected in a network as well as other CP/M-compatible machines.*

shared files, shared resources, and electronic mail. Figure 2 shows how CP/Net and Concurrent CP/M permit each computer to share files and other resources (such as printers and disk drives) with other computers in the network.

The next level of utility is having several virtual consoles running the same or different programs at the same time. Running the same programs can be of help to writers or reporters, for instance, who may be working on several articles or stories at the same time. As an idea strikes you for story two while you are in the middle of story one, merely hit a key and type some notes in that story file. To nonwriters, this feature may seem unnecessary, but I assure you it is an efficient way to work. Flashes of inspiration are best recorded quickly.

This feature would also be helpful to a financial analyst who might have several spreadsheets running side by side in different currencies and who might want to use the same base-line data and generate figures in pound, franc, mark, and yen denominations. By switching screens and entering common base-line data, the appropriate currency spreads can be generated instantly.

Theoretical and Realistic Limits

The number of virtual consoles that may someday be supported by a system depends ultimately on the memory available. Let's imagine we manufacture computers. Knowing that 8086/8088 systems provide as much as 1 megabyte of memory and that Concurrent CP/M can use as much as 90K bytes (supporting four virtual consoles with full-screen buffers), we have about 900K bytes to work with. By dividing that value by the number of applications programs that are to run concurrently, we can determine how much memory we can use for each application program.

Taking another approach, we could divide 900K bytes by an estimated average of how much memory each application (including files) will require to see how many virtual consoles we could expect to have in our system. This result is still only a rough estimate because the operating system must grow when the number of virtual consoles increases beyond four if additional screen buffers are added.

Sixteen-bit microprocessors other than the 8086/8088 have even more memory. Motorola's 68000 provides up to 16 megabytes of RAM, and the

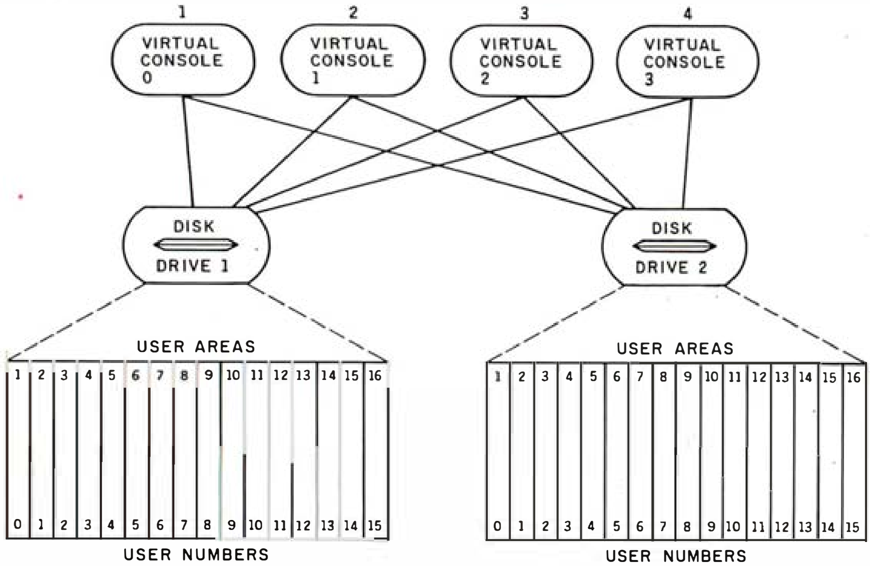

Figure 3: *Under Concurrent CP/M, each disk drive supports as many as 16 user areas, which are numbered 0 through 15. Any virtual console can log on to any disk drive to access programs or files.*

80286 from Intel furnishes much more than that. Clearly, with such abundant memory, tomorrow's machines will be able to handle many consoles, as well as highly sophisticated integrated applications packages.

Two to eight virtual consoles will probably be offered in the first wave of Concurrent CP/M implementations. Four will probably be the average number. After the first wave, manufacturers may find themselves in a race to add consoles to get the attention of increasingly adept users.

Concurrent CP/M supports up to 16 logical disk drives—separate floppy drives or several virtual drives on a hard disk or combinations of the two. Any virtual console can log on to any disk drive to access programs or files.

And as do other Digital Research operating systems, each disk drive supports as many as 16 user numbers (areas), numbered 0 through 15 (see figure 3). These areas are partitions within the file system's environment for grouping files. Files that are to be accessed by any or all user numbers on the drive are placed in user number 0 and given the system attribute. Otherwise, you must be working in the user number to access files within it.

Concurrent CP/M does have some limitations. Because disks are frequently shared by processes on different virtual consoles, you must be careful not to have an open file on a disk you're removing. In many implementations, you will be able to tell this from the status line.

Occasionally you will come across a program that requires a lot of memory. Certain spreadsheets, debuggers, and assemblers fit into this category. If they are loaded first, they could use all available memory and prevent you from loading other programs. It is wise, therefore, to load these last, so that they can use only what memory is left.

Certain applications programs create temporary files during their operation that never appear in the directory. For that reason, if you load several programs from the same drive, they should be loaded in different user numbers to prevent the process on one console from overwriting the temporary file of a process on another.

Concurrency on the IBM PC

The most popular implementation of Concurrent CP/M thus far is on the IBM Personal Computer. The PC is designed to support four virtual consoles with a minimum 256K bytes. Because the PC version of the operating system requires 90K bytes (with all four screen buffers used), you really would not want to run the system with less than 256K bytes.

A PC running Concurrent CP/M requires at least two disk drives. To load the system, the boot disk must be placed in drive A and a system disk in drive B. When the system is running, the boot disk is removed and applications programs are loaded from drive A. On the XT hard-disk version of the PC, the system can be automatically booted from hard disk when the power is turned on.

The system supports both serial and parallel printers, the number of which is determined by the number of printer cards installed, either in the main motherboard or in an expansion interface. Both color and monochrome monitors can also be used with Concurrent CP/M.

Other Machines That Can Run Concurrent CP/M

The list of OEMs (original equipment manufacturers) signed up for Concurrent CP/M is a lengthy one and is growing longer every day. It includes Digital Equipment Corp., Texas Instruments, National Cash Register, Fujitsu, Nippon Electric, Olympia, Eagle, Corona, Commodore, MADD, Vector Graphic, and Toshiba.

Computer systems using Concurrent CP/M may differ; they will probably boot differently, support different subsets of the CCP/M utility superset, or have a different status line. Most of the initial hardware implementations will support two to eight virtual consoles, and some OEMs will also provide unique hardware enhancements that will later build upon the operating system's inherent power.

Popular Application Combinations

One of the beauties of concurrency is that it becomes more useful as the operator becomes more adept. It is also immediately useful, even to the novice. A typical novice might, for example, run only one applications

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program and use another console to run system utilities. It is helpful to a beginner to be able to have the disk directory on one virtual console and the HELP utility on another, so that while he learns how to use the system, useful reference tools are always on line, only a keystroke away.

For those who make intense use of a particular applications program, it can be useful to have several versions of that program on the computer at one time. Such a setup would permit you to jump from one process to another without having to save, unload, and load another file. Managers can thus have several department's budgets on line on different virtual consoles, for instance, to permit quick comparisons of the impact of a percentage change on each.

More popular applications configurations will combine programs that will be more powerful to a user when run concurrently rather than serially. Consider the programmer who can simultaneously run a debugger, an editor, and a compiler or assembler. As the debugger turns up bugs on one virtual console, the programmer can switch to another console and begin editing the program immediately, while on a third console the compiler works on a program that had been debugged earlier that day. After each edit, the programmer can then switch back to the first console, find the next bug, switch back to the editor, and continue in that manner until all the required tasks are completed. What used to be a long tedious linear process thus becomes an interactive one, eliminating much idle time.

Similarly, consider the busy project manager, who may have a word processor on one virtual console, a spreadsheet on another, a database-management program on a third, and the fourth connected to a modem awaiting a call. When the data is phoned in, it is stored in a file that can be shared by any of the other processes. It can be entered into the database or used by the spreadsheet as input for other projections, which may then be entered into the report being written on the word processor.

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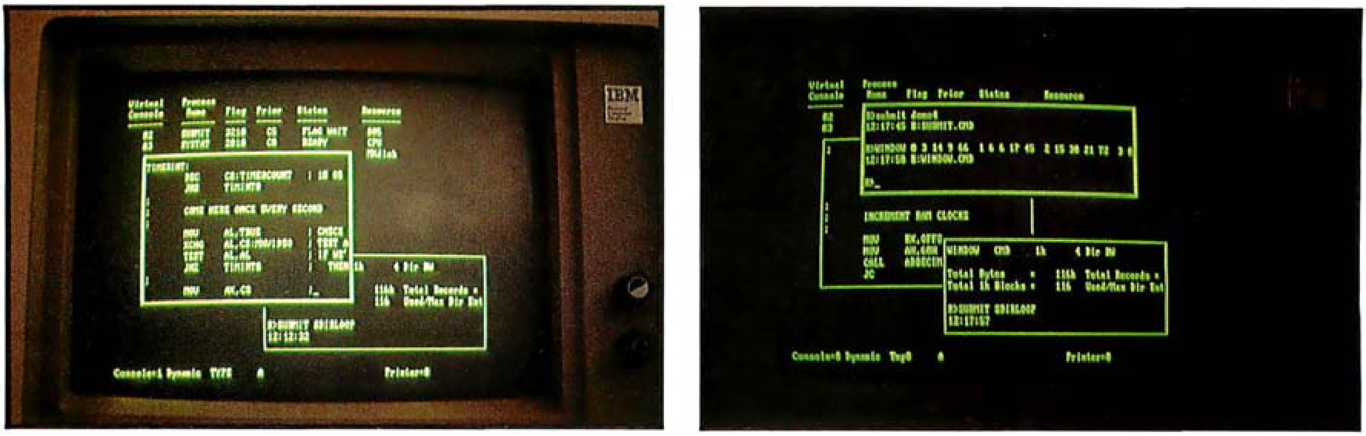

Photo 1: *Two examples of dynamic windows, which allow a user to work and monitor several other consoles at the same time.*

Moreover, the data can be made available to different processes in a fraction of the time and by fewer people than it would have taken otherwise.

Consider the secretary who is connected to a network and has a word processor on one virtual console, a critical-path schedule on another, and an appointment calendar on a third. That secretary can receive input and transmit output to a large number of sources efficiently and, more important, be more up to date each time information is sent out than was ever possible before.

The Future of Concurrency

Concurrent CP/M is having an impact on software developers. Integrated software packages represent the first step in the development cycle of a new generation of software, and other enhancements are appearing. For example, it has already become possible to interact with processes on several virtual consoles by means of dynamic windowing (see photo 1). As you work on one console you can use one or more windows, of whatever size you specify, to show you what is going on in real time in other consoles. Furthermore, you can log on to any console being monitored and send input to it. A programmer can thus see which bugs are turning up on the debugger without ever having to leave the editor and simultaneously see how the compiler is running without having to log on to its virtual console.

Similarly, a project manager can use dynamic windowing to monitor data being received by a modem through a window in his word processor without having to switch screens. Furthermore, the manager can also work on those consoles because they are dynamic (i.e., it is possible to interact with them). In other words, if he presses the function key to log on to console 3 and has customized the window so that he can see enough output, the manager can work right there without switching screens, while also monitoring several other consoles. It may take some effort to customize each window to be able to see the crucial screen output needed, but the results can be impressive. Going back to the TV analogy, it's like having a small window in the corner of your TV screen showing you what's happening on the news while you're watching MASH. When a commercial comes up during MASH, you can always switch the big screen to the news and put the MASH channel in the window to wait for that commercial to end.

The hardware implications of concurrent processing are not as easy to speculate about. Because many machines handle concurrency well, it may be some time before we see hardware designed around concurrent processing. However, features that are desirable for this environment include the hard disk, which can alleviate file-storage problems; multiple floppy drives, for those who want to eliminate shared drives; and larger monitor screens to allow additional and bigger windows.

Conclusion

Three concepts can be used to summarize the effects of concurrency: synergy, holism, and heuristics. Synergy is the total effect of separate processes working together. It describes the cooperative action that single-user Concurrent CP/M permits.

Holism is the tendency in nature to produce larger organisms from ordered groupings of smaller organisms. It is exemplified by people exploring the manifold possibilities that 16-bit computing technology represents and applying it to their needs.

Finally, heuristics, the principle of discovery as it applies to learning, will be practiced as computer users and designers discover the capabilities of concurrency. Concurrent processing will exert a powerful influence on the development of hardware and software and the user interfaces to both.

Computer users have become more aware of how human thinking differs from the way a computer "thinks" and are not as easily impressed by computers as they once were. Users now want enhancements that are extensions of the way they work; they don't want to be forced to adjust to the way a computer works. Concurrency is such an enhancement. It's an idea whose time has come.■

Joe Guzaitis is currently a senior technical writer at Digital Research Inc., 160 Central Ave., Pacific Grove, CA 93950. Prior to joining Digital Research he was an editor for CTB/McGraw-Hill in Monterey, California and before that a project director with SRA/IBM in Chicago.

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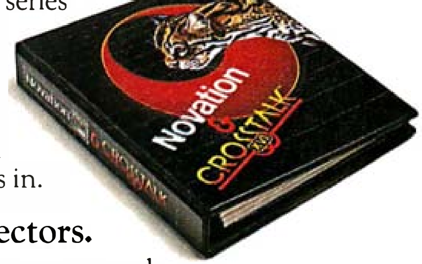

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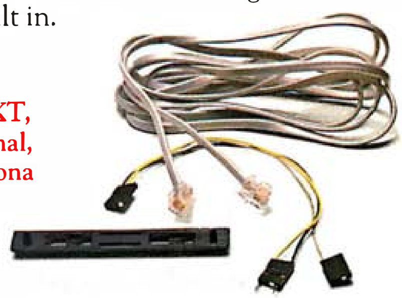

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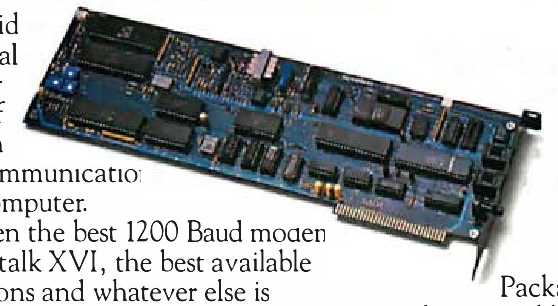

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The IBM PC Meets Ethernet

Adoption of Ethernet technology enables IBM PCs to share peripherals and information

by Larry Birenbaum

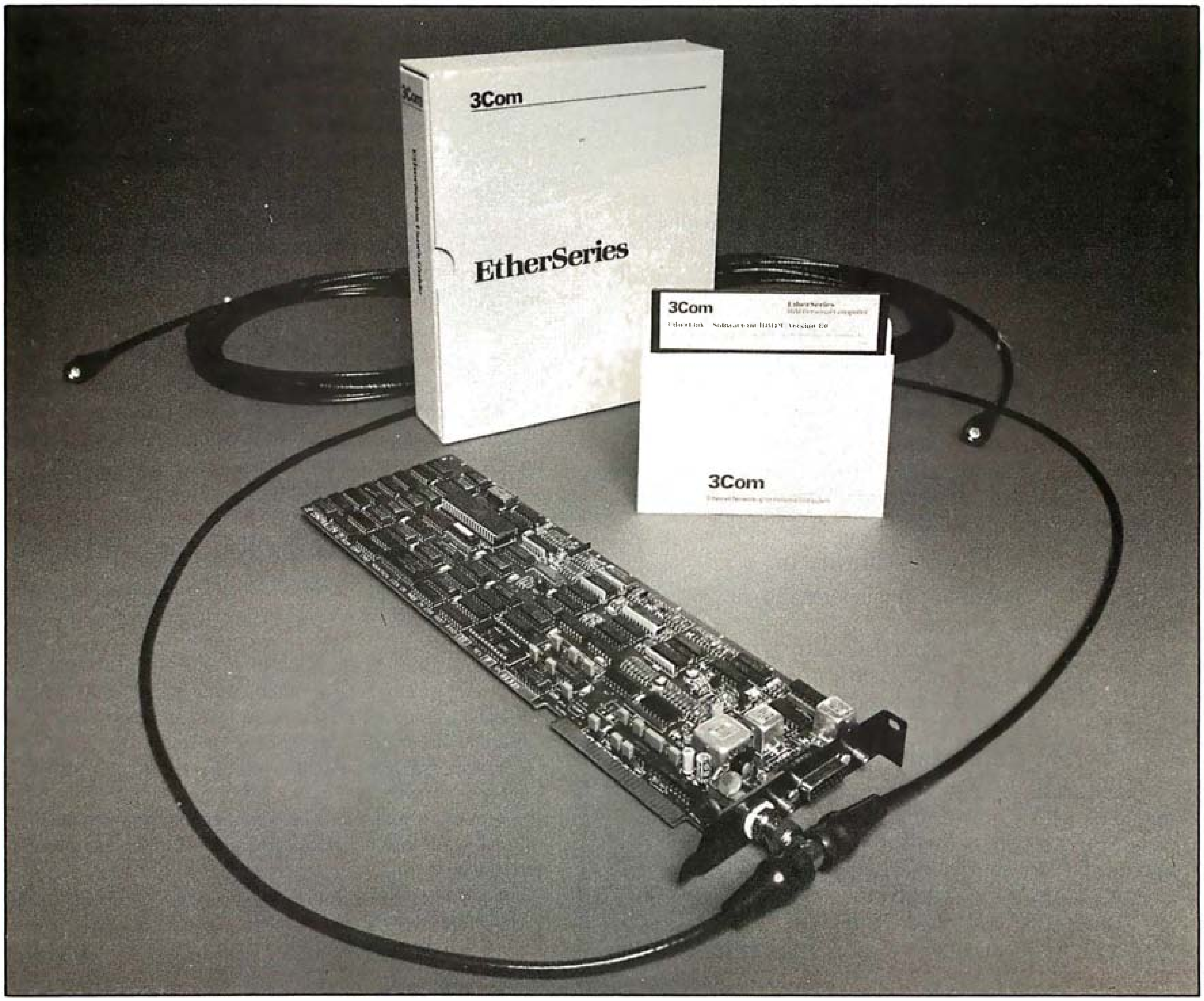

Photo 1: *3Com's Etherlink, consisting of a plug-in board and disk-based software.*

Local networking, the interconnection of computers located within a building, provides a unique computing synergy whose effectiveness is most dramatic in the case of personal computers.

The technology involved in local networking of personal computers (LNPC) combines the friendliness, accessibility, and large software base of personal computers with the extensibility and cost savings of local networking. This article reviews how one popular local network, Ethernet, was applied to the IBM Personal Computer (PC).

Local Networking of PCs

Local networking of personal computers provides three major benefits: peripheral sharing, information access, and personal communication. The most obvious benefit is perhaps peripheral sharing, which, for example, enables networked PCs to share printers and high-performance disks. Another important example of peripheral sharing is extra-network access in the form of shared mainframe gateways, such as IBM's 3270 and modems.

The principal motivation for peripheral sharing is to distribute the cost of expensive or seldom-used peripherals among the entire PC community. Less recognized, but equally important, are ergonomic improvements—sharing of centralized disks and printers that make for smaller and quieter workstations.

The second benefit, information access, enables several networked PCs to share common information. Information sharing has a significant impact on personal productivity not only because of the ease and speed of access, but also because the information is more timely and up to date. And data resident in one place, multiply accessed, isn't prone to errors of transcription and media conversion.

The most underrated benefit of LNPC is personal communication, as epitomized by electronic mail. To be cost-effective, electronic mail must be actively and widely used. Such wide use is often difficult to document in advance, therefore preventing the cost justification needed to get approval for electronic mail's implementation. Nevertheless, any experienced electronic-mail user can attest to the very real productivity improvements that electronic mail provides: it permits the managing of communication at the user's convenience, eliminates "telephone tag," and it allows the dispensing of information directly, quickly, and reliably.

Ethernet

A technology capable of implementing these three benefits—peripheral sharing, information access, and personal communication—on personal computers, Ethernet is a high-performance, bus-oriented local-networking system initially designed by Xerox Corporation in the early 1970s. It was later promulgated as a standard by Digital Equipment Corporation, Intel Corporation, and Xerox and has since been adopted by numerous other companies, including Apple, Hewlett-Packard, NCR, Data General, ICL Ltd., and Fujitsu. Equally significant is the adoption of Ethernet by local-networking standards bodies, such as the IEEE.

Ethernet is a hardware standard that defines connecting equipment.

Ethernet is a hardware standard; it solves fundamental problems of equipment interconnection. It does not, however, address *all* the higher-level (software) protocols. Nevertheless, as a standard, Ethernet does pave the way for efficient communication among a wide variety of computer equipment, from mainframes, through minicomputers, to personal computers. On the 3Com in-house network, for example, about 50 computers from DEC, Apple, IBM, Altos, and other manufacturers all communicate with one another at various levels.

As a consequence of this standardization, Ethernet hardware conforms to a standard architecture whose components are interchangeable regardless of manufacturer. The bus part of Ethernet is a coaxial cable (figure 1). Stations can be attached to this cable anywhere by way of an Ethernet transceiver and a multiwire drop cable. The drop cable, in turn, attaches to an Ethernet controller, which plugs into the computer. Seven companies have announced commitments to supply Ethernet controller ICs (integrated circuits), an important impetus to Ethernet's success.

The coaxial cable can be strung around a building according to communication needs. Each coaxial segment is limited to a length of 500 meters; the use of repeaters allows stations to be up to 2.5 kilometers apart. The number of stations is limited to 100 per segment and to 1000 per network.

How Ethernet Works

Obviously, some cunning scheme must be employed to enable several PCs to share the same piece of wire. In the case of Ethernet, it's a packet-switching access method, formally known as carrier-sense, multiple-access with collision detection (CSMA/CD). Like many technical terms, it sounds more formidable than the concept it represents.

Every station has a unique address. Data to be transmitted is first divided into "packets," each one bearing the address of the destination station. To send a packet, the sending station first listens to the cable to see if it's busy; when the cable is quiet, the sending station transmits the packet. The packet, heard by all stations, is captured by the one with the matching address.

An interesting situation arises when two stations hear a quiet cable and apply their packets simultaneously, which, not surprisingly, results in garbled data. It is important that such "collisions" are detected by the stations, whereupon they each wait a random amount of time and simply retransmit.

At 10 Mbps, Ethernet is an efficient system in practice. In one large, heavily loaded Ethernet implementation, it was found that average utilization was less than 3.6 percent during the busiest hour of the day. Also, collisions are rare events, with servers involved in one per hour on the average (two per day for user stations) on this network.

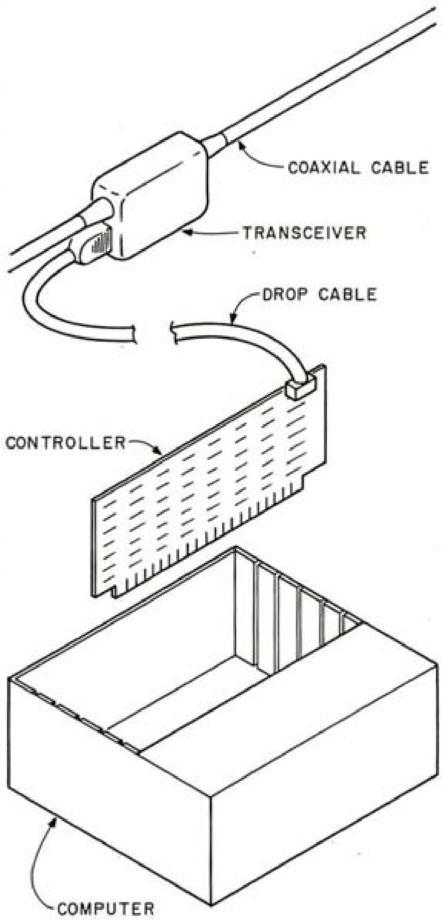

Figure 1: *A typical Ethernet connection.*

A notable feature of Ethernet is its transmission speed of 10 Mbps (megabits per second). In addition to facilitating high-performance communication applications such as disk sharing, this speed makes networks with very large numbers of stations viable.

Network Architecture Defined

In early 1982, 3Com began investigating the application of Ethernet technology to the world of personal computers. Many would have considered this mission misbegotten, claiming that Ethernet couldn't, wouldn't, and shouldn't be used with personal computers. It had a reputation for being too complex, too expensive, and even too fast for humble little microcomputers. Undaunted, 3Com proceeded to define a network architecture suitable for personal computers, called Etherseries, initially focusing on the IBM PC.

Clearly, the main peripherals to be shared by PCs were printers and disks. Printing, dubbed Etherprint in Etherseries terminology, was to be spooled to improve performance and enable concurrency. Disk sharing, called Ethershare, had to be implemented in such a way as to permit data sharing while realizing price-performance benefits. Etherprint and Ethershare are now the fundamental services; other 3Com-supported applications include functions such as electronic mail (Ethermail).

The architecture for realizing these services is based on user PCs and servers, as shown in figure 2. User PCs are the workstations of individuals; servers are computers attached to the high-performance disks, printers, and other shared resources, such as electronic-mail "post offices."

Three server types are available: PC, AP, and VAX. At the low end, the PC Network Server consists of a standard IBM PC, IBM PC XT, or IBM PC look-alike, with a 3Com Ethernet interface and appropriate software. A hard disk is required to support Ethershare service but is optional for Etherprinting. A medium-range system, the AP Network Server is a separate 3Com box containing a high-performance processor and a 30-megabyte disk, with an optional printer, disk, and tape add-ons. The high-end server is a standard DEC VAX computer running the Unix operating system, combined with a 3Com Ethernet interface and software. In this VAX-based system, the server code coexists with the customer's normal VAX/Unix operations.

All three servers provide virtually identical services and are in fact indistinguishable to user PCs. In order to achieve multivendor support, they were carefully developed to have no specific PC dependencies. Ethershare, Etherprint, and other network services are each composed of two parts operating in concert, one in the user PC and the other in the server, communicating over the "ether," in this case, coaxial cable. To maximize overall performance, the two-part partitioning shifts responsibilities from the servers to the user PCs whenever possible. Moreover, servers

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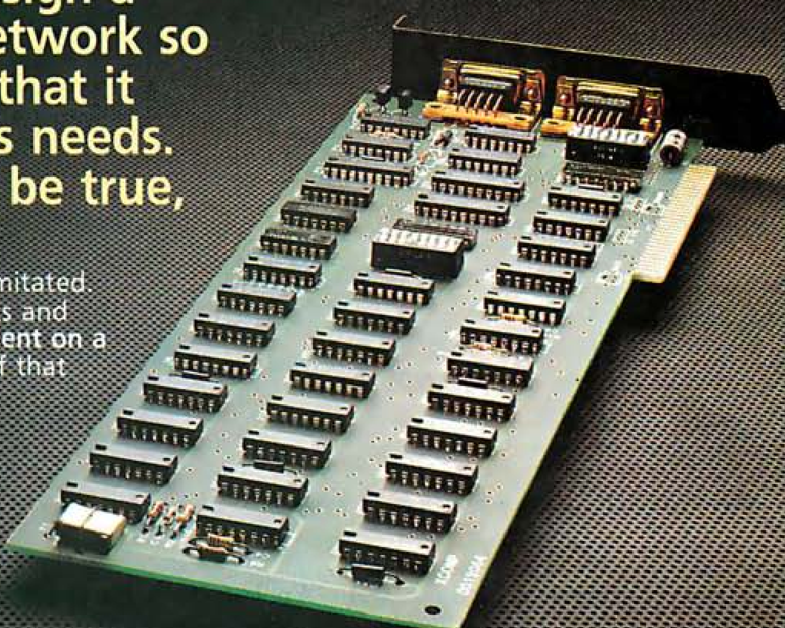

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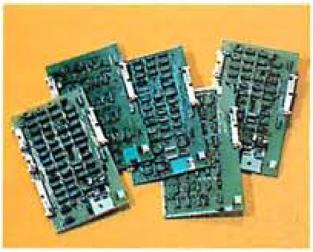

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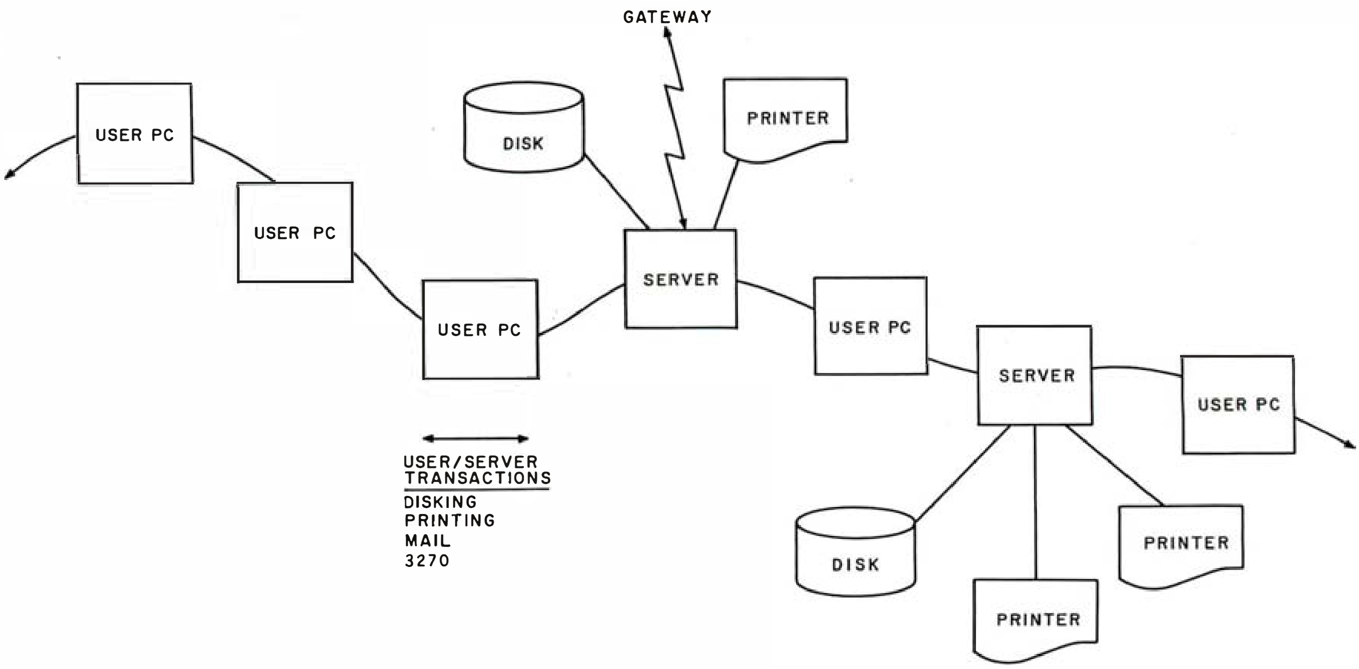

Figure 2: *The Etherseries networking environment.*

implement extensive caching and buffering.

A critical objective was to realize one of LNPC's major advantages: modular extensibility. A local network permits smooth growth in computing resources; servers can be added as existing servers become overloaded or as the cost of special peripherals, such as laser printers, becomes justifiable. (A network's degree of standardization becomes very important in these situations.)

Relative to the Etherseries architecture, extensibility requirements dictate that multiple servers operate in a fully integrated fashion, almost as if they are one. This integration is achieved by enforcing unique user names across the entire network. That a particular user is actually assigned to a particular server becomes a condition that's transparent to users. For example, a user can log in or send a mail message without regard to the specific servers involved. Another powerful example of this integration is the ability to access another user's data by simply specifying that user's name, regardless of where the data actually resides. However, a unique server name can be invoked—if, for example, a user wants to produce a hard-copy output on a particular network printer.

An Interface for the IBM PC

All this elegance would have been for naught without a viable Ethernet connection for PCs. Three technical obstacles—space, power, and cost—faced the 3Com hardware designer. Before the IBM PC interface, the smallest complete Ethernet connection measured 100 square inches, drew 30 watts, and cost about $1800 for the controller, transceiver, and drop cable. The IBM PC restricts the connection to 52 square inches and about 5 watts. 3Com knew the cost had to be kept under $1000.

The space and power solution was based on VLSI (very large-scale integration). 3Com collaborated with Seeq Technology in the development of what turned out to be the first commercialized Ethernet chip, the Ethernet Data Link Controller, which handles the entire Ethernet algorithm. This controller is the functional equivalent of about 50 standard ICs and consumes one-fifth their power.

Although VLSI promised drastic cost reductions, additional economizing was needed to meet the price goal. The breakthrough was to implement the transceiver on the same printed-circuit board as the controller, thus saving the cost of an outboard package and drop cable. A radical new transceiver design, smaller and less power-hungry, was concocted, and the result was a fully compatible Ethernet interface that plugs into one slot of the IBM PC (photo 1).

Recalling the Ethernet hardware architecture (figure 1), using an onboard transceiver means that the coaxial cable can be connected to the PC itself. Standard Ethernet coaxial cable is relatively expensive and inflexible and thus not suitable for this application. Instead, 3Com promoted the use of Thin Ethernet, which is nothing more than standard 50-ohm RG-58 coaxial cable, a TV-like cable that is less expensive, more flexible, more readily available, and easier to install than the standard cable. The only drawback of Thin Ethernet is that the cable has greater electrical attenuation, reducing the single-coaxial-segment limit from 500 meters to 300 meters.

Emulating a Real Disk Driver

With the feasibility of a low-cost compatible personal computer Ethernet interface proven, the challenge fell to the software designers to provide an effective software complement. Not surprisingly, the software took about four times the effort that the hardware did. (Etherseries is comprised of about 85,000 lines of

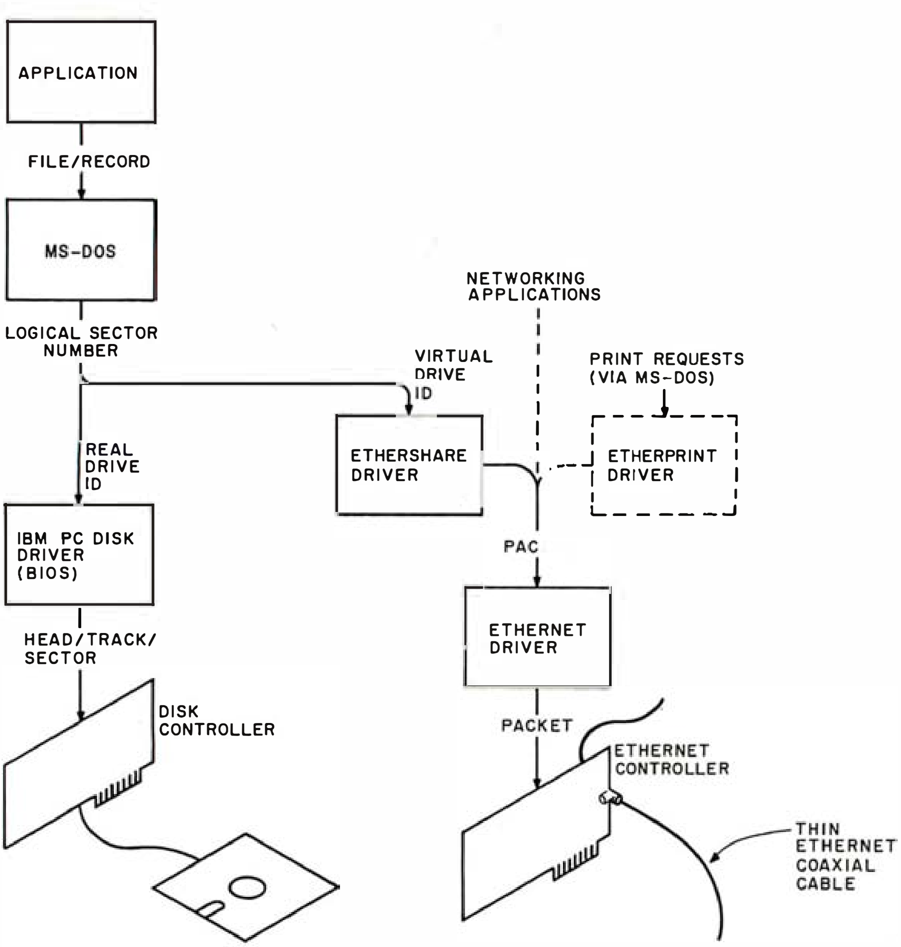

Figure 3: *Anatomy of a disk request.*

code.)

The primary objective was clear: to introduce Ethernet software into the IBM PC in such a fashion that networking would be implicitly affected without any applications program being aware of it. This transparency was the foundation on which 3Com intended to support every existing MS-DOS program. That philosophy is shared by several other networking vendors, but its attainment can be measured only by degree.

3Com had several secondary objectives relating to transparency. One was to make the networking facilities available not only to application programs, but also to all MS-DOS commands and to MS-DOS itself. For example, standard commands such as DIR, COPY, PRINT (the print-spooling command), and even CHKDSK, plus built-in operations such as Shift-PrtSc and Control-PrtSc, were to operate without change as they would normally. For reliability and support reasons, another important objective was to avoid operating-system modifications, thus promising easier upgrades to new versions of MS-DOS.

The addition of a special network driver to MS-DOS was the natural approach, but this had to be considered in light of the transparency objective. While the integration of custom device drivers is a fully supported facility in MS-DOS, how would standard programs avail themselves of the network services without explicitly invoking the network driver?

The answer was to have Ethernet software emulate a real disk driver. (For the purposes of this discussion, we will focus on the shared-disk facility; the spooled-printing development followed similar trade-offs and implementation.) The idea was to have any program, command, or function that normally uses a disk automatically wind up using the analogous network service, Ethershare.

The user's selection of a real disk or a network disk is accomplished simply by the MS-DOS drive ID specifier. The network driver appropriates its own specifiers; for instance, D: through G:, distinct from the real-disk specifiers, say A:, B:, and C:. The network specifiers are called virtual drives, and referencing them causes disk requests to access virtual disks, or volumes, that actually reside on a server. In all other respects, the virtual disks appear identical to real disks—those within a user PC.

Let's examine an MS-DOS disk request (figure 3). The application makes an initial call in the form of file/record to the operating system. MS-DOS references privileged disk and file tables to locate the record on the disk, treating the disk as a linear space. It converts the request to a logical sector number. Normally this number would be passed on to the disk driver, which then would convert the request to head/track/sector information and would access the disk controller directly. But in the case of a virtual-disk request, MS-DOS, directed by drive ID, passes the request on to the Ethershare "disk" driver. This driver passes a logical sector number on to the server, which accesses the appropriate volume.

The communication protocol employed is the nonproprietary Xerox Network Systems (XNS) protocol. For this service, the Packet Exchange Protocol option was used to send a disk read or write request to the server and receive the data (read) or acknowledgment (write). In the rare cases when nothing is returned, the request is simply retransmitted.

Managing Network Data

A problem related to disk requests centers on how servers' virtual volumes get assigned to users' virtual drives. This assignment is achieved through the use of supplementary commands supplied with the Etherseries software.

Every user is assigned to a specific server. There, each user owns a set

of named volumes, each of which can be dynamically associated with any virtual drive. The first step in accessing this data is to use LOGIN. This step serves three purposes: it automatically locates the particular server to which a user is assigned; it establishes the user's private volume domain; and it identifies the user for other purposes, such as Etherprint printout banners and Ethermail delivery. User IDs can be protected by a password for LOGIN.

The next step is to join a volume, by name, to a local virtual drive using the LINK command. (This step is analogous to inserting a disk.) Once connected by a LINK command, the drive is accessed normally. This framework provides a convenient mechanism for data sharing, which is achieved by using LINK to associate other users' volumes to your drives as governed by a concurrency and security system. There are three

Supplementary commands assign servers' virtual volumes to users' virtual drives.

types of volumes: *Private* volumes provide read/write access to one user at a time; *public* volumes provide single-writer, multiple readers access; and *shared* volumes provide read-write access to any number of users. Appropriate defaults coupled with volume passwords determine who can access what. Any volume on the network can be so linked, regardless of what server it's on.

To realize the full potential of data sharing in LNPCs, a small but vital additional capability is required: concurrent file update. While networking systems can control concurrency at the volume (or even the file) level, no workable system has been developed to automatically (i.e., without program change) interlock record requests because systems software cannot accurately foresee when a program has finished with a record. To address this problem, Etherseries and other systems provide semaphores or abstract flags that enable programmers to synchronize their own accesses from multiple PCs. Semaphores are managed by a common server and can be tested, locked, and unlocked.

An Assessment

How well has the Etherseries networking approach satisfied its objectives? Use of the Ethernet hardware standard and the public XNS protocols have addressed the compatibility objective, although complete communications compatibility awaits standardization of the uppermost protocol layers, such as those governing electronic mail. The Thin Ethernet concept has garnered interest from standards bodies (such as the IEEE), who are now investigating its implementation as a standardized communications network. Hardware cost objectives were met by incorporating VLSI and an on-board transceiver, overcoming the claims of critics that Ethernet would remain too costly for microcomputer applications.

The principal Etherseries software objective was ease of use, a feature addressed by, for example, patterning the basic command style after that of MS-DOS and supporting the intrinsic MS-DOS functions (such as the COPY and PRINT commands).

Finally, success in meeting the objective of transparent peripheral sharing is evidenced by the fact that an overwhelming majority of MS-DOS applications programs run on an Etherseries system without modification. Those that do not run on Etherseries provide their own disk drivers, require insertion of specific floppy disks during operation, or are not relocatable.■

Author's note:

Thanks are due to the people who brought this technology to life: Mike Bonnain, Ron Crane, Pitts Jarvis, Jeff Mason, Ken Powell, Greg Shaw, and Lynn Welge.

Larry Birenbaum is vice-president of engineering at 3Com Corp. (1390 Shorebird Way, Mountain View, CA 94043).

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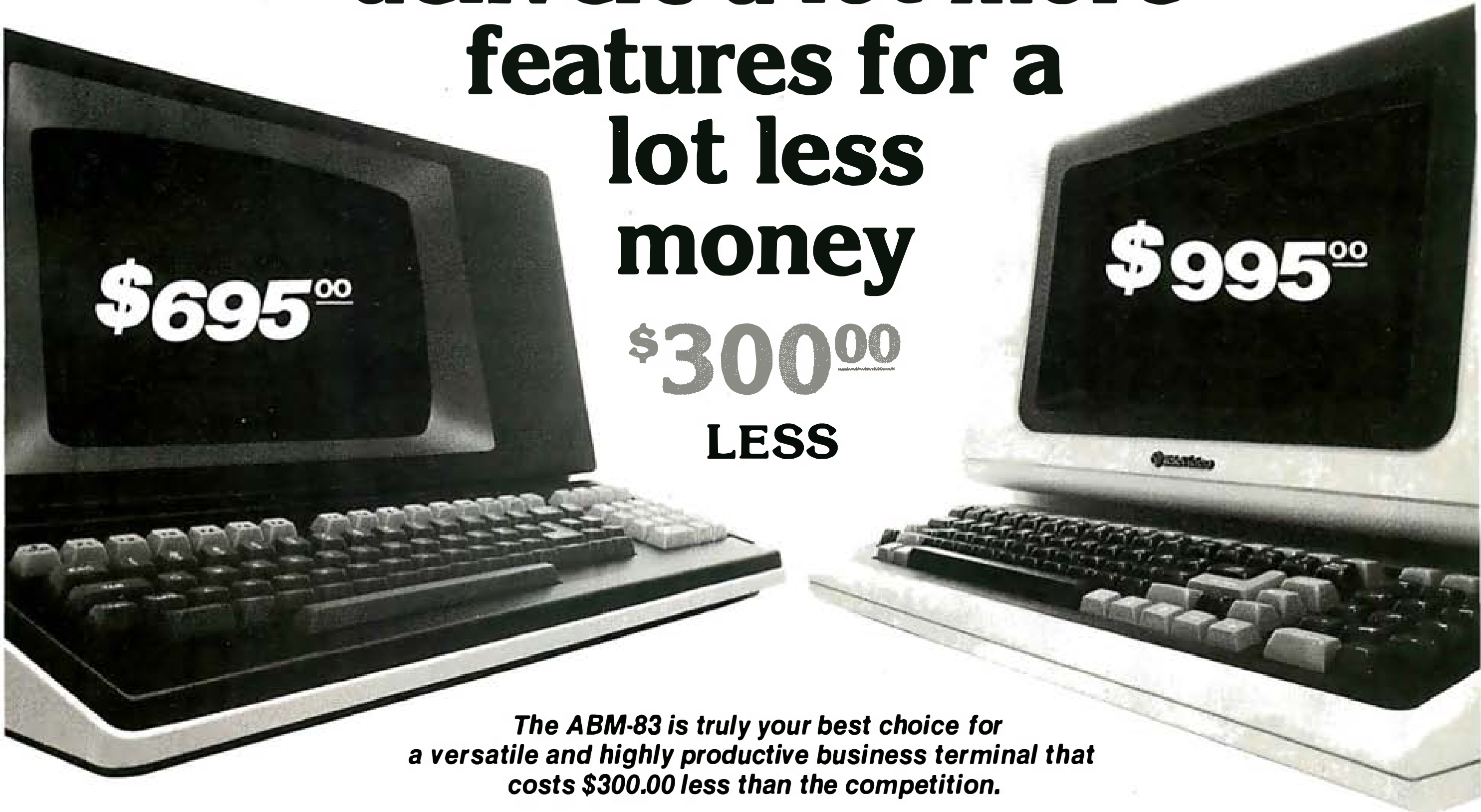

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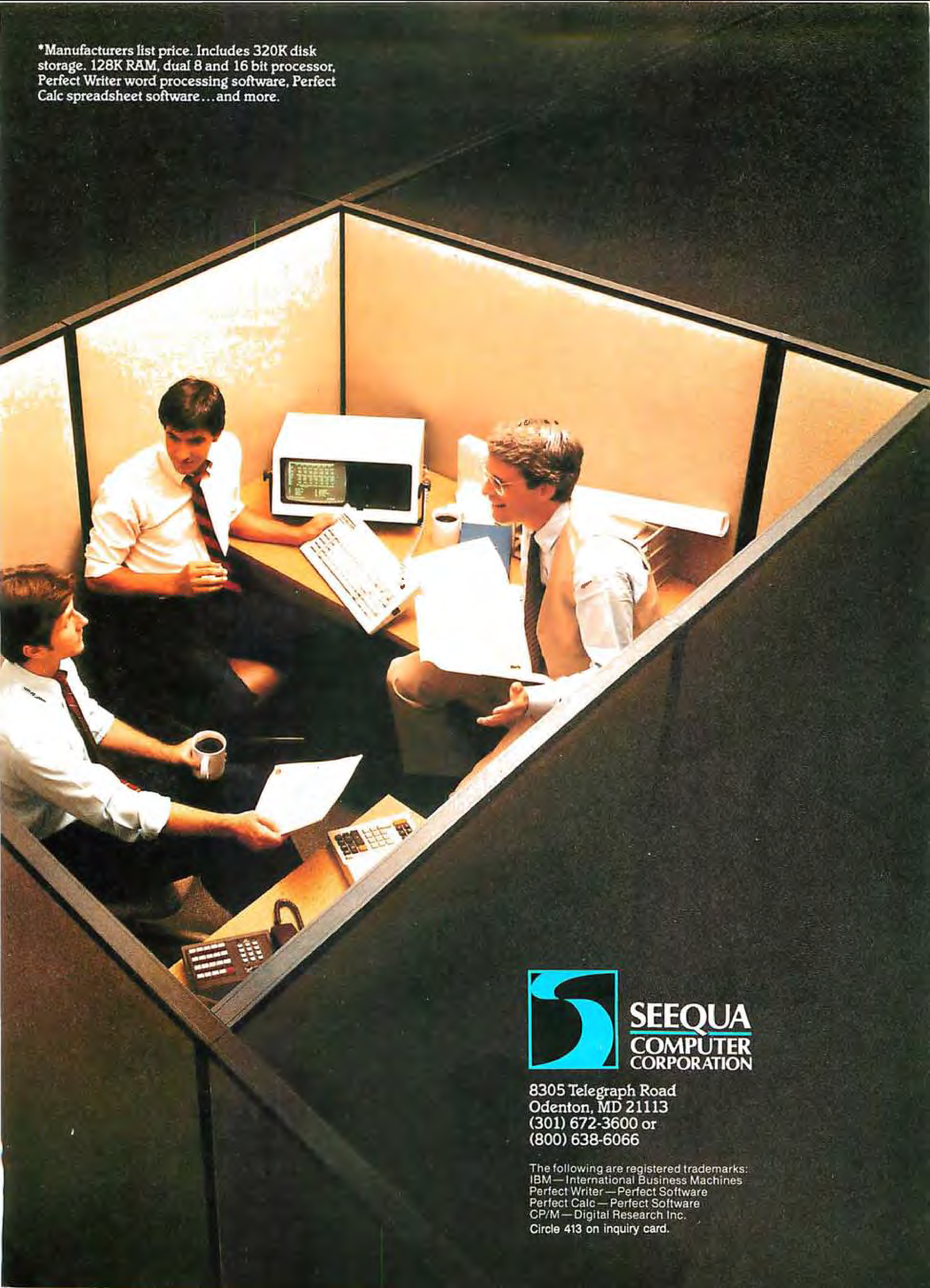
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MS-DOS 2.0: An Enhanced 16-Bit Operating System

Features such as installable device drivers and Xenix compatibility have improved this popular operating system

by Chris Larson

MS-DOS 2.0 is the most recent version of Microsoft's popular 16-bit, single-user operating system. In this article we'll take a look at its most significant new features and how they benefit users.

PC-DOS 2.0 (IBM's version of MS-DOS 2.0) is the operating system used on the IBM Personal Computer (PC), a machine that represents what Microsoft refers to as the third generation of microcomputers. The first generation encompassed such 8-bit machines as the MITS Altair 8800 and other S-100 computers, which were marketed mostly to hobbyists. Stand-alone 8-bit computers, such as those from Apple, Radio Shack, and Commodore, with Microsoft BASIC built into ROM (read-only memory), made up the second generation. With those machines, software productivity tools, such as Visicalc pff, started to appear.

Third-generation microcomputers provide additional power with an Intel 8086 (or its sibling, the 8088), a 16-bit microprocessor that enables you to do more than you could at the 8-bit level, where you were constrained by the lack of space and speed. Typically, 16-bit systems have 128K bytes of memory, even though their minimum configurations may have much less memory. A variety of high-level languages can be run on these machines, and end-user tools are becoming easier to use as the larger addressing space of the 16-bit microprocessor permits the implementation of more sophisticated user interfaces.

The new MS-DOS 2.0 represents a significant advance in personal computer operating systems.

The new MS-DOS 2.0 represents a significant advance in personal computer operating systems—especially compared with 8-bit operating systems.

Installable Device Drivers

A significant new feature of MS-DOS 2.0 is installable device drivers, the software routines used to control such hardware as the keyboard and monitor, which are attached to the machine. Device drivers work differently with systems from different manufacturers.

Specifically, this feature allows the end user, at initialization time, to load any device driver into memory—for block as well as serial devices. A block device transfers more than one byte of data (i.e., a fixed-length block) at a time; a disk, for example, is a block device. A serial device passes bytes one at a time in a stream, which is of variable length. Printers, keyboards, and display screens are serial devices.

In the past, it was the responsibility of the computer-hardware vendor to provide the BIOS (basic input/output system) to permit the operating system to run that company's particular hardware configuration. Independent hardware manufacturers who wanted to sell their equipment for use on another company's computer thus ran into problems. For example, firms marketing hard disks for use on the IBM PC cannot legally distribute IBM's BIOS to their end users because IBM owns its BIOS. Consequently, those manufacturers have two courses of action available to them. They can completely rewrite the BIOS code for the PC, incorporating the hard-disk code, then market that package. Or they can write a rather complicated utility that will read the end user's legitimate copy of the BIOS, alter it, adding in the code required to run the independent firm's device, and finally come up with a working BIOS for the PC. Not surprisingly, this approach hasn't worked out too well. Both of these techniques result in a nonstandard software environment. Each time a revision of the BIOS comes out, independent manufacturers must go through the difficult process of rewriting their code.

MS-DOS 2.0 makes life easier for these independent manufacturers by implementing installable device drivers. Indeed, it also simplifies the work of the computer manufacturer by making it necessary to supply a hard-disk device driver only to those users who actually purchase hard disks. Device drivers thus benefit the manufacturer of the machine as well as third-party vendors.

Previously, some operating systems had a configurable BIOS—the manufacturer included code for every conceivable device and let the end user choose from the list, matching the code with his particular equipment. That approach works well if the manufacturer is supplying all the peripherals; however, users often want to buy peripherals from other manufacturers, so it's important to give the independent manufacturer the capability of installing its hardware in the MS-DOS environment.

The capability of installing device drivers also enables MS-DOS 2.0 to support foreign keyboards. A user can reconfigure his machine by installing, for instance, a French keyboard driver. And although the user will continue to type on an English keyboard, it will behave as though it were designed for use in French applications. The installable-device-driver capability provides the gateway to a sophisticated networking system. Networking drivers can be installed in the same way.

Moreover, MS-DOS 2.0 eases installation and removal of serial-stream processing. Cursor positioning and graphics, for example, can be added to or removed from the console driver. Thus, if a user wants to switch from DEC VT-52-type to ANSI (American National Standards Institute) cursor positioning, he merely installs the appropriate device driver. Then if he wants to add a Virtual Device Interface (VDI) graphic serial-stream interpreter later, he can do that as well.

Microsoft is committed to promoting several serial-stream-processing standards and is trying to make it easy for manufacturers to adopt those standards. The firm has chosen the ANSI terminal-driver standard for cursor positioning, for example, which is used on such systems as the DEC VT-100 series and enjoys wide acceptance. It also is the most versatile of the available standards.

Installable device drivers control the peripherals users attach to their machines.

The VDI graphics system provides the programmer with a standard set of primitive vector operations that work the same way on many different graphics output devices. [**Editor's Note:** *For more information on the Virtual Device Interface, see "Realizing Graphics Standards for Microcomputers" by Fred E. Langhorst and Thomas B. Clarkson III, February 1983 BYTE, page 256.*]

In addition to VDI, Microsoft will provide system-level support for a set of raster primitives to allow programmers to make use of BASIC's graphics capabilities from other languages. This set of primitives will also allow programs in BASIC to redirect output to graphics devices other than the video-display screen.

For each of these standards, Microsoft will provide skeletal drivers, the code to interpret specific serial-stream sequences. Manufacturers will have to implement the skeletal drivers in their specific hardware environment.

Xenix Compatibility

The second most important feature of MS-DOS 2.0 is Xenix compatibility, which is divided into several areas. First are the file primitives, which provide a very efficient way of invoking the operating system to perform a file-management function. The parsing of filenames, for instance, is handled in a more sophisticated way, and the operating system takes care of all the file characteristics, so you are not left with file-control blocks (FCBs) floating around in your memory space. MS-DOS 2.0 also provides a more powerful and efficient way to develop software.

The latest release of MS-DOS also includes Xenix executive-mode system calls, which allow it to deal with a hierarchy of tasks set up in the operating system. With previous versions, only one program could run at a time, and when it ended, computer control was returned to the operating system and the user would see the operating-system prompt on the screen. MS-DOS 2.0, however, provides the capability for one process to invoke another, then either to invoke yet another one or return to the parent process when it is finished.

Suppose, for example, you are within the operating-system shell and then execute an application program such as Multiplan. You can reinvoke the shell at the next level deeper, then go back into Multiplan, and, when you are done, return to the original copy in the shell. This powerful feature thus enables you to be in a context-switching environment.

MS-DOS 2.0 also makes it possible to create programs that can run in either a Xenix or an MS-DOS environment. By avoiding earlier types of system calls and restricting program design to version 2.0's file-system primitives and executive-mode system calls, a software developer can write a piece of source code that can run and be compiled down into either environment with no modifications. Microsoft provides a set of

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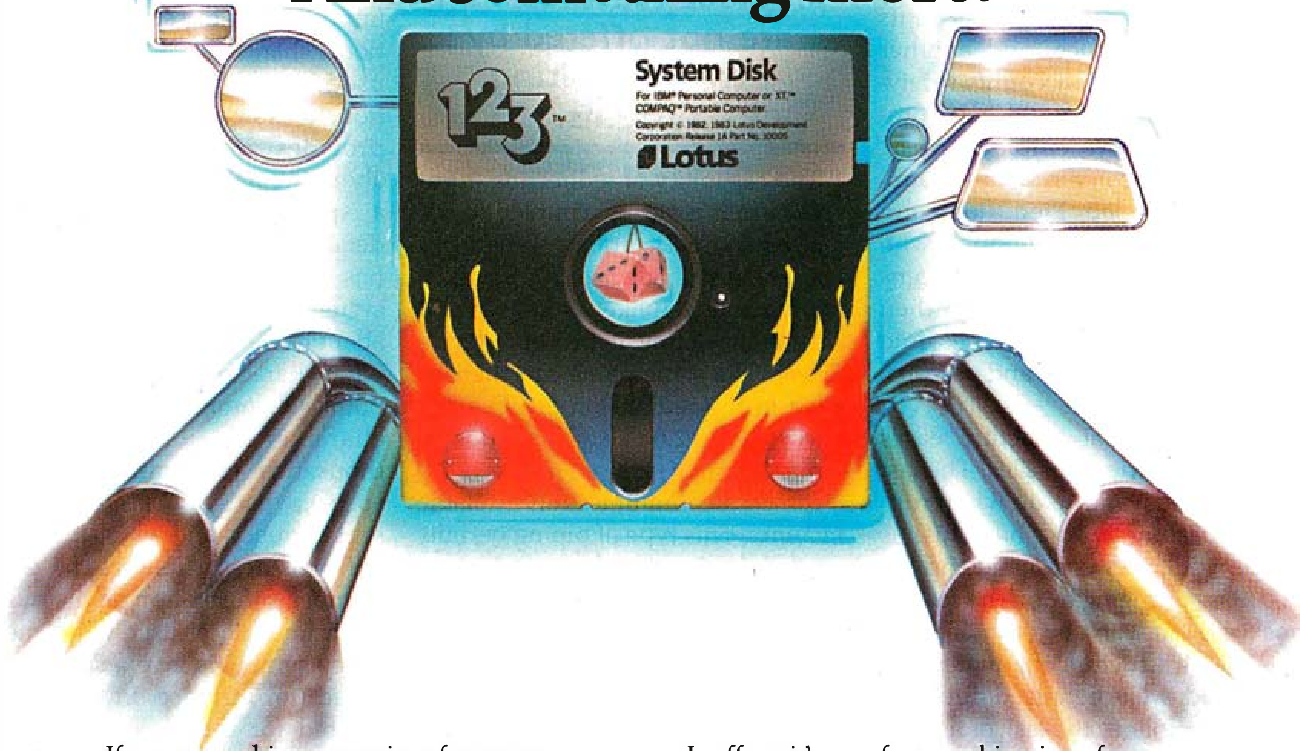

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rules that strictly define the realm of functions within which the software developer must remain to ensure that the program created is transportable between the two operating systems; that is, to provide source-code compatibility but not direct binary compatibility for the end user.

An Improved File Directory

Another example of MS-DOS 2.0's compatibility with Xenix is its enhanced directory system. Logically consistent with the Xenix file structure and physically consistent with the existing MS-DOS file structure, it is a hierarchical system that permits the logical organization of user files. It would allow you, for example, to partition a hard disk shared by five office workers into several areas. One directory might contain all accounts payable, for instance, and another might hold data on accounts receivable, while a third could have programs that all five employees use. Another could contain separate subdirectories labeled Fred, Joe, and Mary—set aside for individuals who would store their own programs there. Those users could each then subdivide their subdirectories into such categories as work and personal files.

This hierarchical structure eases storage and retrieval of files. The last thing anyone wants to do when running a machine with a hard disk is to type a directory command and see 8000 files go zinging by on the screen; most of them won't be of interest. A hierarchical structure eliminates that problem. A well-organized directory not only simplifies the task of finding a file, it also allows you to keep your files together, not intermixed with someone else's. This capability can save time and effort in situations where several users share one machine.

Input/Output Enhancements

In addition to modifying the file structure of MS-DOS, Microsoft has added the capability to redirect input and output. (The company received some criticism for not including this feature in earlier releases because it was possible to accomplish this to some extent in other operating systems.) MS-DOS 2.0's method of redirecting I/O involves an advanced, user-friendly procedure. Logically consistent with Xenix, it uses characters in the same fashion. Output from standard devices, such as a keyboard, display, and communications port, can be redirected to either files or other devices. The redirection can be either a dynamic one, where it is performed on the command line, or one that invokes a utility to redirect output permanently. One type of redirection, for instance, would be to send output from the screen to the printer.

For use in international environments, MS-DOS provides features that are not offered by other operating systems.

The capability of redirecting input and output is closely coupled to the concept of device drivers. When you use a new serial device, you can give it any name you like, as long as you accurately define it in your device driver. The same name can then be used in the redirection of I/O.

MS-DOS 2.0 also provides a limited form of *piping*, a means of interprocess communication available in Xenix. This type of piping permits you to take the output of one process and have the operating system automatically feed it to another process as input. Suppose, for example, that you wanted to sort a directory. Under MS-DOS 2.0, you could issue the directory command and pipe the output into a utility that would sort it. The operating system could automatically handle this procedure.

The SORT utility, a type of filter, is a standard utility that is very helpful for this kind of piping. Other utilities include a simple one called MORE, which suspends output on the screen every 24 or 25 lines so that the user doesn't see all his output go by without being able to read it. Another utility, called FIND, helps locate a given string of characters within a file.

An International Flavor

In addition to the features mentioned thus far, MS-DOS 2.0 contains certain capabilities that are tailored to the operating system's use in various countries. As manufacturers of large computers, long involved in worldwide sales, such as IBM, Wang, and Digital Equipment Corporation, enter the personal computer arena, they are making their products adaptable to various countries. For use in international environments, version 2.0 provides features that are not offered by other operating systems. Many of these features, however, may not be noticed by an end user in the U.S., as the first distribution of MS-DOS was designed around the requirements of the U.S. market.

For example, 8-bit character storage, important for the support of international character sets, has always been used internally in the DOS. In addition, a system call in MS-DOS 2.0 provides important information about the national environment. For a specific country (including the default country for which the system has been configured), the operating system supplies such information about how numeric data is formatted: what character is used for a decimal point (a comma or period), what character is used to separate thousands (a comma, period, or space), what symbol is used to represent currency, and whether that symbol precedes or follows the printed number. Information on the number of decimal places used when the currency symbol is invoked is also provided (for instance, in systems configured for the United States, two decimal places are used, but in Japan the default is zero; the Japanese write about quantities of yen without stating any fractional amounts). Lowercase to uppercase character-conversion information is used in filenames, and the SORT collating sequence is adaptable to different character sets.

The hardware manufacturer supplying MS-DOS 2.0 with its products can customize error messages to suit different languages. The package shipped to manufacturers is a relocatable binary version of the operating system plus source code for the

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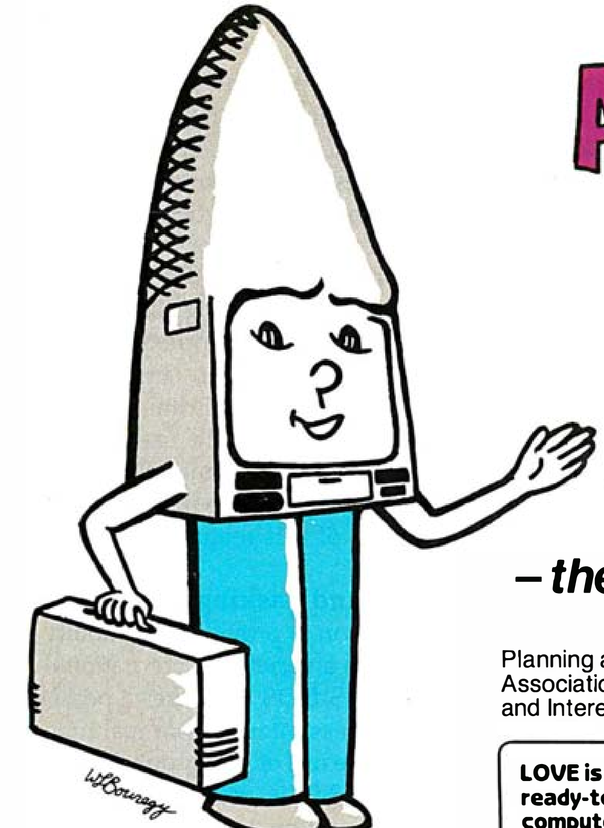

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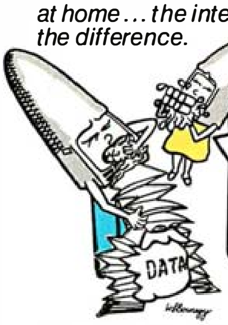

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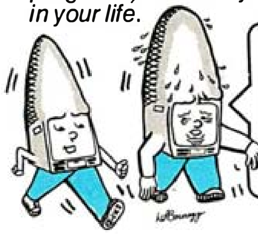

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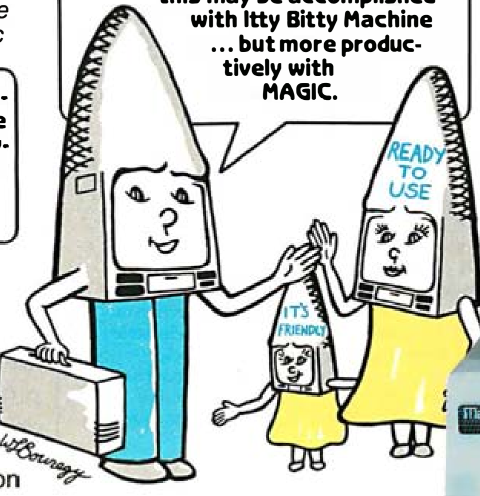

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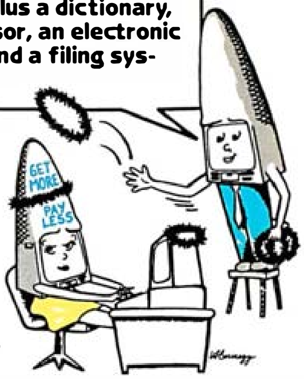

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messages, which the manufacturer can link together. Microsoft provides samples of error messages for major European languages and Japanese. Because manufacturers provide various character sets to support use of their products in Europe, they must adapt the error messages to each type of set.

Other Microsoft products are suited to use in international settings. Therefore, if a user ran Microsoft's Multiplan under MS-DOS with the French default parameters set, he would see numbers using a comma to indicate decimal points, incorporating the symbol for the French franc. MS-DOS would also express the date and time in the appropriate format.

By having this functionality incorporated into language processors, although a user might be running an application program that was not designed to run in an international environment, the operating system will automatically incorporate the appropriate changes. Of course, the best programs will be customized for each environment, but for programs that are not, the user won't have to inform the application program that he is tailoring it to a foreign environment.

Error messages and menus are also suitable for use in particular places. In addition, the operator using an application program—a French version of Peachtree's accounting package, for instance—can tell the operating system to pretend that, instead of France, he is in Great Britain; subsequently, the numbers he uses will be printed in a British format. Eventually, all of Microsoft's products will take advantage of this feature.

Background Tasking

In addition to providing the ability to adapt to a variety of international formats, MS-DOS 2.0 makes it possible to process interrupts in real time through the use of background tasks. MS-DOS 2.0 is not a reentrant operating system and does not support true multitasking. It is thus limited to background processing in interrupt time—the background task can only make use of the operating system as a resource if the foreground task is not interrupted in the middle of an operating-system call.

The operating system still considers only one task at a time, although you can fool it and work on rather intelligent tasks in the background. By following some specific rules, you can also let the computer perform concurrent processing. A print spooler, provided as part of MS-DOS 2.0 (activated by PRINT.COM), makes extensive use of this capability. Potential uses made possible by background tasking include background communications such as receiving electronic mail.

The power of 16-bit microprocessors has provided the foundation for more sophisticated personal computer applications. MS-DOS 2.0 demonstrates the significance of a step in this direction by incorporating many new features. As memory prices continue to drop, users can expect more power and capability in future versions of MS-DOS.■

Chris Larson is a marketing manager at Microsoft Corporation (10700 Northup Way, Bellevue, WA 98004).

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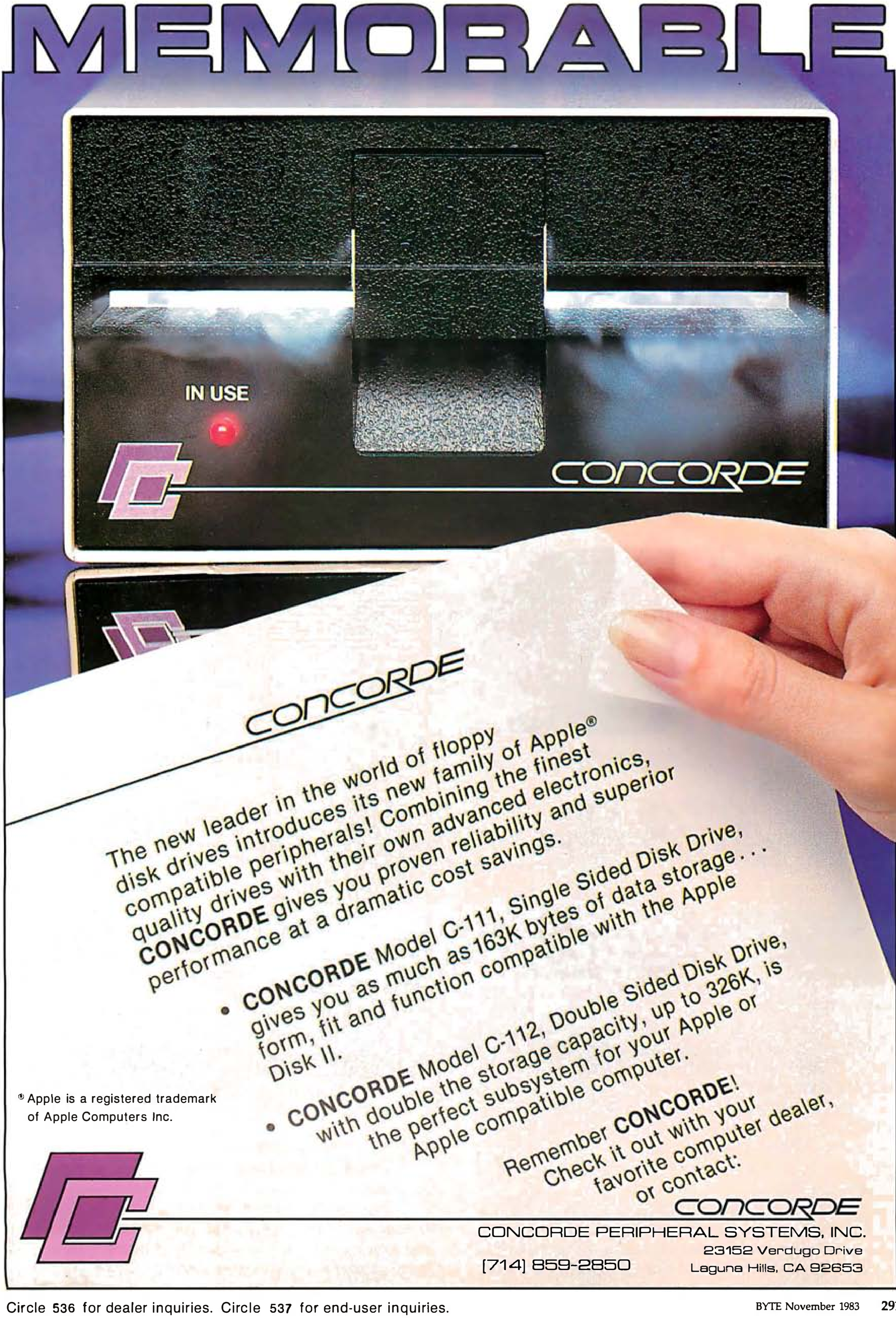

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The IBM PC XT and DOS 2.00

DOS 2.00 has changed more radically relative to its predecessor than the XT has compared to the PC

by Rowland Archer Jr.

Speculation about the IBM Personal Computer XT reached a feverish pitch a few days before IBM unveiled the new machine. Industry pundits had IBM announcing a new PC with everything from 256K-bit memory chips to an Intel 80186 processor running multiple users under the Unix operating system. If you too were looking for an announcement as dramatic as this, you were probably disappointed by the XT, which didn't even replace the PC's 8088 microprocessor with its compatible big brother, the 8086. IBM chose instead to take a conservative, evolutionary step in the development of its highly successful Personal Computer. Perhaps by the time you read this IBM will have announced its "super system." Meanwhile, based on the order backlog at area computer stores, IBM is selling all the XTs it can build.

The PC XT looks just like a PC except for the XT on the name plate and the replacement of the right-hand floppy-disk drive by a 10-megabyte Winchester hard disk (see photo 1). Inside, the XT has eight expansion slots, correcting the frequent complaint that the PC had too few slots—five. Up to 256K bytes of memory can be plugged into the motherboard, which now uses 64K-bit dynamic RAM (random-access read/write memory) chips instead of the earlier 16K-bit chips. The XT comes with 128K bytes of RAM as standard equipment. Also standard is an asynchronous-communications board, providing one RS-232C serial port with modem controls. The cassette port is gone, but it never really caught on anyway. In fact, IBM's latest *Hardware Fact Sheet* brochure fails to mention its presence on the PC at all.

Concurrent with the announcement of the PC XT, IBM introduced new versions of its PC-DOS and BASIC, both revisions 2.00. PC-DOS 2.00, or DOS 2.00, was supplied to IBM by Microsoft and is compatible with the generic MS-DOS 2.00. DOS 2.00 provides many of the features found in Microsoft's Xenix operating system (a licensed version of Unix), including hierarchical directories, pipes, and filters. BASIC 2.00 contains a number of powerful new features, including support for hierarchical directories, double-precision trigonometric functions, extensions to BASIC 1.10's graphics and music statements, and more.

Hardware Overview

The first thing you are likely to notice when you turn on the XT is the sound of its fan. Combined with the whirring of the hard disk, this noise makes the XT a much more obtrusive workmate than the floppy-disk-only PC. On the positive side, the sound of the hard disk in action, evidenced by flashes of its front-mounted LED (light-emitting diode), is only a faint pinging; the familiar groans that accompany floppy-disk-drive head movement are notably absent.

When the XT is powered on, it spends about 30 seconds running through a number of self-test diagnostics, including a memory check. Satisfied that it is in working order, it attempts to boot from the floppy-disk drive. If the drive door is left open, the XT will then try to boot from the hard disk. This two-step process lets you boot floppy disks with ease, a necessity to run some protected software such as Microsoft's Flight Simulator. On the other hand, it also lets you boot directly off the hard disk without having to start from the floppy disk, as some systems require.

The hard disk's speed is impressive if you are used to floppy-disk-based systems. BASICA loads in under 1 second, compared to about 4 seconds from a floppy disk. You hardly notice the pause while Wordstar disk overlays are loaded. In addition to its greater transfer speed (5 million bits per second compared to 250 thousand bits per second for the floppy-disk drives), there is no start-up time associated with a hard-disk access; by comparison, floppy-disk drives take ½ second to come up to speed if their motors are off when they are accessed.

The hard disk contains two platters, for a total of four writable surfaces. Each surface contains 306 tracks; each track has seventeen 512-byte sectors, for a total storage capacity of 10,653,696 bytes. Although this is a lot of storage compared to most floppy-disk-based systems, I was surprised at how fast I filled up half the disk.

The XT I reviewed came with a Seagate Winchester disk that developed an intermittent howling noise after a couple of days. I never lost any data, but the noise was unnerving, and I returned the system for repair under warranty. The dealer swapped in a new hard disk, manufactured by Miniscribe. I haven't had any trouble since then. The disk does its job quickly and reliably; if the fan were quieter, I would have no complaints at all.

Color Display

With the announcement of the XT, IBM concurrently unveiled its first RGB (red-green-blue) color monitor for both the PC and the XT. After using it for several months I must say it has the best colors I have seen on an under-$1000 unit. Resolution is very good, although characters are not quite as readable as on the standard IBM monochrome unit. I have used it alongside the new Quadchrome monitor from Quadram; the Quadchrome has slightly better resolution, but the IBM has truer colors. The IBM also has a nearly black background that gives displayed characters plenty of contrast for improved readability. The color display does have one annoying characteristic. This problem is actually related to the color-graphics card and the software using it, not to the RGB monitor. Machine-language software is supposed to restrict itself to writing only during display-retrace time; some software, notably MS-DOS itself, ignores this rule. As a result, the entire display blinks whenever it scrolls. This problem does not occur in BASIC, which follows the rules for display generation.

Expansion Slots

The first reviews of the IBM PC complained that it

Photo 1: *The XT looks like a PC until you examine the right-hand disk drive closely.*

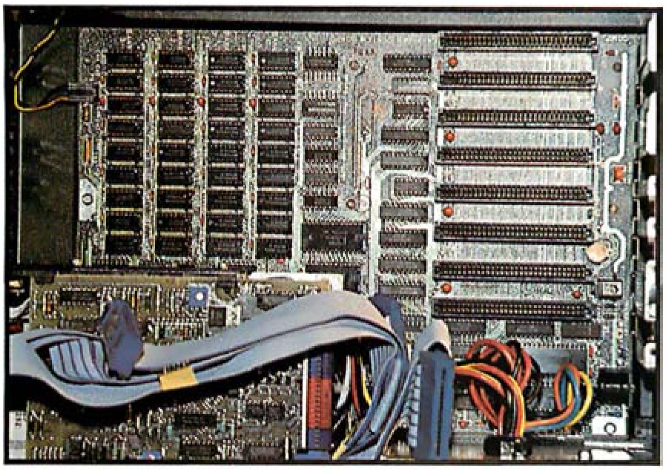

Photo 2: *The XT has eight expansion slots to rectify the common complaint against the PC—that it has only five slots.*

didn't take long to fill the PC's five expansion slots. You need at least one slot for a display card; the second slot is for a disk controller; and a color graphics card fills slot number three. Because the 8088 processor can address a megabyte of memory, you'll want more than the 64K bytes that fit on the motherboard. Add a memory card to the fourth slot, and all the other options must compete for the one remaining slot.

Seemingly hundreds of vendors jumped at this marketing opportunity, offering multifunction cards that provide memory expansion, serial and parallel ports, and extras like clock calendars with battery backup, all in a single slot.

The XT, with its eight expansion slots, should cause these vendors to rethink their strategy. A serial port is standard equipment on the XT. Below the expansion slots are four banks of nine chips (see photo 2). Each chip is a 64K-bit part, giving each bank a capacity of 64K bytes, including a parity bit. The standard XT comes with two banks populated, for a total of 128K bytes. Each of the other banks can be filled separately, up to a maximum of 256K bytes on board, using no expansion slots. You can add memory cards to bring the XT up to a maximum memory configuration of 640K bytes.

Photo 3 shows the system unit from the top, with five of its slots loaded. The slot on the far left is empty; the next slot holds the optional color-graphics card. Skipping a slot, we come to the optional monochrome-display/parallel-printer-port card. Next is the Winchester disk controller card. It boasts automatic error detection and correction, onboard memory to buffer a sector, and use of the system's DMA (direct memory access) feature. The next slot contains the floppy-disk controller card, which is unchanged from that of the IBM PC. The slot to the right of the floppy-disk controller is empty in the photograph, and the slot on the far right holds the standard asynchronous-communications card (RS-232C serial port, 50 to 9600 bits per second).

Not all of the slots are equal. Two of the eight are behind the floppy-disk drive and have only enough space for short cards; one of them comes loaded with the asynchronous-communications card. The other holds cards such as the parallel port or game paddle I/O (input/output) card.

The six full-sized slots are packed into the same space as the five slots in the PC. If you purchase add-on cards for an XT from a non-IBM source, verify that the card will fit in the narrower space of an XT, especially with cards that use piggyback arrangements to package extra boards in a single slot.

The XT comes with a beefed-up power supply to support the extra expansion slots and the hard disk (see the right-hand rear corner of the cabinet in photo 3, behind the Winchester drive). Rated at 130 watts (W), it puts out more than twice the PC's 63.5 W.

Sorry, We Can't Sell You That . . .

I discovered an oddity in the XT's configuration when I tried to design a system with two floppy-disk drives. It seems that the only "legal" way to get an XT with two floppy-disk drives is to buy two 10-megabyte hard-disk drives, too! I wanted two floppy-disk drives so it would be easy to make backups of a floppy disk and so I could run CP/M-86 floppy-disk-based software that required two disk drives (CP/M-86 from IBM does not support the hard disk). The floppy-disk controller in the XT is the same as that used in the PC, and there is even a spare connector on the internal cable, ready to be plugged into a floppy-disk drive. If IBM sold a half-height floppy-disk drive, you could fit two where the left-hand floppy-disk drive now sits, and the problem would be solved. To stay within the official guidelines, however, you must buy an expansion chassis that includes another hard-disk drive; you then move the hard disk out of your XT and into the expansion chassis and put the second floppy disk in the space vacated by the hard disk in the central processor chassis. If you are willing to buy a PC instead of an XT, you can get one with two floppy-disk drives and add the hard disk via the expansion chassis.

DOS 2.00

Although it was overshadowed by the announcement of the XT hardware, DOS 2.00 actually contains far more radical changes relative to its predecessor (DOS 1.10) than the XT does compared to the PC. Microsoft says that DOS 2.00 is a complete rewrite; it incorporates many of the features found in that firm's more expensive Xenix operating system.

I have used DOS 2.00 for several months now, and although it is not without its faults and bugs, it does contain a lot of useful features, and it's fast. I am not easy on software products—I have abandoned many of them as unusable. DOS 2.00 and I have had some quarrels, but I would not want to give it up, either.

Compatibility

DOS 2.00 is a superset of its predecessor, DOS 1.10. Although many of the new commands are related to support for the hard disk, DOS 2.00 will also run on a floppy-disk-only PC system. Not all programs written to run under 1.10 will run under 2.00, but many will. The IBM DOS 2.00 manual contains an appendix explaining how to use programs that will run under 2.00 and listing some programs that won't run under it. It's a safe bet that most software vendors will be providing versions of their products for DOS 2.00 in the months ahead.

DOS 2.00 takes up more memory than 1.10, and many programs that ran in 64K bytes under 1.10 require 96K bytes or even 128K bytes in their 2.00 incarnations. This requirement alone is enough to keep DOS 1.10 alive for a while because lots of 64K-byte PC's are still in use.

File System Changes

Many of the most obvious changes in DOS 2.00 relate to the support for a "hierarchical, tree-structured" file system. This complex-sounding concept can be explained simply. Under DOS 1.10, each floppy disk had a single directory, and that directory could contain one or more files. Under 2.00, a directory can hold files as before, but it can also hold other directories, which in turn can hold more files and directories, and so on.

DOS maintains the concept of a "current" directory, usually referred to as the directory you are "in." You can move freely from one directory to another, but you only have one current directory. You can access files in the current directory by simply specifying their names, and you can access files in other directories by giving their "pathnames."

A pathname is a list of directory names ending in a filename. The master or "root" directory is created when you format a disk. It is prenamed " \ " (backslash). Let's say that two users, Phil and George, share an XT's single hard disk. They create directories called "PHIL" and "GEORGE" in the root directory and store all their files in their own directories. When Phil uses the machine, he enters the command "CHDIR \PHIL," which changes his current directory to " \ PHIL." If this directory contains a file named "TEXT," he can list it with the command "TYPE TEXT." Suppose George has a file named "TEXT" too, in his own directory " \ GEORGE." Phil could list it with the command "TYPE \ GEORGE \ TEXT." Note that DOS contains no security features; there is nothing to keep Phil from reading any of George's files on the hard disk they share.

This same concept extends to as many directory names as you can fit in a maximum pathname of 63 characters. For example, George may create a directory called "ACCOUNTS" in " \ GEORGE," and the pathname of a file named "BILLS" in that directory would be " \ GEORGE \ ACCOUNTS \ BILLS."

The motivation behind this directory hierarchy can be traced to the need to support large mass-storage devices such as the XT's 10-megabyte Winchester. DOS 1.10 and most other floppy-disk-based operating systems keep all the files in a single directory. This is simple and works well if the number of files is small. On a hard disk with hundreds or thousands of files, this structure is inadequate. Just think of the time it would take to find a file if you had to search through a DIR command listing of a thousand filenames.

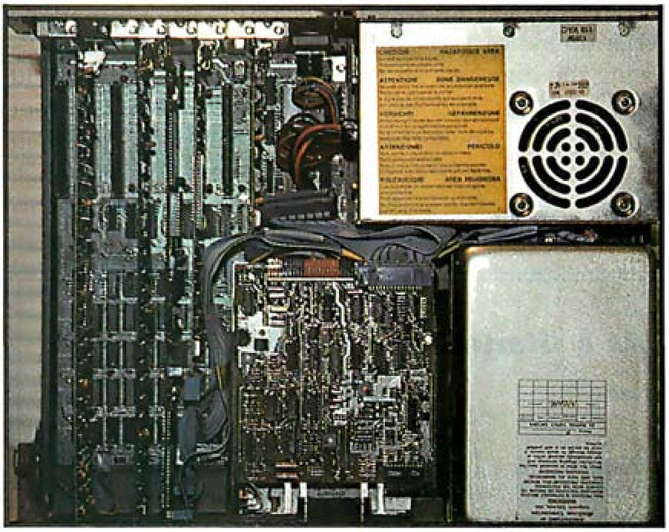

Photo 3: *The XT system unit with five expansion slots filled—see text for description.*

There have been several approaches taken in the past to solve this problem, the most common of which has been to "partition" the hard disk into multiple "logical disks," each one of which appears to the user as if it were a separate floppy-disk drive. Most such arrangements require the user to establish the partitions in advance, when the disk is formatted. When this choice is made, it is assumed you already know the number of partitions you will need. The disk usually cannot hold a single file larger than the largest partition, so you are also setting a ceiling on file size when you determine partition size.

The MS-DOS 2.00 solution is a far more flexible one. It has most of the advantages of the fixed-partition scheme but lets you add new directories dynamically. Furthermore, each file and directory can grow to take up any available space on the Winchester, as it is needed.

DOS 2.00 supports a form of disk partitioning in addition to the hierarchical directory scheme. You can partition the disk when you format it, and each partition can belong to a different operating system. This is IBM's way of letting you share a single hard disk among multiple operating systems. You can make any of these partitions the "boot" partition, and it will get control when the system is started up.

Application Woes

Although hierarchical directories are basically a great convenience, the applications-software world has some catching up to do before we can take full advantage of these directories. For example, I wanted to keep all my commonly used tools, such as BASCOM (the BASIC Compiler) and Wordstar, in a single directory and use them from any directory on the disk. DOS has a PATH command that should be just the ticket—it takes a list of directories as its arguments, and it sets those directories up as places that DOS will look for command files. Using the directory structure discussed earlier, I could load Wordstar and its supporting files into the root directory " \ ," issue the command "PATH \ ," and then be able to invoke Wordstar to edit the file "TEXT" while in the directory " \ GEORGE." Unfortunately, this doesn't work. Wordstar gets invoked correctly, but it then looks for its overlay file in the current directory (" \ GEORGE") and bombs out when it doesn't find it there. For now, you must copy Wordstar's supporting files into the directory containing the files to be edited.

Programs compiled with BASCOM have a similar problem; the BASRUN.EXE file must be in the current directory, or the compiled program will not execute. All this is not to say that hierarchical directories are poorly implemented; it is just a warning that you will have to work around some problems like these until the applications-software developers catch up with DOS 2.00.

Winchester Backup

One of the industry's least favorite topics is discussing how to back up your 10-megabyte Winchester disk. The mainframe and minicomputer world solve this problem with high-speed, large-capacity, high-cost tape

At a Glance

Name
The IBM Personal Computer XT

Manufacturer
International Business Machines Corporation
POB 1328
Boca Raton, FL 33432

Dimensions
System unit: 20 by 16 by 6 inches, 32 pounds
Keyboard: 20 by 8 by 2 inches, 6 pounds

Processor
Intel 8088

Memory
128K bytes of RAM (random-access read/write memory) standard, expandable to 256K bytes on board; to 640K bytes through expansion cards; 40K bytes of ROM (read-only memory) holding BASIC interpreter and DOS I/O (input/output) software

Data Storage
10 megabytes on Winchester hard-disk drive; 360K bytes on double-sided, double-density floppy-disk drive; can add one more of each through purchase of optional expansion unit

Keyboard
Detached with 6-foot coil cord connecting to system unit, 83 keys including 10 function keys, 10 keys for numeric entry and cursor control, automatic repeat on all keys

Standard Features
Eight expansion slots for additional memory, display cards, printer connection, game-control adapter; speaker for sound or music, 50 to 9600 bits-per-second RS-232C asynchronous communications adapter

Software
Runs PC-DOS 1.10, 2.00 (both extra cost); DOS 2.00 required for hard-disk support; most but not all programs that run under DOS 1.10 will run under 2.00; programs that require DOS 1.10 and two floppy-disk drives will require purchase of the optional expansion unit to obtain a second floppy-disk drive

Documentation
Guide to Operations: Personal Computer XT: installation, problem determination, operating procedures, step-by-step instructions with illustrations, 170 5½- by 8½-inch pages, loose-leaf binder

Price
System unit, 128K bytes of RAM, keyboard, asynchronous communications card, 10-megabyte hard-disk drive, 360K-byte floppy-disk drive: $4995. Requires DOS 2.00 ($60) and either monochrome-display adapter ($335) and monochrome display ($345) or color-graphics display adapter ($244) and color display ($680) to have a usable system.

Audience
Computer buyers looking for an expandable system with 10 megabytes of hard-disk storage, capable of running most IBM Personal Computer software

At a Glance

Name
The IBM Personal Computer Disk Operating System version 2.00 including BASIC version 2.00

Type
Microsoft MS-DOS 2.00 Disk Operating System and Microsoft BASIC version 2.00 for the IBM Personal Computer

Author
Microsoft Corporation
10700 Northrup Way
Bellevue, WA 98004

Distributor
International Business Machines Corporation
POB 1328
Boca Raton, FL 33432

Software
Complete disk operating system and BASIC for the IBM Personal Computer and Personal Computer XT. Includes support for the PC XT Winchester disk drive, tree-structured directories, pipes and filters, a line editor, assembly-language program debugger, and linker for Microsoft standard relocatable object programs. BASIC 2.00 includes advanced support for graphics, music, and communications.

Format
Supplied on two double-density, single-sided 40-track floppy disks, formatted with nine 512-byte sectors per track for 180K bytes of storage per disk (360K bytes on double-sided drives)

Computer
IBM Personal Computer with at least 64K bytes of RAM (random-access read/write memory) and one floppy-disk drive; IBM Personal Computer XT with at least 128K bytes of RAM

Documentation
Disk Operating System version 2.00: complete guide with everything from an introduction for the first-time user, to advanced material for the assembly-language programmer, 794 5½- by 8½-inch pages, loose-leaf binder

Price
$60 for DOS 2.00 and BASIC 2.00

Audience
IBM Personal Computer and Personal Computer XT users in need of a disk operating system and BASIC language for their systems

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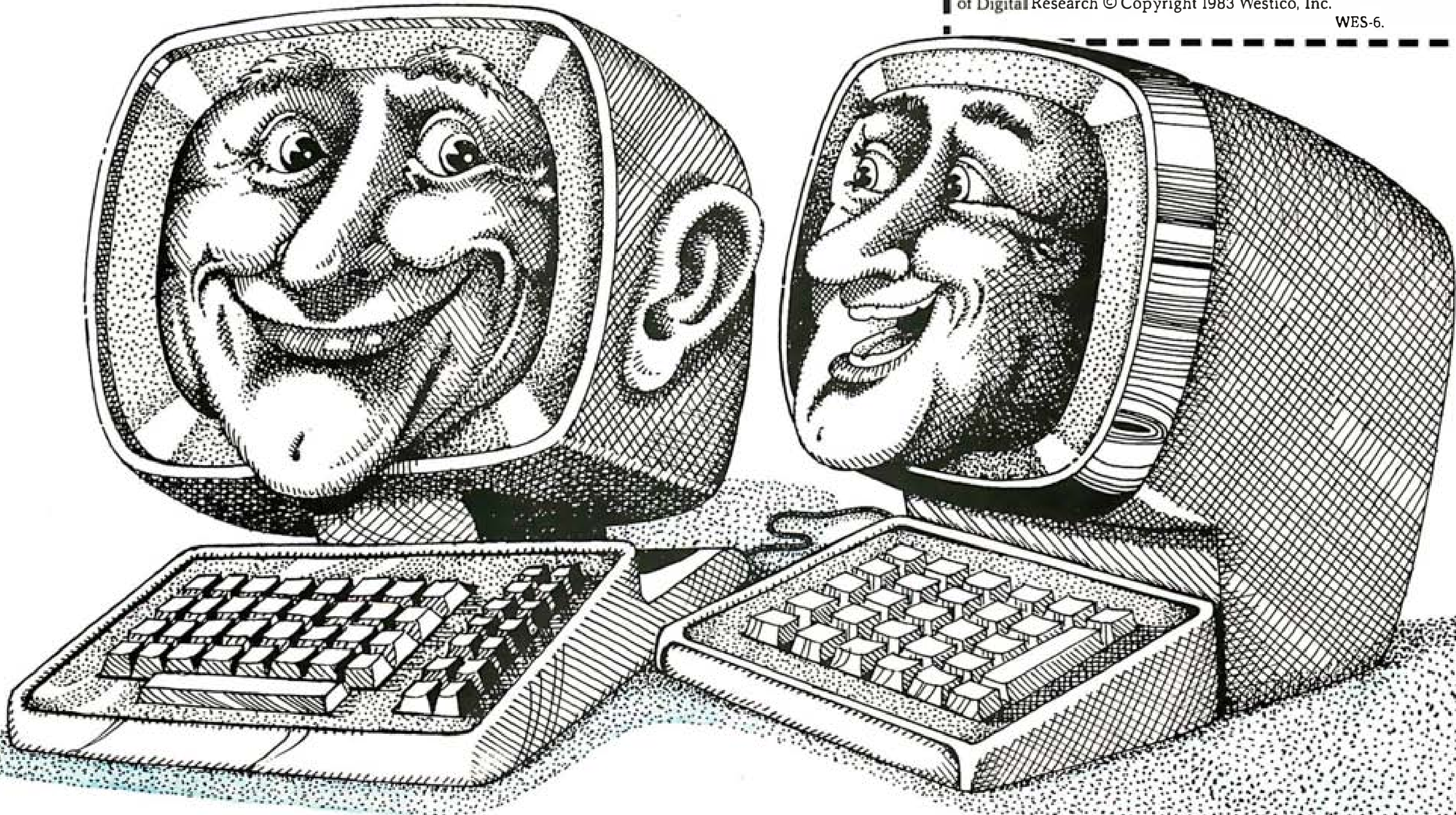

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drives. Because these drives typically cost more than an entire microcomputer system, they are not cost-effective for backup in the microcomputer world. The XT, like most of its competitors, uses the built-in floppy-disk unit for backup.

Given the restrictions in the hardware, DOS 2.00 has introduced several features to help with this problem. Not the least of these is a change in floppy-disk format from 8 sectors per track to 9 sectors. This gives double-sided floppies a capacity of 360K bytes, 40K bytes more than DOS 1.10's 320K-byte size. This change benefits floppy-disk-only users as well as XT users. Furthermore, DOS 2.00 does a super job of automatically recognizing both single- and double-sided disks, with either 8 or 9 sectors per track. The FORMAT and DISKCOPY commands can read and write disks with any of these formats.

DOS 2.00 adds some new features to make batch-file processing even more flexible.

Unfortunately for XT owners, however, even this increased floppy-disk capacity works out to about 30 floppy disks needed to back up the entire hard disk; if you can afford two hard disks, you'll need 60 floppy disks.

To try to cut the backup task down to size, a new command called BACKUP is provided with DOS 2.00. It supports the dumping of files from a hard disk to multiple floppy disks. Although you should periodically make a complete backup of your hard disk, you can also give backup some parameters to restrict the files that get backed up in a given operation. For example, you can supply a filename template, and only those files matching the template will be backed up. One restriction is that you can only give BACKUP a single template; if you wanted to back up all files matching the templates "*.DAT" and "*.COM," you would have to perform two different BACKUP commands. BACKUP allows switches that specify:

- BACKUP-only files modified since they were last BACKed up
- BACKUP-only files modified since a given DATE

BACKUP will write its output to multiple disks, but they must be preformatted. Thus, you must anticipate the number of floppy disks you will need before you begin the operation. Once you have executed BACKUP and created a set of backup disks, you can load them back onto the hard disk with the RESTORE command.

Filters and Pipes

DOS 2.00 inherits some of the most popular features of Xenix, based on the concept of a "standard input" and "standard output" file. These files are by default mapped to the keyboard and CRT, respectively. Programs that read the standard input and write to the standard output are called "filters." DOS 2.00 includes several filter programs:

- SORT sorts input lines and writes the result to the standard output.
- MORE copies standard input to standard output a screenful at a time, then prints MORE and waits for you to press a key.
- FIND reads standard input and passes lines that contain a specified string to the standard output.

Programs, including DOS commands, that read the standard input or write to the standard output can have their input or output streams redirected when they are invoked. For example, the command "DIR >NAMES" puts a directory listing in the file called "NAMES." The command "MORE <NAMES" will type the filenames on the screen, pausing for you to hit a key after every screenful of data.

"Pipes" are DOS 2.00 constructs that allow you to specify multiple filter programs to be run in a single command line, with the output of each one automatically connected by DOS as the input of the next one. For example, DIR | MORE writes a listing of all the files in the current directory to the standard output, which is redirected to the input of MORE; the filename listing will be printed a screenful at a time by the MORE filter.

DOS 2.00 does not actually run pipelined programs simultaneously as Unix does; they are run sequentially, and the output of all but the last is written to a temporary file, which serves as the input to the next program. The temporary file is deleted when the last program finishes. A pipelined command can fail if you run out of disk space while it is executing.

New Batch Commands

One of the powerful features of DOS is the ability to create a file of commands, called a "batch file," that can be executed without user intervention. DOS 2.00 adds some new features to make batch-file processing even more flexible:

- ECHO can write messages to the screen during batch-file processing. Provision is also made to turn off the echoing of commands to the screen as they are executed. There is no way to not echo the ECHO OFF command.
- FOR lets you execute a single DOS command multiple times, giving it new parameters with each invocation.
- IF executes a command conditionally, based on an error code set by a previous command or on the existence of a file. The only commands that currently set an error code are BACKUP and RESTORE. More powerful selection criteria would be useful here.
- GOTO alters the flow of execution in a batch file based on the results of an IF test.
- SHIFT can be used in conjunction with FOR to step through a list of command arguments.

One serious limitation of batch-file processing still persists; there is no way to carry on an interactive dialogue with a user during batch-file execution (ask questions and execute commands conditionally based on the user's response).

Miscellaneous Enhancements

One of the problems you will frequently encounter when trying to run software written for DOS 1.10 is the "hard-coding" of drive designators in the program itself. For example, the program may try to open a file named "B:PROGRAM.DAT;" but there is no drive "B:" on most XTs. The DOS 2.00 ASSIGN command can redirect all references to the "B:" drive to a different drive, say "A:" (the floppy-disk drive) or "C:" (the hard-disk drive).

DOS 2.00 makes the installation of assembly-language code designed to support peripherals (device-driver code) much easier than before. A section in the manual describes the format of a device-driver program (even advanced programmers will pull some hairs figuring this out). A file named CONFIG.SYS, containing the name of your device driver, must be created in the root directory. All device drivers located in this file will be installed when DOS comes up. This procedure will help peripheral manufacturers to add driver support to DOS 2.00 without having to resort to patching the operating system.

Another nice feature is a built-in print "spooler." This feature lets you queue up to 10 files to be printed in a "spool queue," then go on and use the machine to do something else. The files will be printed, somewhat spasmodically, whenever the computer is idle. The design of the SPOOL queue servicing code can be questioned, because it appears to give the spooler the lowest priority—printout halts whenever you are typing at the keyboard, or when a program does disk I/O. It appears that a design giving highest priority to the spooler was attempted but took too great a performance toll on interactive-user-response time. Nonetheless, it is a strange feeling to have the printer start up when I stop typing, and stop when I hit a key; it disturbs my concentration. Note also the difference between this print spooler and the usual implementation: this prints files that already exist on disk, whereas most print spoolers sold in the microcomputer market buffer all program output destined for the printer. If, for example, you have a BASIC program that uses LPRINT statements to write to the printer, you cannot take direct advantage of this spooler. You must redirect your print output to a file, then print the file after your BASIC program finishes executing.

Another much-requested feature in DOS 2.00 is the ability to dump a screen containing graphics output on the system printer. Medium- and high-resolution graphics are both supported, and color is represented by gray scales.

DOS 2.00 provides several ways to recover lost files. The CHKDSK command checks the directory and finds files that are allocated on the disk but have no directory entries. New entries are created for such files, and it is up to you to examine the file and determine if it contains valuable information or not. The RECOVER command can recover files that have become partially unreadable due to bad media. A new directory entry is created for such files, skipping over the bad sectors. Although neither of these recovery techniques is perfect, they may be preferable to trying to reconstruct a file from scratch.

The DOS 2.00 disk format command lets you name a disk with a "volume ID." Unfortunately, you cannot change the ID without reformatting the disk.

DEBUG has been enhanced to allow direct entry of assembly-language statements into memory.

The EDLIN line editor has new commands to read in the contents of a file, move, and copy lines of text.

As a performance enhancement, you can specify the number of file buffers that DOS allocates when it comes up. Data read from files is kept in these buffers until they are used up; they are "recycled" each time a new buffer is needed. If your program requests data that is in one of these buffers, a disk I/O operation may be avoided.

VERIFY forces DOS to perform reads after each disk write, to ensure that the intended data has made it out to the disk.

BASIC 2.00

The new version of BASICA contains many new features, primarily in the screen and music I/O areas. If you are willing to dig in and learn the peculiar syntax of the graphics and music-generating commands, you will have a powerful programming capability at your disposal.

Some of the changes in BASIC 2.00 are in the file area. BASIC statements and commands dealing with filenames have been expanded to accept pathnames. The EOF (end-of-file) function handles redirected standard input files. The LOF (last-of-file) function gives the number of bytes allocated to a file. GET and PUT can handle record numbers up to 16,777,215.

The graphics commands have lots of new features. PAINT takes a parameter that allows you to "tile" an area; that is, to fill it with a pattern instead of a solid color. LINE has an enhancement similar to the tile feature of PAINT; you can specify a line "style" and draw lines composed of patterns of dots and dashes. DRAW supports a command to turn by a given angle, and to issue a PAINT command (no tiling) from within a DRAW command. WINDOW lets you treat the screen as having an arbitrary coordinate system. You must establish the x and y coordinates of the corners of the screen, and then everything you draw using the CIRCLE, LINE, PAINT, POINT, PSET, and PRESET statements gets scaled to the coordinates established by WINDOW. Any points outside the WINDOW are not plotted—this is called "clipping." VIEW defines a portion of the screen as a "viewport," and all output goes only to this portion of the screen until a new viewport supersedes it. By defining multiple viewports on the screen at once, you can experiment with the currently in vogue "multiple-window" techniques used by Visicorp's Visi On and Apple's Lisa.

Odds and Ends

The PLAY statement now recognizes a symbol that raises or lowers the octave of succeeding notes. An ON PLAY statement has been added to play continuous music concurrently with the execution of a program. Whenever there are a given number of notes left in the "music queue," control is transferred to a subroutine in your program that can fill the queue with more notes.

Double-precision support is now available for the ATN, COS, EXP, LOG, SIN, SQR, and TAN functions. RANDOMIZE also supports double-precision seeds for the random-number generation routine.

The "ON TIMER" statement allows you to set up a single-count-down timer; after the specified number of seconds has elapsed, control is transferred via GOSUB to a statement in your program.

You can now specify that all output to the screen should also be sent to your printer. This option was formerly available from DOS, but was disabled when you entered BASIC. It is still turned off when you enter BASIC, but you can now turn it back on.

Documentation

Although still among the better manuals in the microcomputer industry, the DOS and BASIC manuals took a beating when being upgraded to version 2.00. The DOS manual is now bursting at the seams, and it is just a matter of time before pages start falling out. Its formidable size will keep many people from even trying to learn more than "How do I load Visicalc?" It appears to have been rushed out, with a number of typographical errors, some rather glaring (the table of contents lists nine entries for Appendix K, then starts all over again). Considering the volume of information it presents, it is usable, and thoughtfully includes an index as well as a master table of contents and a mini table of contents for each chapter.

The BASIC manual is a "do-it-yourself" kit containing a 1.10 manual and a fat packet of pages to insert. The first manual I received omitted the 2.00 upgrade pages; the second one contained the pages, but repeated a subset of them and left out the VIEW and WINDOW commands.

The examples in both manuals are acceptable, although many are so vague they give the impression the writer did not understand the purpose of the command. The examples also show evidence of hurried preparation and minimal proofreading. It is evident that even IBM, with its enormous pool of resources, must cut corners to get timely updates out in the breakneck-paced world of microcomputer software.

Conclusions

The PC XT is a solidly engineered, although technically modest, encore to the IBM Personal Computer. It is competitively priced, which indicates that not only is IBM in this game to stay, it wants to build its market share.

DOS 2.00 has the right features to support the XT's expanded capabilities and brings many features formerly found only in high-priced microcomputers down to the mid-price range. BASIC 2.00 builds on Microsoft's reputation for innovative features in microcomputer BASICs; its powerful graphics features make it worthy of its generic name GW BASIC (Gee Whiz BASIC).

Now that we know what the XT is all about, we can start speculating on the PC II again; I think it will be multiuser, with an 80186 running Xenix and MS-DOS, and . . .■

Rowland Archer Jr. (5420 Loyal Pl., Durham, NC 27713) is a manager of software development at a Fortune 500 corporation. He holds an MS in computer science from MIT.

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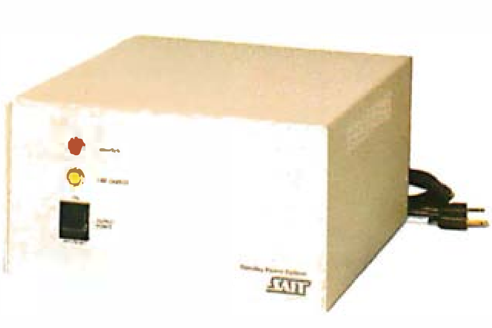

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User Memory
64K-640K bytes

Microprocessor
16-bit, 8088

Auxiliary Memory
2 optional internal diskette drives, 5¼" 160KB/180KB or 320KB/360KB per diskette

Keyboard
83 keys, 6 ft. cord attaches to system unit
10 function keys
10-key numeric pad

Diagnostics
Power-on self testing
Parity checking

Display Screens
Color or monochrome
High-resolution
80 characters x 25 lines
Upper and lower case

Operating Systems
DOS, UCSD p-System, CP/M-86†

Languages
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Printer
All-points-addressable graphics capability
Bidirectional
80 characters/second
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9 x 9 character matrix

Permanent Memory
(ROM) 40K bytes

Color/Graphics
Text mode:
16 colors
256 characters and symbols in ROM
Graphics mode:
4-color resolution: 320h x 200v
Black & white resolution: 640h x 200v
Simultaneous graphics & text capability

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RS-232-C interface
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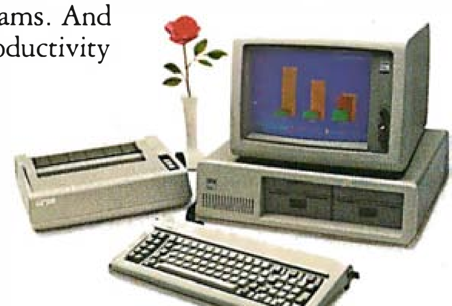

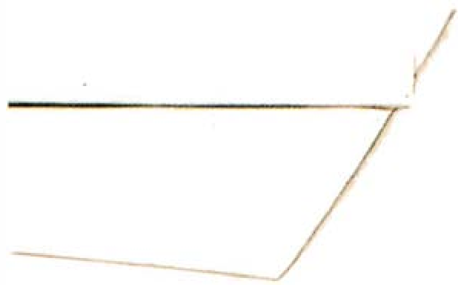

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The Corona PC

An IBM PC-compatible desktop machine that features a high-quality display and the Multimate word-processing program

by Rich Malloy

One thing that continues to amaze me in this industry is the number and variety of microcomputers claiming compatibility with the IBM Personal Computer (PC). Like siblings, these machines share a common theme yet retain an individual character and personality.

The Columbia MPC (Multipersonal Computer) could be the older brother, content to copy his father exactly. The Compaq becomes the proper and dependable sister with a weakness for travel. And, of course, the Eagle PC is the younger brother who has a penchant for tidiness—he keeps the keyboard under his bed.

Then comes Corona (photo 1): the younger sister who reveals tremendous artistic ability and perfect penmanship. While family members settle for simple stick-figure drawings, she spends hours producing intricate and precise drawings. And her free spirit makes her more at home in Fortune 1000 companies than in the Fortune 100, although she would be useful in any office.

The Corona PC is a cream-colored desktop personal computer that is about 90 percent compatible with the IBM PC. In fact, its major incompatibility is also one of its best features—a high-density, high-contrast graphics screen. Its other departure from the IBM PC is its price, $2995 for a system with two floppy-disk drives (320K bytes each), 128K bytes of memory, serial and parallel interfaces, and a medium-size software bundle (MS-DOS, a BASIC interpreter, PC-Tutor, and a word processor). (See At a Glance box for more information.) The equivalent configuration from IBM costs about $1000 more.

The Corona should work fairly well in any office where an IBM PC might be found, especially for word-processing applications. When new applications software takes advantage of the Corona's high-quality graphics, this machine's capabilities will really stand out. Like any new computer, it has a few knots and rough edges, but nothing the experienced computer user cannot adjust to.

Hardware

Physically, the Corona resembles the IBM PC. It takes up about the same space on your desk and is just as heavy when you try moving it to another office. Its disk drives remain true to IBM's, horizontal and on the right side of the unit.

One obvious difference is the position of the Corona's on/off switch. Corona subscribes to a common yet curious school of thought that holds that this important switch should be in the most inaccessible place possible—the back panel. Thus, turning the Corona on requires a prerequisite minute or so while your fingers fumble around for the switch.

While fumbling, however, you discover something handy—a reset switch. The IBM PC and most of its clones use a combination of the Alternate, Control, and Delete keys to trigger a reset that can be deactivated by software. The result is that when certain software packages "hang up," you have to turn the machine off, wait 10 seconds, turn it on, and wait a minute while the computer checks its memory. On the Corona, you simply hit the Reset button on the back panel. This button is not easy to find, and it has a light touch. I usually just flap my fingers around the back for a second or so until I hear the disk drives start up.

The Display

The Corona's major attraction is its display. This display has good resolution (640 by 325 pixels) and extremely good contrast: it reminds me of the Victor 9000. (By the way, the display arrived here in a box from the

At a Glance

Name
Corona PC

Manufacturer
Corona Data Systems
31324 Via Colinas, Suite 110
Westlake Village, CA 91362

Components
Size: 19 by 17 by 18 inches (including monitor). Processor: 8088, 16 bit, 5 MHz. Memory: 128K bytes (expandable to 512K bytes). Display: green-phosphor, 80 by 25 characters, IBM PC-style character set. Characters can be underlined, reverse video, high intensity, or blinking. Graphics format: 640 by 325 pixels, two colors (black and green). Keyboard: 83 keys, modified IBM PC-style key layout, 10 function keys, numeric keypad. Mass storage: one 320K-byte floppy-disk drive. Optional second floppy-disk drive or 10-megabyte hard-disk drive. Interfaces: parallel-printer port and RS-232C serial port. Expansion: four IBM PC-style expansion slots.

Software
MS-DOS version 1.25 operating system, GW BASIC interpreter, Multimate word-processing program, PC-Tutor

Options
Second floppy-disk drive: $450; extra memory modules, 128K bytes each: $295; 10-megabyte hard-disk drive: $2295

Documentation
Four loose-leaf binders, approximately 150 pages each, 5½- by 8½-inch pages

Price

With one floppy-disk drive:	$2595
With two floppy-disk drives:	$2995
With one floppy-disk drive and one 10-megabyte hard-disk drive:	$4495

Photo 2: *The display screen of the Corona (left) compared with that of the IBM PC (right). Both photos were taken under the same conditions. Note the Corona's increased contrast and the IBM's well-formed characters.*

Amdek company.) Photo 2 compares the display with that of the IBM PC.

The people at Corona claim that the true resolution of their display is a whopping 1280 by 325 pixels (picture elements). You can't access these 1280 pixels directly (i.e., through BASIC), but the Corona's character generator seems to use them, with the result that the Corona's character set is smooth and practically free of "jaggies."

In character mode, the Corona PC varies in only one way from the IBM PC. It features the same 80-line by 25-character layout, the same attributes for each character (reverse video, underline, high intensity), and the same variety of characters (see photo 3). The one exception involves formation of the individual characters. Each character occupies a matrix that is 16 pixels wide by 13 pixels high. Yes, that's 16 pixels wide. At first I thought this was inaccurate, but I took out my magnifying loupe, which I use for software warranties and license agreements, and sure enough they were right. Each pixel is about half as wide as it is high. The lowercase "y" is made up of at least 11 pixels from left to right (see photo 4). Add some pixels for the spaces between characters and you get 16.

You might think that with that many pixels to play with, the Corona would have a superb design for each character. But the Corona's characters do not seem to take full advantage of their high-density pixel grid. I think that the character font used by the IBM PC monochrome monitor is more readable than the one Corona uses. The Corona font looks like the IBM font would look after being on a diet for a few weeks.

One of the nice things about the IBM font is that it is richly decorated with serifs, little pen marks that have been helping us distinguish characters for hundreds of years. Corona probably chose to use a thin, sans-serif style to be modern, and I can live with it if I have to. On the Corona's high-contrast screen, any font is OK. But if the company ever came out with a plug-in chip that would generate a font similar to the IBM's, I'd be first in line to buy it.

While the character mode of the Corona's display is functionally (if not visually) compatible with the IBM, in graphics mode the display takes a sharply divergent path. The IBM Color Graphics Adapter card gives the IBM PC three graphics modes; the highest resolution is 640 by 200. The Corona, however, offers only one graphics mode, in black and white, with about 50 percent more

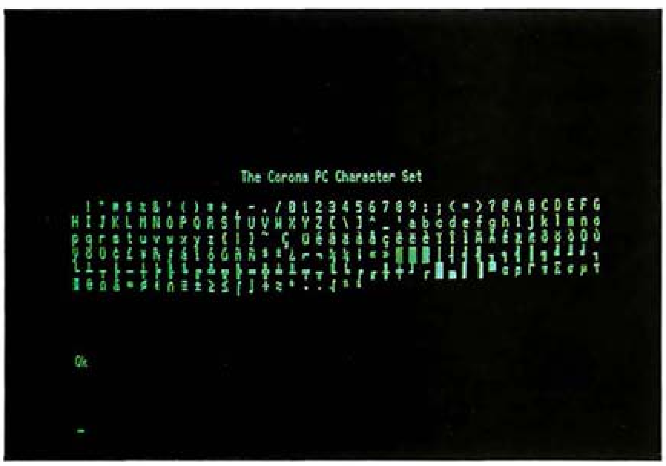

Photo 3: *The character set of the Corona PC. The Corona has the same variety of characters as the IBM PC.*

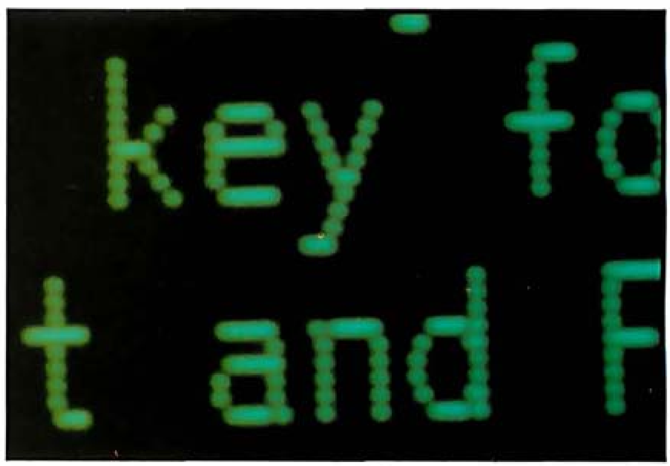

Photo 4: *A close-up view of the characters on the Corona's display Note the large number of pixels that form each letter.*

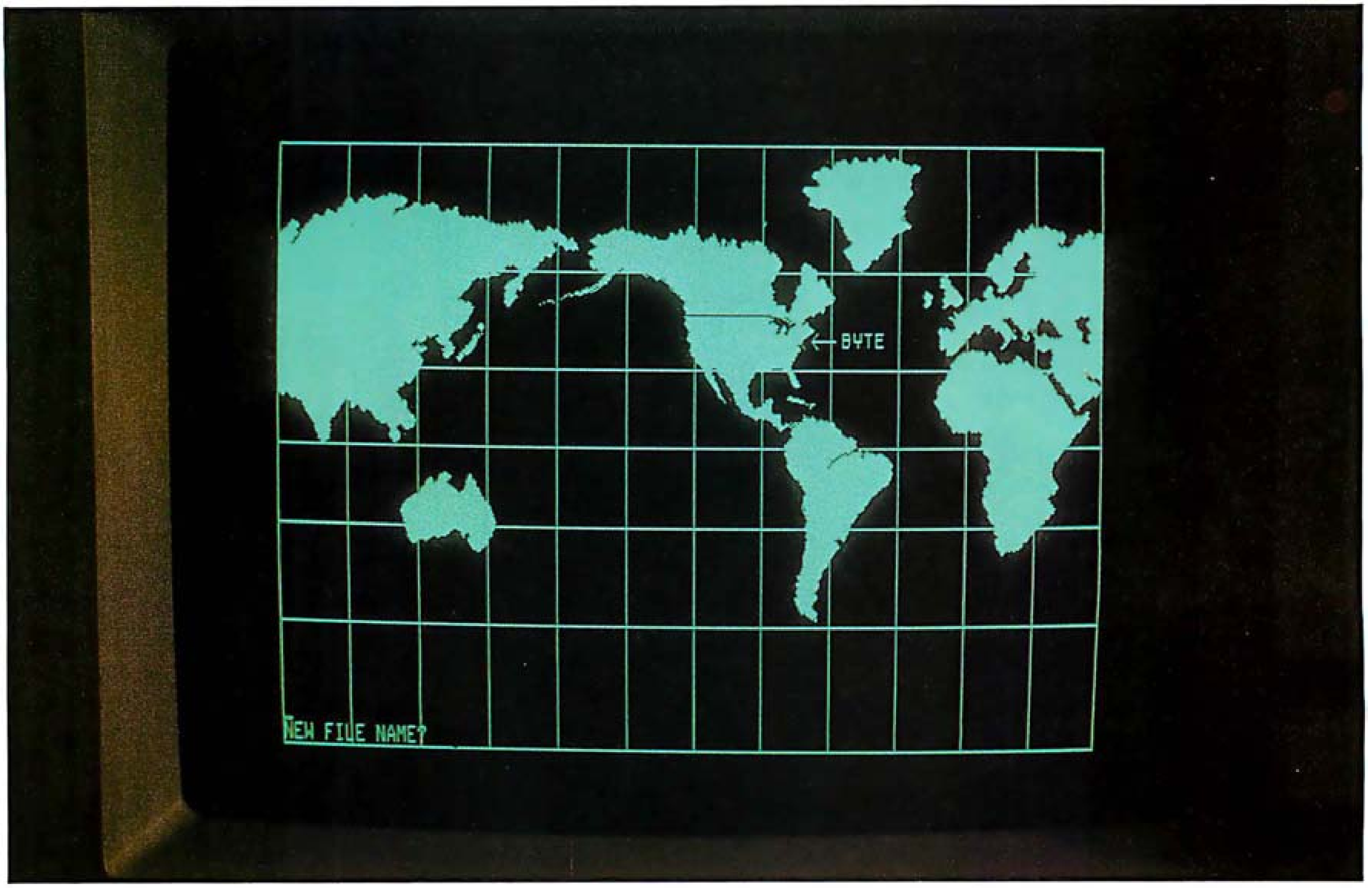

Photo 5: *An example of the graphics capabilities of the Corona, this picture was produced by a BASIC program called Etch. The resolution of the screen here is 640 by 325 pixels.*

pixels (640 by 325) than the IBM has (see photo 5). The Corona has better resolution, but it pays for this by not being compatible with the graphics software for the IBM.

Fortunately, this incompatibility problem with IBM's graphics can be solved in any of three ways. First, you can install an IBM Color Graphics Adapter card into the Corona (just as you would have to with the IBM PC) and purchase a color monitor, and your machine will be completely compatible with any graphics program for the IBM. Second, you can wait until the popular software houses modify their programs so that they can run directly on the Corona. Or third, you can wait until the GSX graphics interpreter for the CP/M-86 operating systems becomes readily available. This interpreter is intended to eliminate all graphics incompatibility from one computer to another or from one peripheral to another. Admittedly, the last two alternatives are a bit chancy. The important thing to remember is that if there is any problem, you can install the IBM graphics board.

I should note that on the Corona's display, graphics and characters can by intermixed anywhere on the screen. Also, graphics information can be stored in several places in memory. An advanced programmer can quickly switch from place to place in memory and set up some fast-moving images.

In BASIC, you can individually address any pixel in a 640 by 325 pixel grid, but only two colors are supported: black and white (actually green). As mentioned previously, the real resolution of the screen is 1280 by 325, so each addressable pixel is actually made up of two smaller pixels. Advanced programmers may be able to individually address each of the these smaller pixels.

The Keyboard

The Corona, like many of the IBM compatibles, uses a keyboard produced by Key Tronic in Washington. Visually, it is almost an exact duplicate of the IBM keyboard (see photo 6). It has the same 83 keys, including 10 function keys, a combination cursor-control/numeric keypad, and keys such as Num Lock, Scroll Lock, and PrtSc. Functionally, it has a similar keyboard processor and type-ahead buffer, but it is lighter, quieter, and has its own indicator lights for the Caps Lock and Num Lock keys.

Key Tronic offers two key layouts for this keyboard. One is an exact duplicate of the controversial key layout used by the IBM PC. The other is a more traditional (i.e., sensible) layout with the left Shift key and the Return key in their usual positions. Corona was originally going to use the exact IBM key layout, but it received so many requests for the traditional layout that it has now switched to that keyboard.

In "The Corona Portable PC" (September 1983 BYTE, page 226), I mentioned that the keyboard on the Corona Portable was one of the best I had seen. It was. But that keyboard had the Shift keys and Return keys in the

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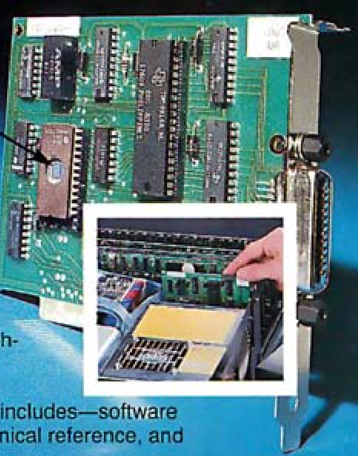

right places. Unfortunately, the keyboard we received with the desktop Corona had the exact IBM key layout, and it was a bit harder to use. Not only were the keys in nonstandard places, but some of the keys had very light touches. For example, I must have a tendency to rest my index finger on the J key because "j" kept appearing in strange places.

No doubt you can grow accustomed to this keyboard, but after three weeks of heavy use, my error rate was still about twice what it was with my old IBM Selectric.

Of course, it's difficult to be objective about keyboards. Everyone has preferences. In fact, some people really *like* the IBM PC key layout. I prefer the Corona with the more traditional keyboard. And I'd prefer a slightly heavier touch.

The Processor

Like the IBM PC, the Corona is built around the 16-bit 8088 microprocessor with a clock speed of 5 MHz. Having this processor, of course, doesn't guarantee compatibility with the IBM PC, but it's a good start. Also, the slightly higher clock speed of this processor means that the Corona will be about 5 percent faster than the IBM PC.

Memory

The most significant thing about the Corona's memory is that you can put up to 512K bytes of RAM (random-access read/write memory) chips directly on the main board; you don't need to tie up any of the expansion slots. Also, the Corona comes with software that enables you to partition part of this memory as a RAM disk.

The standard Corona comes with 128K bytes of memory, a reasonable amount. The unit I used had 256K bytes with 128K bytes of this configured as a RAM disk. I didn't run out of memory, but I didn't run any huge spreadsheets, either.

One nice thing about the Corona is that it doesn't spend a minute checking all of the memory each time you turn on the machine. This should save about 10 hours of time over the life of the machine. The rationale for this is that even if the machine were to find a bad memory chip, it is better to have a machine that works partially than a machine that won't let you work at all. Just in case, Corona provides a nice memory-test program that graphically tells you which chip is bad.

Power Supply

The Corona power supply provides 110 watts (W) compared to the 64 W supplied by the IBM PC. The additional supply in the Corona enables you to add internal peripherals such as a hard disk without fear of overloading the machine.

Floppy-Disk Drives

The standard unit comes with one 320K-byte floppy-disk drive. There is room for another floppy or for a hard disk. The floppy disks use a standard configuration for double-sided double-density disks under MS-DOS ver-

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Photo 6: *The Corona's keyboard, which was produced by Key Tronic. Again, note the similarity to that of the IBM. Also note that future editions of the Corona will have some keys repositioned, specifically the left Shift key and the Return key.*

sion 1.25. When MS-DOS 2.00 becomes available for the Corona, you should be able to put 360K bytes on each disk.

The only difference I've noticed between the Corona floppy-disk drives and those of the IBM is that the Corona drives are quieter, though not as quiet as those of the Compaq.

Interfaces

It's been about a year since I've heard of a new computer that does *not* come standard with both a Centronics parallel-printer port and a serial RS-232C port. Progressive thinking such as this is much welcomed.

The Corona is no exception to this forward trend. The circuitry for both of these interfaces is right on the main circuit board. The connectors for these interfaces are on the back panel (see photo 7). I've used the parallel port with an Epson MX-80 printer and had no problem with it. The serial RS-232C port, however, is more difficult.

Part of the problem is that the RS-232C standard is itself difficult. According to the standard, the whole world is divided into two parts: data-terminal equipment (DTE) and data-communications equipment (DCE). The important thing to remember is that DTEs can talk only with DCEs, and vice versa. Almost all modems are naturally configured as DCEs, and most microcomputers are configured as terminals or DTEs. Serial printers, however, can't seem to make up their minds. Some are DTEs, some are DCEs.

The Corona is one of the few computers that enable you to configure it as either a DTE or a DCE. Theoretically, you could set up the machine as a DTE to have an easy connection with a modem (DCE), or you could set it up as a DCE to connect with any other computer (DTE), or as either of the above to connect with a serial printer (DTE or DCE). The problem in doing this is that to change the configuration you must remove the top cover of the system unit, pull out a jumper (which looks like a memory chip and is very hard to reach), and insert it into another socket.

With this jumper in the modem socket, I could easily connect a Hayes Smartmodem to the Corona. And with

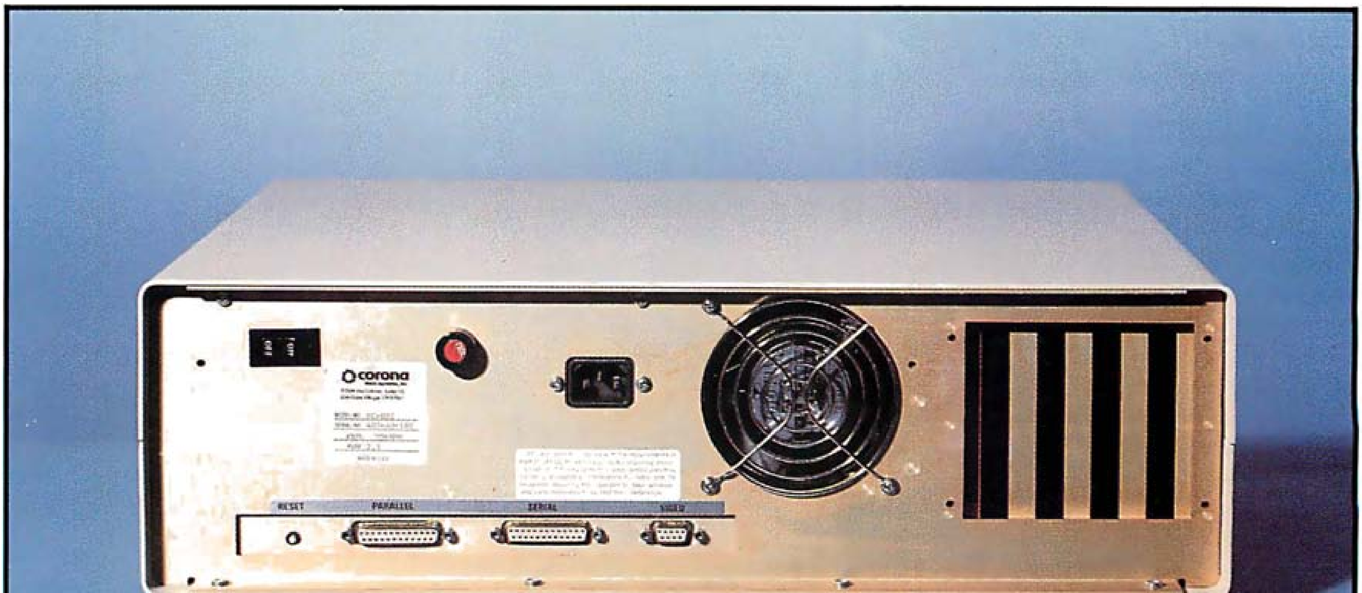

Photo 7: *The back panel of the Corona. Note the Reset switch on the left, the parallel-printer port, the serial port, the video-display port, and the openings for the expansion cards.*

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the jumper in the printer socket, I could easily connect a Diablo 1640 daisy-wheel printer.

But while these hardware connections were satisfactory, the software for them seemed a bit hard to use. For example, I had a hard time trying to access the modem port from BASIC. A popular communications program in BASIC called PC-Talk also had trouble using the modem port. When I connected a serial printer, I was able to access it through BASIC, but I had a little trouble using it with a word processor. These seem to be minor bugs, which I hope will be fixed soon.

Peripherals

The unit we received from Corona included a pleasant surprise: a 10-megabyte hard-disk drive. This disk drive, which up until recently was Corona's major product, is impressive. Its list price is $2295, and I've seen ads offering the drive at a much lower price.

The hard disk can be subdivided into one, two, three, or four parts. You can easily designate the size of each part. The instructions for formatting and loading the disk, however, are a bit less than ideal; you have to execute a series of four programs. (A simple batch file that would execute these four programs automatically would have been helpful.) But once you have the procedure ironed out, it is fairly straightforward. The actual formatting of the disk takes only about 6 minutes.

Overall, the hard disk was a pleasure to use. Disk-access times for the hard disk were usually fairly fast (although some individual accesses can be as slow as that of a floppy disk), and the storage capacity is huge. In fact, a few weeks with a hard disk can spoil you for systems that have only floppy disks. But the hard disk's seemingly bottomless pit of storage capacity has a price. You must be sure that everything on that disk is backed up on floppy disks. Hard-disk errors are not rare. And a 10-megabyte hard-disk drive will require at least 30 floppy disks to back it up.

Expansion Slots

The Corona comes with four expansion slots that should accommodate any board built for the IBM (see photo 8). The IBM Color Graphics Adapter board works fine, but I had some trouble with QuadRAM's Quadboard because it is incompatible with the Corona's hard disk.

Note that the IBM PC with capabilities similar to that of the standard Corona may have only one slot left open.

Software

Some personal computers, such as the Columbia MPC, come with a complete assortment of software. Some, such as the IBM PC itself, come with the bare minimum—a BASIC interpreter. The Corona lies somewhere in the middle.

Like the IBM, the Corona has a BASIC interpreter (GW BASIC from Microsoft). It also features the MS-DOS operating system (version 1.25), a word-processing program patterned after Wang's dedicated word processors,

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Photo 8: *Inside the Corona. A Seagate hard-disk drive is on the lower right and the expansion slots are on the left. One of the slots is taken up by the hard-disk controller. The power supply is on the upper right.*

and a teaching program to guide you through the intricacies of MS-DOS.

MS-DOS

Despite assertions to the contrary, PC-DOS and MS-DOS are not the same thing, although they are extremely close. Moreover, MS-DOS seems to vary from machine to machine. It is true that all MS-DOS machines can read each other's disks, and they can use most of the same MS-DOS utility programs. But there are some differences.

For example, in PC-DOS you can create batch files by using the COPY command to "copy" a file from the keyboard (which is referred to as "CON:") to a batch file. On the Corona, you call the keyboard "CON," without the color.

As I mentioned before, the Corona's version of MS-DOS also seems to have trouble handling the serial port with the Mode utility program. But perhaps this will be only a temporary problem.

Multimate

This relatively new word processor from Softword Systems of East Hartford, Connecticut, was designed as a "professional" word processor for the IBM PC. The word "professional" here means that it is supposed to be similiar to the Wang word processors. When, I wonder, will things come full circle and someone design a word-processing program for the IBM PC based on the IBM Displaywriter?

Multimate for the Corona does not seem to be too different from Multimate for any other MS-DOS machine. But because some impressive claims have been made for it and it is a rather impressive package, I will take some time to describe it here.

Multimate is a fairly powerful and fast system. Among its noteworthy features are the abilities to merge letter files with address files, to spool your printing jobs into a queue that can be printed in the background, to do decimal tabs, to perform column arithmetic, and to move columns. In addition, you can save your preferred tab

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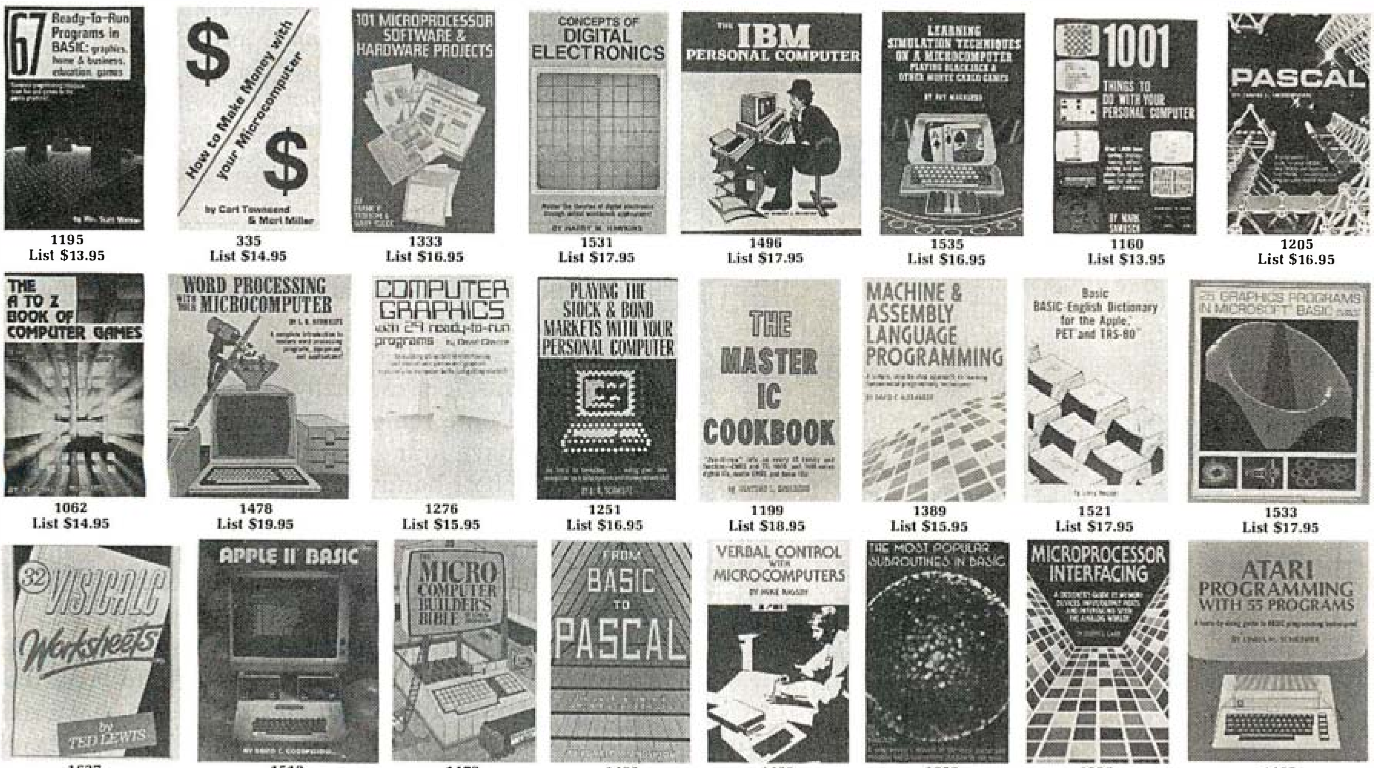

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BASIC Benchmark	Time (seconds) Corona	IBM PC	IBM XT
5000 loops	6	7	7
5000 divisions	19	24	24
5000 GOSUBs	11	13	13
5000 MID$s	23	24	24
Sieve program (1 iteration)	185	192	192
Disk write (64K bytes)			
Floppy	30	31	29
Winchester	14	—	8
Disk read (64K bytes)			
Floppy	22	22	23
Winchester	7	—	8

Table 1: *A comparison of the Corona PC with the IBM PC and PC XT using BASIC. Note the slight advantage of the Corona, but the relatively slow speed of its Winchester disk-write routine. The Corona used GW BASIC running under MS-DOS version 1.25 on a 5-MHz 8088 microprocessor. The IBM PC used BASICA (version 1.1) under PC-DOS version 1.1 on a standard 4.77-MHz processor. The IBM PC XT was running under PC-DOS version 2.00. For a listing of the programs, see January 1982 BYTE, page 54.*

stops, right margin, and printer instructions in default files, which will automatically be inserted into all of your subsequent documents.

Multimate is also fairly easy to use, but it does have some problems. It has so many capabilities that you may have a hard time remembering which keys do what. Some keys have four separate functions. You have to keep a key chart handy at all times.

Also, the program has some minor inconsistencies. In some parts of the program you execute a task by pressing the Return key; in others you must press the F10 key (which attempts to act as Wang's Execute key). In some parts you can delete a character by pressing the Delete key or the Minus key; in others you have to press the Backspace key. And though you can delete characters to the right, you can't delete characters to the left.

A problem that is not minor is a utility program called Fileconv. This is supposed to convert Multimate text files to regular ASCII (American National Standard Code for Information Interchange) format and vice versa. It's necessary because Multimate uses some non-ASCII characters (i.e., characters with codes greater than the decimal number 127; see photo 9). Multimate also requires space for a screen of file information (e.g., author, title, comments, and date created) and format lines, which indicate tab stops and right margins. This conversion program, however, works only 50 percent of the time. The rest of the time it crashes the system.

Here at BYTE, with our mosaic of computer and typesetting systems, such a program is very important. A given document may pass through three different computers. If a document cannot be reliably passed to or retrieved from a given word processor, then that word processor has limited use. Multimate's Fileconv program as it now stands seems to have been an afterthought. I hope Softword will have a better program out soon.

Photo 9: *An example of a document being edited by the Multimate word processor. Note the format line at the top of the screen and the non-ASCII characters to indicate tab stops, carriage returns, and indents. Also note the highlighted area that is to be deleted.*

GW BASIC

The Corona's BASIC interpreter is similar to that of the IBM PC. The major difference is the graphics commands, which are geared to the Corona's unique graphics format.

Almost all of the features I tried worked satisfactorily, but I did find two problems. First, when I was editing a BASIC program using the full-screen editor, the system would on occasion mysteriously hang up.

Second, as mentioned earlier, I had trouble getting the BASIC interpreter to access the serial port. In the GW BASIC manual, Corona supplies a 50-line BASIC program to allow you to use the Corona as a communications terminal. This program looks good, except that it contains a few mistakes. And even when the mistakes are corrected, the program does not work. A mysterious "Device I/O Error" message occurs at certain places. The only way to get the program to work was to trap these errors with an ON ERROR ... RESUME sequence.

As for performance, some standard BYTE benchmarks (see table 1) indicated that the Corona was slightly faster than the IBM PC and XT, faster in fact than the difference in processor speeds might suggest.

PC-TUTOR

This program is designed to lead you through MS-DOS in a painless but tedious manner. This is an interesting program, but beware: you may learn more than you ever wanted to know about things like MS-DOS's "kludgey" line editor called Edlin.

Compatibility

I ran a number of IBM PC programs on the Corona. Almost all of them (including Visicalc, Wordstar, and 1-2-3 from Lotus Development Corporation) worked without any problems. The only one that didn't was a telecommunications program (PC/Intercom) that accessed the IBM PC's monochrome display memory directly. If the IBM Color Graphics Adapter had been installed, even this program would probably have worked.

Of course, if your application depends on a specific IBM software package, be sure to test it on the Corona before you buy either.

Documentation

Once again, Corona emulates the IBM. Four books, with pages approximately the same size as those in IBM manuals, are included: one for GW BASIC, one for MS-DOS, one for Multimate, and one for operating instructions.

The documentation is fairly comprehensive, but it has a few minor errors. It is, however, undergoing continuous evolution.

The Multimate manual and the operating instructions are fairly straightforward. The manuals for GW BASIC and MS-DOS are more difficult. I wouldn't hand these to a new user.

The Manufacturer

Corona was founded approximately two years ago by Robert Harp, who was one of the founders of Vector Graphic, an early microcomputer manufacturer. Vector Graphic historically has leaned toward larger personal computers, and Corona, with its emphasis on hard disks and husky power supplies, seems to follow that trend.

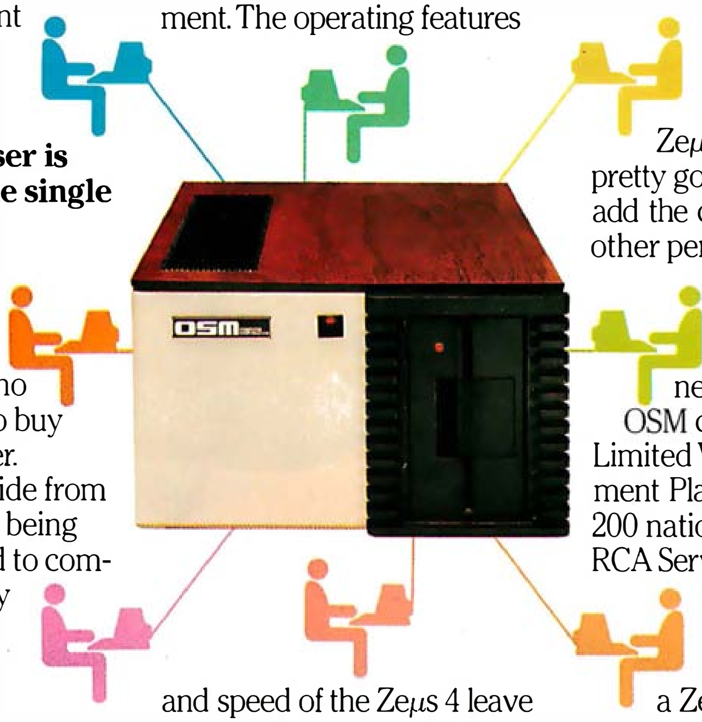
Corona has just recently begun shipping its portable computer, which is almost identical to its PC (see "The Corona Portable PC," September BYTE, page 226). Release of this machine was held up because of problems with its plastic case.

Corona has told us that in the near future it will offer a "professional" computer with a bit more power than the PC. Corona will also be offering another graphics format, 640 by 400 pixels, which will be compatible with the IBM's format of 640 by 200 pixels.

Summary

The Corona PC is a good, reasonably priced IBM PC-compatible computer. As a new machine from a relatively new company, it has a number of inevitable bugs and inconsistencies. If you have the expertise to iron out these bugs or the patience to wait for fixes to come out, then the Corona may be a good way to save some money. For offices that already have an IBM PC, the Corona represents a good way to add extra computing power at a minimal cost. Also, if a high-contrast, high-resolution display screen is important to you, then give the Corona some thought—but wait until some good software for this display arrives. Fortunately, this machine's graphics are so good that it should readily attract graphics programmers. The wait should not be too long at all. ■

Rich Malloy is a senior technical editor at BYTE. He can be reached at POB 372, Hancock, NH 03449.



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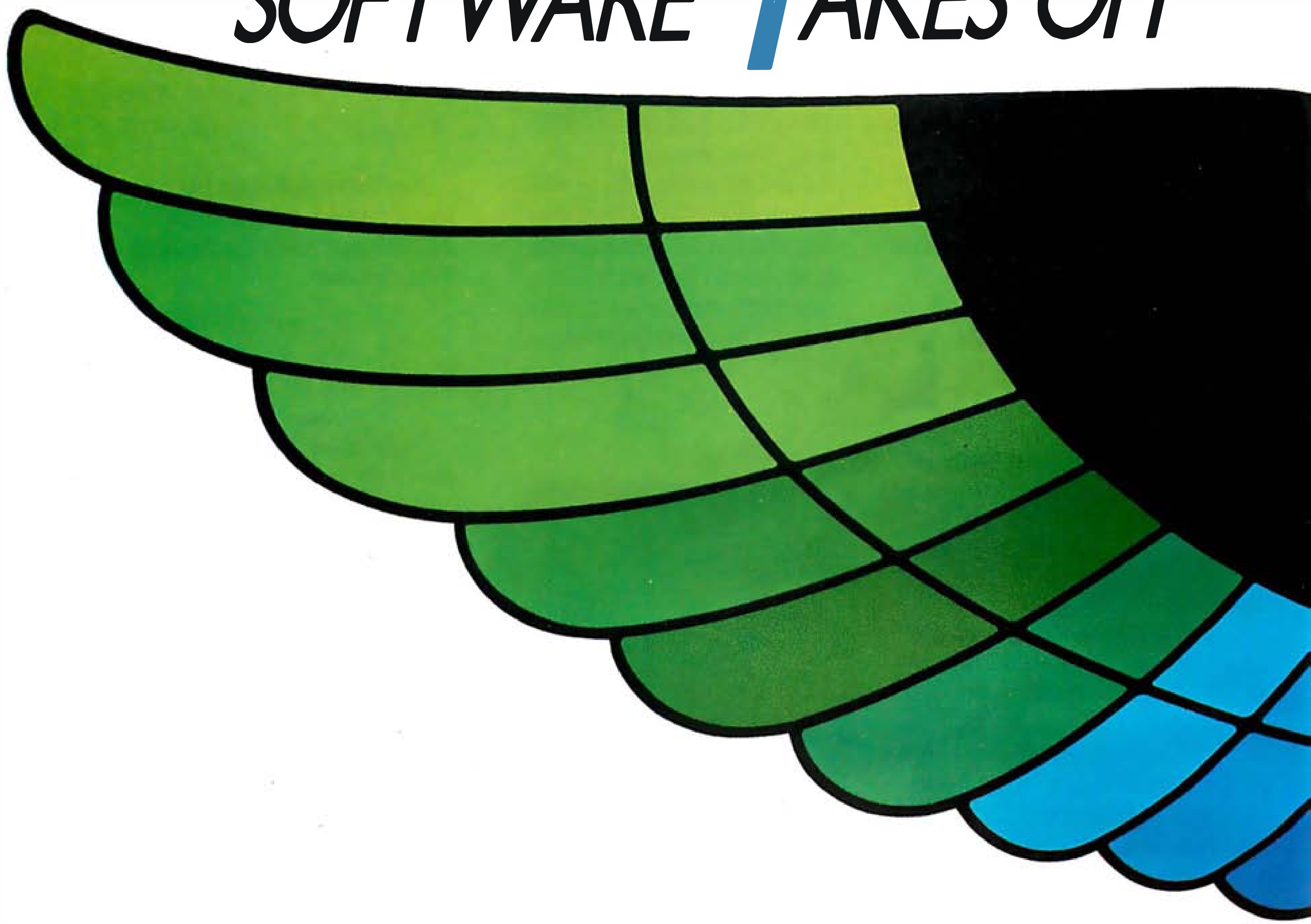

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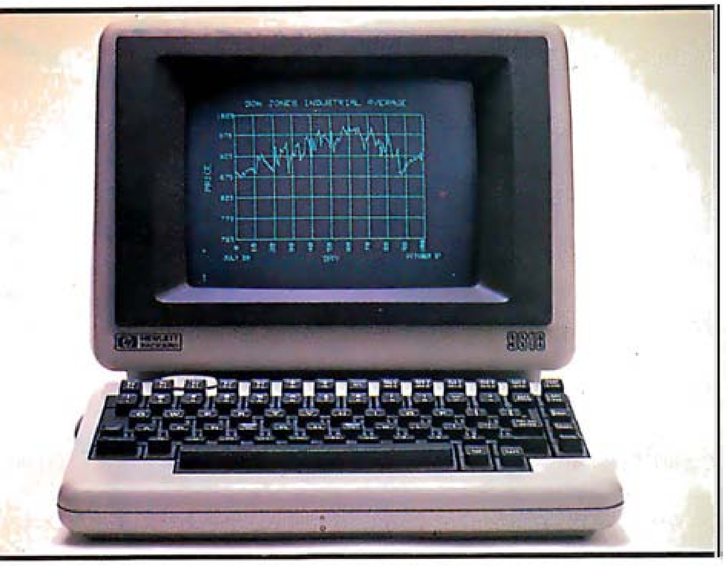

Photo 1: *The HP Series 200 Model 16, or, as it is sometimes called, the HP 9816.*

Photo 2: *The rear panel of the Model 16. Note the HP-IB connector at the center of the bottom part of the panel and the serial connector in the lower-left corner.*

Photo 3: *The Model 16, shown here with a dual 3½-inch floppy-disk drive, takes up a small amount of desk space. Note the "knob," a one-dimensional track ball, on the upper-left corner of the keyboard.*

A Look at the

This 68000-based microcomputer offers quite a bit of power in a small package

by Berry Kercheval

After reading an article in the June BYTE about Hewlett-Packard's new 16-bit computer, I'll admit I was a bit skeptical about some of the claims made (see reference 4). After all, the article was written by an HP designer. However, I was recently given the chance to test this machine myself in my office at Zehntel Inc.

The Hewlett-Packard Series 200 Model 16, or the HP 9816, is one of three versions of Hewlett-Packard Series 200 computers (see photo 1). These computers have a common feature, the powerful 16-bit 68000 microprocessor chip. The other two members of this group, the 9826 and the 9836, are aimed at HP's traditional market—the technical laboratory. The desktop size of the Model 16 seems to indicate that this model is geared for the business or engineering office.

The Model 16 costs $3985 and consists of only a keyboard and a monitor. The unit that I tested was also equipped with an HP 9121 dual-disk drive (3½-inch Sony format, $1775), an HP 2672G thermal printer ($1240), an HP 7470A plotter ($1575), a BASIC interpreter (Pro-BASIC, $355), and a Pascal program-development system (HP Standard Pascal, $1515). As you can see, HP is not a discount house.

Because I picked this system up at BYTE's San Francisco office, I don't know how it was originally packed, but, as products I've ordered from HP in the past have always been efficiently and carefully wrapped, I assume the Model 16 was given HP's traditional care.

Setting up the system was easy. Interconnection of the various units—a difficult task on many systems—was facilitated by the use of the Hewlett-Packard interface bus (HP-IB), also known as the IEEE-488 bus (see photo 2). All of the system's components have identical stacking connectors and can be connected in any configuration (usually a star or daisy-chain layout is used).

After everything was connected and plugged in, I turned the power on and the system came up without a problem. Since then, I have moved the hardware between my office and home several times, and the equipment has survived with very few problems.

The Computer

The Model 16's main box is only 1-foot square and contains the monitor, 512K bytes of memory, an HP-IB interface and an RS-232C interface, and a 68000 microprocessor.

The detachable keyboard has its own microprocessor (an 8041) to scan keys, set timers, and beep.

A round "knob" on the keyboard is a one-dimensional track ball (see photo 3). As it rotates, it generates pulses that are detected by the keyboard microprocessor. This feature can be used to scroll text in both the Pascal and BASIC editors or it can adjust the parameters of, for instance, instruments attached to the interface bus.

I found nothing especially offensive about the Model 16's keyboard layout. However, much of the software supplied by HP was designed for the 9826, which has a different keyboard. Several keys on the 9826's keyboard are not on the Model 16's.

Absent, for instance, are the Alpha and Graphics keys, which toggle the display of the alphanumeric and graphics memory. On the 9826, these keys suppress the display of graphics while commands are being typed. On the Model 16, BASIC commands can be typed in to execute the same functions, but this is not as convenient as using a single keystroke. When using the Pascal system, several keys are mapped by the software to perform these functions, but they only work at the command-line level. It took me four days to find this out because the information was buried in the documentation. Systems that run Pascal now come with a keyboard sticker to indicate which keys have been mapped for Alpha and Graphics functions. Unfortunately, the sticker doesn't fit where the manufacturer tells you to put it.

Absence of a keyboard tilde (~) is also frustrating. Tildes are used in many of the Unix programs, including the C-shell and Berkeley Mail. In my opinion, the lack of this key seriously compromises the system's ability to act as a remote terminal.

The keyboard also has a beeper with software-controlled pitch and duration. The pitch is 81.36 times the value stored in a 6-bit latch set by the keyboard microprocessor. It would have been nice if the designers had taken the time to make the pitches form an equal-tempered musical scale so that tunes could be played on it (as in the HP-85).

The Model 16's main box has two card slots in the back. In my machine one of these slots held a memory card. The no-frills version of the system comes with 256K bytes of RAM (random-access read/write memory) on its main board; 256K bytes of additional RAM cost $1060. In this configuration, however, the system cannot boot the RAM BASIC, and an attempt to do so results in the message "not enough memory." The limitation of two expansion

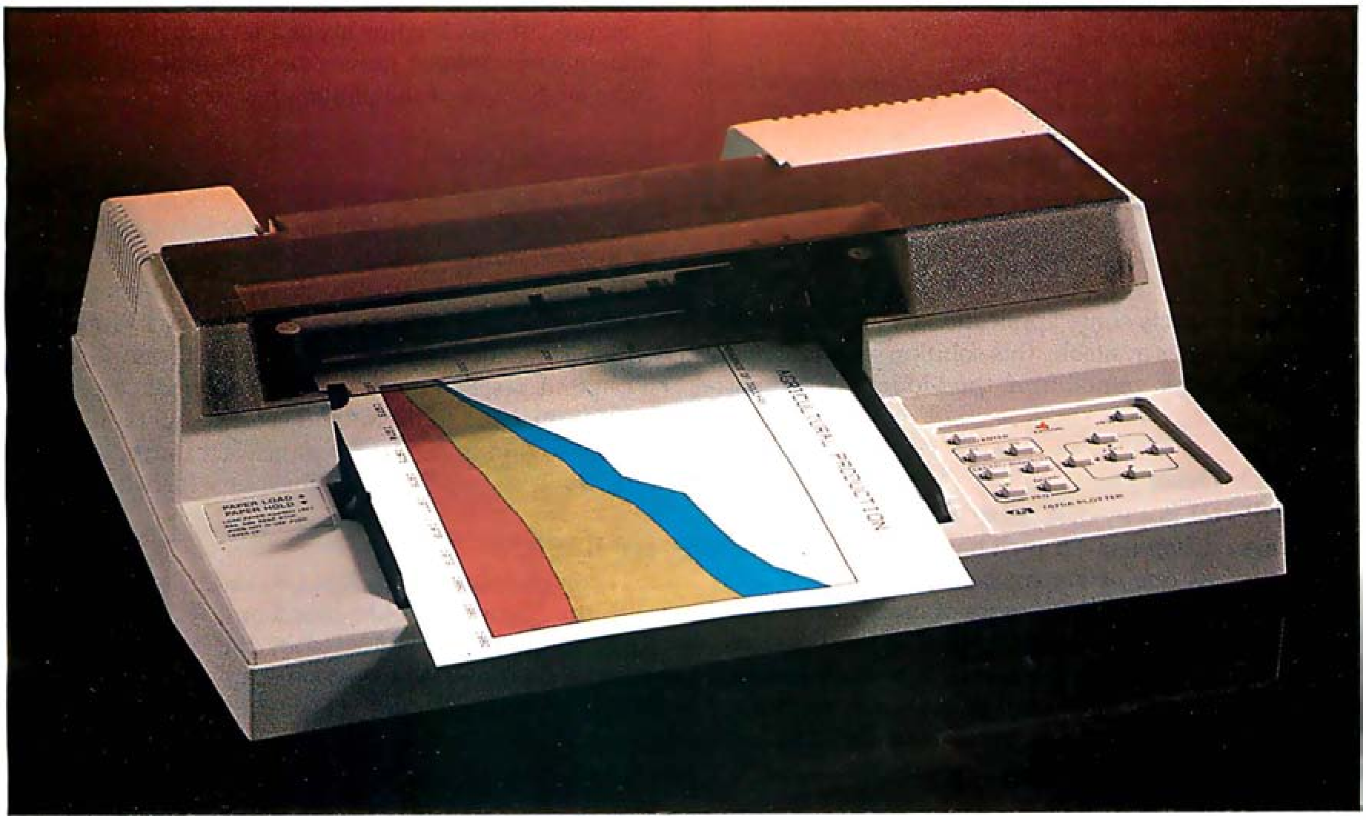

Photo 4: *The HP 7470A two-pen plotter. This plotter comes with either an HP-IB connector for use with the Series 200 Model 16, or an RS-232C connector. It uses 8½- by 11-inch paper, and more than two colors can be plotted by manually changing the pens. The list price for this plotter has been recently reduced to $1095.*

At a Glance

Name
The HP Series 200 Model 16, or HP 9816

Manufacturer
Hewlett-Packard
1820 Embarcadero Rd.
Palo Alto, CA 94303
(800) 367-4772

Components
Size: 12.4 by 19.2 by 11.1 inches
Processor: 16-bit, Motorola 68000, 8 megahertz
Memory: RAM—128K bytes to 256K bytes on main board, 256K bytes additional on optional board ($1060); ROM—16K bytes or 48K bytes of bootstrap code
Display: 9-inch white phosphor (P4), 80 characters by 25 lines, 400 by 300 graphics format (25 pixels per centimeter)
Keyboard: detachable typewriter-style keyboard, 10 function keys plus a "knob" (one-dimensional track ball)
Mass Storage: variety of floppy- and hard-disk drives available; most compatible with the HP 9121D dual 3½-inch floppy-disk drive ($1775)
Expansion: HP-IB and RS-232C interfaces; two expansion slots for extra memory and interfaces

Options (partial list)
Hardware: HP 9121D dual 3½-inch floppy-disk drive ($1775), HP 82901M dual 5¼-inch floppy-disk drive ($2230), HP 9134A 4.6-megabyte Winchester drive ($3500), HP 2671G serial-thermal graphics printer ($1540), HP 7470A two-pen plotter ($1095)
Software: Pro-BASIC ($355), HP Standard Pascal program-development system ($1515), HPL (APL) ($355), Context MBA ($795)

Documentation
Hardware: operating manual, 150 pages, 8½- by 9-inch; BASIC: four volumes; Pascal: two volumes

Price
With 128K bytes of RAM, less disk drives and software: $3985; with 256K bytes, less disk drives and software: $4450; with 512K bytes plus Pro-BASIC: $5550; with 256K bytes, Pro-BASIC, and dual 3½-floppy disks: $6580

cards thus restricts some applications. Although an expansion chassis is available, this solution sacrifices many of the advantages gained from the Model 16's compactness.

The Disk Drive

The HP 9121 floppy-disk drive is a real gem. Built by Sony, these drives use 3½-inch hard-shell floppy disks, or "stiffies" as one of my coworkers christened them. Each disk holds about 270K bytes of usable data, under the formatting scheme used by HP. The hard case provides better protection from damage than ordinary floppy-disk casings. Additional protection is afforded by a metal flap covering the access hole in the case and a metal bushing reinforcing the center hole.

The disk spins at a high rate (for a floppy), enabling high data-transfer rates. The built-in controller performs bad-block substitution, making these disks reliable. I used more than 20 disks and experienced no trouble.

The Printer and Plotter

The 2671G printer that comes with the system prints on special thermal paper and has graphics capabilities. (The G in 2671G indicates that the printer has these capabilities.) The first printer I tried mysteriously expired soon after I got it to my office, but Hewlett-Packard replaced it with little delay.

The printer was designed to sit on top of a 9826, but it does not fit on the Model 16. Because some Pascal utilities require an online printer, the advantages of the Model 16's small size are lost here.

The replacement printer worked well. Its only disadvantage is that it requires expensive thermal paper. Special holes in the paper enable the printer to detect the end of a page. (Use of paper other than that supplied by HP voids the warranty.)

The plotter was the system's star attraction when I set up the unit at my office (see photo 4). A novel mechanism pinches the paper between a wheel coated with a fine grit and a polyurethane pinch roller to provide the plotter's x-axis motion. This motion moves only the paper back and forth, greatly reducing the mass that must be accelerated. This means smaller motors can be used, lowering the manufacturing costs.

Sliding the pen-holder along a precision stainless-steel rod enables the y-axis motion. Twin pen stalls at either end of the rod can be used to make multicolored plots.

Clever engineering of the DC servo motors and optical encoders used for position feedback also help keep the unit's cost down. At $1095 (list price) this plotter is a real bargain.

Figure 1 shows the first six of a set of recursive figures known as Sierpinski curves (see reference 5) and provides an example of the plotter's resolution and accuracy.

System Software

Even the greatest computer hardware is useless with outdated software; the quality of the software is critical to the computer's utility.

The first piece of software a user encounters with the Model 16 is the code in the boot ROMs. Version 3.0, which is installed in the computer, initializes everything it can find, tests memory, polls the interface cards to see what is attached to them, and searches all online mass storage to find bootable programs. If it finds more than one, the user is offered a choice of which to load.

HP BASIC

The manufacturer provides two varieties of HP BASIC with the Model 16: RAM-based and ROM-based. The RAM-based BASIC is loaded by the boot ROMs off a disk, while the ROM-based software resides in a set of ROMs on a plug-in card. This card takes up one of the two card slots on the main box.

The BASIC is good, for BASIC. (I should mention here that BASIC is not my favorite language, however, *this* BASIC system is almost pleasant to use.) The manual is clear and complete, and the language includes constructs to make structured programming (and even recur-

Which is a better buy, a shovel or a bulldozer?

Obviously, the answer depends on what you want to build. The same principle applies to the purchase of computers. For some users and for some applications so-called "home" or "personal" computers are efficient. But before you decide whether an 8- or 16-bit single-user system is right for you, be sure to consider the MegaMicro—the 32-bit multi-user virtual memory microcomputer made by LMC. The MegaMicro is a "big" computer in a small box. It allows one or up to 32 users to run big applications programs (ones so big they can't even be compiled by smaller 8- or 16-bit machines) simultaneously. Because the MegaMicro is a multi-user system, it allows easy sharing of data bases and peripherals—obstacles that soon haunt business and scientific users of "personals" who find a need to "network" or to add devices such as laser-printers, multi-color plotters and the like.

LMC's MegaMicro is built around the newest state-of-the-art VLSI logic—the 16000 family developed by National Semiconductor. Each MegaMicro is supplied with UNITY—HCR's full Bell-licensed UNIX operating system—as well as FORTRAN and C. Also standard are hardware virtual memory and hardware floating point, a half Meg. of RAM and a very fast 20 Meg. Winchester hard disk. The result is a computer with the performance of a large mini, at a "micro" price. For example, the MegaMicro does 161,000 double-precision (64-bit) floating point multiplications per second. All this costs $15,000, and even less with OEM and quantity discounts (about the same as a single IBM XT or Apple LISA). The result is a cost per "work-station" far lower than similarly configured (and less powerful) "personals."

Because the MegaMicro is powerful, inexpensive and designed around the Multibus (IEE 796) (which means it has a completely "open" architecture), it is an ideal choice for the OEM wishing to supply powerful applications software solutions on a microcomputer.

So which do you want, the shovel or the bulldozer?

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The Logical MicroComputer Company
140 South Dearborn, Chicago, IL 60603, (312) 580.0250, Telex 270384

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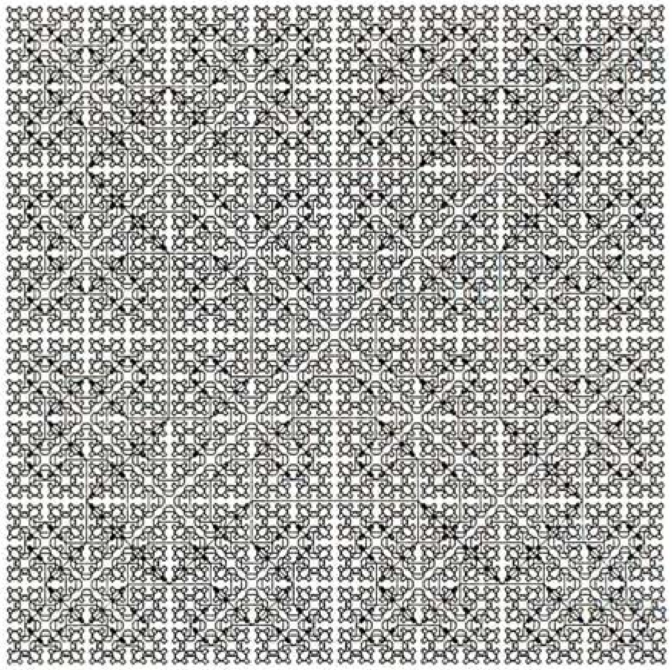

Figure 1: *The Sierpinski curves illustrate the 7470A plotter's resolution and accuracy.*

sion) easy. This machine was designed to run this BASIC and it runs it fairly well, but a bit slowly.

The famous Eratosthenes Sieve prime-number benchmark (see reference 3) ran in HP BASIC in 265 seconds. In comparison, Apple Integer BASIC ran the program in 1850 seconds, and a DEC VAX-11/780 ran the equivalent C program in 1.42 seconds. The Model 16 demonstrates respectable capabilities for a desktop computer.

A rather primitive game I wrote in BASIC (see listing 1) slowed markedly on the Model 16 whenever several objects had to be moved at once. Unfortunately, time constraints and an omission in the Pascal system routine to access the knob prevented me from coding the game in Pascal for comparison. A Centipede-like game ran well on the system in Pascal, but the BASIC version was sluggish.

An optional set of extensions to the RAM BASIC enhances program entry, editing, and debugging and adds string utilities, real-time features, I/O enhancements, and other features. However, the Model 16 has insufficient memory to run the prime-number benchmark program with extensions.

HP Pascal

A license to use HP's version of Pascal, which began as a version of UCSD Pascal, costs $250. Its implementers chose to compile to 68000 machine code instead of p-codes, which accounts for its impressive benchmark performance. Overall, the Pascal system looks much like the UCSD p-System. The filer, editor, linker, and compiler have substantially the same user interface that the UCSD system does. Details of operation are different, however.

For instance, the file system has been changed from that used with the UCSD system. HP uses its proprietary

Text continued on page 340

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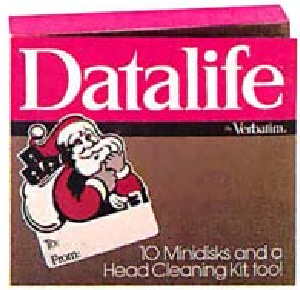


The Datalife Holiday Pack: 10 minidisks and a free Head Cleaning Kit.

Circle 494 on inquiry card.

Listing 1: *A simple game, written in HP BASIC, was played on the Model 16. It slowed considerably when several objects had to be moved simultaneously.*

```
        ALPHA OFF
10      DEG
20      Kills=0
30      Prob=.08
40      Ssize=10
50      DIM S(10)       !dimension must match Ssize
60      DIM Dir(10)     !here too
70      FOR I=1 TO Ssize
80          S(I)=0
90      NEXT I
100     Tsize=10
110     DIM Tx(10),Ty(10),Tdir(10)
120     FOR I=1 TO Tsize
130       Tx(I)=0
140     NEXT I
150     DIM Sin(360)
160     DIM Cos(360)
170     FOR I=0 TO 360
180       Sin(I)=SIN(I)
190       Cos(I)=COS(I)
200     NEXT I
210     RANDOMIZE
220     Score=0
270     LORG 5
280     Len=150
290     WINDOW -250,250,-200,200
300     X=90
310     MOVE 0,0
320    !ON KBD GOSUB Keyaction
330     ON KNOB .1 GOSUB Knob_action
340     ON KEY 5 LABEL "Fire!" GOSUB Keyaction
350     ON KEY 6 LABEL "score" GOSUB Key_score
360     ON KEY 7 LABEL "bogies" GOSUB Key_bcgies
361     ON KEY 8 LABEL "Destruct" GOSUB Key_destruct
370 Loop:     !
380     PEN 1
390     MOVE 0,0
400     PLOT 0,0
410     PLOT Len*Sin(X),Len*Cos(X)
420     FOR I=1 TO Ssize
430       Stmp=S(I)
440       IF Stmp<>0 THEN
450         Sindir=Stmp*Sin(Dir(I))
460         Cosdir=Stmp*Cos(Dir(I))
470         DISABLE
480         MOVE Sindir,Cosdir
490         PEN -1
500         LABEL "O"
510         Stmp=Stmp+5
520         Sindir=Stmp*Sin(Dir(I))
530         Cosdir=Stmp*Cos(Dir(I))
540         PEN 1
550         MOVE Sindir,Cosdir
560         LABEL "O"
570         ENABLE
580         FOR J=1 TO Tsize
590           IF (Tx(J)<>0) THEN
600            IF (ABS(Tx(J)-Sindir))<5 THEN
610              IF (ABS(Ty(J)-Cosdir))<5 THEN        !collision!
620                Stmp=0
630                S(I)=0
640                DISABLE
650                MOVE Sindir,Cosdir
660                PEN -1
670                LABEL "O"
```

Listing 1 continued on page 336

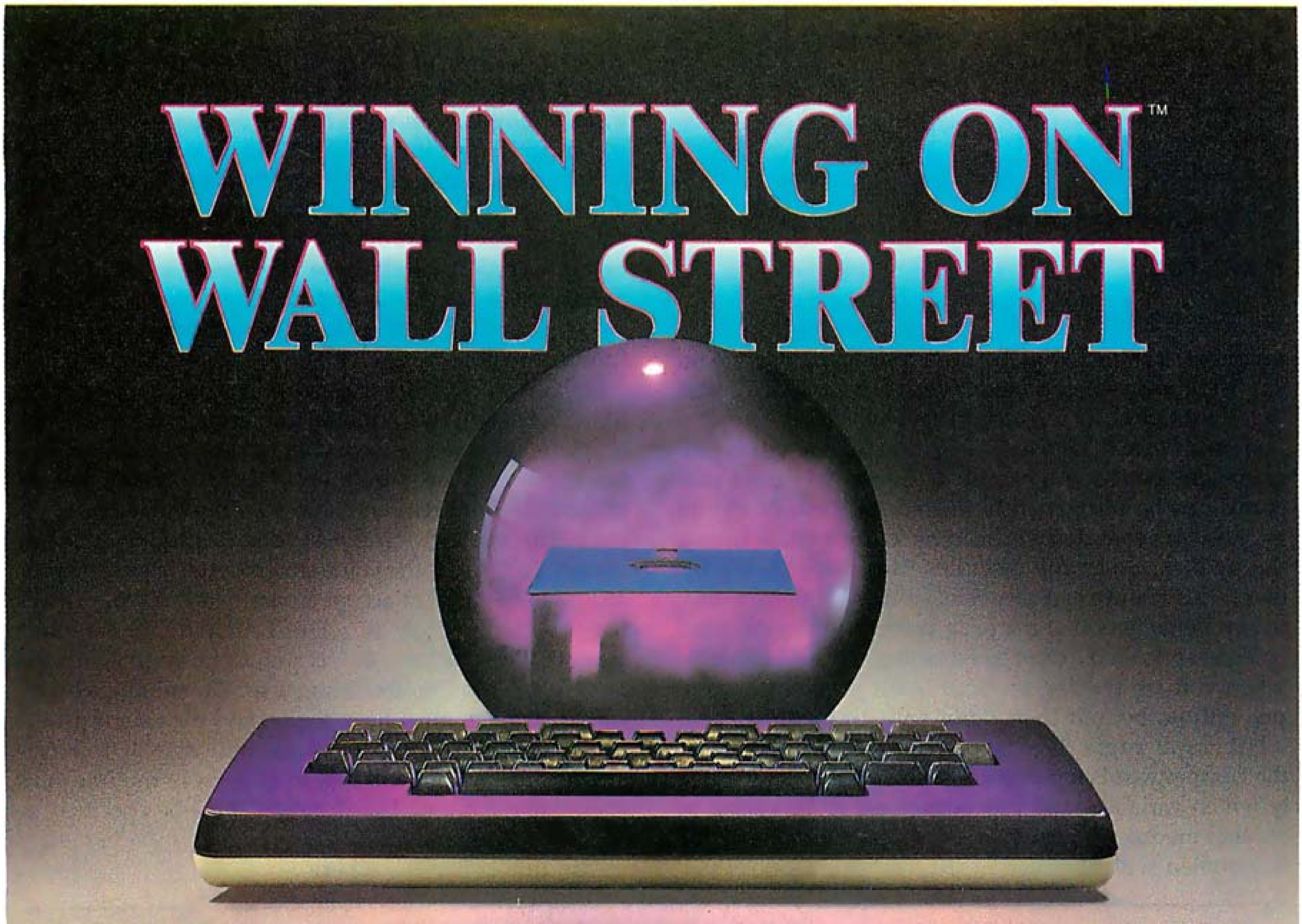
Listing 1 continued:

```
680              MOVE Tx(J),Ty(J)
690              LABEL "x"
700              PEN 1
710              MOVE Tx(J),Ty(J)
720              LABEL "*"
730              ENABLE
740              BEEP 80,.1
750              Score=Score+10
760              Kills=Kills+1
770              Prob=Prob+.02
771              DISP
780              Tx(J)=0
790              GOTO 840
800            END IF
810          END IF
820         END IF
830        NEXT J
840        IF Stmp>Len THEN ! bullet at max range.  destroy it
850           !MOVE 0,0
860           !PEN -1
870           !PLOT 0,0
880           !PLOT Len*Sindir,Len*Cosdir
890            PEN -1
900            MOVE Sindir,Cosdir
910            LABEL "O"
920            S(I)=0
930        ELSE
940            S(I)=Stmp
950        END IF
960        PEN 1
970      END IF
980    NEXT I
990    IF RND<.01 THEN ! Create new target
1000     FOR J=1 TO Tsize
1010       IF Tx(J)=0 THEN
1020         Tx(J)=100*RND-50
1030         Ty(J)=100*RND-50
1040         Tdir(J)=RND*360
1050         DISABLE
1060         MOVE Tx(J),Ty(J)
1070         PEN 1
1080         LABEL "x"
1090         ENABLE
1091         DISP
1100         BEEP
1110         GOTO 1170
1120       END IF
1130     NEXT J
1160   END IF
1170   FOR I=1 TO Tsize   ! Move targets
1180     IF Tx(I)<>0 THEN
1190       IF ABS(Tx(I))>250 THEN
1200         Tx(I)=0
1210         BEEP 800,.1
1211         Escapes=Escapes+1
1213         GOTO 1370
1220       END IF
1221       IF ABS(Ty(I))>200 THEN
1222         Tx(I)=0
1223         BEEP 800,.1
1224         Escapes=Escapes+1
1225         Prob=Prob+.02
1227          GOTO 1370
1228        END IF
1230        DISABLE
1240        MOVE Tx(I),Ty(I)
1250        PEN -1
```

Listing 1 continued on page 338

```
1260        LABEL "x"
1270        ENABLE
1280        Tx(I)=Tx(I)+2*Sin(Tdir(I))
1290        Ty(I)=Ty(I)+2*Cos(Tdir(I))
1300        DISABLE
1310        MOVE Tx(I),Ty(I)
1320        PEN 1
1330        LABEL "x"
1340        ENABLE
1350        IF RND<.05 THEN Tdir(I)=360*RND !change course to make it interesting
1360      END IF
1370    NEXT I
1371    IF Escapes>10 THEN
1372      GOSUB Key_score
1373      GRAPHICS OFF
1375      STOP
1376    END IF
1380    GOTO Loop
1390    !
1400    ! Knob interupt handler
1410    !
1420  Knob_action:      !
1430    PEN -1
1440    Dx=KNOBX
1450    MOVE 0,0
1460    PLOT 0,0
1470    PLOT Len*Sin(X),Len*Cos(X)
1480    MOVE 0,0
1490    X=X+Dx
1500    IF X<0 THEN X=X+360
1510    IF X>360 THEN X=X-360
1520  !DISP SIN(X),COS(X),X,Sin(X),Cos(X)
1530    PEN 1
1540    RETURN
1550    !
1560    !  Keyboard interrupt handler
1570    !
1580  Keyaction:     !
1590        FOR K=1 TO Ssize
1600            IF S(K)=0 THEN
1610                S(K)=1
1620                Dir(K)=X
1630                Score=Score-1
1640                GOTO 1670
1650            END IF
1660        NEXT K
1670    RETURN
1680    !
1690  Key_score:  !
1700     DISP "Your score is ",Score,"You have ",Kills,"kills and ",Escapes,"escapes"
1710  RETURN
1720  !
1730  Key_bogies: !
1740     B_cnt=0
1750     FOR B_lp=1 TO Tsize
1760       IF Tx(B_lp)<>0 THEN
1770         B_cnt=B_cnt+1
1780       END IF
1790       NEXT B_lp
1800       DISP "There are ",B_cnt," Bogies out"
1810     RETURN
1811     !
1812     !
1814  Key_destruct: !
1815     FOR D_lp=1 TO Ssize
1816     IF S(D_lp)<>0 THEN
1817       MOVE S(D_lp)*Sin(Dir(D_lp)),S(D_lp)*Cos(Dir(D_lp))
```

Listing 1 continued on page 340



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Listing 1 continued:

```
1818         PEN -1
1819         LABEL "0"
1820         S(D_lp)=0
1821       END IF
1822       NEXT D_lp
1823       Score=Score-5
1824    RETURN
1825      END
```

Text continued from page 332:

LIF (Logical Interchange Format) directory structure on its disks, so users can move files between BASIC and Pascal systems.

Memory is managed as a large "heap" into which programs are loaded and executed. Commonly used programs can be permanently loaded or "p-loaded" into memory to avoid delay caused by loading them from a floppy disk. Since the compiler uses more than 200K bytes, this feature can save a lot of time. Unfortunately, the implementation of the heap prevents programs from being un-p-loaded except by rebooting. This is frustrating when you are waiting for your latest program to compile only to be told there's not enough memory.

HP Pascal supports separate compilation with what the company calls modules. The user can specify exactly which variables and procedures are to be visible to another module. A generous set of system-level modules is supplied with Pascal.

Unfortunately, HP did not adhere to a consistent naming scheme for the various procedures in the modules. If, for example, you wish to use the keyboard beeper, you must import the module KBD. It would be natural to then name a procedure to do the beeping "beep," but it is the system-level routine that actually commands the keyboard microprocessor to beep, and this routine is called "beep." It would have been more logical for HP to have given system-level procedures names that start with "sys" or "HP." Then users would be relatively safe from confusion.

Both BASIC and Pascal can produce beeps. The BASIC BEEP statement has optional parameters to specify the beep's frequency in hertz and duration in seconds. Pascal has the beep procedure mentioned previously, but its parameters fall between 0 and 63. That value goes into the hardware latch on the keyboard, producing a frequency 81.36 times the value stored in the latch. The procedure is declared to accept a parameter of type "byte." Byte is declared in IO_DECLARATIONS (another module that you have to include) to be an integer subrange from 0 to 255. Declaring a similar subrange is not sufficient; beep must have a byte, and the user must include IO_DECLARATIONS as well as KBD; consequently, the system will link in all sorts of modules the user may not want. The duration must be specified in tens of milliseconds.

Also unlike BASIC, where

RYDEX

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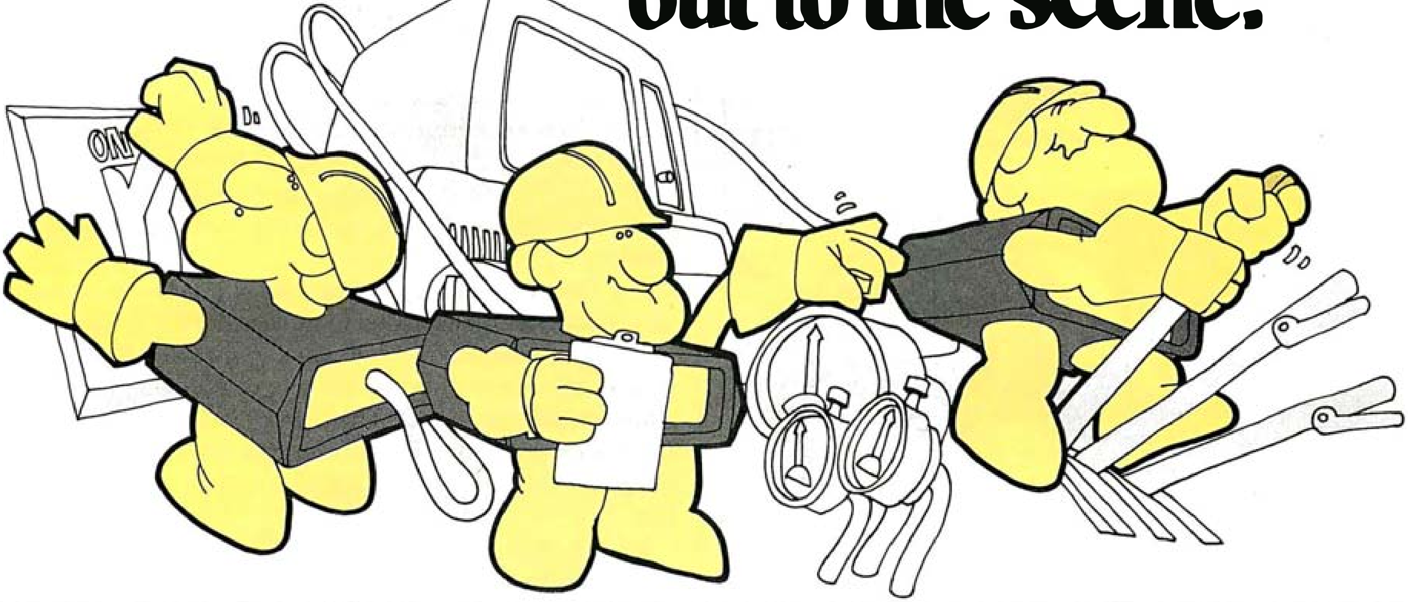

Who can blame you if you've only been using your computer as an efficient filing system. Up to now, getting it to physically do things for you, ike regulate equipment or even just open the garage door, has been complex, troublesome and expensive.

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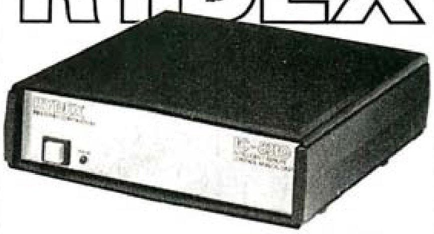

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```
10 BEEP 400,0.5
20 BEEP 800,0.5
```

produces two ½-second tones of different pitches, the Pascal statements

```
beep(400, 50);
beep(800, 50);
```

(which would seem to do the same thing) produce only the latter tone. Beep sets up a tone and a timer and returns immediately. It does not check to detect a tone-in-progress when next called.

The beep procedure is documented in neither the *Pascal Language Reference Manual* or the *Pascal Procedure Library User's Manual*. I had to disassemble the interface text of the KBD module to figure out how the procedure works.

The Pascal system is riddled with similar inconsistencies. When Zehntel decided to replace the HP Command Interpreter with its own software so that Zehntel's customers would only have to learn to use one kind of software, problems arose. The *Pascal Language Reference Manual* clearly states that a user can write a command interpreter to replace the one that comes with the system.

It's not that simple. The new command interpreter must be fully linked.

Normally, the Pascal system resolves calls to system procedures at load time, but because a new command interpreter is loaded before the loader is, this procedure won't work.

Moreover, a command interpreter must call the undocumented procedure CISWITCH early in its initialization code, so that it uses the kernel stack instead of the user stack. If the procedure is not labeled CISWITCH, strange things happen when the command interpreter tries to run another program. We found this out when Zehntel was a beta test site for the Pascal system, and we badgered HP's development staff for a copy of the system designers guide and a system source listing. (Incidentally, the Pascal system won't compile with the HP-Pascal compiler, but that's another story.)

An average user faced with these problems would probably give up in disgust.

There are other problems. The *Pascal Language Reference Manual* says that certain characters: #, [,], $, and the comma (,), etc. are not permitted in filenames. The filer, though, blithely allows a user to create files named #$%[@. When using the filer's make-a-file feature, you can specify the file's size in blocks by placing the desired size in square brackets after the filename. Unfortunately, size must be stated in 512K-byte blocks, while the filer displays the count of 256K-byte blocks when a directory listing is requested. If the trailing square bracket is left off (i.e., the user requests a file named FOO[20), then the filer interprets the [20 and creates the file 20 (512K-byte) blocks long, naming it FOO[20.

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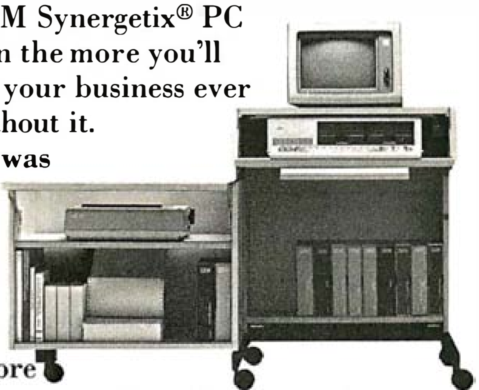

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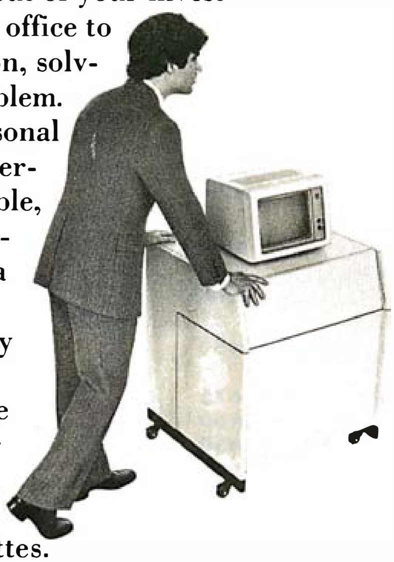

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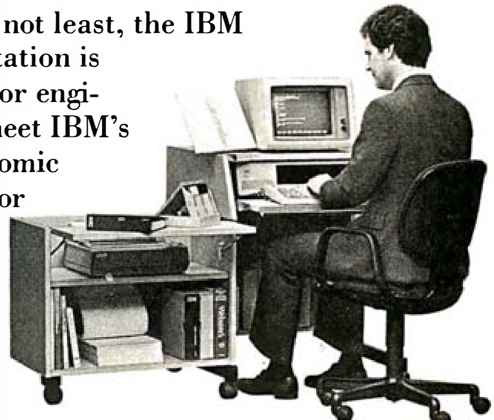

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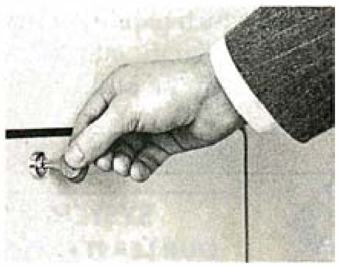

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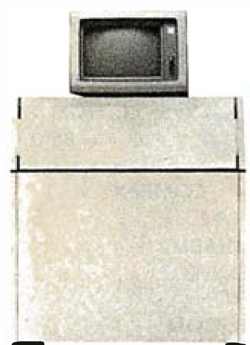

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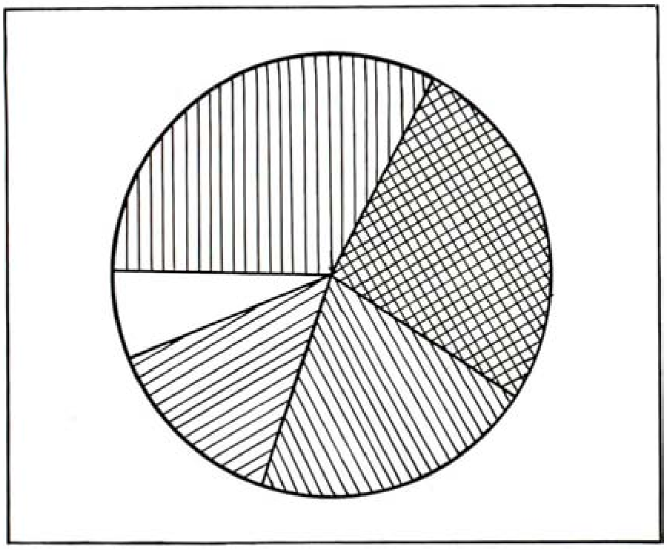

(2b)

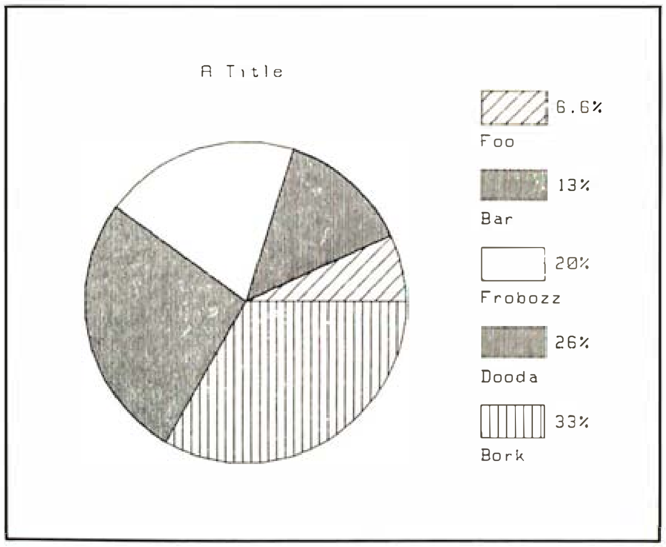

Figure 2: *Two pie charts; (a) is a representation of the one produced on the system's 2671G printer, and (b) was produced on the 7470A plotter.*

The output of the linker's disassemble option can be redirected into a file but is then incorrectly formatted for use with the system's assembler.

The Sieve benchmark, by the way, showed a 31-fold gain in performance in Pascal over its run in BASIC. For production of graphics, however, which requires much code in the boot ROMs, the gain was significantly less—only 2.5-fold. Figure 1 was plotted on the cathode-ray tube in 39.6 seconds by a Pascal program and in 97.5 seconds by a similar BASIC program. When the plotter was used, the differences were less striking: plotting times for Pascal and BASIC were 448 and 523 seconds, respectively.

An Electronic Spreadsheet

The Context MBA-integrated spreadsheet package I re-

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(3a) (3b)

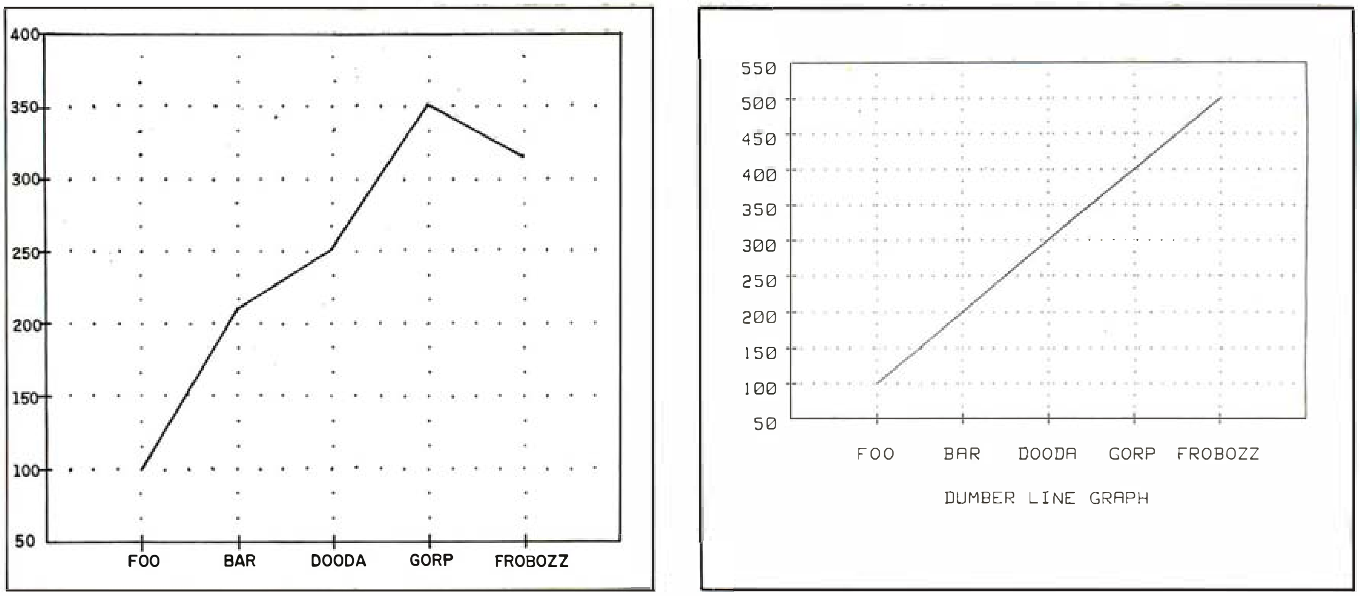

Figure 3: *A representation of a line graph done on a printer (a) and the same graph produced on a plotter (b).*

ceived with the Model 16 is useful and deserves a review of its own. Not just another Visicalc clone, it includes a database-management system, a word processor, and presentation graphics. It was fairly simple to use, and, with its help, I managed to do my federal income-tax return.

An outstanding feature of the spreadsheet package is its ability to produce various types of graphs directly from data in the spreadsheet cells. For an example of a pie chart done on the 2671G printer and the 7470A plotter, see figure 2. Figure 3 shows a line graph done on the same printer and plotter.

A minor flaw in the MBA package is a bug in the shading subroutine that draws graphs. If the region to be

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shaded is to be dark with light crosshatches, the program first completely colors the region and then draws the white lines hatching the region. This works fine on the cathode-ray tube, but on the plotter it tries to draw the white lines with the null pen. (In figure 3, for example, the DOODA region was intended to be hatched this way.)

Originally written for the IBM PC, the MBA package has been successfully moved to the Model 16 by Context Management Systems. The accompanying manual is not perfect, but a little digging always turned up the answer to my questions within a short time.

Miscellaneous Software

The Model 16 also runs a great deal of engineering software. HP provides tools for tasks such as electronic and mechanical design, circuit analysis, statistics, circuit-board layout, circuit simulation, and presentation graphics, as well as support for them. A program called HP-Plus makes software written by other firms, including Visicalc, available.

An asynchronous terminal emulator enables the system to act as a terminal when it is connected to a remote computer. Files can then be transferred between the Model 16 and the remote host.

Several games are available for the system. Versions of Startrek, Tailgunner, Pac-Man, and Centipede are some I tried. Most were written in Pascal for speed, and they worked well.

Summary

The Hewlett-Packard Series 200 Model 16 is an excellent engineering computer with many diverse peripherals available to it. Support of other manufacturers' peripherals, however, either in actual drivers or system-level interface documentation (for those who "roll their own" drivers), is nonexistent. The BASIC system is excellent, but the Pascal system, although fast, has some serious consistency and documentation problems.■

The opinions expressed in this article are those of the author and do not necessarily represent the official position of Zehntel Inc.

Special thanks to Dennis Vetter of Hewlett-Packard for his support in the preparation of this article and to Mark Wittenberg and Stephen Lewis of Zehntel for helping me ferret out the dark secrets of the Model 16.

Berry Kercheval holds a B.S. in applied science from the University of California at Riverside. He can be reached at Zehntel Inc., 2625 Shadelands Dr., Walnut Creek, CA 94598.

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Three Generations of Charts for the IBM PC

Design philosophies and operational reviews of three graphics packages

by Jack Bishop

The three graphics packages for the IBM Personal Computer (PC) reviewed in this article illustrate three phases or philosophies of graphics software design. As I became familiar with the packages, I felt I was seeing three generations of programs, ranging from the utilitarian first generation to the menu-driven, easy-to-use third generation. Side by side, these three packages showed me how quickly a product can be surpassed by a product that's more powerful and easier to use. All three have their advantages and disadvantages, of course, and the best choice is largely a matter of personal taste.

What I expect of a graphics package is the same today as when I first threw away my ruler and charting tapes. The only difference that I recognize is a decline in the "new toy" factor. With the first packages I used, I was so grateful to be rid of the annoying drudgery of charting that I was willing to put up with anything the charting program threw my way. As I have gained more experience, however, I am less tolerant of a program's idiosyncrasies. A program that is promoted for use in business should not flinch when confronted with a normal user, and vice versa.

The goal I set for these packages is that they produce charts that *work.* If you can understand the economic message of each chart in this article, the chart is a success. The photos that illustrate this article were taken from a screen (IBM Color Monitor, Princeton Graphics Monitor, or Amdek Color I), and the figures were produced on a Hewlett-Packard two-pen plotter and an IBM dot-matrix printer.

First-generation programs, as I define them, provide few if any cosmetics; the information is the focal point. These programs may not work under certain circumstances. Such programs are most appropriate for experienced computer users who might want or need to "go into" the program and customize the code for their particular needs. The typical user is an engineer or social scientist.

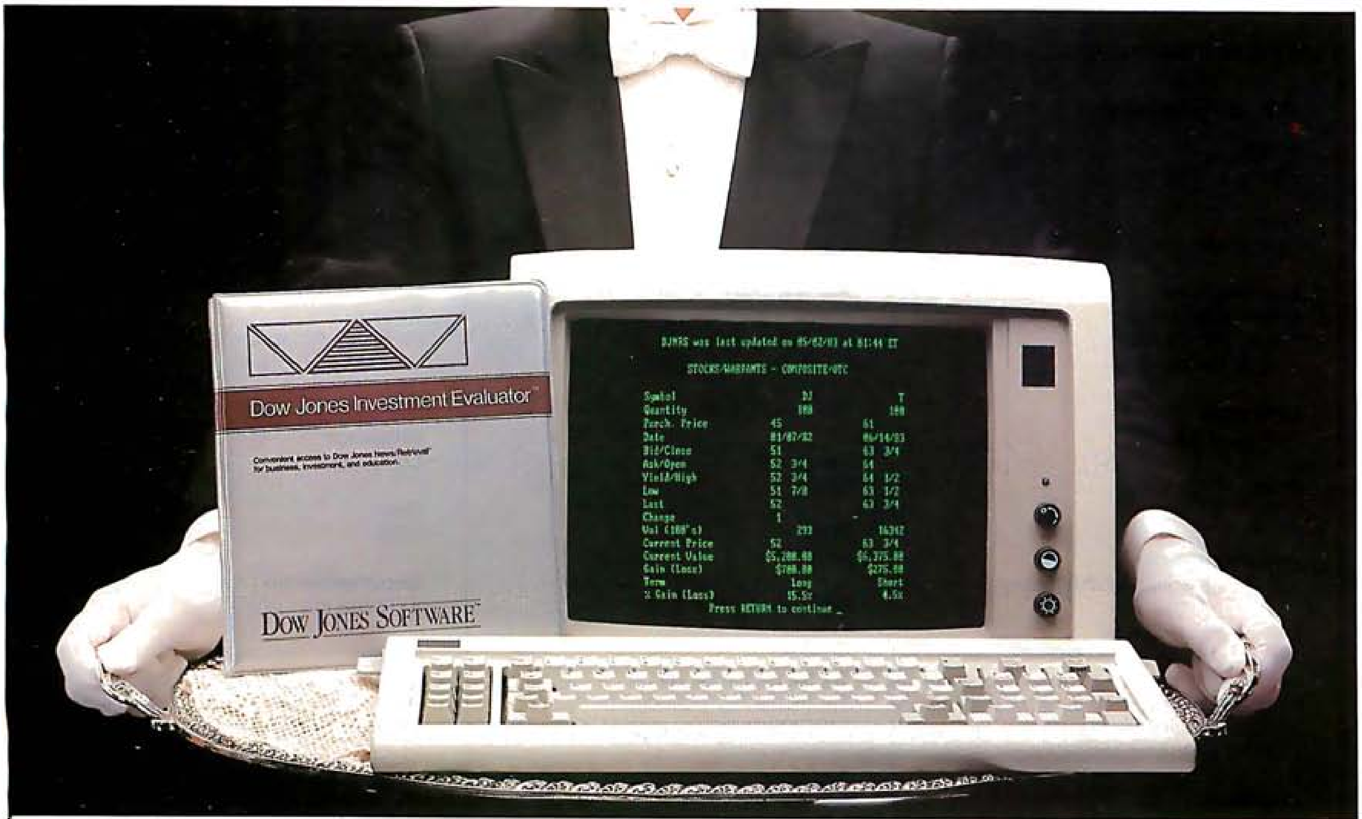
Second-generation programs have been cleaned of the "bugs," have more options, and are powerful and fairly simple to use. In general, they require some computer expertise because the program does its work through commands (EDIT, DRAW BAR, etc.) that require the user to learn a new vocabulary. If you use such programs regularly and memorize the codes, you may not believe that any improvements are either necessary or desirable.

Third-generation graphing programs are characterized by menu operation. Because a menu relieves the user of the burden of remembering another language, these programs are ideal if you have an occasional need to make charts (or if you have limited computer experience, time, and patience). Third-generation programs may also add some cosmetic amenities to make the product more visually pleasing and professional looking.

Graphics Generator

Graphics Generator (GG) from the Robert J. Brady Co. requires that you select the type of chart you want to make before you enter data. This is fine if you know in advance what type of chart you want, but I usually have the data in hand and want to first get it into the program (either from another file or from my tired old fingers). If after seeing the result you decide to try bars in place of lines, go directly to jail.

GG relies on the PC's function keys to develop a chart. Each function key has two uses (or levels): the first level selects the type of chart, and the second level controls the chart parameters and input. At the second level, some function keys have different meanings in different types of charts and thus send the user scurrying to the manual or reference card to ferret out the current meaning of each key. The on-screen menu, which should



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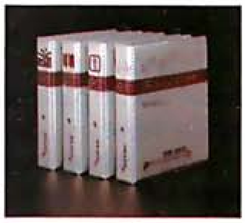

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At a Glance

Name
Graphics Generator

Type
Chart maker

Manufacturer
Robert J. Brady Co.
Bowie, MD 20715
(301) 262-6300

Language
Advanced BASIC

Price
$195

Documentation
150-page manual, reference card

Equipment required
IBM PC (64K or more), color graphics board, one disk storage device; for hard copy, dot-matrix printer and Hewlett-Packard 7470A or Houston Instrument DMP3-7 plotter

Audience
Anyone who wants to plot data

Name
BPS Business Graphics

Type
Chart maker

Manufacturer
Business & Professional Software Inc.
143 Binney St.
Cambridge, MA 02142
(617) 491-3377
(800) 342-5277

Language
Pascal

Price
$350

Documentation
410-page manual

Equipment required
IBM PC (UCSD p-System) or PC XT (MS/DOS); two disk storage devices

Audience
Anyone who wants to plot data

Name
Chartmaster

Type
Chart maker

Manufacturer
Decision Resources
25 Sylvan Rd. South
Westport, CT 06880
(203) 222-1974

Language
Compiled BASIC

Price
$375

Documentation
100-page manual

Equipment required
IBM PC XT (128K or more), two disk storage devices, asynchronous communications adapter, DOS 1.1 and BASICA 1.1; or, with somewhat restricted capabilities, an Apple II Plus (64K), one disk drive, DOS 3.3, IEEE 488 interface

Audience
Anyone who wants to plot data

serve this function, is in many instances too cryptic to be of much use. Graphics Generator gives the illusion, but not the ease, of a menu-driven program.

The process of entering data into the program was an experience. Why wasn't I born knowing that the term "X-calibrations" would mean the number of "tic marks" for the horizontal (x) axis? This illustrates a consistent problem with Graphics Generator: the terms used to describe the program, both in the manual and in prompts on the screen, are potentially confusing to anyone who does not use it often. For example, when prompted for the "length" of a chart, you are expected to respond with the width of the x-axis. Searching the manual and indulging in trial and error, you will eventually create a chart; if you use the program often, you will no doubt become fluent. For the occasional user, however, this can lead to frustration.

Musical accompaniment would help pass the time during the laborious data entry sequence of <function key> <observation number> (that's x-axis, for the uninitiated) <data point>, <enter>, but make the tempo r-e-a-l s-l-o-w. The entry sequence requires the manual dexterity of a concert pianist.

As each data point is entered, it is immediately plotted on the monitor. Ponder this sentence from the program manual to understand the concept of "user-friendly": "Unfortunately there is no simple way to correct errors in the coordinate system and labels of a chart." In other words, get it right the first time or start over. I have mixed emotions about this kind of message. If the authors realized what they were doing to us, why didn't they go a step further and fix the thing?

Each axis is labeled at the end, making for short axis labels. The title of the chart appears at the bottom; don't ask me why. I didn't run into any errors or bugs, so either the program was well developed or I simply did not chance upon any problems. The manual, however, has a decidedly "first-generation" cast. The pie chart commands include:

1. Begin. Start a new chart.
2. Alter. Start a new chart. Same as Begin.

How's that again?

I called R.J. Brady, the manufacturer, to find out what sort of support I could expect if I had trouble with the program. The company referred me to the program developer rather than to a customer-service organization.

BPS Business Graphics

Business Graphics from Business and Professional Software Inc. (BPS) is a more free-form package that uses computer commands in a fairly flexible sequence to develop a chart. An extensive index, reference cards, and many examples in the manual provide the help most people need to attack the task of chartmaking. An inexperienced user can choose an example from the text that fits the case at hand and follow the example. Given the small number of standard charts you are likely to use, this is a reasonable approach. If anything, there are too

YOU'VE GOT TO SEE IT TO BELIEVE IT

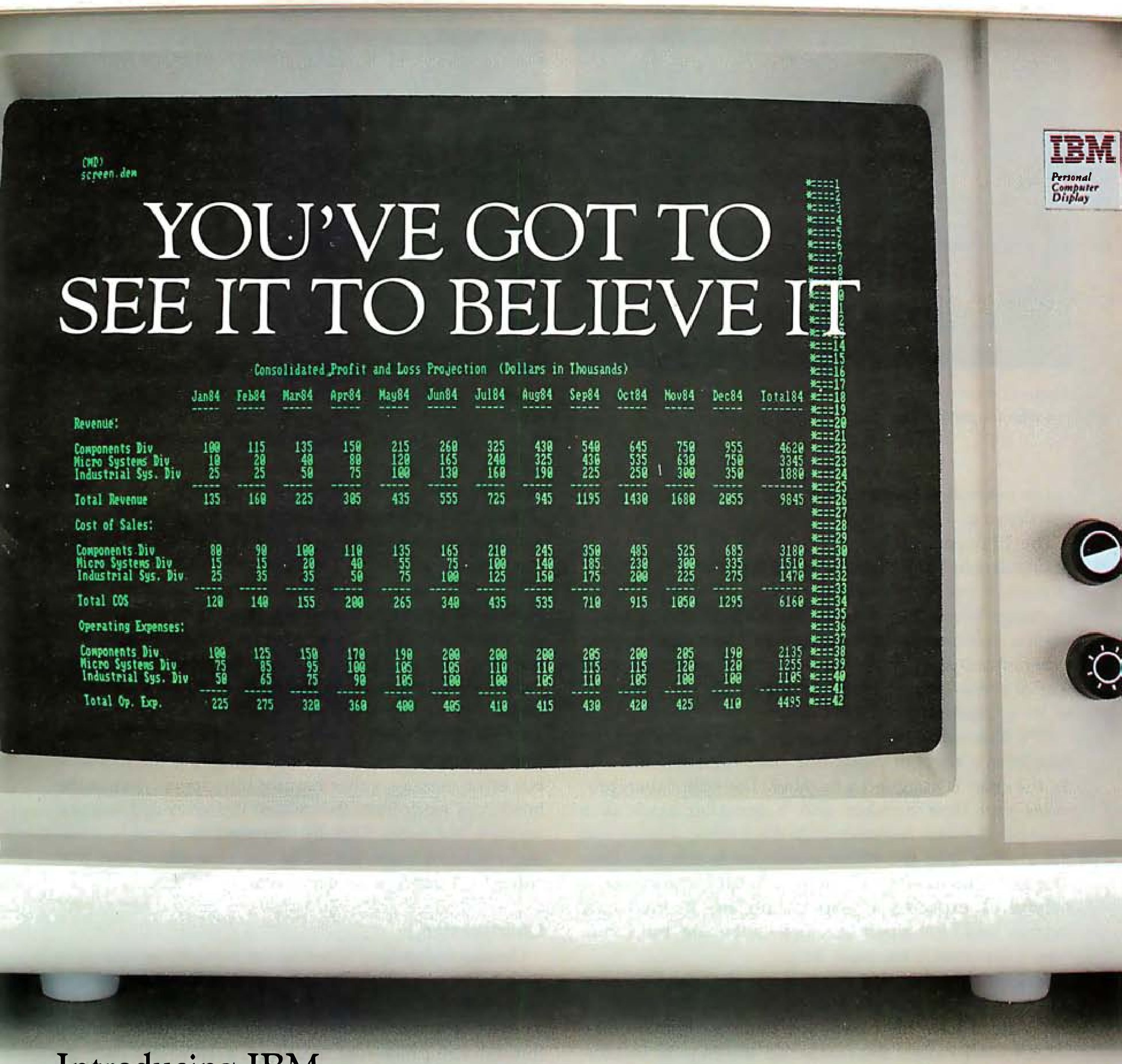

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Photo 1: *An error message from Chartmaster that should help but not offend a wary user.*

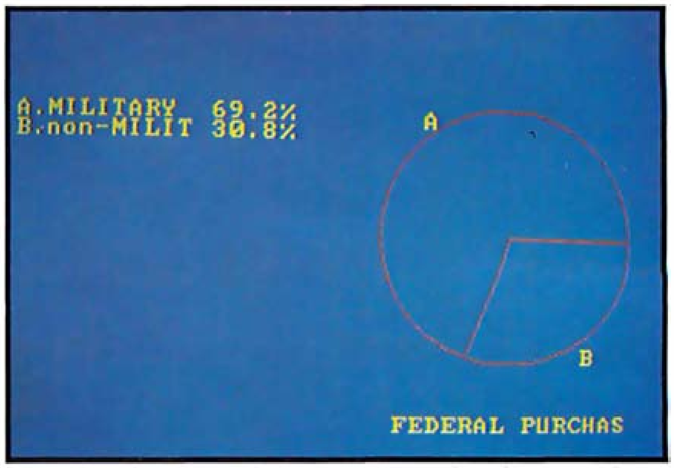


Photo 2: *Graphics Generator's screen version of a two-segment pie chart.*

many examples; finding your case among them can be bewildering.

The BPS package requires you to be familiar with "computerese." You must learn the program's vocabulary and use it properly to get the expected result. You are in charge here—the program sits back to let you work. Such a user base is most represented by engineers and experienced users, but after business people lose their fear of computers, there is no reason for the approach to be so limited.

BPS Business Graphics provides an editor to get the data from a sheet of paper into the program. Each line on the chart is assigned a number. The editor then provides each line number and a question mark as a prompt. The user responds with the x value, a space and the y value, and the editor moves on to the next line. This form of data entry is neither difficult nor particularly helpful. I expected transportation for a cross-state journey and I got a pair of shoes—adequate, but somehow I expected a bit more help.

Because the operation is free-form, data can be added any time in the process without making the program fret. After I have filed away the data, a command like DRAW LINE causes the command screen to be instantly replaced by the chart. After looking over the quality of the chart and determining if I want to make any changes, say to vary the range of the horizontal axis, touching any key brings the command file bouncing back.

The program will save commands for a chart as a "take file," enabling an experienced user to hassle through the charting commands and save them as a file separate from the data. This leaves the simple data entry/updating and chart preparation to someone of a more modest skill level.

My first encounter with BPS Business Graphics consisted of starting the demonstrations. The program blew with a display of random cursor moves and sound effects. The BPS hotline (800-DIAL-BPS) provided a replacement copy, and, because I knew I could call someone about problems, a level of comfort. A backup disk is available in exchange for a completed registration agreement and answering the vendor's market research questionnaire.

The BPS documentation is so extensive that crucial parts end up buried or forgotten. For example, the reference card commands assume a default disk drive has been set. As I went "by the numbers" through an example (with the help of an experienced beta-test user), I tried a number of alternative SAVE commands, without success. In retrospect, the error message "File name missing volume name" provided the clue to the problem, but error messages that require retrospect transfer the burden of work from the system designer and manual writer to the users. I finally corrected the error by making a page-by-page search of the manual, a task that should not have been necessary.

Chartmaster

Decision Resources' Chartmaster replaces computerese with "computerease." The menu operation and commonsense way the program is structured make it a cinch for a novice who needs power. A series of menus takes you through the process of creating a graph. The path for the first chart is smooth indeed. The designers of the program assumed several standard charts, then provided the capability to select alternative options. The typical drawback to a menu lurks behind the scenes (if it's not on the menu, you can't do it), but few users will ever need to go beyond the choices provided.

The menu that is standard issue with Chartmaster makes data entry a breeze. If you put numerical data (years, for example) on the horizontal axis, the program assumes the data is in sequence and provides the observation number and x-axis label for each point as the prompt. This makes it much easier to keep track of your place in a list of data points, and the carriage return is the only key outside the number pad that you need to touch. The display would be easier to use if the data were lined up evenly, but compared to other forms of data entry I have used, this display is head and shoulders above the rest.

If you enter too many labels for a plot, Chartmaster warns you (rather than overprinting labels) and gives the option of specifying labels at larger intervals, say every five years. Although the program provides the capability of verifying data, it assumes that all is well and scrolls off into the sunset rather than stopping at the end of a screen.

The test of any program is the way errors are handled. I ran into one with Chartmaster, and the result was charming (see photo 1). I remained unperturbed. I liked the "just keep calm" approach because I have seen too many experienced people react with primordial violence to abusive or uninformative "error messages." I don't want to be told I made a "probable programmer error"—I just want to know how to get the thing to run.

Output

Each of these packages provides screen output and an alternative means of hard-copy output. Graphics Generator's screen output is illustrated in photo 2. A presentation mode provides the capability to run through a set of predeveloped charts just like a slide show.

GG surprised me as I sat dumbfounded while the dump to the dot-matrix printer developed a kindergarten version of a chart (see figure 1). Not only was the quality of the chart abysmal—the process was excruciatingly slow. Imagine, if you will, sitting for 8 minutes and 47 seconds while a chart of this quality is wrung from the system. Few users have the patience for the process, and none should tolerate the result. I did not try the "high-speed print utility," which can be called from DOS (disk operating system), and perhaps the picture would be acceptable from a plotter. But if you expect reasonable quality graphs from your dot-matrix printer, forget about Graphics Generator.

A useful feature of BPS Business Graphics is its capability to use the regular monochrome IBM-type monitor for commands and a color monitor (TV, regular, or high-resolution red-green-blue) for charts. Seeing the commands and their results side by side is a great advantage.

Chartmaster provides the option of several outputs: high-resolution black and white, medium-resolution green-red-brown, and medium-resolution cyan-magenta-white on the screen, or hard copy can be made on a plotter. The screen color sets can be customized, with a choice of 16 colors. I found the cyan-magenta combination hard to read, but there was no discernible difference in readability between the high-resolution black and white and the medium-resolution green-red-brown. The latter is used to illustrate most of the Chartmaster capabilities in this article.

The operation of the program driving the plotter was smooth and trouble-free. Also, data can be dumped to the printer to provide a hard-copy verification of the numbers, then the resultant chart can be produced on the plotter. Line and bar charts are both enhanced by the capability to plot one set of data against the left axis and another set against the right axis. Another convenient option is the capability to print the y value adjacent to each point. This is useful if only a few data points are present because the numbers get very small as the number of points to be plotted increases.

A final basic charting option that is very welcome is the capability to develop an "area" chart, shading the space between the line and the x-axis (see photo 3).

To create the text of a chart, you can use Chartmaster's 16 sizes of type; six fonts; center, right, or left position-

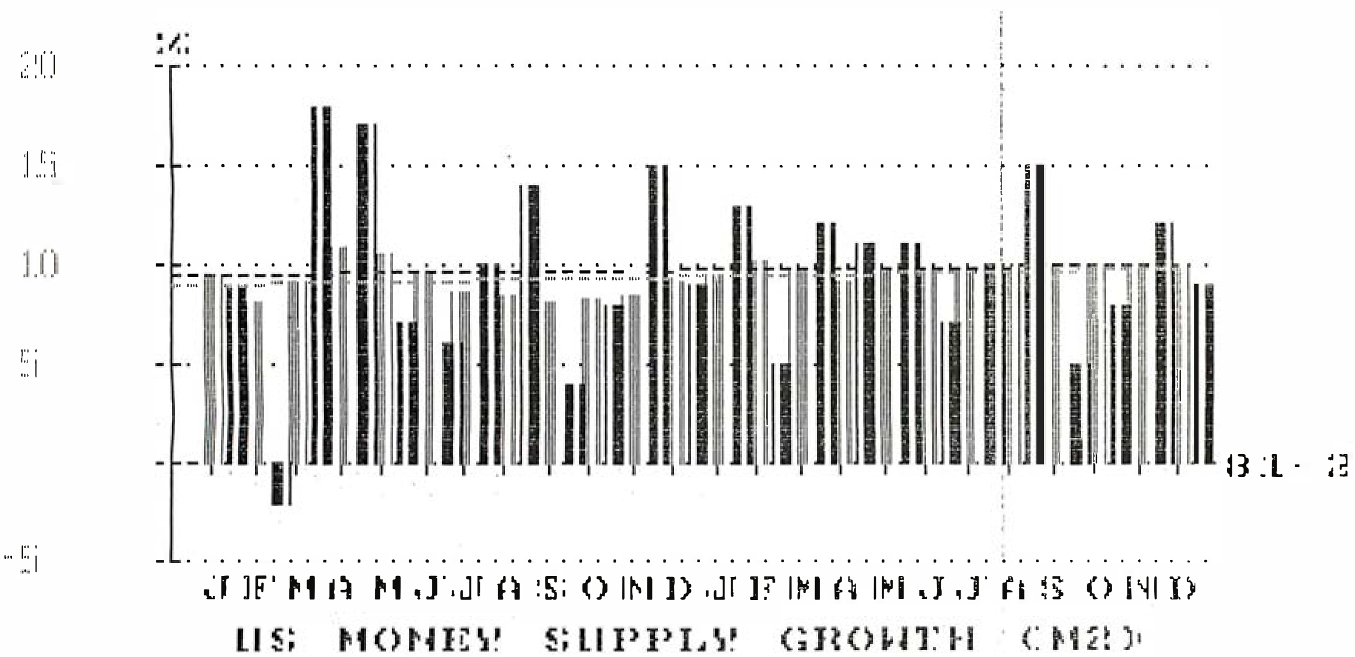


Figure 1: *This bar chart was produced using Graphics Generator and a dot-matrix printer.*

ing; and standard or italic script, with or without underlining. This is more flexibility than most packages for microcomputers can muster.

A second disk provides the Signmaster program, which uses all of Chartmaster's character and size options to develop transparencies or signs. The menu-driven operation makes the development simple. This is a valuable addition; it's probably worth the price of the package if you plan to make many presentations.

Statistics

A danger lurks in the ease with which you can fiddle with a graph using these packages. Even without changing the data, you can change your perspective on the data and create a misleading impression. The ability to develop a chart in less than five minutes can seduce you into pushing and shoving the ends of the chart until the picture looks the way you think the world should be, but isn't. For example, the government-spending chart (photo 4) would show unprecedented increases in the last decade if you chopped off the earlier years (the forties), which do not support that conclusion.

Another possible pitfall lies in the fact that these graphics packages can perform certain basic statistical calculations, such as means, variances, standard deviations, and regressions. If the software provides the computational tools but no suggestions as to how they may best be used or when they are appropriate, it is easy to fall into a trap. Worse, the program may provide options that in some combinations make graphs that are visually interesting but statistically meaningless. From both a purist and a practical standpoint, I question the sanity of anyone using simple regressions from these packages. It's almost like getting the keys to a pharmacy and practicing self-medication.

Graphics Generator provides the capability to easily develop basic characteristics of the data, such as mean, regression lines, standard deviation, and variance (photo 5). Niceties for the latter two, such as the distinction between population and sample, are beyond the scope of the manual. Because the program will cheerfully figure a standard deviation or variance to seven decimal places, a user gets an exercise in precision, not accuracy.

GG supports "function graphing," provided you enter the equation in "proper computer syntax." Just what that syntax is, however, is not clearly explained.

BPS Business Graphics measures the characteristics of data by calculating minimum, maximum, sum, mean, variance, and standard deviation. Like Graphics Generator, the BPS system does not confuse you by asking whether the common assumption of a normal distribution is appropriate or whether you are dealing with a population or a sample of a population. For charting stock prices, orders, shipments, or whatever, Business Graphics provides a modestly powerful set of analytical features: smoothing (moving average, one-parameter exponential smoothing) and regression (line, parabola, log, sine).

Chartmaster offers some interesting options. First, regression is available and, like the options in GG and Business Graphics, subject to all of the nasty things I

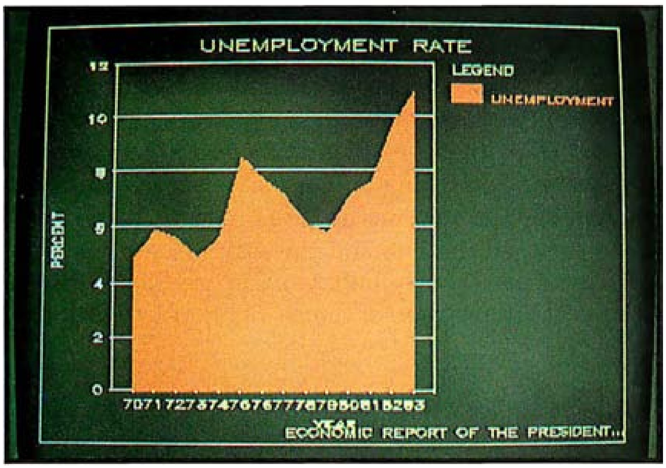


Photo 3: *This chart of the unemployment rate illustrates the area-shading capability of Chartmaster.*

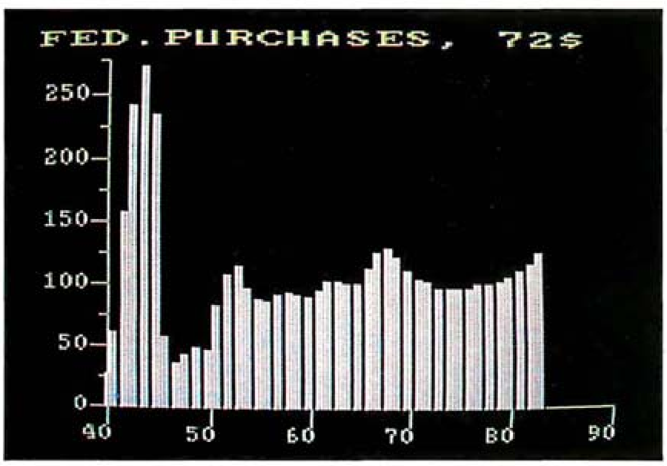


Photo 4: *Federal spending as a simple bar chart produced by the BPS Business Graphics package.*

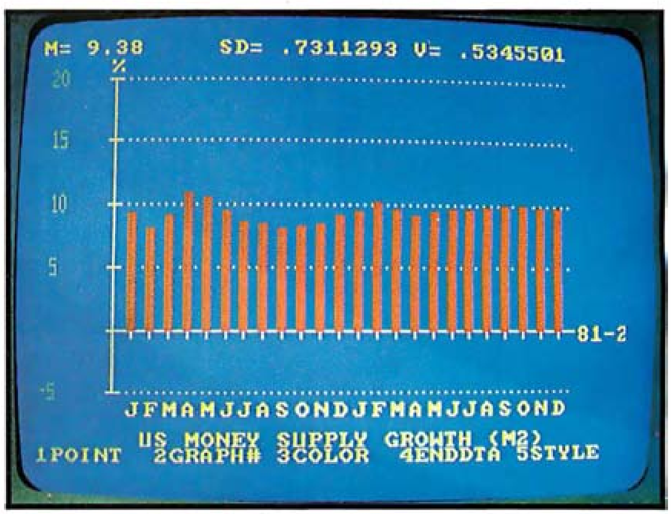


Photo 5: *A bar chart designed using Graphics Generator.*

said about the lack of proper background. Regression performed with the log-scale option, for example, creates an incorrect regression line (see photo 6), so don't combine these two options. Let the buyer beware of the need for individual education in the use and misuse of these programs. The plotting of stock prices is enhanced by the capability of a high/low/close option. Similarly, the Chartmaster folks provide the capability to plot floating bars.

Simple Plots: Line and Bar Graphs

The simplest plot of data is a series of points. The points may be connected to form a line graph or may be charted with bars. Fourteen years of the inflation rate in the US provides a satisfactory example of a line graph. Any of the three programs reviewed here would produce a decent line or bar chart without much trouble.

The chart that GG produces on the screen is not too bad. Putting the title at the bottom is odd, and the short axis labels could be inconvenient. Otherwise, there's nothing unusual here.

BPS's package did a good job without frills (see photo 7). The data goes through 1983, but Business Graphics would not allow me to set the horizontal axis any closer than 1985, and the program insists that the years be divisible by 5 when there are too many to be listed individually. (Why shouldn't you be able to specify increments anywhere you like?) This chart can be transformed from a line graph into an area graph by a single command: DRAW AREA instead of DRAW LINE.

With my first stab at a simple bar chart, Business Graphics fell into a common trap and sliced the first bar in half (see photo 8). I usually circumvent this problem by setting the horizontal axis for one extra year at the beginning and end of the series. However, Business Graphics exhibits strong opinions in this regard; the program likes charts to begin and end with numbers divisible by 5 or 10 most of the time. If I thought such presumption was to my benefit I would be more charitably inclined. I react to the package's semiautomatic scaling in the same way I reacted to my mother's assertion that a hunk of fried liver was good for me.

Now for a more difficult task: a similar bar graph, but with a lot more data. I used federal purchases of goods and services in constant dollars, 1940-1983. Business Graphics took care of the data entry satisfactorily. The resultant chart (photo 4) is utilitarian, but the vertical spaces between the bars would drive a fastidious user nuts.

The default value for the size of the graphs is handy, but there is no simple way to override it. An easier way to specify the size of the type on the main title involves leaving the main title blank and placing a floating legend (the size of which can be specified) in the place of the main title.

Photo 9 illustrates the difference a generation makes. Chartmaster gives outlining and balance, which provides a more appealing product. Data entry with Chartmaster is faster and easier, allowing both the time and the impetus to add some extra touches to the chart. When this kind of a chart can be developed easily to give a decent

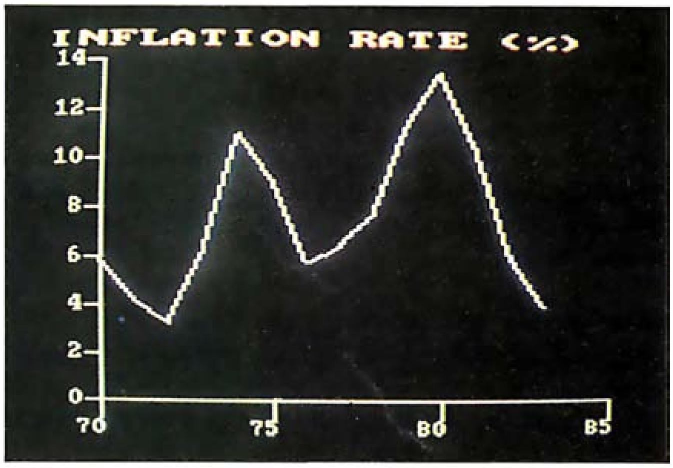


Photo 7: *A simple line chart produced by Business Graphics.*

Photo 6: *Performing regression with Chartmaster's logarithmic scale results in an error in the regression line.*

Photo 8: *The inflation rate as a Business Graphics bar chart.*

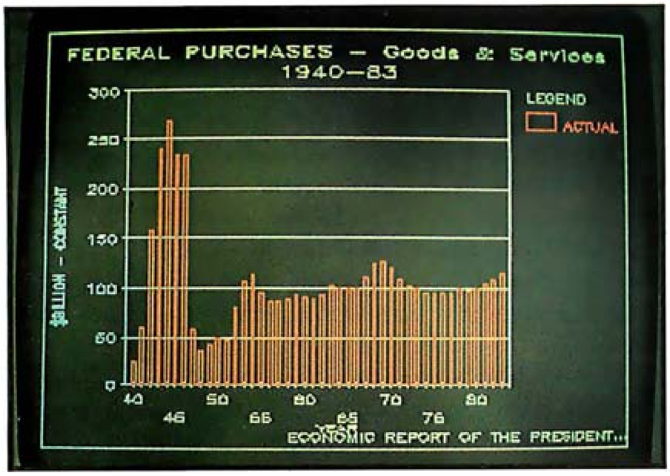


Photo 9: *A two-line chart drawn with Chartmaster.*

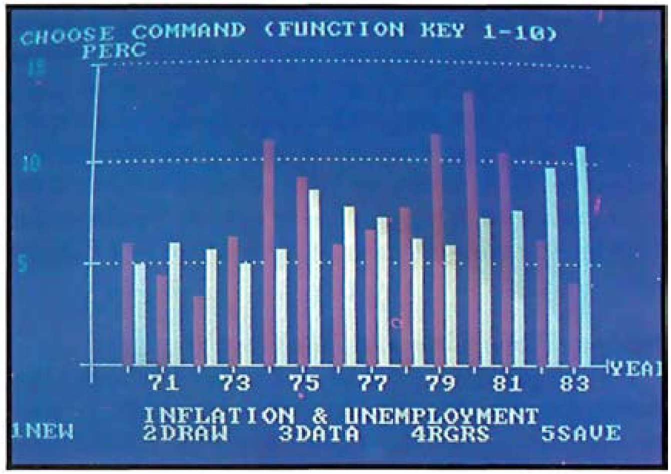


Photo 10: *Graphics Generator produced this first-generation bar chart.*

result in less than 15 minutes, I am impressed.

Now let's get down to the kind of nit-picking that separates a good chart from a very good one. The easy placement of a footnote is a nice touch, but things can get too crowded at the bottom of the chart. The two-level main title, with type size and font set by the user, adds to the professional character of the chart. However, editing a line of the title to change the font meant I had to retype the title each time. Surely there is a way around this problem. The bars are all designated as open, but many appear closed because of the limits of the resolution of the screen. The legend could be moved to the bottom (so says the manual), and doing so could alleviate crowding problems. Overall, this is a graph I would be pleased to use.

Side-by-Side and Stacking Bar Charts

Let us move to side-by-side charts and add the unemployment rate to the inflation rate.

The chart Graphics Generator produces on the screen (photo 10) is exactly what I expected. Like the line chart, it is simple and unadorned. Nonetheless, it is a first-generation chart an engineer could love, with minimal cosmetics and plenty of space for data.

Chartmaster produces a chart from the same data in less than half the time GG requires. Photo 11 illustrates the other extreme: many cosmetics and the area devoted to the data is substantially reduced. Although I could use the Chartmaster options to approach the data area provided by GG (in this case by reducing the size of the legend), the converse was not true.

I switched to money-supply growth figures and used the Chartmaster options to play around with labeling (photo 12). I increased the size of the main title, added two lines of subtitles at larger-than-default size, and threw in an italicized fourth line, which is really pushing the capabilities of Chartmaster and is well beyond the capabilities of many packages for mainframes or microcomputers. Long labels and open bars are a real test of the program. The package failed in only that some of the open bars become closed as they get narrower. The monthly labels are very close together, but I managed to get away with 24 of them without triggering Chartmaster's "too many labels" message.

Text continued on page 364

Photo 11: *A side-by-side bar chart produced with Chartmaster.*

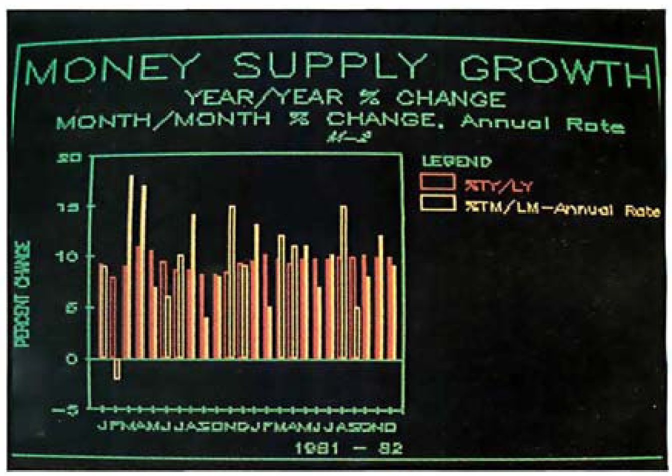
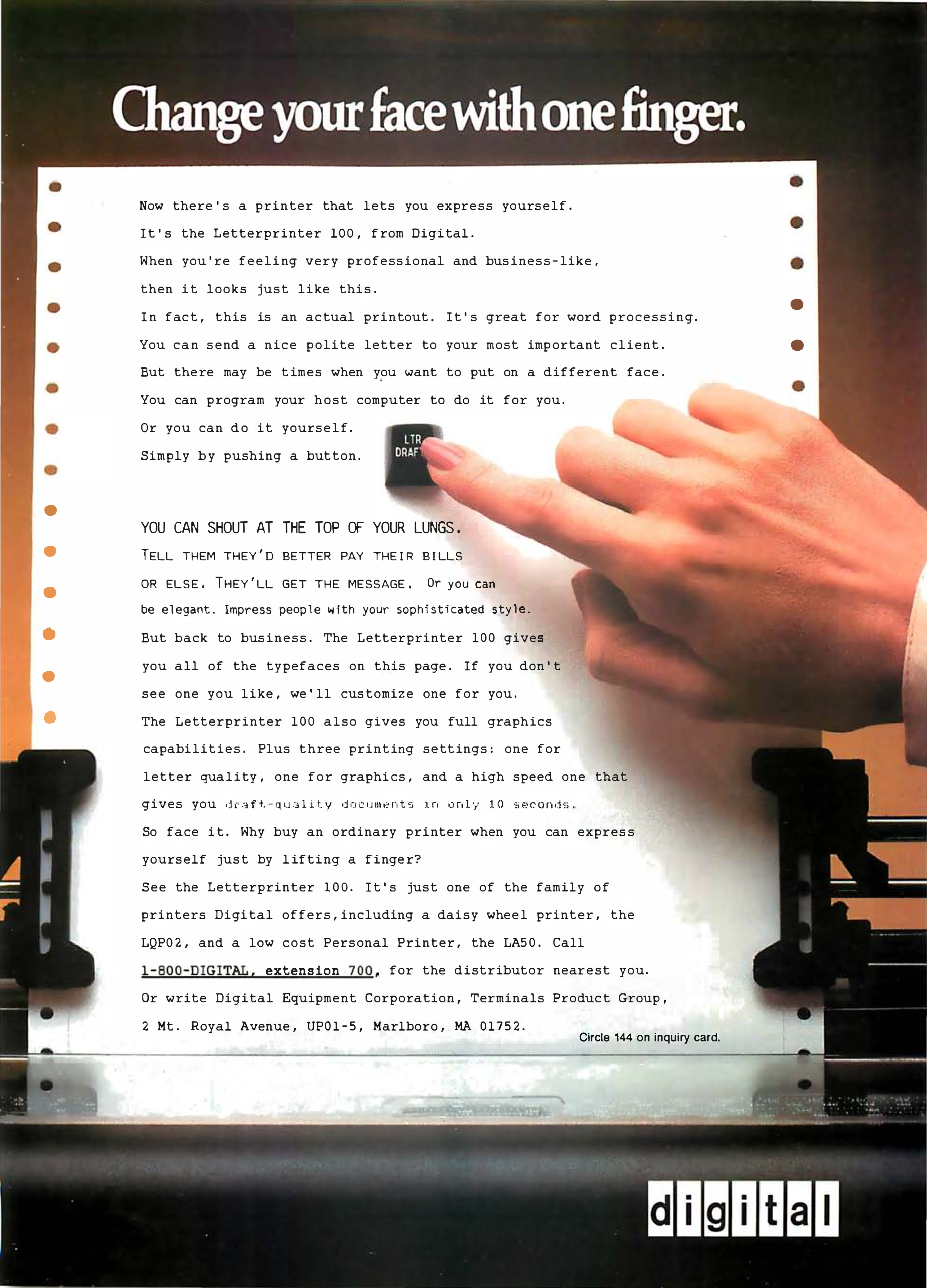


Photo 12: *This side-by-side bar chart illustrates Chartmaster's titling capabilities.*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Now there's a printer that lets you express yourself.
It's the Letterprinter 100, from Digital.
When you're feeling very professional and business-like,
then it looks just like this.
In fact, this is an actual printout. It's great for word processing.
You can send a nice polite letter to your most important client.
But there may be times when you want to put on a different face.
You can program your host computer to do it for you.
Or you can do it yourself.
Simply by pushing a button.
LTR
DRAF
YOU CAN SHOUT AT THE TOP OF YOUR LUNGS.
TELL THEM THEY'D BETTER PAY THEIR BILLS
OR ELSE. THEY'LL GET THE MESSAGE. Or you can
be elegant. Impress people with your sophisticated style.
But back to business. The Letterprinter 100 gives
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see one you like, we'll customize one for you.
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	Graphics Generator	Business Graphics	Chartmaster
Chart complexity			
charts/page	manual	manual	automatic
graphs/chart	10 lines 3 bars	many lines	9 lines 4 pies
data points/graph	50 points or 25 bars	4000 plus	600 points or 52 bars
segments/pie graph	12	many	20
Storage			
charts/disk	varies (14-17)	varies	varies
Titles			
main lines	1	1	4
characters	14	many	many
horizontal			
lines	1	1	2
characters	4	many	many
vertical			
lines	1	1	2
characters	3	many	many
legends			
location	none	manual	manual or automatic
lines	none	many	many
characters	none	many	many (boxes optional)
Scaling			
horizontal			
alphabetic	yes	yes	yes
hours	manual	manual	automatic
days	manual	manual	automatic
months	automatic	manual	automatic
years	automatic	manual	automatic
vertical			
linear	yes	yes	yes
log or ln	no	no	yes
user control of			
minimum	yes	yes	yes
maximum	yes	yes	yes
increment	yes	yes	yes
grid (horizontal/vertical)	both	both	both
Plot characters			
points	1	9	4
lines	3	5	4
bars	3	5	9
Labels			
characters	no	many	8
length	no	manual	manual
location	no	manual	automatic
Other data files			
Visicalc	yes	yes	yes
Lotus 1-2-3			yes
others		yes	
Curve fitting			
least squares	yes	yes	yes
moving average	no	yes	no
exponential smoothing	no	yes	no
parabola	no	yes	yes
exponential	yes	yes	yes
power curves	yes	yes	yes
log or ln	yes	yes	no
sine	no	yes	no

Table 1: *Specifications of three plotting packages.*

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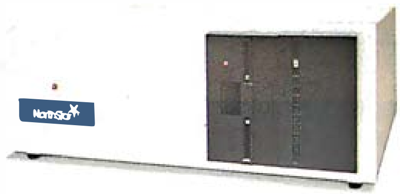

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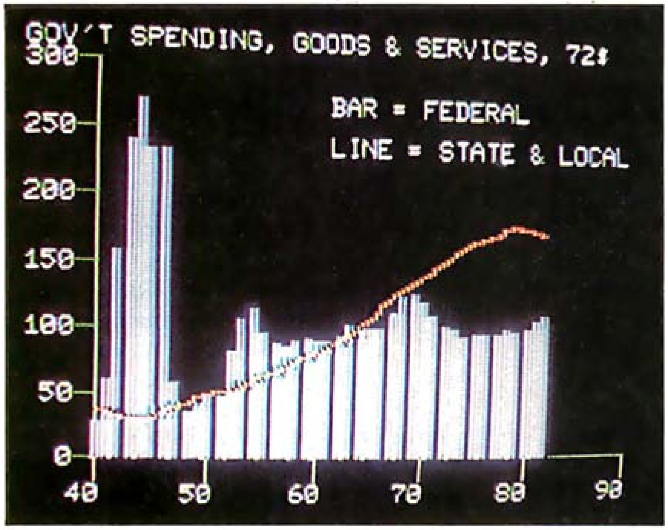


Photo 13: *A combined bar and line chart produced with the Business Graphics package.*

Photo 14: *A Chartmaster scatter chart.*

Text continued from page 360:

To provide an example of the hard copy available with the Hewlett-Packard two-pen plotter in comparison to the screen image, I took figures from the federal purchases of goods and services in constant dollars (1940-83) and added state and local purchases. A large number of data points is a trial for many packages, but Chartmaster handled the assignment well. The data preview scrolled this amount of data off the screen, but otherwise I could find no fault with the program in the development of this chart.

Chartmaster enables changing from side-by-side to stacking bars with a short tour through the menus. I can use the inflation and unemployment levels charted earlier to provide a third piece of information: the sum of two, a "discomfort index." Few packages provide this ease of operation, going from side-by-side bars to stacking bars in less than two minutes.

Bar and Line Charts

A purist will contend that a bar chart should be used to represent discrete events and a line chart should represent continuous events. A fine esoteric argument can be made for or against such a position. In practice, the selection of the type of chart should be based on whatever will communicate the message most honestly and without distortion. With such a criterion, a combined bar and line chart is acceptable.

BPS Business Graphics provides a reasonable bar and line chart (see photo 13). The 40 or more points of data are too trying for many microcomputer-based products, but the BPS program takes the chart in stride. Much fiddling can create a better chart, but the basic options of Business Graphics develop an acceptable product. There are some flaws: the title runs into the *y*-axis, and bars have gaps every so often that detract from the quality of the chart. The legends are manually placed using the cursor, a feature that can vary the placement of the main title, subtitle lines, footnotes, and so forth. On the whole, the product is good but not great.

My admiration for Chartmaster comes to a roaring halt at this point. Combining different types of graphs on the same chart is not possible. Combined bar and line charts are outside the bounds of the menu-driven program.

Scatter Plots and Pie Charts

Scatter plots are used mainly by the scientific community. They appear much less frequently in a business context.

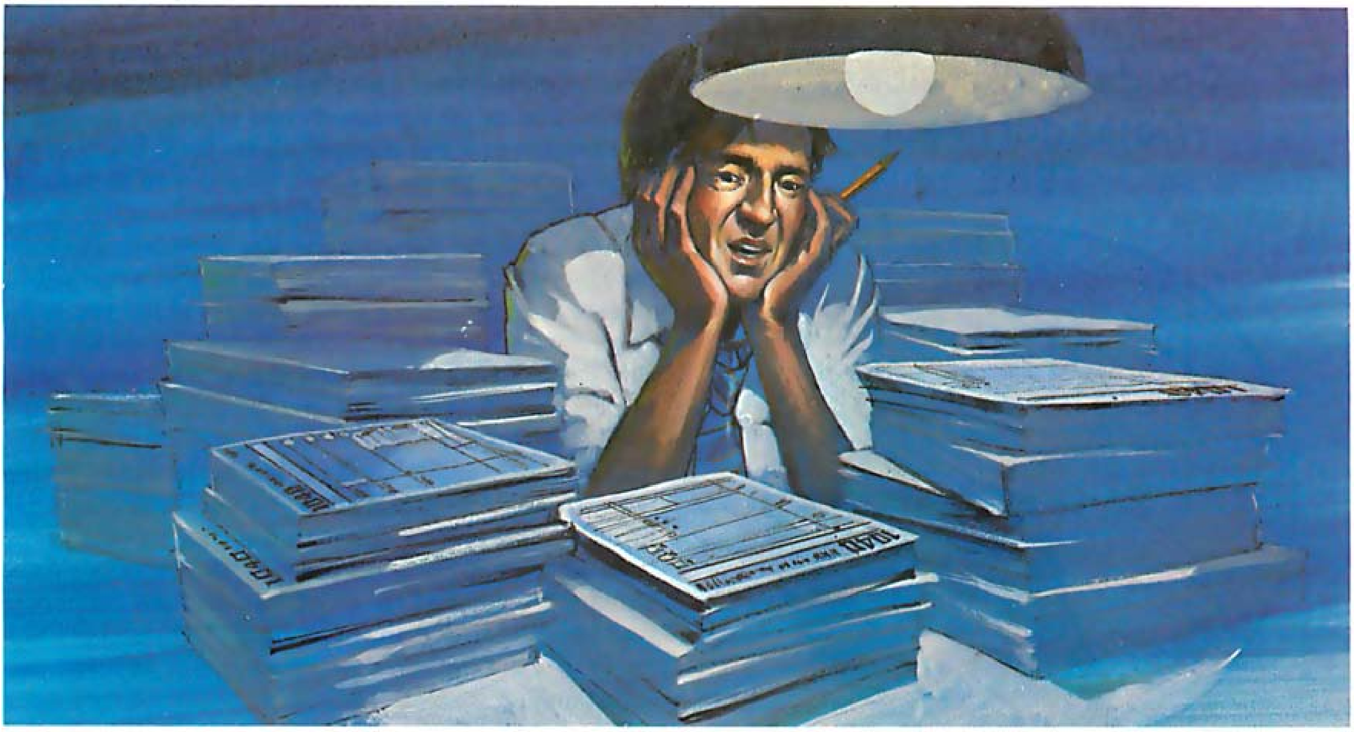
Chartmaster enables a user to develop a quick and easy scatter plot (photo 14). Once again the *x*-axis labels are scrunched together, but the overall chart should prove acceptable to all but the most demanding.

A pie chart is a common way to show the relative composition of something. In this case, I will use the federal purchases of goods and services, split between military and nonmilitary.

The Graphics Generator chart in photo 2 is an accurate reflection of what I consider first-generation graphics: spare and unelegant. The title of the pie chart, like those of the other GG charts, is at the bottom, restricted to about 15 characters. The percentages are calculated automatically and printed as a default. You want a pie chart, you got a pie chart.

BPS Business Graphics took the same data and in less than five minutes produced a more satisfactory second-generation product. The labels for the slices are restricted to 11 characters. If there are so many labels that readability suffers, Business Graphics automatically deletes some of them. This is a nice feature as long as the deleted labels are not the focus of a presentation.

For more flexibility and ease of development, I would choose the Chartmaster version of the same chart (see figure 2). The four-level title, using the "underline," "boldface," and "standard" options, makes a clear presentation. The labels for the slices are put inside the slice whenever possible, with the option of including the percentages and/or cross-hatching, both of which I used here. Menus that simplify the development of a chart are available for all Chartmaster operations, and relieve



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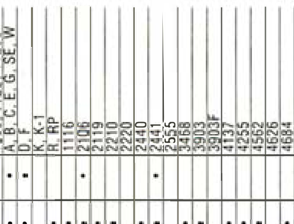

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Level I, Individual $195	•		•	•				•					•														•						•	•	•	
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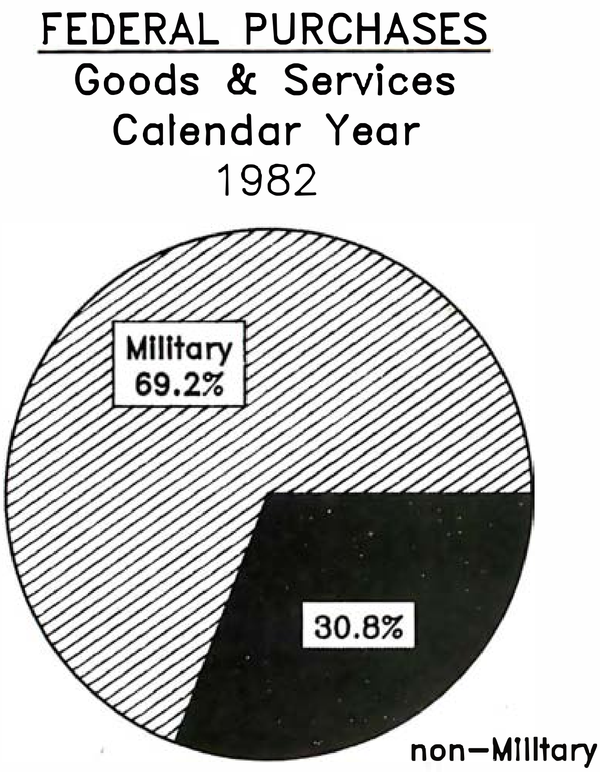

Figure 2: *A Chartmaster two-segment pie chart, printed on a two-pen plotter.*

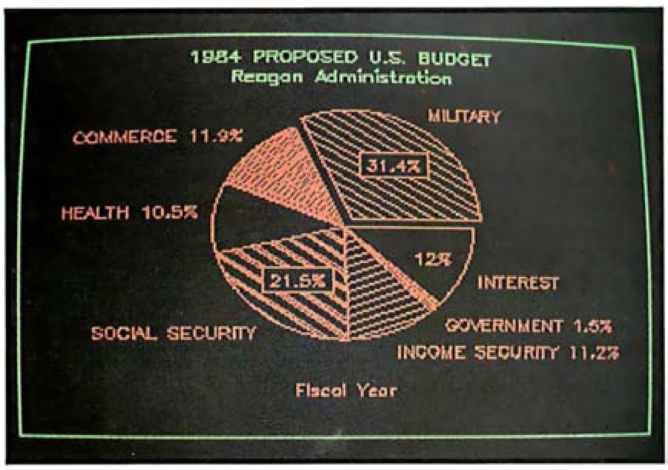

Photo 15: *A Chartmaster seven-segment pie chart.*

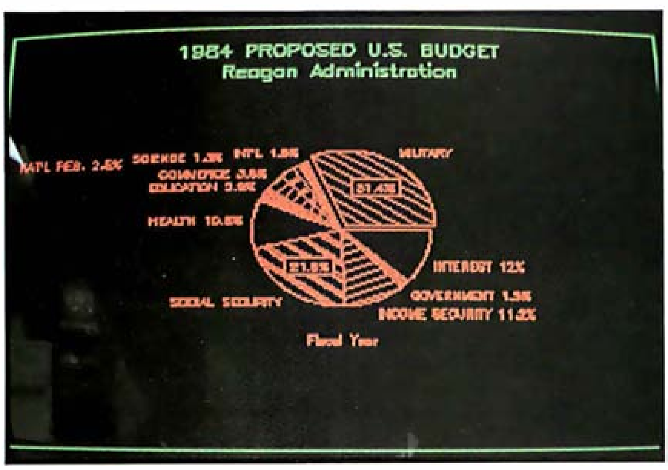

Photo 16: *An 11-segment pie chart produced using Chartmaster.*

users of the burden of memorizing commands. Looking at the eight options for a Chartmaster pie is like taking a quick tour of the possibilities. I then duck back to put the results on the screen and repeat as necessary. The proportional pie selection allows up to four pies per page, each pie proportional to the value of the sum of the elements of the appropriate pie.

Now let's make it harder and use seven slices to illustrate the president's proposed 1984 budget. Once again, Chartmaster provides a good example of the versatility I expect from a third-generation product (photo 15). Each slice has a different cross-hatching, which can be varied by returning to the menu and overriding the default results shown here.

Chartmaster automatically balances the size of the pie with the space required for the labels. Percentages are included and appear either in the slice or next to the label, as space in the slices permits. The largest slice, the military, is exploded for emphasis, and the separation could be extended to any or all slices. The package's flexibility in handling titles permits a clean, accurate presentation.

Because the president was kind enough to provide even more detail, let's push the readability beyond the limits of common sense to develop an 11-segment chart. In this case, the readability is reduced by the length of the titles and segment labeling. Chartmaster uses all of the labels and handles the task with better results than I expected (photo 16). I could develop a more acceptable chart from this data by reordering the slices. My concept of the fourth generation features the machine helping me by allowing me to specify the reordering of the segments.

The Fourth Generation

A fourth generation of business graphics packages would begin with the best features of these programs and add enhancements. Such a package might use a mouse, so that a user could make changes simply by pointing to the element on the screen that needs to be modified. Other features might include having the data listing and the chart visible at the same time, either on the same screen or on separate screens. A fourth-generation program should certainly be capable of getting information (such as stock quotes, government economic figures, and company sales reports) directly and easily from outside sources.

If a package is to be used for forecasts, it must include scaling that allows a graph to extend beyond where the data currently exists. A program should also accommodate data that begins in the middle of a scale. Naturally, statistical calculations included in a fourth-generation graphics package should feature some checks to insure that they are used appropriately.■

Jack Bishop is a management consultant specializing in mergers and acquisitions, planning, and economic issues. He has a BS in chemical engineering and a PhD in business and economics. He can be reached at 916 Maple Ave., Evanston, IL 60202.

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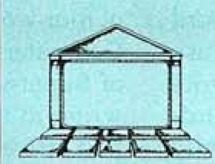

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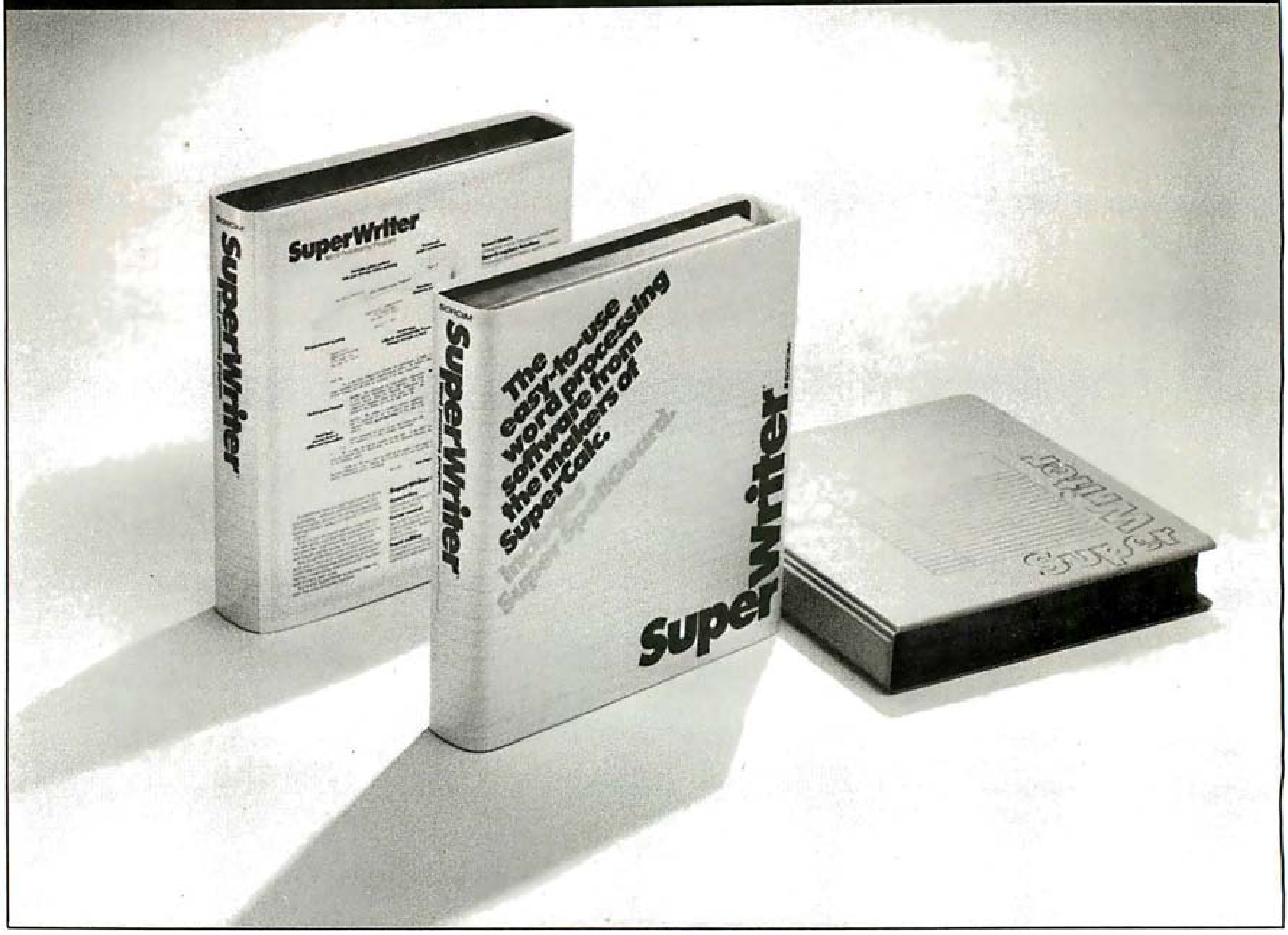

Photo 1: *Superwriter is one of many word-processing programs now available for the IBM Personal Computer and Personal Computer XT. Superwriter provides many functions useful in a business environment. (All photos by Ed Crabtree.)*

A Versatile IBM PC Word Tool: Sorcim's Superwriter

This word-processing program combines surprising power with ease of use

by Richard S. Shuford

You've just bought an IBM Personal Computer for your office, and you're looking around for software to do word processing. You especially want a program you can use for writing letters, and you'll sometimes need to write memos and short reports. But you've heard that word-processing programs are hard to use, and you're too busy to spend time reading a fat notebook of documentation. Sorcim Corporation's Superwriter could be the word-processing program you need.

Last spring, just as I was completing my evaluation of four word-processing programs for the IBM Personal Computer (see reference 3), I received a preliminary copy of Superwriter (see photo 1). Although I used Superwriter to write most of that review article, the product had arrived too late and was not mature enough to be included in the project.

Since then I've had several months to use Superwriter, and Sorcim has also had time to revise and improve it.

Superwriter

Minimum practical hardware configuration: 96K bytes of RAM, 80-character display (preferably monochrome display adapter), two 5¼-inch floppy-disk drives

Maximum number of characters directly manipulable: 32,175

Editing universe: window into buffer in RAM

Command structure: program modules invoked through nested menus; in editing, single-control characters (most editing commands also assigned to function keys) augmented by two sets of extended multiple-keystroke commands plus command assignments to IBM PC special keys

Tutorial course for beginners? 16-page booklet *10 Minutes to Superwriter* with example requiring user to type a short letter

Online help during editing? full-screen, context-sensitive displays of help information invoked by typing the F1 key

Longest line length that can be set: 250 characters (with automatic horizontal scrolling)

On-screen status information shown during text entry and editing: file name, current line and column in buffer, insert-mode status, buffer-modification flag, Escape-command and print-control prompting

Screen location of status information: bottom line, inverse dim or colored video

Use of IBM PC function keys: all F*n* keys used, with and without Shift key, cursor-pad keys used; some assignments disagree with IBM's recommendations

Action of Del key: deletes character to the left of cursor

Action of backarrow key: nondestructive backspace

Decimal tab stops? implemented through print-time formatting with numbers automatically aligned at decimal point

Column-move capability during editing: no

Possible insertion of nonprinting ASCII control characters: yes, both by embedding in file and through print-time OUT command. Characters with values above decimal ASCII 128 may be inserted with editor, but print and spelling modules cannot handle them.

Formatting scheme: on-screen or with extensive print-time formatting commands embedded in text

Transition time from edit mode to printing start (includes answering queries as fast as reasonably possible): 40 seconds for 26,376-character file

Print while editing? yes, after formatting

Obtain file directory without leaving program? yes, also shows document history if it exists

Can user change default parameters? yes, both editing and printing

Document assembly during editing: can include entire files or marked sections of files

Document assembly during printing: extensive capabilities for document assembly, file access, and interactive input

Accept operator input for immediate inclusion in printed output? yes

Automatic formatting capabilities (other than defaults)? extensive and complex

Default text-justification style: flush-left (can be changed)

Can documents be printed without being saved to disk? no

Difficulty of changing from single spacing to double spacing: easy, with formatting command

Can text be searched for printing attributes? not in all cases

Printers supported: NEC Spinwriter 3510, 3550, 5510, 5520, 5530 (also with Sellum modification); Diablo 630, 1650, 1750; Xerox; Qume Sprint 5, 9, 11; (with proportional spacing—others without full capability)

Special features of disk-file format: program can write files in three different output formats. The normal format uses only Linefeed characters to mark ends of lines within paragraphs, with Return characters at paragraph ends; normal-format files may be saved with or without document history embedded. The other two formats are intended for saving files to be used as input for other programs—the document format is frozen into the screen format existing at the time the document was saved. One format places only Return characters at the ends of all lines, the other puts in Return/Linefeed pairs. Both formats delete document history and special characters

Checking of spelling integrated into program? yes, Super Spellguard is provided and can be called from the main menu

Most annoying characteristics: limited buffer space for editing, inability to search for printing attributes, small size of spelling dictionary

Most pleasing characteristics: ease of use for beginners, including online availability of full-screen help information at every phase of the program's operation; consistency of user menus and command structures; powerful built-in formatting and form-letter capabilities; execute-file batch editing; user setting of most default parameters; provision of Maintain program module to ensure program-code integrity.

Miscellaneous comments: Superwriter can read files created by Wordstar and automatically translate them to its own format. The Supercalc spreadsheet program may be called from the Superwriter menu. The program can operate under both versions 1.10 and 2.00 of PC-DOS and on the IBM PC XT Model 5160 as well as the PC (5150).

Table 1: *Technical characteristics of the Superwriter word-processing program. This table has been arranged for easy cross-referencing with the comparison table in the article "Word Tools for the IBM Personal Computer" (May 1983 BYTE, page 176), in which Easywriter II, Volkswriter, Wordstar, and The Final Word were compared. See "At a Glance" box on page 376 for additional information.*

We'll look at some of the characteristics of this product after we consider some background information.

Broad Categories of Use

Most people who have personal computers use their machines at least part of the time for writing documents to be read by other people. There are as many possible writing tasks as there are people, but most of these tasks fall into one of four broad categories: composing long continuous documents (a novel, for instance), typing short personalized letters for individual recipients, preparing form letters for mass mailings, or merging and formatting text for exact reproduction, possibly including illustrative materials (as in a newsletter).

Most word-processing programs are suited to one or two of these categories. A newsletter editor trying to wrap a news article around a photograph had best use a program with extensive on-screen formatting capabilities; an author needing to enumerate and delineate the subsections of a complicated long document could most easily do it with a program containing a sophisticated print-time formatter. No single program is best for all four uses.

Coaxing the Timid User

A word-processing program is a tool. So is a hammer. But because most folks have a clearer idea of how to pound nails than how to use a piece of computer software in the process of putting words on paper, it takes time to learn how to use the software.

Because time is money, people naturally want to spend as little of it as possible learning to use a word-processing tool. This creates a problem for the software designer. The tool should be flexible, with enough power for it to tackle whatever writing task its user sets it to. Yet it must not be so complex that it frightens away potential users, leaving its power and flexibility to lie forever undiscovered.

As you might expect, different software designers have offered different solutions to this problem. The author of Lifetree's Volkswriter chose to limit the number of features and flexibility of his program, and he produced a streamlined word processor that is easy to learn for writing uncomplicated documents. The designers of Wordstar decided to offer the user more of a Swiss-army-knife approach (with some blades optional) and devoted as much as one-third of the video screen to giving the user hints about what command options are available. The designers of The Final Word evidently decided to offer a lot of raw power for a certain set of operations, assuming that some experienced users would need that power and would therefore take time to read the lengthy documentation to learn to use it.

The most striking characteristic of Superwriter is its approach to making a relatively large amount of word-processing power easy to learn and use.

Superwriter will probably find its most favorable reception in business offices. It is particularly suited for secretarial letter and contract writing and for producing form letters. Its context-sensitive online help facility will give aid and comfort to uneasy first-time users of micro-

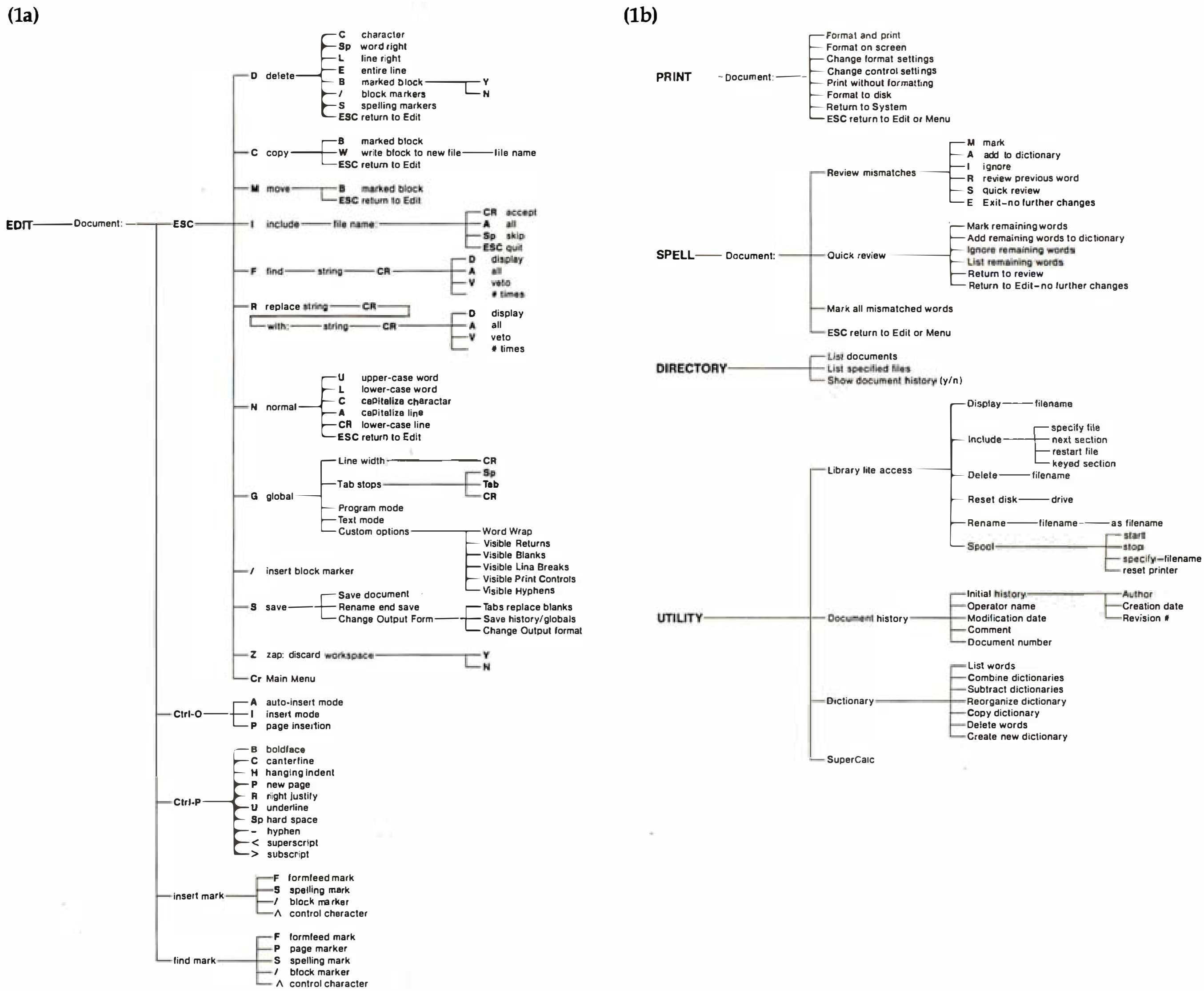

Figure 1: *These menu maps show how the control functions in Superwriter are nested in several levels of menus. These maps have been reproduced from the documentation, courtesy of Sorcim Corporation.*

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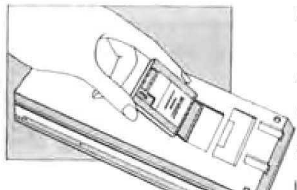

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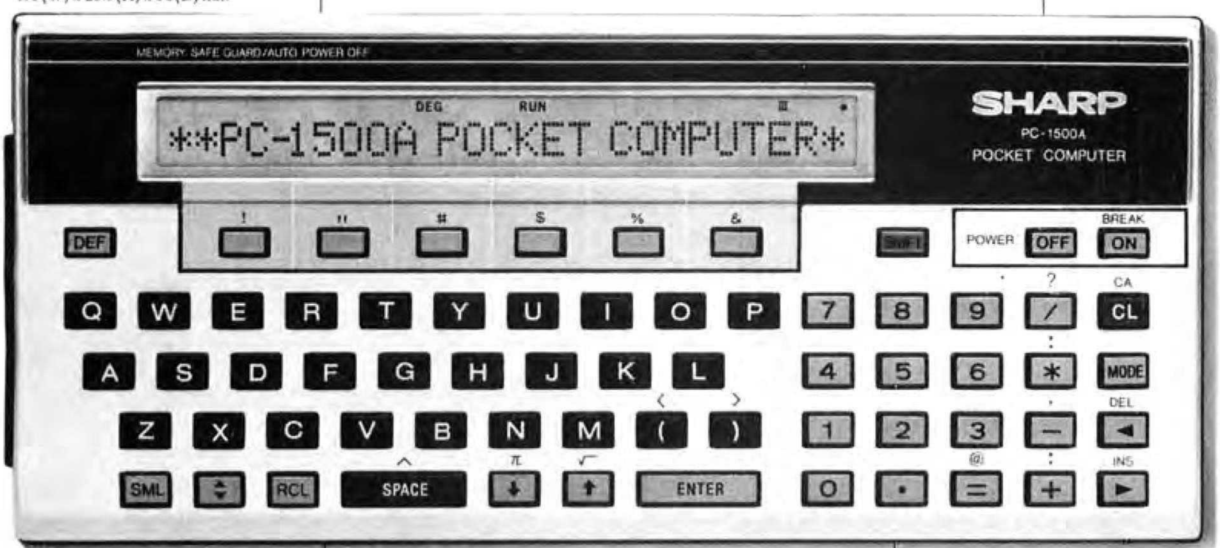

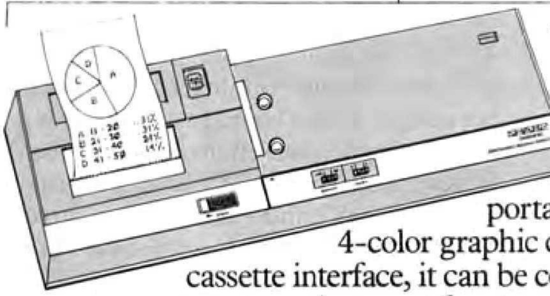

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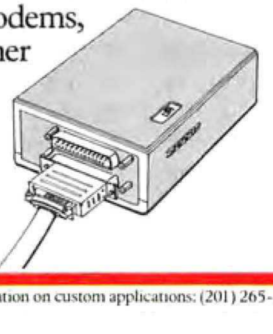

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Photo 2: *The main menu of Superwriter, reached after you invoke the program from the operating system (in this case, PC-DOS 1.10).*

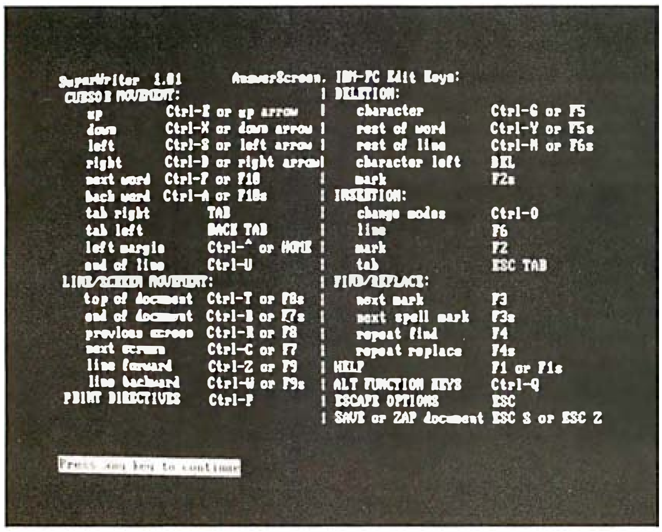

Photo 3: *The help display ("Answerscreen") for the main editing mode in Superwriter. By pressing the F1 key at any point in the operation of the program, you can call up a help display explaining the exact command options available at that point.*

computer word processing; its flexible document-merging, formatting, and data-file capabilities will please experienced users; and its built-in spelling-check function will satisfy both. Certain details of its characteristics are shown in table 1.

Structural Overview

Superwriter's control functions are divided into several groups: editing, printing and formatting, checking spelling, displaying disk directories, and general utility functions, as shown in the "menu maps" from the documentation (reproduced in figure 1). The principal working parts of the program are physically divided into seven disk files: two for the most-used utility functions and editing routines, one for printing and formatting, one for the text of help-screen displays, and three for the spelling checker and its large dictionary. In addition to these, you can prepare an eighth file containing your own preferred set of default editing and printing parameters that is automatically read by Superwriter when the program is started up.

When you activate the Superwriter program, you are presented with a screen containing the main menu (see photo 2). You select the desired function group by moving the cursor (with the space bar or a cursor key) to the proper item and then hitting the Enter (Return) key. Most of the main-menu selections lead to submenus; some functions are three levels down from the top. But the Escape key will consistently get you out of a lower menu into a higher one, up to the main menu. The menu and function-transition routines were thoughtfully designed to remember the name of the document you are working on, so you never have to type the filename more than once.

At any point during the execution of Superwriter, you can hit the help key, the assignable function key F1. (Sorcim calls it the "Answerkey"—for compatibility with non-IBM-PC versions, Control-backslash also works.) Pressing F1 causes the program to search a file on the system disk and display information pin-pointed to help you, no matter what mode or submenu you happen to be in. The help display for the main-editing mode is shown in photo 3.

Editing Functions

When you select the edit mode from the main menu, you are queried for the name of the disk file you wish to edit, and then the program brings up the main editing screen. The bottom line of the display is taken up by some minimal status information. As shown in photo 4, the rest of the screen shows the text being entered or edited in bright characters. Line endings at the ends of paragraphs are termed "hard" Return characters and are indicated by dim house-shaped symbols; lines ending where words have been automatically wrapped to fit the assigned line width are called "soft" Return characters and are shown as dim plus signs.

When execution is begun, Superwriter assumes one of two sets of global display settings deemed suitable for either human-language text or program editing, based on the extension of the filename. If you want to change these settings, you use one of the extended commands. When you hit the Escape key, the bottom-of-screen status line is replaced by a line containing a series of letters that hint at the possible extended command functions now available.

If you hit the G key after Escape, you can see a menu for the global edit settings, such as that shown in photo 5. If you then proceed to hit the help key (F1), an explanation of the normal global settings of the display will appear: word-wrap on, make hard and soft line endings visible, show soft hyphens, and do not show blanks as dim underscores. You can change these settings to suit your task and temperament; an editing display with everything shown (including blanks shown as underscores) appears in photo 6. After you have adjusted the global settings, you hit Escape to jump back to the main editing screen.

Some aspects of Superwriter mimic functions found in other programs (see the text box "Historical Roots"). You can move the blinking-block cursor character by character or line by line around the editing screen in three ways: with the special IBM PC cursor-movement keys, with a set of control keys the same as those used by Wordstar (the "magic diamond": Control-S, -E, -D, and -X), and with another set of four keys as used by the old Magic Wand (Control-H, -K, -L, and -J). The cursor can be moved through areas on the screen that contain no text. Wordstar's influence also shows up in the assignment of control characters for deleting the character at the cursor (Control-G), moving of the cursor by word forward and back (Control-A and -F), moving by screen (Control-C and -R), and single-line scrolling (Control-Z and -W).

Many of the other functions appear on the assignable function keys (see table 2). My complaints about the key assignments are that some of them—the Del key, for instance—ignore IBM's recommendations for keyboard use (see pages 3–17 and 2–16 of the IBM PC *Technical Reference Manual*), and no fewer than four keys or key combinations have the function of moving the cursor one column left.

If you've used other word processors that have on-screen formatting, you'll be surprised to find that Superwriter does not have or need a reform-paragraph command: the Sorcim program automatically reforms each paragraph after text has been entered or changed. The drawback of this feature, however, is that a fast typist can get several words ahead of the screen while the program is trying to figure out where to break the lines. However, I have never lost any characters; they always show up eventually.

You can select from four character-entry modes: typeover, insert, page insert (for long insertions), or auto-insert. This last mode is unusual in its behavior. A combination typeover/insert mode, auto-insert is most beneficial when you want to substitute a longer word for a shorter one: you put the cursor on the first letter of the old shorter word and begin typing the letters of the new longer word. As you type, the new letters replace the old until you reach the space at the end of the old word; then the remaining new characters are inserted in front of the space. These modes are toggled by two-character control sequences, with the active mode shown in the status line.

The Escape-activated extended commands include some versatile options for finding and replacing character strings: some, all, or a specified number of strings may be found or replaced. The search functions can look past soft line endings to match a character string, and you can search for a hard Return character. Letters are

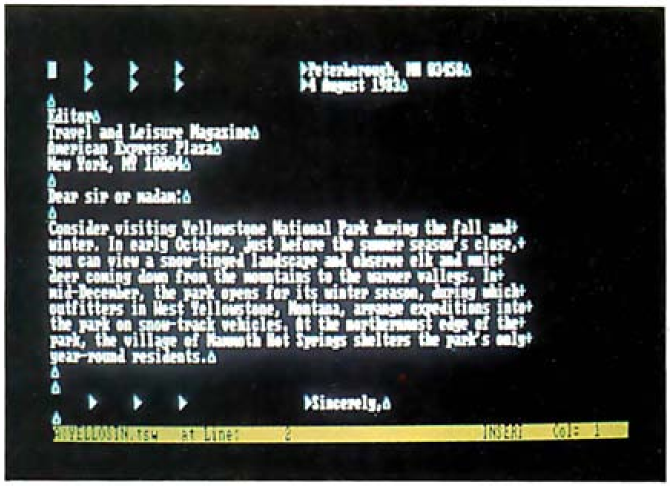

Photo 4: *The main edit screen that you see when you are typing or editing some text in Superwriter. On a monochrome display, the text is shown in bright characters and everything else on the screen is dim. On a color monitor, the text is shown in bright white characters, while formatting or control information is displayed in bright blue and the status line and transient prompting lines are displayed in reverse-video green or brown.*

Photo 5: *By issuing the Escape G extended command, you can get to a menu for changing the global document settings. Two major groups of settings are available, one mode for editing text (used in these examples) and another for editing program code. You can mix and match the settings to your taste.*

always matched exactly (searching for "the" will not find "The"). Spelling-check marker characters, formfeeds, page marks, and block marks may be searched by a command associated with the F3 key.

Searching and replacing print-attribute marker characters (the directives you type to underline a word, for instance) is a difficult puzzle in many word-processing programs. Superwriter is somewhat susceptible to this problem, although not totally. It is not possible to search for or replace the special printing-attribute markers that you embed in the text through the embedded-print-control extended command, but Superwriter allows you to assign seldom-used regular printing characters as

At a Glance

Name
Superwriter

Type
Word-processing program

Manufacturer
Sorcim Corporation
2310 Lundy Ave.
San Jose, CA 95131
(408) 942-1727

Price
$295

Format
Two 5¼-inch single-sided 8-sector floppy disks

Language
Translation from 8080 assembly code supplemented by Pascal/M

Computer
IBM Personal Computer and XT running PC-DOS 1.10 or 2.00 (as tested)

Documentation
Loose-leaf binder, 170 typeset pages, 4-page index; folded pocket reference card; 16-page spiral-bound beginner's booklet; function-key stickers

Audience
Business users of microcomputer word processing

Key	Normal Function	Shifted Function
F1	help key	help key
F2	insert mark (special character)	delete mark
F3	find next mark	find next spelling mark
F4	repeat last find operation	repeat last replace
F5	delete character at cursor	delete to word end
F6	insert new line	delete to line end
F7	next screen (forward)	go to bottom of document
F8	previous screen (backward)	go to top of document
F9	scroll down	scroll up
F10	go to next word	go to previous word
Del	delete character to left of cursor	period
Ins	insert one space at cursor	zero
Alt	not used*	

* If you wish to use Superwriter to create files for viewing on the IBM PC's screen, you can use the Alt key in conjunction with the numeric keypad to insert any character by its decimal numeric value. Superwriter can display and edit even the graphics characters, although the spelling-check and print routines are not set up to handle them.

Table 2: *Uses given by Superwriter to the IBM PC's assignable function keys.*

markers for underlining, boldfacing, superscripting, subscripting, soft ("ghost") hyphens, and hard spaces. If you anticipate needing to search for attribute markers, you can use these, which are later interpreted by the printing routine to produce the desired results in the hard copy.

Blocks of characters may be marked for moving, for deletion, or for copying (either within the same document or into a separate disk file). Block markers are special characters inserted using an extended Escape command and symbolized by dim slashes; there is little possibility of confusing them with ordinary slash characters present in the document. A block marker may be placed at any point in the text.

Superwriter has been provided with a versatile "normalize" mode of operation. Invoked by an Escape command, this mode allows you to adjust the capitalization style of words or entire lines. The cursor can be moved in normalize mode, but none of the other usual editing commands work. A similar delete mode allows systematic removal of marked blocks, words or portions of words, lines or portions of lines, block markers, and spelling-check markers.

Sections of external text may be merged with the current document during editing by use of the include command, which is invoked as an extended Escape command.

When you want to stop editing your document, you give the Escape S command to save the contents of the text buffer into a disk file. You are given a chance to change the name and output format of the file, if needed, but in the normal case, you won't do that. A sign of the thought given to the menu structures of Superwriter is that the most commonly invoked command in the save menu is the one the cursor falls into when the menu

Historical Roots

Although Micropro's Wordstar has for some time been the most commonly used word-processing program for 8-bit microcomputers, a significant minority of users have found an effective tool in a program that began under the name of Magic Wand but later became known as Peachtext when Peachtree Software bought its rights. When I began to use Superwriter, I was struck by its resemblance to Magic Wand, which I had long used on an 8-bit Z80-based computer running the CP/M operating system. The resemblance is no coincidence, as I later found out.

When the managers of Sorcim Corporation decided to add a word-processing program to the company's line of software, they decided not to build a program from scratch. They looked around for an existing suitable software product, and at length Sorcim struck a deal for a program exchange with Peachtree Software. The code of Supercalc was traded for the code of Peachtext (by the way, now you know why Peachcalc seems similar to Supercalc).

Peachtree eventually made Peachtext available for the IBM Personal Computer, but Sorcim was not content to merely repackage the program. After gathering data on how users responded to the virtues and defects of various existing word-processing packages, Sorcim added the Super Spellguard spelling-checker program (that Sorcim had acquired by buying the company that had invented it, Innovative Software Applications Inc.) and devised a set of menus and command structures to link all the routines together in a consistent way. After these pieces had been adapted to the Intel 8088 processor, Superwriter was sent out to seek its niche in the IBM PC word-processing market.

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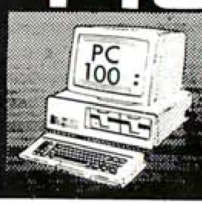
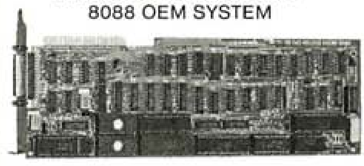
appears. This easily reached menu item saves the document under its old name while renaming the existing disk file with the extension of .BAK, providing an automatic backup. Then, after the document has been stored, you just have to hit the Enter key twice more, and Superwriter, remembering the filename of the document, reads the disk file and puts you back into the edit mode (although at the top of the text and not exactly at the point where you left off, as The Final Word does).

Superwriter was optimized for use on an IBM PC equipped with the monochrome display adapter. On such a system, the scrolling of text is smooth, and scrolling backward is just as fast as scrolling forward. Using the IBM color/graphics display adapter, however, is not as pleasant. True, on a color monitor the line-ending symbols, print attributes, and other special embedded characters are displayed in an appealing shade of light blue, and the status lines appear in green or brown. But the scrolling suffers. In both directions, scrolling proceeds from the edge of the screen away from the edge where the fresh text is to appear, so what you just scrolled to see is the last thing on the screen that settles down.

If you don't have a color monitor attached to your color/graphics display adapter, that is, if you are using the color card to drive a non-IBM monochrome composite-video monitor, you need to invoke the program by typing "SW/BW" from the PC-DOS "A>" command prompt. This undocumented option stops the display from trying to produce color. Otherwise, if you invoke Superwriter from the operating system normally, the status line and command prompts become unreadable as the monochrome CRT (cathode-ray tube) tries hopelessly to produce the different colors, and the special characters seem to change shape or disappear.

The size of the editing buffer is the worst deficiency





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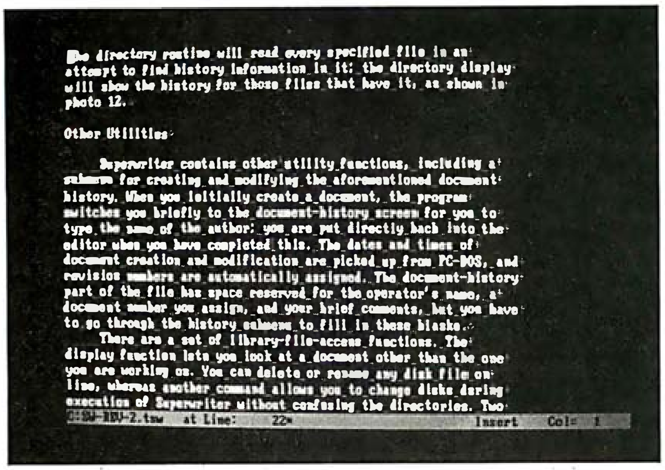

Photo 6: *The main editing screen after a global-settings command has been issued to make blank characters be shown as dim (or blue) underscores. This setting is most useful for editing programs.*

Photo 7: *After the spelling-check routine has searched the document file for words not in its vocabulary, you must review the words it does not know and weed out the ones that are invalid spellings from wrongly flagged mismatches. You need only strike a single key to seal the fate of a word—to ignore it, mark it in the document for correction, or add it to the dictionary file. You can also change your mind about the previous word, give up and go back to the editor, or decide to treat all mismatched words the same.*

of Superwriter. In the final version I tested (version 1.01), the editing buffer is contained entirely in the RAM (random-access read/write memory) of the computer, and there aren't even any commands for explicitly reading and writing parts of the buffer to the active disk file so you could edit a document larger than fits in the buffer. Worse yet, the buffer space still reflects the old memory-address limitations of 8-bit software—my IBM PC has half a megabyte of user memory in it, and still the buffer size is only slightly over 32,000 bytes. (I bumped my head on this buffer size while writing the May article, so I switched to The Final Word.) And as the text grows to nearly fill the buffer, the program's response to keyboard insertions (other than page-mode insertions) becomes sluggish. As we'll see shortly, you can use print commands to splice many short files together into one long printed document, but often it is desirable to keep a document in one contiguous file. A representative of Sorcim told me that the company plans to deal with this restriction eventually, but for now it limits the usefulness of the program.

Execute-File Editing

One unusual feature Sorcim has built into Superwriter (after successfully using a similar idea in Supercalc) is the ability to read editing commands from a disk file, called the *execute file*, which can contain both printing text characters and control characters. When this feature is being used, Superwriter reads each character of the specified file as if it were being typed at the keyboard. With practice, you can set up an execute file to read in a document, perform editing operations on it, save the document, and print it, all without touching the keyboard during the process.

This essentially batch-oriented process, used in conjunction with Superwriter's print-time document-composer capabilities, has potential for automating many repetitive tasks of document revision that might be required for tasks such as contract drafting.

Spelling Checking

Sorcim has been separately selling the spelling-checker routine used in Superwriter under the name Super Spellguard. The program was previously sold by Innovative Software Applications Inc. and was tested by Phil Lemmons (see reference 2). The functions of this relatively mature product have been integrated into Superwriter in a logical and pleasant way.

The words it knows to be correct (its vocabulary) are kept in the "dictionary," a 56,000-byte disk file containing some 20,000 words. The spelling checker does not follow any rules for creating plurals and possessives from word roots, so any word form not in the file is flagged as a possible misspelling. During the first few weeks of use, most people will find many valid words flagged until they have put most of their working vocabulary into the program's dictionary file. However, the flagged-word review routine makes it as painless as possible to add words.

Once the proofreading routine has compiled a suspect-word list, you have three possible courses of action: to mark all mismatched words in the document, to review mismatched words individually, or to "quick-review" all words (treat them all alike, by marking them, ignoring them, adding all of them to the dictionary, or listing them on the screen or printer). The recommended method is individual review, and the program allows you to dispose of each word with a single keystroke—to mark it, add it, or ignore it, or to reconsider the previous word, as shown in photo 7. Once all the words have been marked, you are returned to the editor, where you can use a special search command to locate all the marked words for correction.

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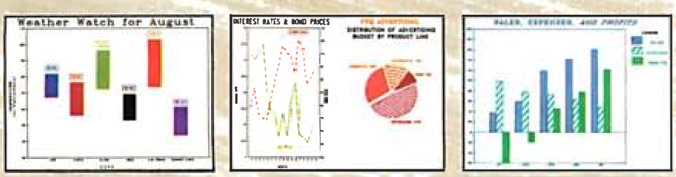

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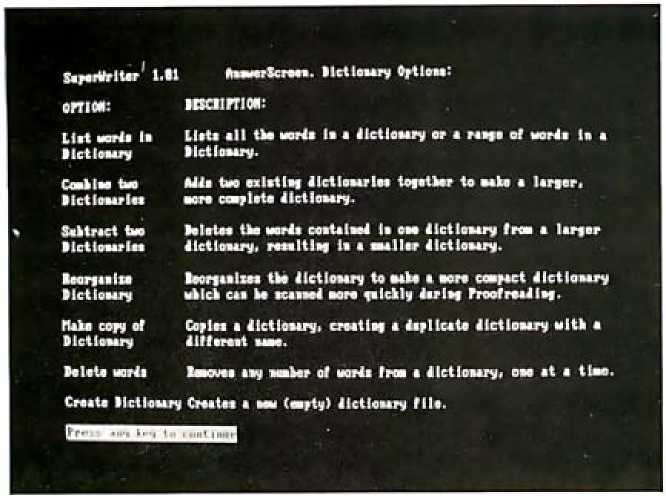

Photo 8: *If you need to change the dictionary file (list of known words) used by the spelling-check routine, you can use the utility menu for dictionary maintenance. As for any other menu in Superwriter, if you become confused, you need only hit the F1 key and this display will appear to give details on the action caused by each menu item.*

Misspelled words in file:	7
Words found suspect:	47
Words wrongly found suspect:	40
True misspellings found:	7
Misspelled words missed:	0
Time to proofread file:	0:40
Time until ready to correct file:	1:25
Time until corrections done:	2:30

Table 3: *Results of spelling-checker benchmark, based on checking the spelling of the 400-word document shown in figure 2 by Superwriter's built-in spelling-check routine. Timings include the user's responding with keyboard input as fast as reasonably possible at the appropriate points. The individual-word-review procedure was used. It would take longer to correct a document if you have to look up the correct spellings of any words. This same test document was used by Phil Lemmons in his article "Five Spelling-Correction Programs for CP/M-Based Systems" (November 1981 BYTE, page 434), and the results are presented in the same format.*

I'd had the joint staked out for two years and nine months. I'd been waiting for a break in the investigation all that time. This looked like the break I'd been waltzing for.

The tall stranger walked up to the bar, ears akimbo. I knew he meant trouble from the moment I saw the insignia on the back of his black leather jacket: "Hell's Twirps." That was the same gang that peddled into the all-Mahler Philharmonic concert last year and hummed the collected works of John Cage in unison. Not that John Cage has ever been in unison. Quite the canary.

Why was this particular Hell's Twirp barging into the only Austro-Mongolian fife and drum factorial east of the Rockies? Why wasn't he riding his unicycle? And what was the meaning of the gold mandalas hanging from the tips of his handlebore mustache? Then I saw his baton. The sight of its sleek crome length turned my bblood to issicles. When I glimpsed the white plastic knobs at the ends of the baton, I saw my whole life rush before my eggs.

Suddenly the Twirp slammed his fist down on the bar. His ears swayed gently in the breeze as he demanded, "Give me four hundred snare drums to go! Give me the five longest fifes in your inventary! Give me the old college try! Give me liberty or give me grief!"

I knew better than to let this build to a crisis before interseeding. I swizzled up behind the big Twirp and said, clam and easy like, "Shove off, Twirp. Vamoose. Leave well enough aloft."

He whirled, ears slashing, baton twirling. I thought of the health-insurance premiums I hadn't paid. I realized how happy I would have made my dear old father if I'd only gurgitated from college. I thought of the thousand times I'd wanted to be where I wasn't, and knew this was the thousand and first. If I had'nt been in a cunnubial mood, I wouldn't have been able to stand up to the singing shroud, the short shrift and the five and dime. But I had no time for all that now. Before it was too late, I reached into my vest pocket and pulled out my well-thumbed copy of Milton's Areopagitica.

"That'll be seven ninety-eight!" the bartender suddenly screamed.

I'd been counting on him.

Figure 2: *A 400-word text sample devised to tax the limits of the spelling-check routine and serve as data for a benchmark test.*

But the spelling checker has some limitations and idiosyncrasies. One of these is that hyphenated and otherwise punctuated word compounds are treated as possible misspellings and are flagged for your inspection. (Observe that "All-Mahler" shows up in photo 7.) This is nice if you are trying to produce a fully justified printout with words at line ends divided and hyphenated to maintain good character spacing. However, if you are merely writing a technical document, the constant attention to hyphens is tiring. (Technical documents, especially BYTE articles, are replete with punctuated terms like "random-access read/write memory.") You can add words and hyphenated terms to the dictionary file, but it would be nice if you could just tell the spelling checker to ignore certain marks of punctuation. Furthermore, the spelling-check routine cannot tell the difference between a definitely-going-to-be-there hard hyphen and one of the merely-maybe soft hyphens that you can insert with the Superwriter editor for possible line divisions by the print routine.

On the other hand, the attention to punctuation is not all bad. It can keep you from publishing a boner like "had'nt."

One of Superwriter's many submenus is a dictionary-maintenance menu, which gives access to functions for listing the words in the dictionary, combining two dictionary files, deleting all the words in one dictionary file from another or deleting individual words, copying and reorganizing dictionary files, or creating empty dictionary files. The help screen for this menu is shown in photo 8. You can use an entry in the default-parameter file (read when Superwriter starts up) to name your own dictionary file (other than the supplied SW.DIC) for normal use.

I tested the spelling checker on a document devised by Phil Lemmons as a difficult test case (see reference 1); the document is shown in figure 2, while the results are shown in table 3.

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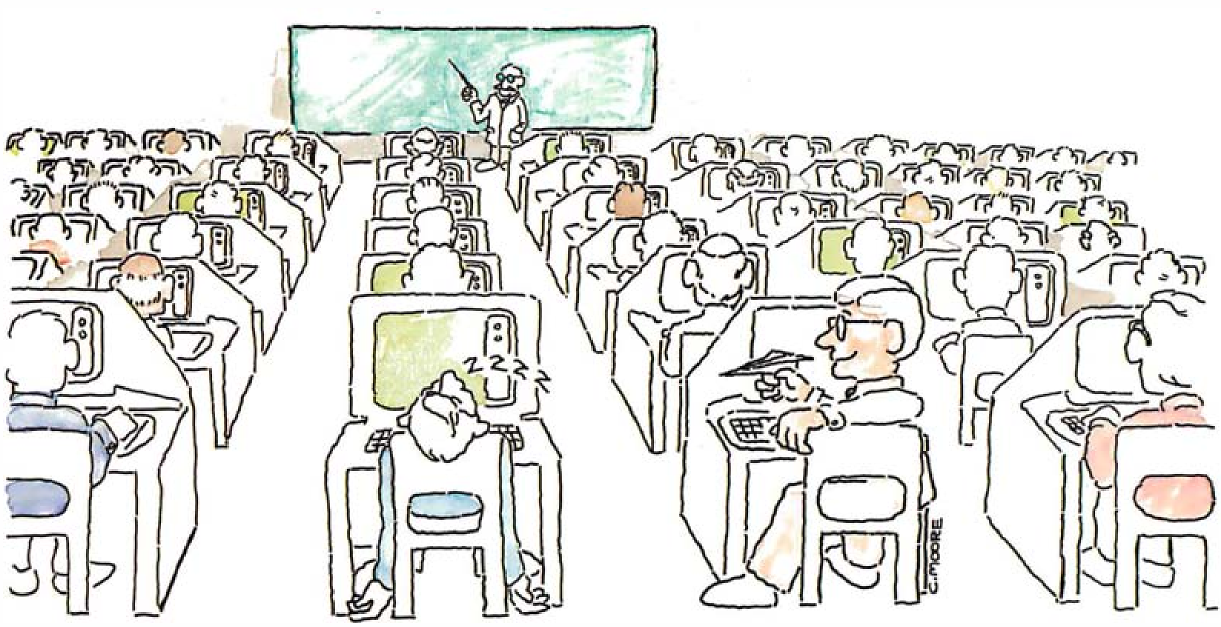

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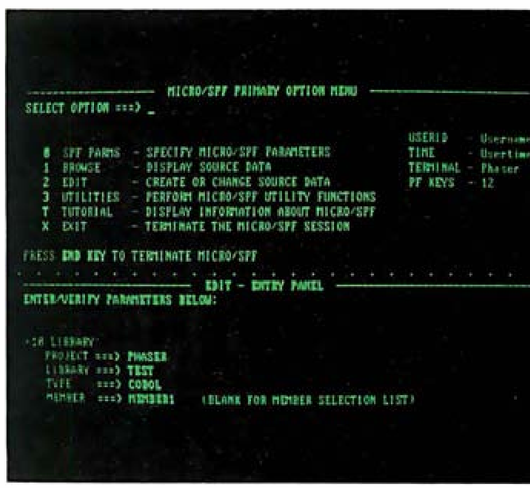

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Text Positioning

IN *n*	indent *n* characters
PI *n*	indent *n* characters at paragraph beginning
PI −*n*	negative indent *n* characters
TAB *n*	move to column *n*
TAB "*c*" *n*	fill blanks with specified character up to column *n*
LINE *n*	move down to line *n* on page
LINE −*n*	move back up to line *n*
SP *n*	insert *n*−1 blank lines between printed lines
SP +*n*	insert *n*−½ blank lines between lines
LEFT	print in flush-left format
RIGHT	print in flush-right format
RF	print only current line flush-right
JUST	fully justify by inserting blanks between words
JUSTC	fully justify by character-spacing
CENTER	center all lines on page
CTR	center current line only
LIT	print line literally as it stands

Margin-Setting Commands

LW *n*	set line width at *n* characters
LM *n*	set left margin at *n*th column
PL *n*	set page length at *n* lines
TM *n*	set top margin at *n* lines
BM *n*	set bottom margin at *n* lines

Control Settings

COPY *n*	print *n* copies of document file
FORM C	assume continuous-form paper
FORM S	assume single-sheet paper
DISK ON	start saving output to disk
DISK OFF	stop saving output to disk
DISK "*filename*"	format document into named disk file
PRINT ON	begin output to printer (or spool file)
PRINT OFF	stop output to printer

Headers and Footers

AP	automatically number pages
HEADER	start heading specification
HE	end heading specification
FOOTER	starting footing specification
FE	end footing specification
SP 0	output no linefeeds until further notice
%PAGE	current page number (also %P)
PG *n*	set current page number to *n*
CCH	clear current header
CCF	clear current footer
HSIZE *n*	reserve *n* characters in memory for heading
FSIZE *n*	reserve *n* characters for footing
PH	print header on first page

Special-Character Control

CMD*c*	set *c* as command marker (default is backslash)
UNB	use broken underscoring
UNS	use solid underscoring
BF*n*	use *n* overstrikes for boldface intensity
HY*c*	set *c* as soft (ghost) hyphen character
UN*c*	set *c* as underscore delimiter (toggle)
BF*c*	set *c* as boldface delimiter (toggle)
SSA*c*	turn superscripting (negative half linefeed) on at *c* or end subscripting
SSB*c*	turn subscripting (positive half linefeed) on at *c* or end superscripting
HS*c*	set *c* as hard (nonadjustable) space
IGNORE*c*	set *c* as character to be ignored for formatted output

Specialty (Letter-Quality) Printer Commands

DRAFT	deactivate special print attributes for draft printing
FORMFEED ON	turn mechanical formfeed on
FORMFEED OFF	turn mechanical formfeed off
OUT *m*, *n*, ...	send arbitrary decimal ASCII characters to output
CPI *n*	set pitch of *n* characters per inch
H *n*	use horizontal movement of *n* increments per character
K *n*	kern (add or subtract *n* increments to next character)
LPI *n*	print *n* lines per inch vertically
V *n*	vertical movement: *n* increments per line
PROP ON	turn proportional-spaced printing on
PROP OFF	turn proportional spacing off
BI ON	turn bidirectional printing on
BI OFF	turn bidirectional printing off

Print-Time File Merging

INSERT "*filename*"	insert the specified document at this point in text

Variables

:*var*	print value of variable in character-string format
$*var*	print value of variable in dollar format
#*var*	print numeric value of values (from 0 through 32767)
&*var*	print string length of variable's value (truncated)
−*var*	print nontruncated variable
%PAGE	contains number of current page
%DATE	contains current date obtained from system
%LINES	number of lines on page, including current line
%LINE	current line number
%COL	current column number
%PASS	number of times document processed this printing
%REC	current record number processed
%EOF	variable equals 1 if end of file reached, 0 if not

Table 4: *Formatting and document-content-control commands that can be embedded in text for interpretation by Superwriter's print module. Some formatting results can be achieved only by use of embedded commands, but most types of simple formatting can also be done on the screen using the edit routine.*

Superwriter's print formatting will be the program's strongest selling point. Superwriter not only provides straightforward on-screen formatting ideal for whipping out a quick letter, but it also provides, at no extra cost, a set of powerful print commands you can use to manipulate the form and content of a document even as the print head buzzes across the paper.

The on-screen formatting allows you to center and right-justify lines; adjust line widths; create hanging indentations; insert page breaks; mark points where words may be hyphenated; and specify the printing attributes of underlining, boldface, hard (nonadjustable-width) spacing, superscripting, and subscripting. The special command characters for these functions are inserted into the text through an extended-command mode that you invoke by typing Control-P. Left-justification, centering, and right-justification may be mixed on a single line.

When you are formatting on the screen, you can set

Variable Commands

GET *var*	allow entry of value for variable from keyboard
GET *var*= "*prompt*"	allow appropriate prompting for keyboard value entry
GET *var(len)*	enter value for variable with limit on length
SET *var*= "*string*"	set value of variable to character string
SET #*var*= *n*	set numeric value of variable to *n*
DECIMAL P	use period as radix point (American usage)
DECIMAL C	use comma as radix point (international usage)
VSIZE *n*	set *n* as maximum number of variables

Data Files

FILE T*n*, *filename*	prepare to read text file, *n* elements per record
DATA *v1*, *v2*, ...	assign successive record elements to variables
FILE F*n*, *filename*	prepare to read file with fixed-length records
DATA *v1*(*n*)	assign *n* characters from record to variable

Conditional Commands

IF	beginning keyword of conditional statement
IF NOT	complementary conditional keyword

Processing Commands

SKIP	skip one line of text file during output
SKIP *n*	skip *n* lines of text file
SKIP TO *c*	skip to next occurrence of character *c*
START *n*	start or resume processing at *n*th record
STOP *n*	stop processing at *n*th record
ENDPASS	end current processing of document
QUIT	return to editor
FF	issue mechanical formfeed to printer
NP	force printing on new page
CNP *n*	force new page at beginning of paragraph if fewer than *n* lines remain on page (effective globally)
CPB *n*	force new page if fewer than *n* lines remain (one page)
NL	new line

Operator Aids

*	internal note, not displayed or printed
NOTE	comment displayed on screen during output
WAIT	pause during printing
SHOW *v1*, *v2*	display values of named variables on screen
DV	display values of all variables on screen
DF	display values of file variables
DB	display size of buffers
CLS	clear screen

Format Templates

SETUP	beginning of the document's formatting directives
TEXT	end of the initial formatting directives

global parameters (margin size, line spacing, line width) from the editing global-settings menu, or you can change them from the print menu (which Sorcim calls the "Document Composer" menu).

On-screen formatting is nice for short letters and memos. But for more complex documents, Superwriter provides more than 80 different commands (not including variants) that can be embedded anywhere in the text and combined into program-like constructions for conditional branching and insertion of text based on string and numeric comparisons. Also, the print routine keeps track of eight numeric variables (such as current page number, line number, and file-record number) that may be accessed by the embedded commands.

The print commands, most of which are identical in form to those used in Peachtext/Magic Wand, fall into 13 groups, as shown in table 4.

You can use the embedded commands to set up the ordinary printing parameters—the margins, line widths, and character attributes—but they are capable of much more: multiple-line headers and footers, inclusion of external boilerplate files into the printout, accepting input from the keyboard during printing, and prompting the computer operator to take needed actions. You can even use the conditional statements and up to 128 of your own variables to literally write printout programs that read external data files and take different actions according to the file contents. (However, you do need a certain level of programming skill to do this.)

These capabilities make Superwriter a powerful tool for writing form letters and generating customized versions of contracts and standard documents. You could set up a contract document file in such a way that it asked you for the exact terms of the agreement and printed out only paragraphs specifically applicable to the agreed conditions.

An example of a form letter is shown in figure 3, while the document source file is shown in figure 4a and a part of the mailing-list data file appears as figure 4b. In this example, the print commands in the document source file are set up to use a mailing list that contains two intermixed kinds of entries (personal friends and business-only contacts). At the beginning of print processing, the commands cause Superwriter to ask for certain information needed in the letters; after this data has been typed in, printing proceeds without intervention until the end of the mailing-list file has been read.

When you select the print routine from the main menu, Superwriter saves the current version of the document (while maintaining the backup file) and loads the program overlay that contains the print routine from the system disk. (This takes a few seconds.) If you have no document in the editing buffer, Superwriter asks you which document to print.

The print menu, shown in photo 9, displays information on the printing status, format and control settings, and a choice of several printing options. You can immediately format and print the document, or you can view the formatting on the display screen first, as shown in photo 10. Other options allow you to change the settings or invoke a secondary print menu; the secondary options include printing without interpreting the embedded commands (they show up in the output) and writing the formatted output to a disk file instead of directly to the printer. This last option allows Superwriter to perform its own print spooling, although the operating-system-level print-spooling programs (such as Quadram's QSPOOL) that have become popular among users

23 October 1983

Brook Stone
3 Vose Farm Rd.
Peterborough, NH 03458

Dear Brook,

The long-awaited event has come to pass. A baby boy was born to us yesterday at 9:52 a.m. in Monadnock Community Hospital.

His name is Isaac Steven, and he weighs 7 pounds, 5 ounces.

Mother and child are healthy and doing fine.

Sincerely,

Sue and Richard Shuford

Figure 3: *An example of a form letter that can be produced by Superwriter's print routine from a letter template, a data file, and print-time user input. The data in the letter is for demonstration only.*

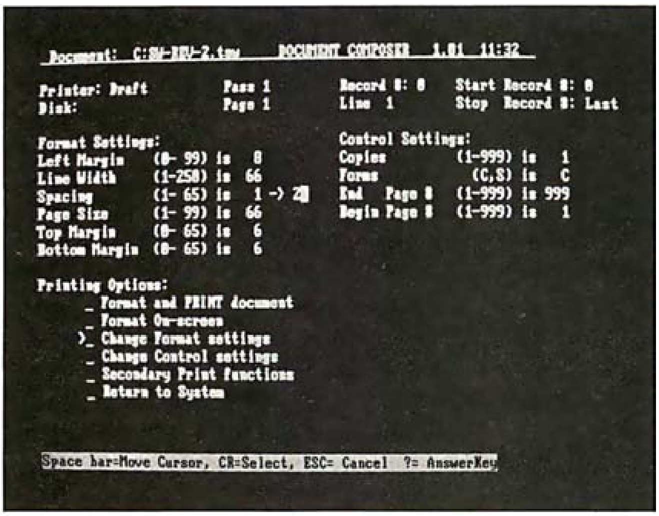

Photo 9: *The main menu of the print routine. If you have not used embedded commands to override the default page-arrangement settings (margins and such), you can change them using these menu options. However, it is not possible to type in any formatting command other than the ones available as menu choices—for instance, you cannot change from Diablo-printer formatting to draft-printer formatting by an interactive command.*

of IBM Personal Computers usually print faster.

The programmers have assumed that most uses of a program that excels in printing letters will require a letter-quality printer, so all of the printers supported by Superwriter at this writing are daisy-wheel units. Less-expensive dot-matrix printers can be used in the program's draft mode, but some of the printing character attributes (such as superscripting) are not available in this mode. Again, assuming the use of a daisy-wheel printer, Superwriter does not explicitly support an italic font. Superwriter does make use of almost any character-sequence-activated printer function in two ways: most ASCII (American National Standard Code for Information Interchange) nonprinting control characters (including Escape) can be embedded in the text using the insert-mark function, and the print routine can emit any character value by means of the OUT embedded command.

As with other microcomputer word-processing programs, Superwriter is susceptible to printer-interface incompatibilities; see the text box Printers: Word Processing's Chronic Headache" on page 388.

Disk Directories

Sorcim has built into Superwriter a mechanism for finding out what files reside on what disks. In a submenu called from the main menu, there are three fundamental disk-directory functions: list all documents, list specified documents, and toggle on or off the condition of showing the complete document history for each file, if it exists.

These commands are fairly flexible. They default to listing files (giving name, extension, and size) on the disk that contains your current edit file that seem to be of a type that you could edit with Superwriter, as inferred from the file extension (filenames ending in extensions such as .TXT or .LTR). But you can specify any existing disk drive and use either a single- or multiple-character wildcard specification to see the files you want to see. If you give the complete wildcard spec, "* . *", Superwriter will even show you the hidden system files that the PC-DOS directory commands don't reveal (see photo 11).

If you have turned on the mode of showing document history, the directory routine will read every specified file in an attempt to find history information in it; the directory display will show the history for those files that have it, as shown in photo 12.

Other Utilities

Superwriter contains other utility functions, including a submenu for creating and modifying the aforementioned document history. When you initially create a document, the program switches you briefly to the document-history screen for you to type the name of the author; you are put directly back into the editor when you have completed this. The dates and times of document creation and modification are picked up from PC-DOS, and revision numbers are automatically assigned. The document-history part of the file has space reserved for the operator's name, a document number you assign, and your brief comments, but you have to go through the history submenu to fill in these blanks.

There are a set of library-file-access functions. The display function lets you look at a document other than the one you are working on. You can delete or rename any disk file on line, whereas another command allows you to change disks during execution of Superwriter without confusing the directories. Two sub-submenus allow you to include all or portions of another document into the current edit buffer and control the background printing of spooled document files.

You can also begin execution of the Supercalc spread-

Printers: Word Pr cessing's Chronic He

Has your printer given you a headache? The odds are that you've had some kind of printer difficulty, especially if you've tried to run a word-processing program on your computer. According to Nick Vergis, vice-president of marketing for Perfect Software, 60 nt of th who call that mpany's telepl mplai le in getting a printer to work ith the rest of the computer system. It's probably a safe bet that sers of other brands of software experience printer problems with similar frequency.

ers are electromechanical e n paper in wonderfully complex ways with a level of precision and economy once only dreamed of. But perhaps they are too complex. The multiplication of printer features ltiplied the number of potential problems.

sually ari onnecting the printer the ystem. Th of diffi y be solved by com g some knowledge of the non ways of conne g printers (RS-232C serial E-488 nd Centronics-styl rallel connections) with a go f trial r in wiring onnection.

ly after you successfully s ed the h e connection problems that you discover the more subtle software problems. You may find that your word-processing software has printed the text of your letters over the logotype on your letterhead stationery. You may discover that words you wanted underlined are not, while the und haracters intended for hat p have over int ght margin paper. Or you may find completely correct lines of text alternating with lines of gibberish. These are the kinds of problems you get when your software does not know how to properly control your print r. (I've problen .)

Lack of standard surely the c of this head There seem to be no uniformly applied protocols used to control the functions of printers, and every manufacturer of printers seems to have unique ideas of how printer features should be used.

Trying to make a given program work with all the va of printers can d grammer to distraction. Jaso nt of Mark of the Unicorn Inc., says "It's an different [printers] are. They differ in such fundamental ways there s no way to describe [their functions] without writing code. Each company that inven ew feature in a new way of specify- otes th pporting a nd of printe quires to mod 5 different program routines in Final Word.

But what about the so-called "code-compatible" printers announced by some manufacturers? Some new printer models are claimed to respond to the same commands as certain familiar old printe Here aga on Linhart s s a discou note, saying, "No two n cturers ever make completely compatible printers. Dot-matrix printers are the biggest current problem. Epson-compatibility [has been negated] because Epson keeps changing what its print he FX series differs from the MX series, oth, and various versio iftrax , there has been a slight daisy-wheel printers toward Diablo-compatibility, but the fine detail is different, so if you have a program that takes advantage of every feature, it messes up." He adds that sometimes even two units of the same-model printer do not work the same.

f these nces in printer behavior, you can avoid ins onl aking other pains to make sure that the ing package you buy works properly with your printer.

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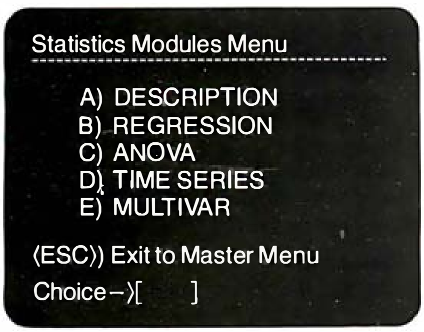
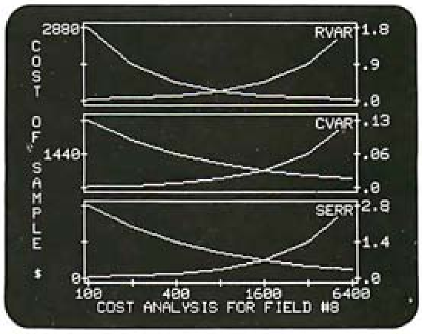


Transformations and over 400 conversions are available. You can place the results of these transformations into the same field or any other field in STATPRO's database.



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Circle 502 on inquiry card.

```
\SETUP
\IGNORE *
\GET DATE="Today's date? "
\GET FILN="Name of address file: "
\GET BABYSEX="Is it a boy or a girl? "
\GET BABYNAME="What is the baby's name? "
\GET BABYWEIGHT="How much does the baby weigh? "
\GET TIME="What time of day was the child born? "
\FILE T11,:FILN
\DATA NAME,TITLE,COMPANY,ADDR1,ADDR2,CITY,STATE,ZIP,SALUT,CODE
\TEXT
\IF NOT CODE="P",IF NOT CODE="p",SKIP 46
\CLS
\SHOW "Record Number ",$REC
\SHOW NAME
\IF NOT TITLE="", SHOW TITLE
\IF NOT COMPANY="", SHOW COMPANY
\IF NOT ADDR1="", SHOW ADDR1
\IF NOT ADDR2="", SHOW ADDR2
\SHOW CITY," ",STATE," ",ZIP

\RIGHT,:DATE\
\LEFT







\:NAME\
\IF NOT TITLE="",:TITLE,NL
\IF NOT COMPANY="",:COMPANY,NL
\IF NOT ADDR1="",:ADDR1,NL
\IF NOT ADDR2="",:ADDR2,NL
\:CITY\, \:STATE\  \:ZIP\



Dear \:SALUT\,

The long-awaited event has come to pass. A baby \:BABYSEX\ was
born to us yesterday at \:TIME\ in Monadnock Community Hospital.

\IF BABYSEX="boy", SKIP 2
Her name is \:BABYNAME\, and she weighs \:BABYWEIGHT\.
\SKIP 1
His name is \:BABYNAME\, and he weighs \:BABYWEIGHT\.

Mother and child are healthy and doing fine.

                                Sincerely,



                                Sue and Richard Shuford
```

Figure 4a: *The form-letter source template interpreted by Superwriter and merged with address information from the file and with interactive input to produce the finished series of letters.*

```
John Jones
Manager
AAA Electronics, Inc.

1234 Main St.
Peterborough
NH
03458
John
B

Duncan MacKenzie
Engineering Consultant
Orphanode Hops, Inc.
Graphics Department
POB 403
Peterborough
NH
03458
Duncan
B

Eric Arthur Blair


1984 Wigan Pier
Hancock
NH
03449
George
P

Brook Stone


3 Vose Farm Rd.
Peterborough
NH
03458
Brook
P

Steven A. Ciarcia
Consulting Editor
BYTE Publications

POB 582
Glastonbury
CT
06033
Steve
B
```

Figure 4b: *A section of the data file used to produce the form letter.*

sheet program from the utilities menu, but that takes you out of Superwriter and therefore out of the scope of this review.

Documentation

Many who learned word processing using Magic Wand have fond memories of acting the part of Abraham Lincoln's private secretary, which the excellent lessons in Magic Wand's user's manual bade you to do. Well, the *Superwriter User's Guide and Reference Manual* does not contain the *Gettysburg Address*, but it is nevertheless serviceable, attractively typeset and containing many line drawings that help beginners become oriented to the concepts of word processing. The notebook contains an appendix with elaborations on the meanings of most of the error messages that could possibly occur, another feature likely to be appreciated by inexperienced operators.

Experienced users might wish the manual had a quick-reference section that outlines the precise rules for using the print-formatting commands better than the terse appendix currently charged with that duty. (With all the online help available in Superwriter, experienced users may seldom need to read the documentation for anything other than for formatting commands.)

Sorcim also furnishes several auxiliary devices to help you learn the program: a 16-page quick-start booklet called *10 Minutes to Superwriter*, a pocket-size reference card (the "Answercard"), and a set of small adhesive labels intended to be placed on the appropriate function keys.

Installation

Appendix 5 of the documentation contains instructions to get Superwriter running from the two single-sided 8-sector distribution disks, including advice on formatting a floppy disk. Even so, if you are a novice to computers, it's risky for you to attempt to install any piece of software.

One of the distribution disks contains an installation program called INSW.COM. Because you need not specify terminal parameters in the IBM PC version of the program, this utility routine is used only to select the variety of printer you will be using for formatted out-

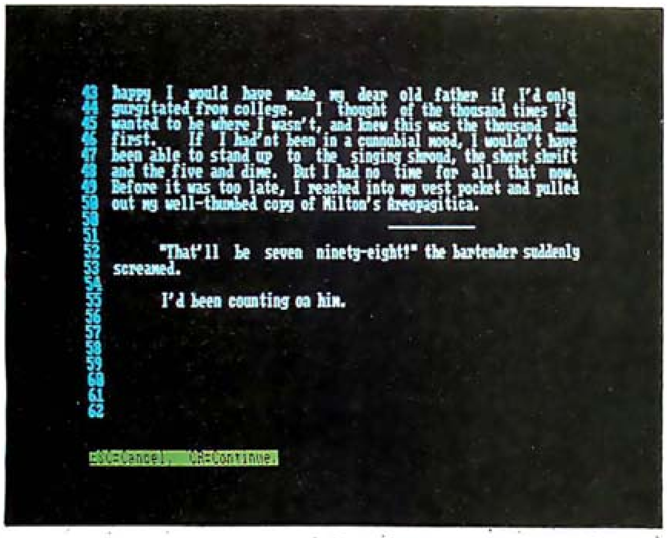

Photo 10: *You can preview what the formatted, printed document will look like by issuing a command from the print menu. Each line on the printed page is assigned a number, and sections of the pages are displayed sequentially on the screen. An overprinted line is shown twice. The printed paper may look slightly different from the preview because of the difficulty of reproducing all printer functions on a video screen.*

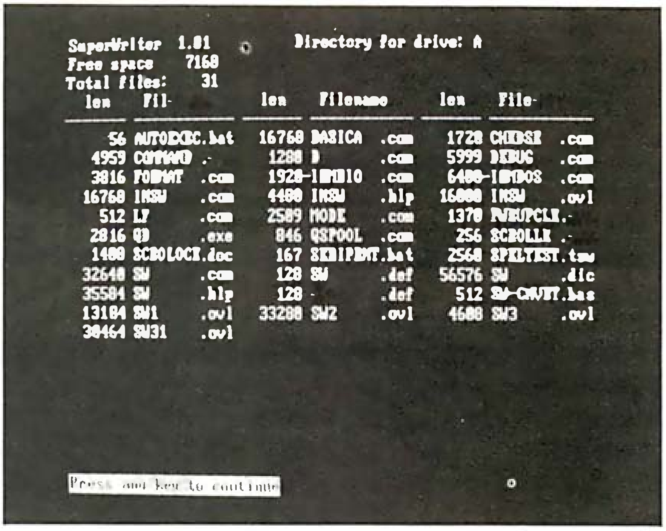

Photo 11: *Superwriter provides a function for inspecting the directory of a disk. If you do not elect to view the document history, the files are listed in three columns in alphabetical order by name (in ASCII collating sequence). One surprise is that the hidden operating-system files IBMBIO.COM and IBMDOS.COM show up when you demand to see all files—normally only files that Superwriter can edit are shown.*

Photo 12: *If you elect to see document history in the disk-directory function, Superwriter reads every disk file in the listing and looks for document history, which is kept at the end of the file after the text. Not every file in this display had such history stored.*

put. The disk also contains a utility called MAINTAIN.COM, which allows you to verify that each of the program's main code and overlay files are intact and functional and can also allow you to apply any bug fixes supplied by Sorcim.

After you have established your work habits using Superwriter, you may want to set up a personalized parameter-default file on the disk containing the program. Whenever you run Superwriter, it reads the contents of the file SW.DEF (if it exists) to establish initial values for such constants as global text settings, tab settings, the document-storage disk, margins, author's and operator's names, insert-mode status, and whether continuous-form or single-sheet paper is used in the printer.

Closing Thoughts

Superwriter is a versatile word-processing program with features that make it especially suitable for certain writing tasks common in the business world. Although it has a large amount of editing and processing power, the program contains well-planned command structures and help facilities that will help first-time users adapt to the concepts and procedures of writing with a computer. Its most constrictive limitation is its small editing workspace—it forces you to break up any large writing task into pieces small enough to fit in the buffer.

If you plan to purchase Superwriter, be sure to get version 1.01 or a later revision; the first release, version 1.00, didn't have all the kinks ironed out. (I've had no trouble yet with 1.01.) If you are a registered owner of version 1.00, you should have received a free update from Sorcim.■

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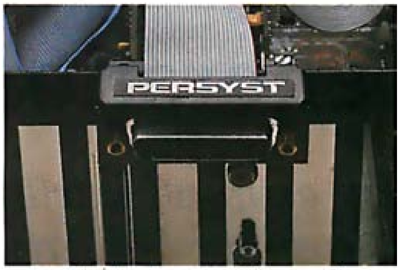

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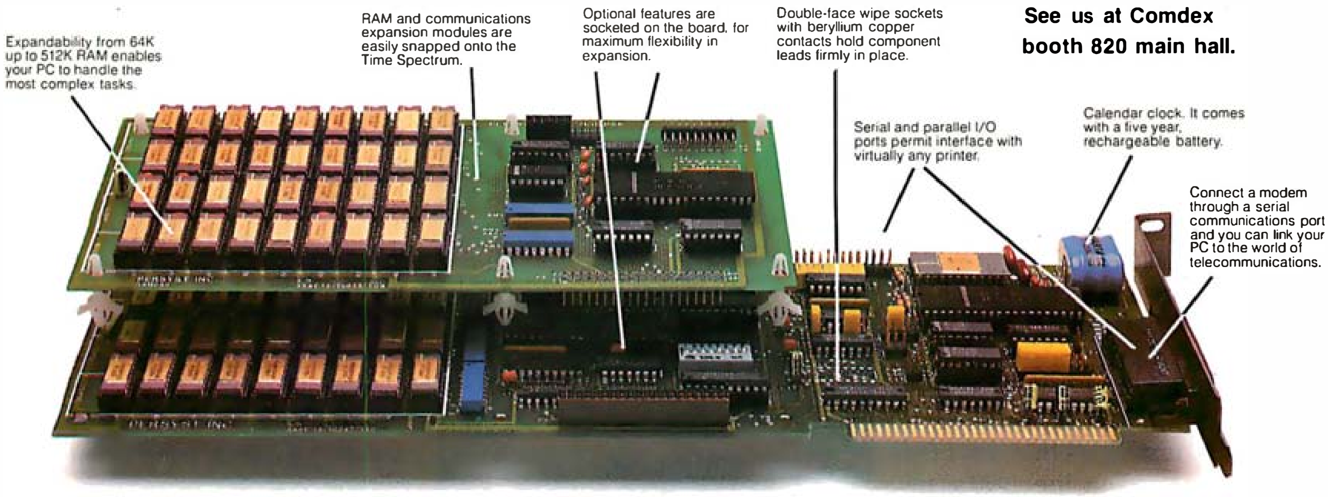

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Japan and the Fifth Generation

Japan's efforts to develop artificial intelligence are intended to make computers easy for ordinary people to use

by Phil Lemmons

Efforts to develop artificial intelligence in Japan cause some Americans to lose all reason. Consider these two examples: according to *Science News* (June 18, 1983, page 390), William Shaffer of the Microelectronics and Computer Technology Corporation says that Japan's plans for a "fifth-generation" project "amount to a kind of *Mein Kampf* in electronics terms—a clear-cut statement of intentions that U.S. companies can only ignore at their peril." *Mein Kampf* is, of course, a racist, militarist plan written by a madman, and its implementation is the outstanding example of evil in the twentieth century.

Are Japan's research plans really worthy of comparison with Hitler's plans for conquest and persecution? BYTE reprints here Japan's plans for fifth-generation computers, the "Outline of Research and Development Plans for Fifth-Generation Computer Systems," published by the Institute of New Generation Computer Technology (ICOT) in April 1983 (see page 396). In brief, ICOT plans to develop "knowledge information processing based on innovative inference functions and technologies that meet the needs anticipated in the 1990's, including intelligent interaction between man and machine and inference using knowledge bases." The implementation of ICOT's plans would seem to pose no threat of military conquest or racial extermination. Indeed, if ICOT's plans are a "Mein Kampf," then the instructions on Burpee's seed envelopes are the "Mein Kampf" of sweet peas and marigolds, and Dr. Benjamin Spock's books on child rearing are the "Mein Kampf" of millions of American parents.

Newsweek's characterization of ICOT rivals Shaffer's in unfairness and bad taste. In its July 4, 1983 issue (page 58), *Newsweek* wrote, "Even though American universities had produced the basic research the Japanese would rely on, American companies were as serenely unaware of danger as the battleships that swung at anchor in Pearl Harbor more than 40 years ago." This irresponsible use of metaphor defies some obvious differences between ICOT's activities and the attack on Pearl Harbor. For one thing, the Japanese didn't publish their plans for Pearl Harbor before the attack, whereas ICOT has published its plans. For another, the Japanese militarists of 1941 were planning to kill Americans and destroy the Sixth Fleet, whereas the Japanese computer scientists of today are planning to improve man/machine interaction. For a third, the Japanese strike force in 1941 included no Westerners, while five Western researchers worked as visitors at ICOT during 1982, including Dr. D.H.D. Warren of SRI International in Menlo Park, California, and Professor J.A. Robinson of Syracuse University.

Kazuhiro Fuchi.

I visited Kazuhiro Fuchi, director of the ICOT Research Center in Tokyo, in May 1983. Dr. Fuchi talked quietly about ICOT's plans and then handed me the English translation of the outline reprinted here. Fuchi seemed not the least bit sinister. The research center proved to be a large open office, as pictured behind Dr. Fuchi in the photo on page 394, and there was no sign of security measures.

When asked about American reactions to ICOT's plans, Fuchi expressed some amazement. "Our main goal is to have computers that are very easy to use and can handle natural language. It may turn out that the big, powerful computer at the center of a network does not have to have such functions, that the personal computers in the network can perform those functions." Fuchi continued, "We expect that personal computers will benefit from the research that we are doing."

In the first English-language issue of the *ICOT Journal* (June 1983), Professor Tohru Moto-oka of the electrical engineering department of the University of Tokyo, who is credited with a leading role in the MITI (Ministry of International Trade and Industry) research and studies committee that recommended establishing ICOT, explained the background of ICOT's plans: "As for the society of the 1990s, we envisioned an ideal society. . .Then we discussed what information systems and computers would be required to work toward realizing that ideal society. . .We identified the need to develop computers that could be used in areas of productivity such as agriculture, fishery, and service. And we discussed what contributions computers could make toward solving energy or resource shortages that would be a global problem from now to the twenty-first century.

"We predicted that Japan would be developing high technologies such as those represented by computers and would be contributing to the growth of the world economy by so doing. Foreign people view Japan as a closed society. It is true that the language barrier prevents our thinking from being well understood by other nations. Computers capable of helping to remove the language barrier are necessary.

"In addition, there is the possibility that our society will undergo a substantial change from now to the 1990s. One indication is an abrupt increasing of the aging population, though Japan is not alone in this respect. In this light, some committee members proposed developing computers that would allow the aged to work in society and help the physically handicapped and other people. On these lines, the task force on basic theory pointed out as a very important challenge the need to pursue research and development of artificial intelligence and to develop computers suited for that purpose.

There is no question that Japan's national economic plans rely on progress in computers.

Potential uses and applications include translation and interpretation as a solution to the language barrier and robots as an aid to human activities in an aging society."

There is no question that Japan's national economic plans rely on progress in computers. Osamu Seki, director of the Electronics Policy Division of the Machinery and Information Industries Bureau of MITI, put it this way: "As a resource-poor country, we have no alternative but to base our prosperity on technology as recommended by the council at the MITI. It is our desire to keep the status of an advanced nation."

Japan will compete with the United States and other Western nations in information processing technology over the next decade. As for the prospect of Japan dominating the field based on the $800 million, 10-year ICOT project, that seems unlikely. Several United States projects and firms can bring comparable resources to bear. The Microelectronics and Computer Technology Corporation, headed by former Admiral Bobby Inman and backed by 12 American corporations (including Control Data, Honeywell, RCA, and Motorola) has an annual budget of $75 million. The Semiconductor Research Corporation has the backing of Control Data, IBM, Hewlett-Packard, Digital Equipment Corporation, and Motorola and will sponsor $30 million in research at American universities next year. And according to *Newsweek* (July 4, 1983), the Defense Advanced Research Projects Agency (DARPA) is ready to spend $1 billion on research into artificial intelligence (AI) and supercomputers. *Science News* reports that Lynn Conway has left Xerox PARC (Palo Alto Research Center) to join DARPA and head a program that DARPA says will "develop computers capable of symbolic reasoning with effective computational speeds 1000 times greater than those used in military systems today." In addition, the Lawrence Livermore and Los Alamos national laboratories will join SRI International in an effort to develop a network of supercomputers. It is also worth remembering that IBM's annual research budget exceeds ICOT's and that IBM's research division has 2000 people (not counting those in product research and development) to ICOT's 40.

While the goal of winning greater private and public funding for AI research in the United States will help in international competition and is commendable, that does not justify sensational journalism that insults an ally. Furthermore, there is little hope that true artificial "intelligence" can be built in the United States or anywhere else on a scaffolding of groundless rhetoric about Pearl Harbor and *Mein Kampf*. Stupidity breeds stupidity.

The Japanese find themselves in a no-win situation. If they fail to make research breakthroughs, they will have to endure another generation of remarks about their lack of originality. If the Japanese do make research breakthroughs, they will be accused of posing a threat to American national security and therefore risk losing their most important ally. The threat is all the more mysterious because the Japanese would undoubtedly sell 80 percent of their future supercomputers and AI products to the United States. Otherwise, Japan's plan to base its prosperity on high technology would make no sense.■

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Outline of Research and Development Plans for Fifth-Generation Computer Systems

1. Background and Introduction

As computerization advances, information technology with computers as its core has been applied to various areas of society and become an indispensable tool in modern society.

To provide for the conditions and information demands of the society in the 1990s, more advanced and higher-level functions and performance will be required of information technology; these include utilization of more varied media, easy-to-use computers, higher software productivity, and application of information technology to those areas in which existing information technology has not been applied.

In order to meet these needs, the design philosophy itself of the current computer technology should be studied and evaluated.

Conventional computers, following the von Neumann computer architecture, are now realized by the simplest hardware because the hardware was expensive and bulky when the first computers were invented. Most of the functions required are then realized by software in order to provide an efficient processing system. Therefore, the conventional computers have become numerical-processing oriented, stored-program sequential processing systems. High speed and large memory capacity have been pursued from the economic standpoint, producing the present enormously big computer systems.

However, the situation has evolved as follows:

(1) VLSIs [very large-scale integrations] have substantially reduced hardware costs, so computer systems can use as much hardware as required.
(2) A new architecture for parallel processing is now required because device speed has approached the limit for sequential processing.
(3) Parallel processing should be realized in order to utilize effective mass production of VLSIs.
(4) The current computer technology lacks the basic functions for nonnumeric processing of speech, text, graphics and patterns, and for artificial intelligence fields such as inference, association, and learning.

For these reasons, the Fifth-Generation Computer Systems (FGCS), which provide knowledge information processing systems, should be developed. FGCS should thus employ the latest research results in VLSI technology, as well as technology of distributed processing, software engineering, knowledge engineering, artificial intelligence, and pattern information processing.

Thus we have concluded that it is meaningful to pursue research and development of the FGCS as innovative information technology. We hope not only to conduct creative research in this field, but also to contribute thereby to the benefit of all humankind.

2. Research and Development Themes

The Fifth-Generation Computer Systems aim at knowledge information processing based on innovative inference functions and technologies that meet the needs anticipated in the 1990s, including intelligent interaction between man and machine and inference using knowledge bases.

The functions required of such a system can be broadly divided into four types:

(1) Problem solving and inference function

This function is intended to enable the system to find solutions to problems by carrying on logical reasoning using data and knowledge stored in the system as well as information given to it from outside. This capability covers deductive inference, inductive inference including guessing based on incomplete knowledge, and cooperative problem solving by mutual complementation of several bodies of knowledge.

(2) Knowledge base function

This function is aimed at providing systematic storage and retrieval of not only so-called data but also reasonable judgments and test results organized into a knowledge. Besides knowledge accumulation, it includes knowledge representation tailored to problem solving, knowledge acquisition and updating, and simultaneous utilization of distributed knowledge sources.

(3) Intelligent interface function

This function is intended to enable computers to handle speech, graphics, and images so that the computers can interact with humans flexibly and smoothly. It might be regarded as giving computers the equivalents of human eyes, mouth, and ears, but its primary objective is to provide computers with a linguistic ability close to that of man.

(4) Intelligent programming function

This function is intended to enhance the intelligence of computers so that they can take over the burden of programming from humans. While its ultimate goal is to achieve an ability to automatically convert problems into efficient computer programs, it is aimed preliminarily at achieving a modular programming system and a program verification system and at establishing a specification description language.

To achieve these four functions requires the development of innovative technologies encompassing the diverse fields of architecture, hardware, and software. The major research and development themes are listed below.

(1) Hardware architecture and software to achieve inference function. This will include:
1. An inference mechanism based on a distributed control-based architecture which is oriented to parallel processing instead of sequential processing.
2. Basic software to manage and execute parallel inference.

(2) Hardware architecture and software to achieve knowledge base function. This will include:
1. A knowledge base mechanism based on structured memory instead of one-dimensional memory.
2. Basic software to manage knowledge bases for high-speed retrieval and relational storage of knowledge data.

(3) Hardware architecture and software to achieve intelligent interface function. This will include:
1. An intelligent interface mechanism composed of a voice or signal processor and other devices.
2. Basic software for natural language processing and graphics and image understanding to ensure flexible man-machine interaction.

(4) Software to achieve intelligent programming. This will include:

1. Basic software for automatic creation of optimum programs.

New Application Fields

The knowledge information processing systems realized by the Fifth-Generation Computers are expected to expand extensively the fields where computers are applied, such as manufacturing, service, engineering, and office and business management.

VLSI CAD, machine translation, and consultation systems are chosen to develop as the model systems to apply the basic Fifth-Generation software to as well as to prove and assess the basic software system. The development of these application systems is planned in the intermediate and later stages.

3. Research and Development Plans

3.1 Overall Plans

The research and development goals of the Fifth-Generation Computer Systems are such core functions for the knowledge information processing as problem-solving and inference systems and knowledge base systems, which cannot be handled within the framework of conventional computer systems.

We are obliged to move toward the target systems through a lengthy process of trial and error, producing many original ideas along the way.

In Japan, little effort has been made in research on the key technologies, particularly software and basic theories. The research in this field should be promoted because it has a great influence on development of hardware technology, including computer architectures and VLSIs.

Since this project aims at computer technology for the 1990s, plans encompass as wide an extension of basic technology as possible. And this project is planned to span about 10 years, divided, as shown in figure 1 [which appears below] into initial, intermediate, and final stages.

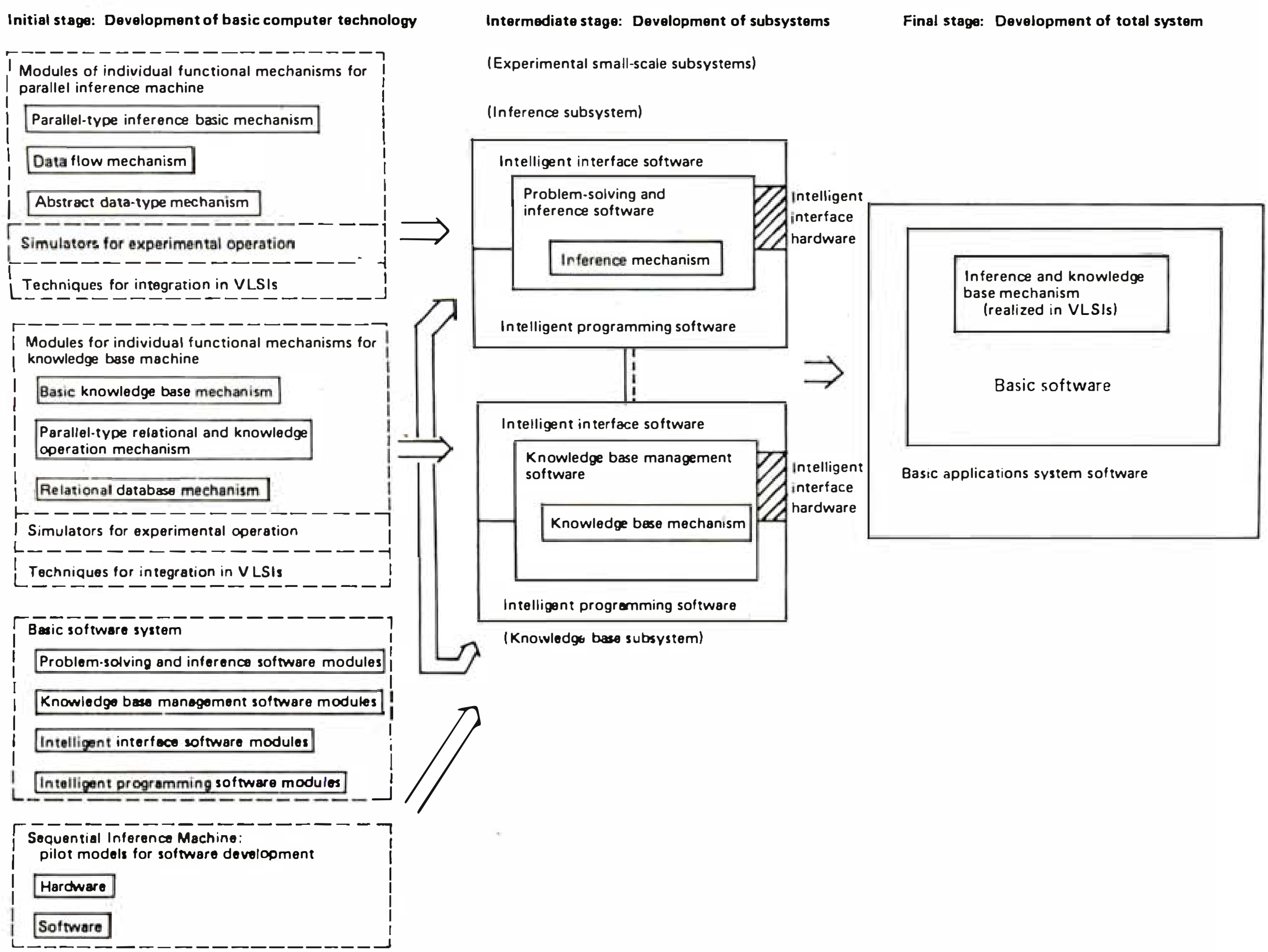

Figure 1: *The stages of fifth-generation computer research and development.*

The emphasis in the research and development of the initial stage is on accumulating the research achievements of the past in the field of knowledge information processing and evaluating and restructuring them. In addition, candidates for each research subject have to be screened and basic technology is developed for the intermediate stage.

The research and development of the intermediate stage is focused on establishing computation models as the basis for software and hardware as well as algorithms and basic architecture based on the evaluations of the initial stage. Small- to medium-scale subsystems are then built.

The final stage puts an emphasis on appropriate functions of both software and hardware systems, interfaces to maximize these functions, and the architecture for the total system.

Concerning the overall flow of research and development efforts, the initial stage is envisioned that software and hardware modules are built and also some experimental systems configured by integrating these modules. These systems include hardware and software simulators, prototypes for language processing, and experimental natural language processing systems.

The intermediate stage is mainly devoted to improving and extending the results of the initial stage and integrating

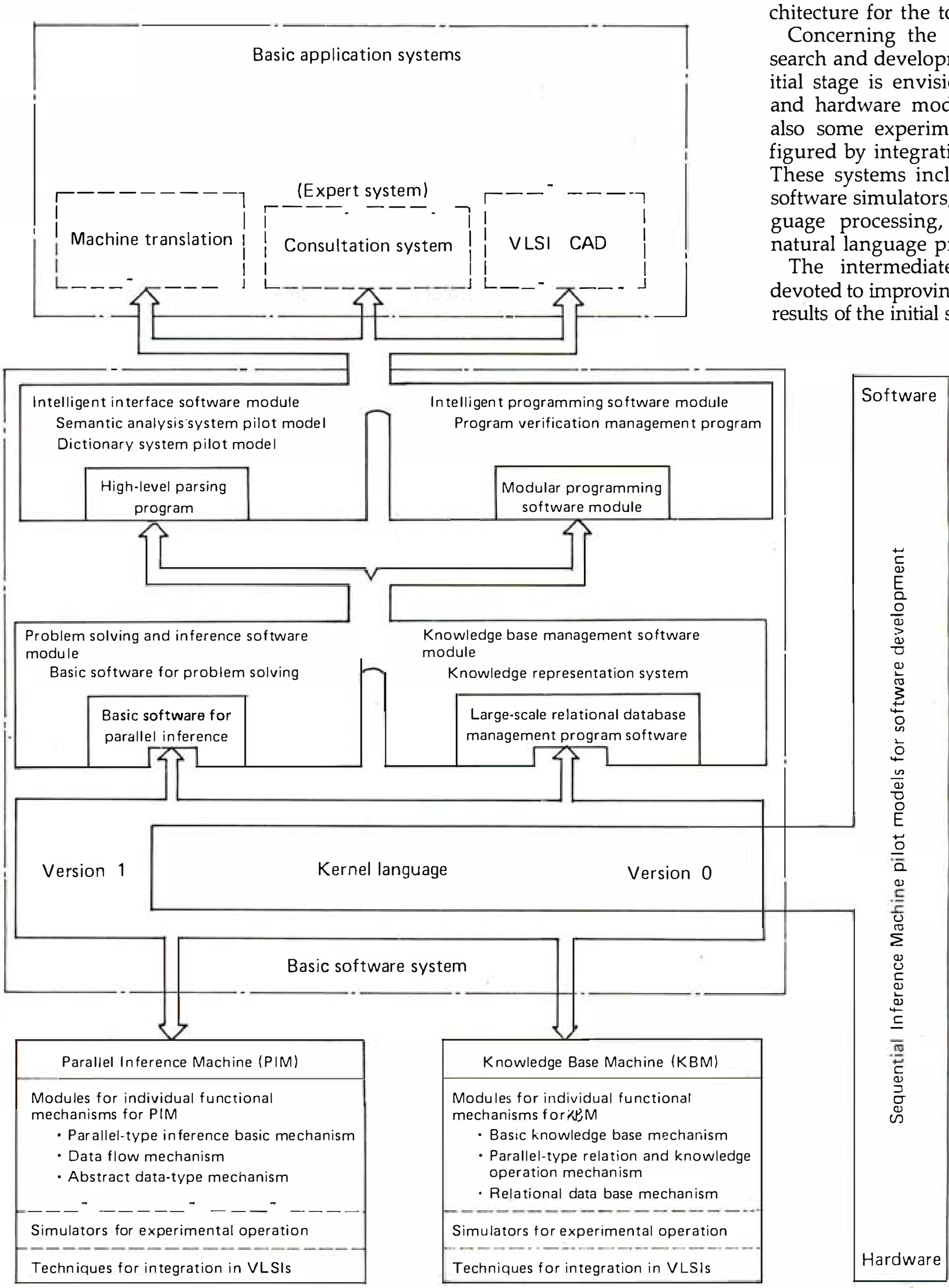

Figure 2: *An overview of research and development in the initial stage.*

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them into inference and knowledge-base subsystems.

In the early part of the final stage, the configurations of these software and hardware systems developed in the intermediate stage are reviewed and evaluated. The total system is developed, integrating the subsystems in order to define the ultimate goals clearly.

3.2 Research and Development Plans in the Initial Stage

Research in the initial stage of the Fifth-Generation Computer Systems Project is based on the new programming language the Version 0 Kernel Language, which is extended on Prolog. The specification of the Version 0 Kernel Language was completed in 1982. The Version 0 serves as the machine language for Sequential Inference Machine, a pilot model for software development, as well as it is tentatively used for program description in software development. While the Version 0 was developed for sequential processing, the Version 1 Kernel Language is parallel processing oriented. The Version 1 is a logic programming language based on accumulation of experiences on the Version 0 with new functions added.

As shown in figure 2 on page 398, the Parallel Inference Machine (PIM) is a high-level parallel processor to directly execute the Version 1 Kernel Language. The Knowledge Base Machine (KBM) is responsible for high-speed execution of knowledge operations derived from the study on knowledge representation and relational database operations.

Research and Development Theme	Details
Parallel Inference Machine (PIM)	The parallel inference machine, together with the knowledge base machine, forms the nucleus of the Fifth-Generation Computer hardware. At the initial stage, an evaluation and study will be made on the basic inference module configuration composed of the following: (1) A parallel-type inference basic mechanism to manage the parallel execution of inference operations. (2) A data flow mechanism to execute inference operations and rapidly determine solutions. (3) An abstract data-type mechanism to consolidate detailed inference operations into several groups and control them by group.
Modules for individual functional mechanisms for PIM	The parallel-type inference basic mechanism, data flow mechanism, and abstract data-type mechanism individually consists of functional sub-modules. Initially, prototypes of these sub-modules will be constructed. Then these prototype sub-modules will be combined to construct a prototype module for each of the three functional mechanisms.
Simulators for experimental operation	Prototype simulators for experimental operation will be built to simulate module configurations, using different numbers and combination of sub-modules. They will also be used to determine the optimum configuration of the modules for three functional mechanisms and also of the inference basic module which these sub-modules will comprise.
Techniques for integration in VLSIs	Prototype software will be developed for evaluation and examination of the VLSI convertibility of the circuit composition of each sub-module designed. It will be used to data gathering and evaluation for integration in VLSIs.
Knowledge Base Machine (KBM)	The knowledge base machine, together with the parallel inference machine, forms the nucleus of the Fifth-Generation Computer hardware. At the initial stage, an evaluative study will be made on the configuration of the basic knowledge base module composed of the following: (1) A basic knowledge base mechanism to provide overall management of the execution of basic knowledge base operations. (2) A parallel-type relation and knowledge operation mechanism to provide speedy knowledge accumulation, retrieval and updating, data conversion, etc. (3) A relational database mechanism to provide large-capacity knowledge accumulation, storage and management.
Modules for individual functional mechanisms for KBM	The basic knowledge base mechanism, parallel-type relation and knowledge operation mechanism, and relational database mechanism individually consist of functional sub-modules. Prototypes of these sub-modules will be constructed at the initial stage. These prototype sub-modules will be subsequently combined to produce a prototype module for each of the three functional mechanisms.
Simulators for experimental operation	Prototype simulators for operation tests will be built to simulate module configuration using different numbers and combinations of sub-modules. They will also be used to determine the optimum configuration of the modules for three functional mechanisms and also of the basic knowledge base modules which these sub-modules will comprise.
Techniques for integration in VLSIs	Prototype software will be developed for evaluation and examination of the VLSI convertibility of the circuit composition of each sub-module designed. It will be used to data gathering and evaluation for integration in VLSIs.

Table 1: *Research and development plans in the initial stage.*

The Fifth-Generation software comprises two software modules: a problem solving and inference software module for the purpose of problem processing and a knowledge base management software module for knowledge accumulation and management. The two software modules have two hierarchical levels. On the lower level are the description or execution supporting systems to provide various functions on the upper level. For the intelligent interface system whose main purpose is to realize natural language processing, and the intelligent programming system for realizing automatic programming, though, it remains in a preliminary form for the initial stage. These two software modules could be also regarded as having two levels, but rather complementary than hierarchical.

The elementary application systems in the top of the figure are half experimental, half practical systems which are planned to develop in the intermediate stage based on the research results of the basic software systems.

Among these, the consultation system has rather well established technology. So, it is purposely chosen to prove and assess the basic software system and its preliminary version called Experimental Knowledge-Based System is planned to develop in the initial stage. This development is understood as an additional subject to table 1 on page 400.■

"Outline of Research and Development Plans for Fifth-Generation Computer Systems," published by the Institute of New Generation Computer Technology, April, 1983.

Research and Development Theme	Details
Basic software system	The basic software system forms the nucleus of the Fifth-Generation Computer software and is composed of the following four software modules for knowledge information processing: (1) Problem solving and inference software module (2) Knowledge base management software module (3) Intelligent interface software module (4) Intelligent programming software module An extended Fifth-Generation kernel language needed for the intermediate state will be developed by organizing the knowledge obtained through designing and breadboarding the basic software system. Furthermore, a prototype software system will be produced to test the correctness of specifications and validate their accuracy.
Problem solving and inference software module	The problem solving and inference software module has the capabilities of deductive inference, inductive inference including conjecture proposing based on incomplete knowledge, and inference by mutual complementation of knowledge. The development of a prototype of basic software for parallel inference is planned for the initial stage for use in high-speed execution of deductive inference and basic software for problem solving to determine efficient solutions to problems.
Knowledge base management software module	The knowledge base management software module has the capabilities of knowledge accumulation, distributed-knowledge source utilization, and knowledge acquisition. The development of a prototype of a knowledge representation system is planned for the initial stage in order to define knowledge data representation methods. A large-scale relational database management program is also planned to accumulate and manage a large volume of data represented as knowledge.
Intelligent interface software module	The intelligent interface software module is for flexible interaction between human and computer. The development of a prototype of a high-level parsing program is planned for the initial stage and is aimed at achieving high-speed parsing and simplified algorithms for natural language understanding, which is critical to the man-machine interaction. Basic technologies for semantic analysis and a pilot model of a support dictionary system will also be developed.
Intelligent programming software module	The intelligent programming software module has the capability of automatic conversion of an input problem into an efficient computer program (a kernel language level). A program module management system with extraction capability of component modules and verification facility of a program is planned to develop at the initial stage with the objectives to establish modular programming, which is basic to intelligent programming, extraction of the necessary program, and program verification prepared thereby.
Sequential Inference Machines (SIM) pilot models for software development	A pilot model (a prototype sequential inference machine) for efficient development of software for the Fifth-Generation Computer Systems will be developed. This model will be developed by improving a selected language suitable for inference and by partly modifying the existing von Neumann-type architecture.

Speech Images on the IBM PC

The PC can plot the sounds of vowels with an experimental speech-input card

by A. J. Cote Jr.

Steve Ciarcia described a means of portraying a sound spectrogram in "Use Voiceprints to Analyze Speech," (Circuit Cellar, March 1982 BYTE, page 50). The approach was described as a tool for exploring some of the factors involved in the design of a speech-recognition system.

I've arrived at a different portrait of speech by pursuing similar interests in my spare time for a number of years. Its purpose is to directly reveal the presence of more meaningful sounds, which are the specific *phonemes* in an utterance.

Figure 1 is an example of such an image. It was plotted using an IBM Personal Computer (PC) equipped with an experimental speech-input card. Vowel sounds were extracted from three utterances, each of five words. Each point on the plot was generated by software that first isolated the vowel portion of the word, then transformed the data from the card in such a manner as to produce a point within the triangle at a location that can be used to identify the vowel.

If such displays could be made to portray the other phonemes as well, they could prove useful as speech training aids for the deaf. Specialized preprocessors exploiting the approach might have applications ranging from auditory prostheses to continuous speech-recognition subsystems for fifth-generation computers.

In this article I'll describe the rationale behind the approach I took, explain the display of sounds through such images, and then offer a functional description of the speech-interface card and the acquisition/transformation software. Finally, I'll examine issues for the future.

The Strategy

The triangle in figure 1 demonstrates an attempt at acoustic-phonetic decoding, a task that has been characterized as "one of the major unsolved problems" in the speech-recognition field (reference 4). Some researchers have also argued that it is unrealistic to anticipate very accurate phoneme recognition in the near future because accuracies to date range from 50 to 80 percent (reference 7). Yet human listeners achieve about 90 percent accuracy (reference 5). They also demonstrate continuous speech-recognition capabilities unmatched by any of today's machines.

It may be appropriate, therefore, to adopt an emulation strategy that speculates on the probable neural processes involved and creates implementations based on those speculations. That is the approach I've taken.

The foundation of my strategy is the contention that the nervous system is a qualitative analog computer. Its decisions are based on the relative strength of transient signals at various points within the system. To describe the events that triggered the signals, it's necessary to consider the strongest signals and where they materialize.

With respect to the phoneme-recognition problem, it becomes pragmatically appropriate to focus on two questions:

- Because relative analyses of competing signals appear to be the central function of neural processes, what sort of instrumentation technique would effectively portray relative relationships?
- On the premise that neural pro-

cesses employed in one sensory channel are likely to be used in others, is it possible that speech signals are perceived in a way analogous to that used to recognize colors?

The remainder of this article describes the application of this strategy.

Cochlea Images

Sound entering the ear is coupled to a long coiled structure called the cochlea. The auditory nerve is linked to this structure and senses the cochlea's internal vibrations. Resulting signals are then routed into the brain, having undergone appropriate processing along the way.

It is convenient to view the array of signals along the cochlea as a time-varying "image" of the incoming sound. Thus, in making an analogy to the operation of the eye, the relative placement and intensity of "features" that are evident across this image should offer a means of identifying the sound responsible for them. To gain insight into the character of such sound images, I created an experimental speech data-acquisition card. It contains filters that serve as a very crude model of the cochlea. The filters extract the sound energy from four broad regions of the speech spectrum. Each region is sampled every millisecond, then data is converted to digital form for acquisition by an IBM PC, which transforms it for display.

The Speech-Interface Card

A block diagram of this speech port is shown in figure 2. Containing 21 integrated-circuit chips mounted on a prototyping board, it performs five major functions: amplification, filtering, rectification, clock generation, and bus interfacing.

A cardioid electret condenser microphone drives a two-stage preamplifier whose high-frequency rolloff starts at about 6 kHz and serves an antialiasing role for the card's switched-capacitor filters.

All filtering is accomplished using EG&G Reticon switched-capacitor filters that are pin- and clock-pro-

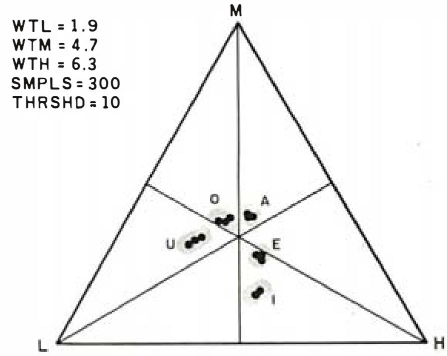

Figure 1: *A portrait of speech vowels. WTL, WTM, and WTH are the weights applied to the low- , mid- , and high-band data, respectively. SMPLS refers to the number of samples taken within each vowel utterance, and THRSHD represents the voicing-channel threshold.*

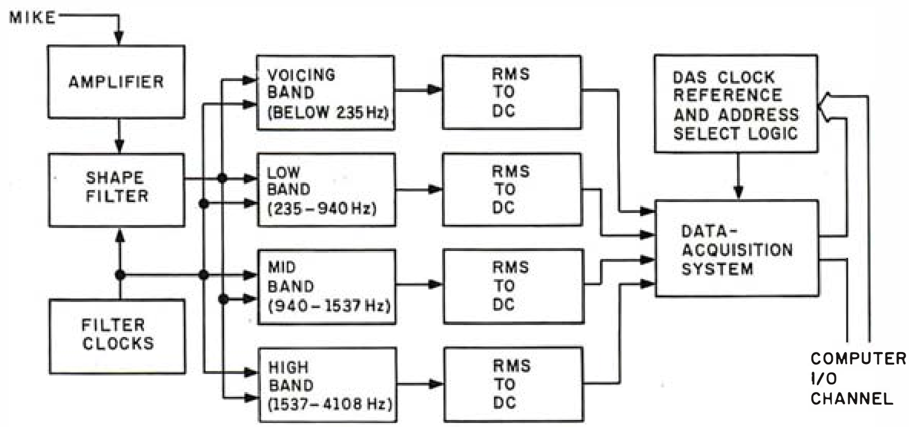

Figure 2: *An overview of an experimental speech-input card for the IBM PC.*

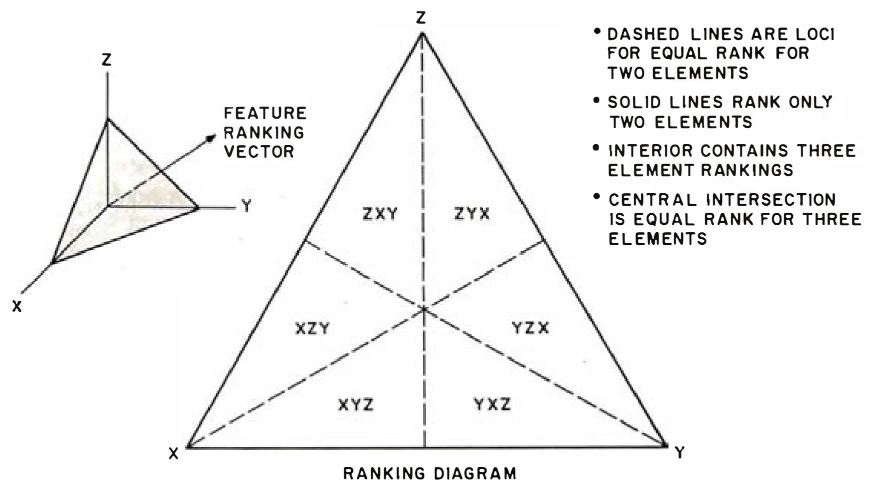

Figure 3: *This figure is a ranking diagram, a convenient means of conveying the relative level of three variables. You can thus look at figure 1 and determine that the i vowel has its strongest component in the high band and its weakest in the mid band.*

grammable. Functions (bandpass, lowpass, highpass), Q (a measure of filter sharpness), and frequencies are established by pin connections. The shape filter shapes the overall spectrum presented to the others to create a response similar to that of a more elaborate cochlea model employed in earlier experiments. A lowpass filter with a 235-Hz corner serves as a voicing channel. Three bandpass filters yield low-, mid-, and high-frequency channels whose corners are 235, 940, 1537, and 4108 Hz.

To translate the AC spectral signals to DC levels, the card uses Analog Devices true RMS-to-DC converters. Although not exploited in this design, these chips can be connected to obtain the logarithm of the RMS input, providing a conversion with a useful dynamic range of 60 db (decibels).

Outputs from the four converters are fed to an Analog Devices monolithic 8-bit, 8-channel, memory-buffered data-acquisition system (reference 1). The system sequentially converts each of its eight inputs into a digital byte, storing the results in an 8- by 8-bit dual-port RAM (random-access read/write memory). The scan period of the clock employed here is about 670 microseconds. Data readout from the chip is independent of the scanning/conversion, and interleaving of the memory updates and readout is automatically managed by on-chip logic.

The compiled BASIC software monitors the voicing channel until its level exceeds a threshold. Passing the threshold level signals the presence of speech (reference 8) and initiates acquisition of data on the low, mid, and high channels. The purpose is to capture vowel-sound data; trailing consonants should not be captured unless the buffer is too long. Each set of three-channel data represents the components of a vector in three-dimensional space and only one sample of the cochlea's dynamic image. The collection of samples is combined to create a single vector, which is then transformed for plotting.

Plotting Transformation

This vector reflects the relative level

of the energy in the three filter channels. Colors are often described with diagrams that result from the relative levels of the underlying components that cause the perception of a particular color sensation. A similar approach is applicable to the characterization of speech in relative terms.

Figure 3 illustrates the concept of a ranking diagram, a means of expressing the relative levels of three variables as one point in a planar image. The three variables are normalized with respect to the peak and treated as the components of a vector extending out from the origin. Given a plane that intercepts the three axes at unity, the vector will pierce the plane at a point that reflects the relative intensities of the variables. The triangle is a view of the plane and its intersections with the planes of the coordinate axes, as seen from a perpendicular to the pierced plane that passes through the origin of the coordinate system. This is the transformation carried out by the software to produce the points in the triangle plot of figure 1.

Vowel-Position Variations

Several annotations in figure 1 require explanation. The first three are weights applied to the low-, mid-, and high-band data. Their dominant impact is on the position of the response grouping within the triangle rather than on the separation between the vowel clusters. Item 4 is the number of collected samples of each utterance, and 5 is the voicing-channel threshold.

A couple of different sets of crossover frequencies between the three main bands have also been considered. If a corner coincided with the range of values for either the first or second formant frequencies, you'd expect that the relative strength of the adjacent channels might change significantly with a change of speakers. This is because the *formant* (a characteristic component of a sound) of a vowel might fall on a different side of the corner for specific speakers.

The results of a few casual multiple-speaker experiments have been mixed. They reveal, however, that the vowel that exhibits the greatest tendency to wander is the *i*, as in feet, while the most stable seems to be the *a* in mob.

It should be noted that other vowels will appear in the spaces between those shown in figure 1. Similar vowel loops have been reported in the past (references 6 and 9). In one investigation, frequencies of the first two formants were used as the axes of a two-dimensional coordinate system. Another approach was more akin to the one described here. It was advanced as part of a theory of speech perception motivated by color-perception considerations. Plotting instrumentation based on that approach is described in reference 3.

Other Phonemes

Plotting vowels does not seem difficult to accomplish. Limited vocabularies with insignificant vowel overlap also yield good performance in isolated speech-recognition machines. But discrimination that depends on accurate recognition of

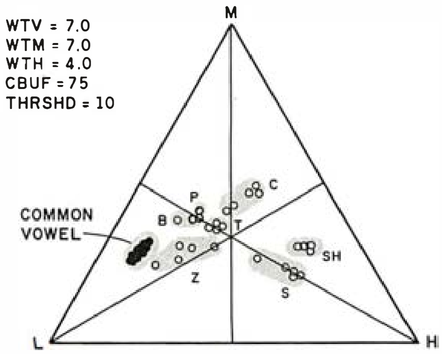

Figure 4: *An example of consonant plots based on the use of voice, mid, and high bands. Sounds were consonant-vowel pairs with a common vowel (the dark cluster at the left). CBUF refers to the number of consonant samples taken within each utterance.*

consonants presents a more significant challenge (reference 2).

Figure 4 was obtained using different acquisition software. Data was continually collected in a circular buffer until voicing was detected. That point was marked as the start of the vowel, and a segment ahead of it was considered as the consonant portion. Collection was terminated after some vowel data was gathered. Thus, the software can handle consonant-vowel sequences, treating the two components separately and plotting them with different symbols.

Consonant energy is concentrated in the high band, but for some of these phonemes, voicing is present. Figure 4 was based on the use of the voice, mid, and high channels (with appropriate weight changes). Of course, with that combination, the vowel position also shifted because of the different channels and weights. But a software change would permit acquisition of vowel data from the three original channels and combination of that data with consonant data from these channels. Interpretation of such a display would then be based on symbol differences as well as positions. Color could also be used to distinguish data.

Another way to improve the separation is to split the combined mid and high bands into three subbands, with the plot displayed in a subtriangle of the original. Experiments conducted earlier using a cochlea model driven by a speech synthesizer confirmed that that, too, is a feasible option.

Future Directions

The most effective techniques are likely to be those based on change because response to change is a dominant characteristic of the nervous system, and the consonants are the dynamic segments of the speech sound. Perhaps, instead of plotting the relative energy levels in the band, we should consider the relative changes in level, or even movement among bands. There are many possibilities; unfortunately, none can be readily evaluated with the current card. Therefore, it's back to the drawing board to design a new interface card. ■

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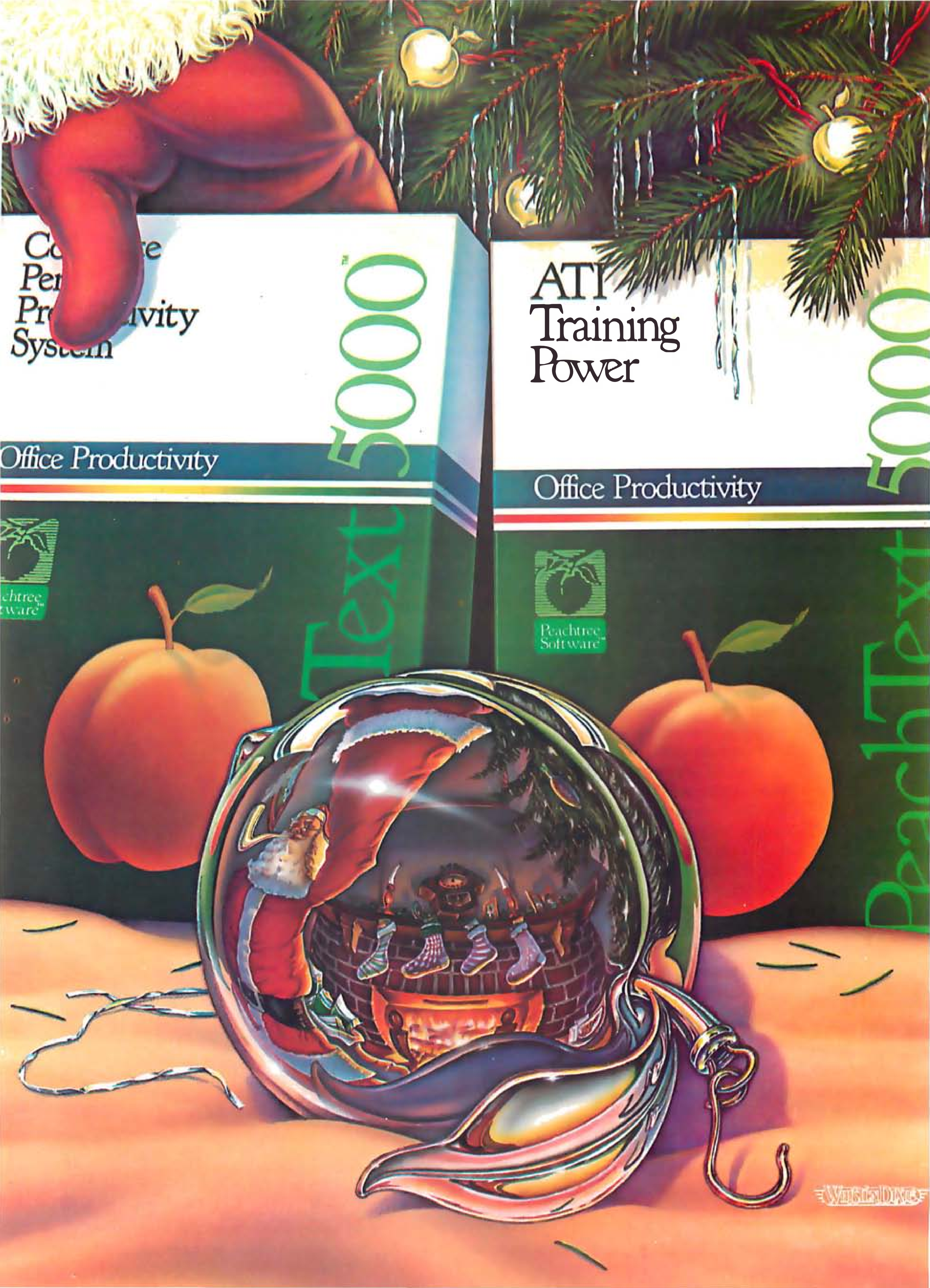

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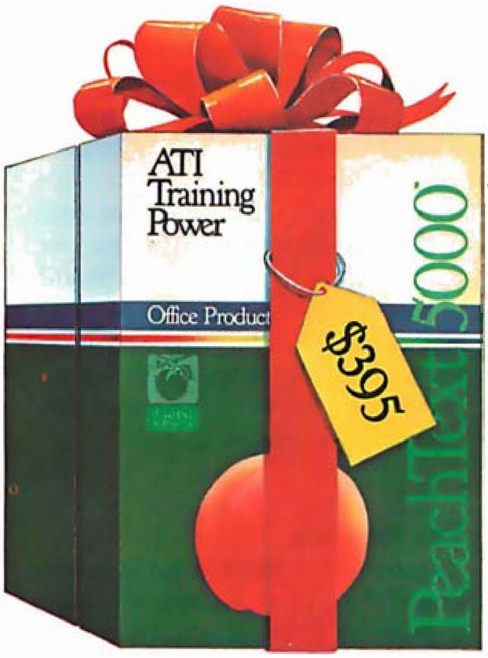

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Lmodem: A Small Remote-Communication Program

A no-frills, smart-terminal program for CP/M systems written in BDS C

by David D. Clark

In the past few years, there has been a tremendous increase in the number of remote computing facilities available to microcomputer users. These include online databases, large timesharing operations, The Source, Compuserve, computer bulletin boards (CBBs), and C nodes. In order to use such facilities, you need a terminal program. This article describes one such program, Lmodem, a "little modem" program written in BDS C for CP/M-based systems.

The most basic form of telecomputing consists of connecting a local terminal to a remote computer over a telephone line. In its simplest case, a terminal program makes your computer emulate a dumb terminal to the remote system. This arrangement is fine if you don't have to transmit lots of information or don't need to keep a record of responses from the remote system.

The next step up in sophistication is to include *text capture* capabilities in the terminal-emulator program. Text capture consists of holding text in a buffer for later storage on disk. With this capability, you can obtain a program listing by commanding the remote system to list the program to your terminal. (The program from which Lmodem is derived—Cmodem 13.c—was obtained in just this manner.) Finally, a file-transmission protocol can be added to the program. Several protocols are in common use, but all transmit chunks of data with some type of error checking. By using a file-transfer protocol, you can transmit binary-code files and data files; you are not limited to text files.

The Lmodem program employs what is known as the Ward Christensen (or XMODEM) protocol for file transfer. (Ward Christensen has written so much good public-domain software that he deserves an award of some kind.) This transfer protocol is used by C nodes. Originally written in assembly language, the algorithm has since been translated into high-level languages like C.

The Program

Lmodem is written in the BDS version of the C programming language. It provides terminal emulation, text capture, and transfer of files using the Ward Christensen protocol. Lmodem is about as simple as such programs come. The hardware-dependent information and operations have been isolated in a small number of functions and constants. The program is modular enough that it can be implemented in simple stages if necessary.

Hardware-dependent Routines: You will need to be familiar with your hardware to implement this part of the program. In the Lmodem program (listing 4), the last eight routines comprise the functions that you may have to change for your computer system. The routines in the listing were written for a Teletek FDC-I single-board computer, using the second serial port as the modem port. I attached a Novation Cat, a 300-bps (bits per second) answer/originate, acoustic modem.

A brief description of each of these routines follows:

1. initializemodem(): performs any hardware-dependent initialization. The version in the listing simply calls purgeline() to clear the communications line.
2. purgeline(): clears the communications line of any characters that may be present.
3. mcharinp(): for modem character input. Reads a single character from the modem port and returns it to the calling function.
4. mcharout(): for modem character output. Sends the character passed as an argument out through the modem port.
5. moutrdy(): for modem output ready. Returns a result of True if the modem can accept a character for transmission; otherwise, False.
6. minprdy(): for modem input ready. Returns a result of True if the modem has a character available to be read; otherwise, False.
7. ctsready(): for clear-to-send ready. Clear-to-send (CTS) is an RS-232C interface line. If your modem can detect the state of this interface line, ctsready() should return a result of True while the CTS line is active. In listing 4 this function is set to always return a result of True.
8. hangup(): before the program finishes, this routine should be

called to perform the termination procedures, if any. In listing 4 this function is set to always return a result of True.

If you have an auto-dial/auto-answer modem, you should expand some of these routines to take advantage of those features. If you have a basic 300-bps modem like mine, simple routines similar to those in listing 4 will be sufficient. For more information on adapting this program to your hardware, see the section on modifications.

The value of SPS, defined near the beginning of the program, is also hardware dependent, but its value is not critical. SPS is explained more fully in the section on file transfer.

Terminal Emulation: The part of the program that makes your computer look like a terminal is contained in a small portion of code making up the main() function. The loop starting with the statement

```
while (ctsready() && (KbData != QUIT))
```

first looks for input from the keyboard by making a call to the bdos() function with the arguments DIRCTIO (defined to have a value of 6) and INPUT (defined to a value of 0xff). Bdos() is a BDS C library function that calls the CP/M BDOS (basic disk operating system) function with the same number as its first argument and puts the second argument in the DE register pair. Thus, the expression

```
(KbData = bdos (DIRCTIO, INPUT))
```

calls the BDOS direct-console I/O (input/output) routine. If a character is available at the console, its value is assigned to the variable KbData. Any character found is checked against various special-command characters, described later. For now, let's just say you type a character you want to be transmitted to the remote system. In this instance, the default section of the switch statement is selected, and the character is sent by means of the mcharout() function.

If no character is pending at the keyboard, the entire switch statement is skipped. In either case, the modem is then checked for a character awaiting input (if (minprdy())). If so, it is retrieved and printed on the console.

That's all there is to terminal emulation. The logic of the process can be represented more succinctly by the pseudocode fragment in listing 1.

In order to end the program, you type the QUIT command character, the value of which is declared in a # define statement near the beginning of the program. If you have a sophisticated modem and an appropriate ctsready() function, the program can be made to end if the telephone is hung up.

Text Capture: Keeping a record of an entire session with the remote system is not much harder. A few more variables, two commands, and a lit-

Listing 1: *A pseudocode representation of the terminal-emulation algorithm used in Lmodem.*

```
while (the communication line is open) and
      (the quit command has not been issued) {
          if (there is a character at the keyboard) {
                  get it;
                  send it out over the modem;
          }
          if (there is a character at the modem) {
                  get it;
                  display it on the console;
          }
}
```

Listing 2: *The file-transmission process, using Christensen's XMODEM protocol written in pseudocode.*

```
open the file to be sent;
initialize the modem;
while (there are still sectors to send) {
          repeat {
                  send an SOH;
                  send the sector number;
                  send the sector number complemented;
                  send the data and compute a checksum;
                  send the checksum;
                  wait for a response;
          } until (the response is an ACK);
}
send an EOT character;
wait for an acknowledgement;
close the file;
```

Listing 3: *The file-reception algorithm, using the XMODEM protocol written in pseudocode.*

```
create the new file in the directory;
initialize the modem;
repeat {
          wait for an initial SOH, EOT or TIMEOUT;
          if (the character is an SOH) {
                    get the sector number;
                    get the sector number complemented;
                    get the data and compute a checksum;
                    get the checksum;
                    if (checksum = computed checksum)
                              send an ACK;
                    else
                              send an NAK;
          }
          if (the character is an EOT) {
                    close the new file;
                    send an ACK;
          }
} until (the initial character was an EOT);
```

tle code are all you'll need. The CAPTURE command character toggles the state of the variable BFlag, which is False when the program starts. In the listing, the character for this command is Control-C. If your BIOS (basic input/output system) detects this character and warm-boots CP/M, change the character for the command. When BFlag is True, characters received from the remote system are stored as received in a buffer of BUFSIZ characters, using the TxtPtr variable as an index to the buffer. By typing the CAPTURE command character during the session, you can save those parts of the session that you want a record of. You can also use the CAPTURE command to keep track of the free space remaining in the capture buffer.

The Lmodem program does not directly save the characters that you type. If you are in full-duplex operation, the remote system will echo all the characters that you type, so they will be in the text buffer. If your connection is half-duplex, the characters you type will not be echoed back to your system. In this case, if you want to keep your input, add a statement to the default switch to store those characters in the buffer.

When the session is over or the capture buffer is nearly full, type the KEEP command character to save the contents of the buffer in a disk file. You will be asked to supply a file name. The file will then be created and the buffer contents written to it. After the buffer has been saved, text capture is turned off and the buffer index is reset.

File Transfer: The majority of the Lmodem program consists of code to perform file transfers. Lmodem uses the Ward Christensen file-transfer protocol used by C nodes. Before delving deeper into the program, see listing 2 for the transmission algorithm in pseudocode.

The SOH (start of header), ACK (acknowledge), and EOT (end of transmission) characters are ASCII (American National Standard Code for Information Interchange) control characters used by the protocol for synchronization and communication between the host and the remote computer. The NAK (negative acknowledge) character is used in place of ACK if an error is detected.

The receiving algorithm is complementary (see listing 3).

The Protocol

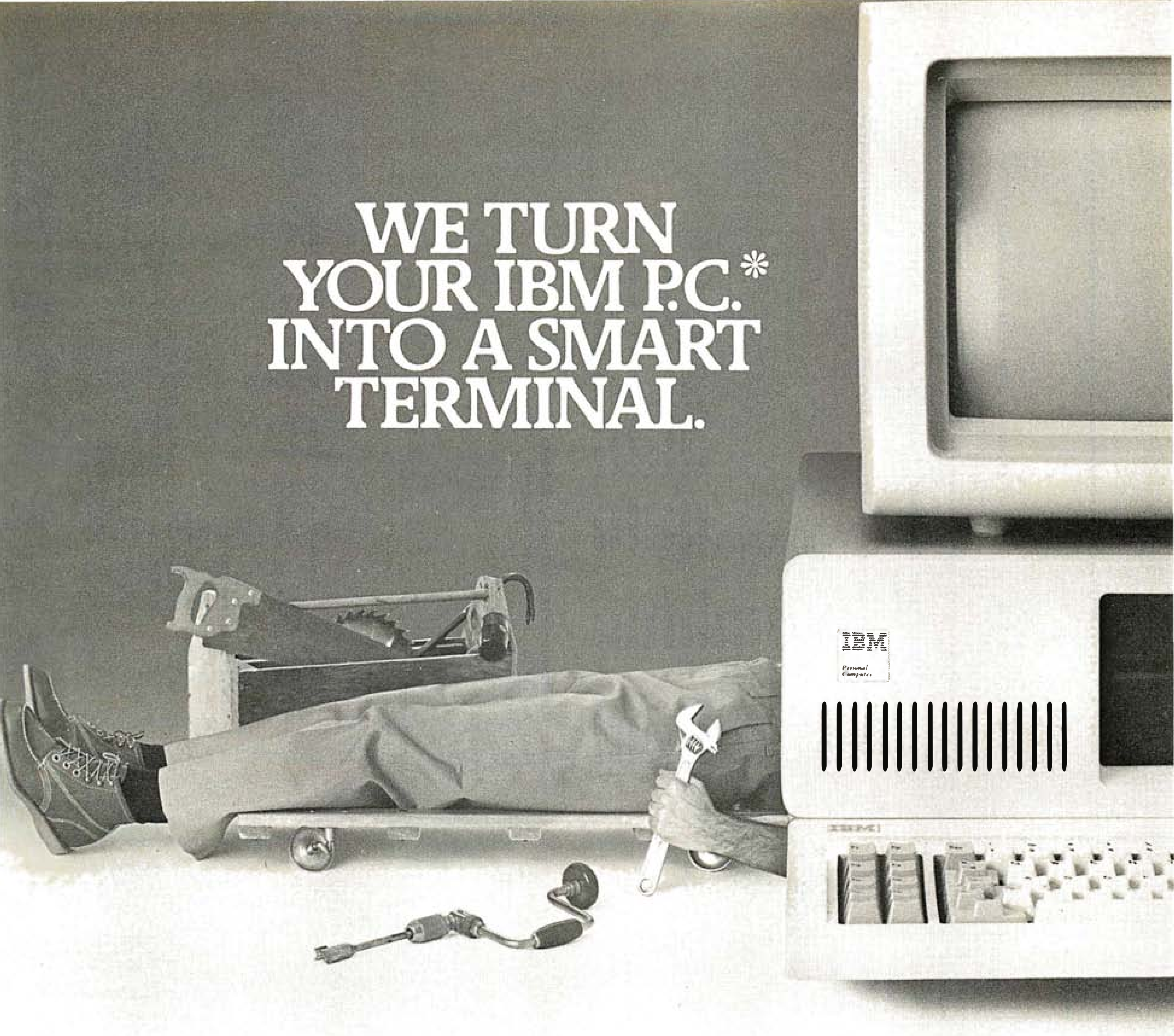
The two terminal programs first synchronize with each other. An SOH is transmitted to signify that a sector of data will be transmitted. Next comes the sector number and its one's complement followed by the 128 bytes of data that make up the sector. As the data is transmitted, a checksum is calculated at both ends of the transfer (the checksum is the sum of the numerical value of all the characters sent). After the data has been sent, the checksum is also sent. The receiving program compares the checksum it receives with the one it calculated during transmission.

If the checksums agree, the receiving program returns an ACK character to the sending program to notify it to proceed to the next sector. If the checksums do not match, the receiving program returns a NAK character to the sending program and the sector will be retransmitted. This retransmission can be repeated for a predetermined number of attempts. Upon reaching the end of the file, the sending program transmits an EOT character instead of an SOH. If everything is okay with the receiving program, it returns an ACK character to the sending program and they both close up the files.

Send and Receive

The functions sendfile() and readfile() handle the operations of sending and receiving files by means of the Christensen protocol. If you compare Lmodem's source code (listing 4) with the pseudocode (listings 2 and 3),

Text continued on page 424



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Listing 4: *The source code of Lmodem.c written in BDS C version 1.46.*

```
/*************************************************************************/
/*                                                                       */
/*     lmodem -- little modem program                                    */
/*                                                                       */
/*     This program implements the Ward Christensen assembly-language   */
/*  program in C.  It is closely derived from the cmodem13.c program    */
/*  by Jack M. Wierda and Roderick W. Hart.  The modes available have   */
/*  been greatly reduced.  The program provides terminal emulation and  */
/*  text capture as well as file send and receive capabilities.         */
/*                                                                       */
/*     Hardware-dependent functions have been isolated from the          */
/*  majority of the program.  This particular implementation has been   */
/*  set up to run with an interrupt-driven modem input from the second  */
/*  serial port of an FDC-I single-board computer system.  The modem    */
/*  used is a very simple Novation Cat.                                  */
/*                                                                       */
/*  Compile and link with (BDS-C ver 1.46):                              */
/*                                                                       */
/*      ccl lmodem.c -o -e 2800                                          */
/*      l2 lmodem                                                        */
/*                                                                       */
/*                                                                       */
/*     Written by David D. Clark                                         */
/*     9-Jan-83                                                          */
/*                                                                       */
/*************************************************************************/

#include "bdscio.h"

#define     DOTS        50       /* sector counting dots per line */
#define     SPS         9500     /* loops per second */
#define     SECSIZ      0x80
#define     DATAMASK    0x7f
#define     BUFSECS     128      /* number of file sectors to buffer */
#define     BUFSIZ      0x7f80   /* large text buffer (32K less 1 sector) */
#define     ERRORMAX    10       /* maximum errors before abort */
#define     RETRYMAX    5        /* maximum retrys before abort */
#define     DIRCTIO     6        /* cpm bdos direct-console io command */
#define     INPUT       0xff     /* direct-console io input */


/*************************************************************************/
/*                                                                       */
/*     Special characters used in the file transfer-protocol.           */
/*                                                                       */
/*************************************************************************/

#define     TIMEOUT     -1       /* timeout character */
#define     SOH         1        /* start of sector character */
#define     EOT         4        /* end of transmission character */
#define     ACK         6        /* acknowledge sector transmission */
#define     NAK         21       /* error in transmission detected */


/*************************************************************************/
/*                                                                       */
/*     Miscellaneous ASCII characters.                                   */
/*                                                                       */
/*************************************************************************/

#define     TAB         9
#define     LF          10
#define     CR          13
#define     CTRLZ       26       /* end of text-file character */


/*************************************************************************/
/*                                                                       */
/*     These #defines determine which keys will be interpreted as       */
/*  command characters.                                                  */
/*                                                                       */
/*************************************************************************/

#define     CTRLC       3
#define     CTRLK       11
#define     CTRLL       12
#define     CTRLQ       17
#define     CTRLR       18
#define     CTRLS       19
#define     CTRLV       22
#define     CAPTURE     CTRLC    /* toggle text capture */
#define     KEEP        CTRLK    /* keep text buffer */
#define     LITERAL     CTRLL    /* send literal character */
#define     QUIT        CTRLQ    /* quit */
#define     RECEIVE     CTRLR    /* receive file by sectors */
#define     SEND        CTRLS    /* send file by sectors */
#define     VIEW        CTRLV    /* view data transferred */


char ViewMode, BFlag, KbData, ModData;
char AsciiFlg, ShowTrans, ShowRecv, View;
char Bufr[BUFSIZ];
char FileName[14];
int Fd;
unsigned TxtPtr;


main(argc,argv)
int argc;
char **argv;
{

        AsciiFlg = ShowRecv = ShowTrans = BFlag = View = FALSE;
        TxtPtr = 0;
        ViewMode = KbData = NULL;

        instruct( );
        initializemodem( );

        /* the main loop */
        while (ctsready( ) && (KbData != QUIT)) {
                if (KbData = bdos(DIRCTIO, INPUT)) /* get any char at kbd */
                        switch (KbData) {

                        case CAPTURE:
                                BFlag = ~BFlag;
                                if (BFlag)
                                        printf("Capture initiated");
```

Listing 4 continued on page 416

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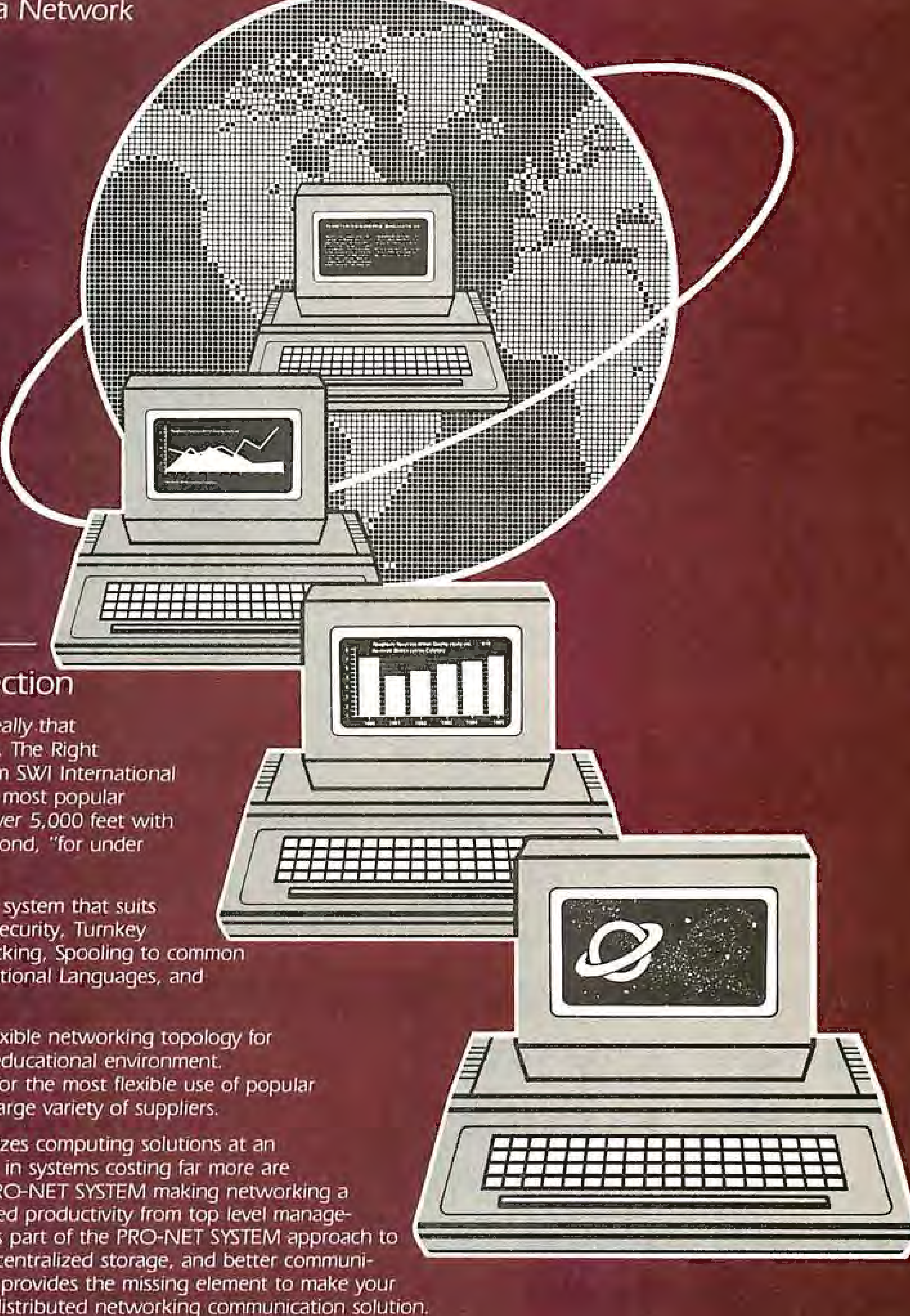

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Listing 4 continued:

```
		else
			printf("Capture terminated");
		printf(", %u", BUFSIZ - TxtPtr);
		printf(" bytes free\n");
		break;

	case KEEP:
		if (!TxtPtr)
			printf("Nothing to save\n");
		else {
			printf("Save as what file? ");
			scanf("%s", FileName);
			Bufr[TxtPtr] = CTRLZ;
			Fd = creat(FileName);
			if (Fd == ERROR)
				printf("Cannot create %s\n",
					FileName);
			else {
				write(Fd, Bufr,
					1 + (TxtPtr/SECSIZ));
				close(Fd);
				BFlag = FALSE;
				TxtPtr = 0;
			}
		}
		break;

	case RECEIVE:
		printf("Receive what file? ");
		scanf("%s", FileName);
		readfile(FileName);
		break;

	case SEND:
		printf( "Send what file? ");
		scanf("%s", FileName);
		sendfile(FileName);
		break;

	case QUIT:
		hangup( );
		break;

	case VIEW:
		View = ~View;
		if (View) {
			Printf("view as ascii or hex? ");
			ViewMode = toupper(getchar( ));
			printf("\ndisplay will be in ");
			if (ViewMode == 'A')
				printf("ascii\n");
			else
				printf("hex\n");
		}
		else
			printf("viewing disabled\n");
		break;

	case LITERAL:
		while ( !(KbData = bdos(DIRCTIO,INPUT)) ) ;
						mcharout(KbData);
						break;

					default:
						mcharout(KbData);
						break;
					}


				if (minprdy( )) {
					ModData = mcharinp( );
					if (BFlag && (TxtPtr < BUFSIZ))
						Bufr[TxtPtr++] = ModData;
					else if (BFlag)
						printf("Capture Bufr overflow\n");
					putchar(ModData);
				}
			}
}

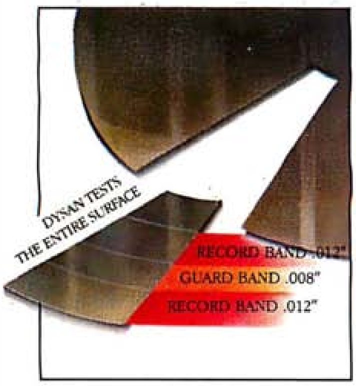

instruct( )
{
	printf("     lmodem is a small remote communication program.\n");
	printf("When started, it acts simply as a dumb terminal.  The\n");
	printf("following commands are available:\n\n");

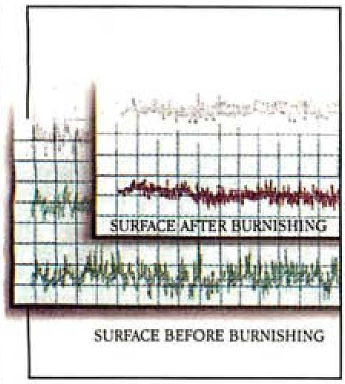

	show_char(CAPTURE);
	printf("\t- Toggles text capture.  Initially inactive.  When\n");
	printf("\t  acting as a terminal, all text received will be\n");
	printf("\t  saved in a buffer.  The buffer may be saved on disk\n");
	printf("\t  with the 'keep' command below.\n");
	show_char(KEEP);
	printf("\t- Keep. Lets you save captured text in a disk file.\n");
	printf("\t  You will be asked to name the file in which the text\n");
	printf("\t  will be saved.  The text buffer will be cleared if the\n");
	printf("\t  text is saved successfully.\n");
	show_char(RECEIVE);
	printf("\t- Receive file in Ward Christensen protocol.  You will\n");
	printf("\t  be asked for the name of the file to write into.\n");
	show_char(SEND);
	printf("\t- Send file in Ward Christensen protocol.\n");
	show_char(VIEW);
	printf("\t- Toggle data viewing.  Initially inactive.  Data\n");
	printf("\t  transmitted will be displayed in ASCII or hex.\n");
	show_char(LITERAL);
	printf("\t- Send literal character.  A character typed after this\n");
	printf("\t  character will be sent as is.  In this way, characters\n");
	printf("\t  that represent commands may be sent without being\n");
	printf("\t  interpreted as a command.\n");
	show_char(QUIT);
	printf("\t- Quit.  Exit program.\n\n");

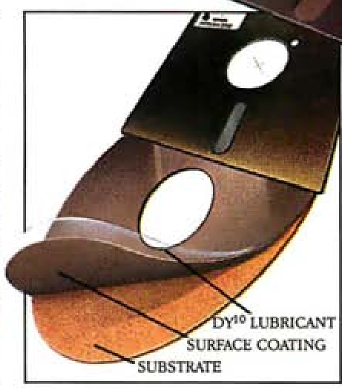
	return;
}
```

Listing 4 continued on page 418

Four Reasons Why The Dysan Difference is Worth Paying For







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Listing 4 continued:

```
show_char(c)
char c;
{
        if ((c >= 0) && (c <= 31))
                printf("ctrl-%c", c + '@');
        else if (c == ' ')
                printf("<spc>");
        else if ((c >= '@') && (c <= '~'))
                putchar(c);
        else if (c == 127)
                printf("<del>");
        else
                printf("%xH", c);
        return;
}


readfile(file)
char *file;
{
        int firstchar, sectnum, sectcurr, sectcomp, errors;
        int checksum;
        int errorflag, Fd;
        unsigned j, bufptr;

        if (View) {
                 ShowRecv = TRUE;
                 ShowTrans = FALSE;
        }
        Fd = creat(file);
        if (Fd == ERROR) {
                printf("Cannot create %s\n", file);
                return;
        }
        else
                printf("Receiving %s\n\n", file);
        sectnum = errors = bufptr = 0;
        initializemodem();
        sendchar(NAK);
        do {
                errorflag = FALSE;
                do                          /* get synchronization character */
                        firstchar = readchar(5);
                while (   firstchar != SOH
                       && firstchar != EOT
                       && firstchar != TIMEOUT);

                if (firstchar == TIMEOUT) {
                        errorflag = TRUE;
                        printf("Timeout error\n");
                }


if (firstchar == SOH) {
        sectcurr = readchar(1);
        sectcomp = readchar(1);
                if ((sectcurr + sectcomp) == 255) {
                        if (sectcurr == (sectnum + 1 & 0xff)) {
                                checksum = 0;
                                if (ViewMode == 'A')
                                        AsciiFlg = TRUE;
                for (j = bufptr; j < (bufptr + SECSIZ); j++) {
                        Bufr[j] = readchar(1);
                        checksum = (checksum + Bufr[j]) & 0xff;
                }
                AsciiFlg = FALSE;
                if (checksum == readchar(1)) {
                        errors = 0;
                        sectnum++;
                        bufptr = bufptr + SECSIZ;
                        if ((sectnum % BUFSECS) == 0) {
                                bufptr = 0;
                                if (write(Fd, Bufr, BUFSECS) == ERROR){
                                        printf("Error writing file\n");
                                        close(Fd);
                                        return;
                                }
                                /*
                                ** If the sender times out while
                                ** we're still writing, it will
                                ** resend the sector.  Hang here
                                ** until it's done resending, then
                                ** fall through and acknowledge.
                                */
                                do ; /* nothing */
                                while (readchar(1) != TIMEOUT);
                        }
                        if (!ShowRecv)
                                if (((sectnum - 1) % DOTS) == 0)
                                        printf("\n<%4d>.", sectnum);
                                else
                                        printf(".");
                        sendchar(ACK);
                }
                else {
                        printf("\nChecksum error, expected ");
                        printf("<%0x>\n", checksum);
                        errorflag = TRUE;
                }
        }
        else if (sectcurr == (sectnum & 0xff)) {
                printf("\nReceived duplicate sector %d\n", sectnum);
                /* wait for silence on the line */
                do ; /* nothing */
                while (readchar(1) != TIMEOUT);
                sendchar(ACK);
        }
        else {
                printf("\nSynchronization error\n");
                errorflag = TRUE;
        }
}
else {
        printf("\nSector number error\n");
        errorflag = TRUE;
}
```

Listing 4 continued on page 420

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Listing 4 continued:

```
	if (errorflag == TRUE) {
			errors++;
			printf("Error %d\n", errors);
			while (readchar(1) != TIMEOUT);
			sendchar(NAK);
		}
	} while (firstchar != EOT && errors != ERRORMAX);

	if ((firstchar == EOT) && (errors < ERRORMAX)) {
		sendchar(ACK);
		write(Fd, Bufr, 1 + (bufptr/SECSIZ));
		close(Fd);
		printf("\n\nTransfer complete\n");
	}
	else
		printf("\n\nAborting\n");
}


readchar(seconds)
unsigned seconds;
{
	char data;

	seconds = seconds*SPS;
	while (!minprdy() && seconds)	/* wait until input ready */
		--seconds;
	if (!seconds)
		return TIMEOUT;		/* nothing arrived in time */
	data = mcharinp();		/* get it */
	if (ShowRecv) {			/* show it if needed */
		if (AsciiFlg)
			if (((data >= ' ') && (data <= DATAMASK))
			    || data == LF || data == CR || data == TAB)
				putchar(data);
			else
				printf("[%0x]", data);
		else
			printf("[%0x]", data);
	}
	return data;
}


sendfile(file)
char *file;
{
	int sectnum, sectors, attempts;
	int checksum, Fd;
	unsigned j, bufptr;

	if (View) {
		ShowRecv = FALSE;
		ShowTrans = TRUE;
	}
	Fd = open(file, 0);
	if (Fd == ERROR) {
		printf("Cannot open %s\n", file);
		return;
	}
	else
		printf("Sending %s\n\n", file);
	initializemodem();
	attempts = 0;
	sectnum = 1;


while ((sectors = read(Fd, Bufr, BUFSIZ/SECSIZ)) && (attempts != RETRYMAX)) {
	if (sectors == ERROR) {
		printf("\nError reading file\n");
		close(Fd);
		return;
	}
	else {
		bufptr = 0;
		do {
			attempts = 0;
			do {
				if (!ShowTrans)
					if (((sectnum - 1) % DOTS) == 0)
						printf("\n<%4d>.", sectnum);
					else
						printf(".");
				sendchar(SOB);
				sendchar(sectnum);
				sendchar(~sectnum);
				checksum = 0;
				if (ViewMode == 'A')
					AsciiFlg = TRUE;
				for (j = bufptr; j < (bufptr + SECSIZ); j++) {
					sendchar(Bufr[j]);
					checksum = (checksum + Bufr[j]) &
						   0xff;
				}
				AsciiFlg = FALSE;
				sendchar(checksum);
				purgeline();
				attempts++;
			} while ((readchar(10) != ACK) &&
				 (attempts != RETRYMAX));
			bufptr += SECSIZ;
			sectnum++;
			sectors--;
		} while (sectors && (attempts != RETRYMAX));
	}
}



	if (attempts == RETRYMAX)
		printf("\nNo acknowledgment of sector, aborting\n");
	else {
		attempts = 0;
		do {
			sendchar(EOT);
			purgeline();
			attempts++;
```

Listing 4 continued on page 422

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Listing 4 continued:

```
} while ((readchar(10) != ACK) && (attempts != RETRYMAX));
if (attempts == RETRYMAX) {
        printf("\nNo acknowledgment of end of file");
                        printf(", aborting\n");
                }
                else
                        printf("\nTransfer complete\n");
        }
        close(Fd);
        return;
}


sendchar(data)
char data;
{
        while (!moutrdy());     /* wait until output ready */

        mcharout(data);         /* send it */

        if (ShowTrans) {        /* show it, if needed */
                if (AsciiFlg)
                        if (((data >= ' ') && (data <= DATAMASK))
                            || data == LF || data == CR || data == TAB)
                                putchar(data);
                        else
                                printf("[%0x]", data);
                else
                        printf("[%0x]", data);
        }
        return;
}

/**************************************************************************/
/*                                                                        */
/*      The following functions may be hardware dependent.  These are    */
/*  set up to use a Novation Cat modem running through the interrupt-    */
/*  driven second serial port on an FDC-I board.                          */
/*                                                                        */
/**************************************************************************/


#define     MDMPORT    2        /* modem data port (FDC-I serial b) */
#define     DATAB      0xf7cd   /* serial b input data location */
#define     STATB      0xf7be   /* serial b character-ready flag */


initializemodem()
{
        purgeline();            /* not a lot to do on Novation */
}


purgeline()
{
        while (minprdy())       /* while there are characters... */
                mcharinp();     /* gobble them */
}


mcharinp()
{
        char c;

        while (!peek(STATB));   /* do nothing until ready */
        c = peek(DATAB);        /* get FDC-I serial B data byte */
        poke(STATB, 0);         /* reset FDC-I serial B status byte */
        return c;
}


mcharout(c)
char c;
{
        while (!moutrdy());     /* do nothing unitl ready */
        outp(MDMPORT, c);       /* send the character to FDC-I serial B */
}


moutrdy()
{
        return ((inp(3) & 4) > 0);
}


minprdy()
{
        return peek(STATB);
}


ctsready()
{
        return TRUE;            /* nothing to do */
}

hangup()
{
        return TRUE;            /* nothing to do */
}
```

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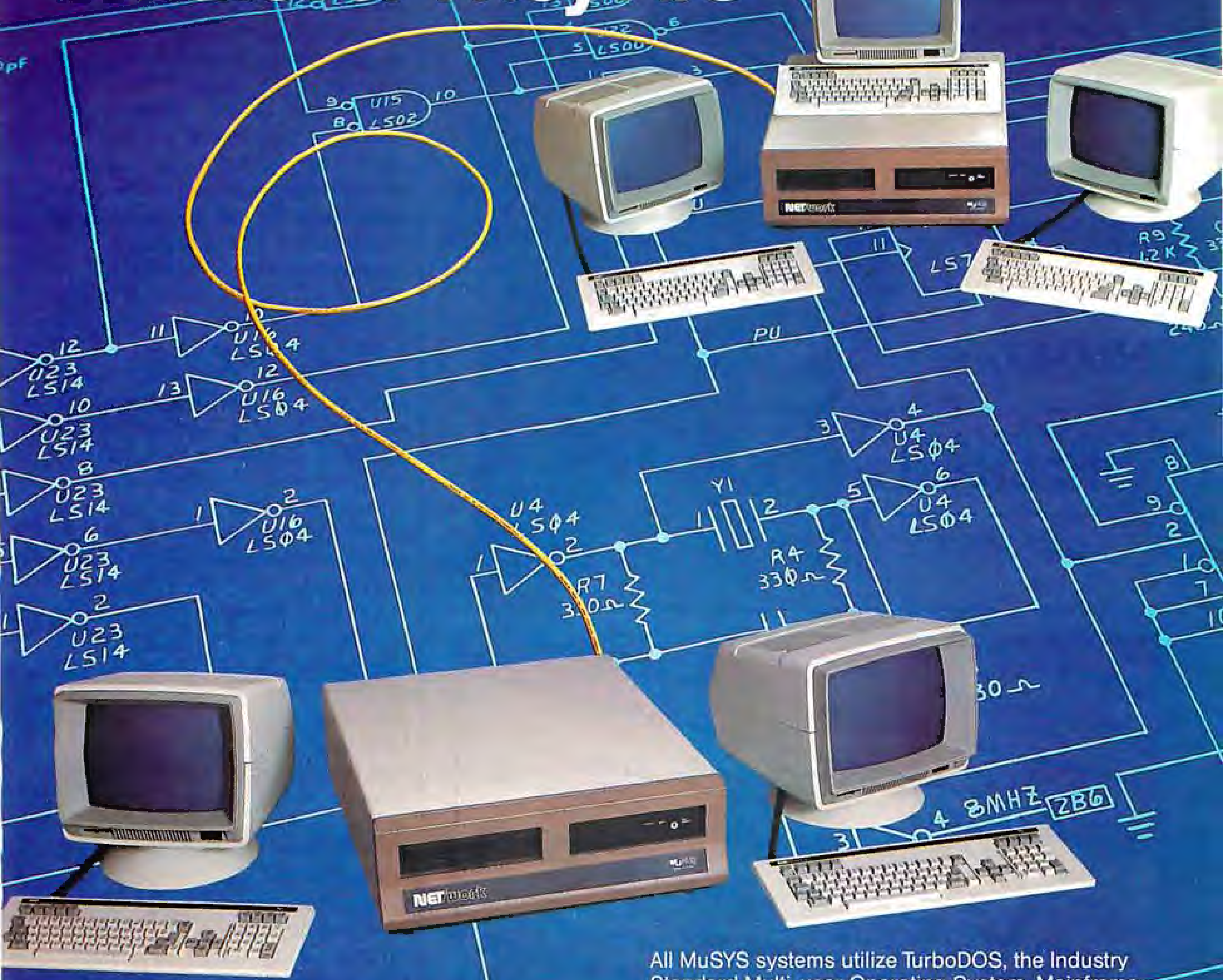

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Text continued from page 412:

you will see that they are quite similar. The basic algorithm is apparent in the code. The main differences are in the more extensive error-checking code that is present in listing 4. In addition to the checksum, the synchronization, sector numbering, and timing are all monitored for accuracy.

The sectors are not read from and written to disk one at a time. The sendfile() and readfile() functions buffer the files being transferred. The same buffer used for text capture is used for file buffering. Any text in the buffer when file transfer begins will be lost. If you use the same value for BUFSECS as that in the listing, you will be able to buffer 16K bytes or 128 sectors at a time. On most CP/M systems this corresponds to one CP/M directory extent. It is possible to buffer additional sectors, but the process of allocating an additional directory extent is usually slow enough that it causes a timeout error in the sending program while the receiving program is writing out the buffer. I rarely need to transfer files larger than 16K bytes, but the routines are constructed so that any size file can be transferred. At 300 bps, the rate of transfer is approximately 15 sectors per minute. I have used the program only at 300 bps, but I believe it is fast enough to keep up with a 1200-bps modem, if you have one.

The byte-by-byte send and receive operations are performed by the complementary routines sendchar() and readchar(). Basically, all these functions do is transfer the character and display it in the appropriate format, if needed. The readchar() function has one other duty: it is passed an argument that corresponds to the number of seconds it is to wait for a character to be ready at the modem. If nothing has been received within this period of time, readchar() will return a timeout character as its value. The timing function is based on the value of the constant SPS. It corresponds to the number of loops per second executed by the statement

```
while (!minprdy() && seconds)
    --seconds;
```

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On my computer (the Teletek FDC-I with a 4-MHz Z80A), I set the value of SPS to 9500. You should adjust this constant for your hardware configuration.

The VIEW command allows the transfer to be monitored at the console, and you are given the option of viewing transmitted characters as ASCII characters or as hexadecimal values. If the ASCII mode is selected, unprintable characters will be displayed as hexadecimal numbers. If the hexadecimal option is selected, all transmitted characters will be displayed as such. If the viewing feature is not active during the transfer, a period (.) will be displayed on the console for each sector sent or received.

Miscellaneous Features: When the program is started, the instruct() function displays the command characters and gives a short description of each.

A LITERAL command is provided that sends the next character typed through the modem without any interpretation. This is useful in the event that you wish to send a command character to the remote system without it being interpreted as a command by Lmodem.

Running Lmodem

To run the program after it has been compiled and linked, just type *lmodem* and a *<cr>*. It prints the command menu and then enters the terminal-emulation mode. From this mode, any of the commands can be invoked at any time.

Next, make the connection with the remote system. If you are using an acoustically coupled modem, set your modem to originate mode with full-duplex, dial the remote system, wait for the tone, and put the handset in the coupler collars on the modem. If nothing happens, try tapping the Return key a couple of times. The remote system should respond with some sort of sign-on message and provide you with further instructions to log onto the system.

Elect to Receive

To receive a file from the remote system, send the appropriate commands to cause the remote system to set up a file for transfer. When the remote system notifies you that the file is ready for transmission, type the RECEIVE command character. After you supply a name for the new file, the transfer should proceed automatically. If everything proceeds normally, a message will be printed at the end of the transfer and you will be back in the terminal-emulation mode. If uncorrectable errors occur, Lmodem will display the error message and the transfer will cease. The procedure for sending a file is completely analogous—type the TRANSMIT command and specify the file name.

A final note on file transfer. The error checking in the program seems to be adequate; however, that aspect has not been thoroughly tested because I cannot seem to generate any errors. In all the time that I have used the program, the only errors I have been able to cause are time-outs—generated while attempting to

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Listing 5: *Specific I/O functions defined using BDS C macroinstructions.*

```
moutrdy()
{
     return ((inp(MSTAT) & MOMASK) == MAHI);
}


minprdy()
{
     return ((inp(MSTAT) & MIMASK) == MAHI);
}


moutchar(c)
char c;
{
     while (!moutrdy());
     outp(MDATA, c);
}


minpchar()
{
     while (!minprdy());
     return (inp(MDATA));
}
```

receive a file without being connected to a remote system.

Modifications

The FDC-I has an interrupt-driven serial port; therefore, if the modem receives a character, it generates an interrupt and control is transferred to an interrupt handler in the CP/M BIOS. The interrupt handler gets the character and stores it at memory location DATAB. It then sets a status byte at STATB to 1 and returns from the interrupt condition. Determining whether or not a character is available involves simply examining memory location STATB, which is what the minprdy() function does. Reading a character consists of waiting until STATB equals 1, retrieving the character from memory location DATAB, and resetting the status byte to 0.

In the more probable event that your modem port is not interrupt driven, you will have to write your own minprdy() function to read the status port and mask off the appropriate status bits in a manner analogous to the moutrdy() routine. Your mcharinp() routine will be similar to the mcharout() routine too: wait for a character to appear, then read the appropriate data port.

If you have BDS C, the standard I/O header file, bdscio.h, defines several macros that you can set for your modem characteristics. MSTAT and MDATA define the status and data ports respectively. MIMASK and MOMASK define the input data ready and output port ready masks. MAHI should be set to True if the status returns high for ready. If you have these values set up for your hardware, the routines in listing 5 should work for your system.

If you are not sure about your hardware, use my routines for initializemodem(), purgeline(), ctsready(), and hangup(). Then get some help with minprdy(), moutrdy(), mcharinp(), and mcharout(). These routines must work before the rest of the program will operate correctly.

If you want to implement Lmodem in another version of C, some cautions apply. The BDS version does not implement the file I/O functions in the standard C library. The creat() function in BDS C takes only one argument, the filename. No permission-mode argument is expected as in the standard I/O library. The BDS versions of read() and write() return the number of sectors read or written, not the number of characters. If you use a version of C in which these routines are implemented in a standard fashion, some modifications in the program will be needed.

Summary

The Lmodem program (listing 4) written in BDS C is a bare-bones communication program that provides terminal emulation, text capture, and file transfer using Ward Christensen's XMODEM protocol. These capabilities are based on a small number of very simple machine-dependent functions and a few more complex portable functions.

Once you have this small base program implemented, it can easily be extended for other file-transfer protocols, automatic log-on sequences, database scanning, and any other functions you want. ■

Dr. David D. Clark (246 South Fraser St., #2, State College, PA 16801) is a postdoctoral research scholar in enzymology at Penn State University.

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The Software Tools

Unix Capabilities on Non-Unix Systems

This package includes utility programs, a command interpreter, and a large programming library

by Deborah K. Scherrer, Philip H. Scherrer, Thomas H. Strong, and Samuel J. Penny

The Software Tools package is a set of programs and subroutines that provides the power and elegance of Bell Laboratories' Unix on non-Unix computer systems. The tools offer Unix-like program development features that complement systems ranging from microcomputers to mainframes.

Available in various forms from several sources, the Software Tools package includes more than 60 utility programs, a command interpreter (*shell*), and a large programming library.

Code sharing, coupled with early feedback from users, has allowed developers to build on each other's work and has produced a dynamic environment in which new ideas are rapidly tried and proven. The natural selection process that results produces high-quality, useful utilities that have been tried, improved, tested, and accepted by many users with varying needs and a variety of systems.

The Tools

The Software Tools utilities provide a framework for executing most common computing tasks. Each tool is a powerful but general software module designed to do one thing well.

The tools are easy to learn and use. They perform functions such as organizing and manipulating files, creating, editing, and rearranging text, examining files, preparing documents, and transforming language and data. Frequently used tools are:

diff	determines the differences between two files
ls	lists the file names in a directory
ar	maintains multiple small files nested inside a larger one
sort	sorts lines of a text file in several ways
find	locates text patterns in a file using a flexible expression syntax
field	rearranges data columns in a file
sedit	performs serial editing functions on a file
format	formats a document for publication or distribution

The complete set of Software Tools provides most of the functional capabilities of the Unix tools. Table 1 is a list of the tools and their Unix equivalents.

The Shell

The Software Tools shell is a command interpreter that reads lines from the user terminal or a file and interprets them as requests to execute programs. The shell includes mechanisms to redirect the input and output of the tools to the user terminal, files, or other programs. It also enables the user to group commands together to make up new commands. The ease of generating and executing complex user-tailored commands from simple ones distinguishes Unix and the Software Tools from other systems in which utilities are often clumsy. The text box "Software Tools Shell" describes the shell in greater detail.

The Library

The Software Tools library provides a framework for accessing system services by both the tools and user programs. The library includes basic system operations as well as groups of functions satisfying common programming needs. These include:

- Unix-type I/O (input/output) functions
- file and directory manipulation
- dynamic memory allocation
- string manipulation
- linked-list handling
- symbol-table creation
- text-pattern matching
- data-type conversion and manipulation
- date and time formatting
- command-line argument handling
- process control

Table 2 describes the library functions in detail.

Text continued on page 436

Text Manipulation

Software Tool	Unix Utility	Description
e, edin	ed	editor
sedit	sed	stream editor
ch	gres	change text patterns
tr	tr	transliterate characters
find	grep	locate text patterns
fb		find text patterns in blocks of lines
isam		build index sequential access list
xref		cross reference of symbols
field		manipulate fields of data
mcol	pr -n	produce multicolumn output
sort	sort	sort lines
lam		laminate lines of files together
uniq	uniq	strip duplicate lines
rev	rev	reverse order of characters
number		number lines
detab		convert tabs to spaces
entab		convert spaces to tabs
crypt	crypt	crypt and decrypt files
cpress		compress files
expand		expand compressed files
os		convert backspaces for printing
	col	convert reverse line feeds for printing
pl		print specific lines in file
	awk	pattern scanning and processing language
	join	join lines with identical fields
	prep	put words on single lines

Manipulating Files

Software Tool	Unix Utility	Description
cat	cat	concatenate/copy files
crt		paginate files to terminal
cp	cp	copy files
pr	pr	paginate files for printing
show		show all characters (control too)
tail	tail	print last lines of files
tee	tee	copy input to output and named files
includ		include files within files
split	split	split up file
cmp	cmp	simple file compare
diff	diff	differential file compare
	diff3	three-way differential file compare
comm	comm	print lines common to two files
ll		print longest, shortest line lengths
wc	wc	count words, characters, lines
	dd	convert and copy a file

Managing Files and Directories

Software Tool	Unix Utility	Description
ls	ls	list files
cd	cd	change directory
pwd	pwd	print working directory name
mv	mv	move/rename file
rm	rm	remove files
ar	ar	archive files
n.a.	chown, chgrp	change owner/group of files
n.a.	chmod	change mode of file
	find	search for files
	ln	link files
	mkdir	make a directory
	rmdir	remove a directory
	sum	validate a file (checksum)
	tar, tp	tape archiver
	touch	update last-change-date
	file	determine file type

Document Preparation

Software Tool	Unix Utility	Description
format	roff, nroff	text formatter
	troff	text formatter for typesetter
form		form letter generator
spell	spell	spelling checker
lookup	look	look up words in dictionary
kwic, unrot	ptx	generate permuted index
	deroff	remove nroff commands
	eqn	generate equations for nroff
	tbl	generate tables for nroff
	refer	find and insert literature references
	pubindex	make index for "refer"
	tc	translate troff output for Tektronix 4015

Process Control

Software Tool	Unix Utility	Description
sh	sh	command-line interpreter (shell)
run		run a tool (without shell)
which		print full pathname of command
reset		reset system after media change
logout	logout	log out of shell
n.a.	at	run process at specific time
n.a.	login	log into system
n.a.	kill	kill (background) process
n.a.	nice	run process at low priority
n.a.	ps	process status
n.a.	sleep	suspend termination for specified period
n.a.	wait	wait for completion of a process
	time	time a process
	prof	display profile data

Table 1: *The Software Tools and their Unix equivalents.*

Table 1 continued on page 432

Table 1 continued:

Software Tool	Unix Utility	Description
User Support/Information Retrieval		
dc	dc	desk calculator
date	date	print/set time and date
echo	echo	print command-line arguments
man	man	print manual entry
n.a.	passwd	set/change password
n.a.	tty	get terminal name
n.a.	who	list users on system
	true, false	commands which return true or false
	basename	print basename of file
	cal	print calendar
	calendar	remind user of appointments
	expr	evaluate arguments as an expression
	factor	factor a number
	test	condition command
	units	quantity conversions
Language Translation/Program Development		
macro	m4	macro processor
ratfor	ratfor	RATFOR preprocessor
fsort		sort FORTRAN declarations
rc	rc	RATFOR, FORTRAN, link, load
fc	fc	FORTRAN, link, load
ld	ld	load
tsort	tsort	topological sort
yacc	yacc	compiler-compiler
lex	lex	lexical analyzer
	adb	debugger
	as	assembler
	bas	basic interpreter
	bc	arbitrary-precision arithmetic language
	cc, pcc	C compile
	lint	C syntax check
	F77	FORTRAN compile
	struct	convert FORTRAN-66 to RATFOR
	lorder	find ordering relation for library
	nm	print name list of object files
	od	octal dump
	size	print size of object file
	strip	remove symbols and relocation bits
	ranlib	convert archives to random libraries
Miscellaneous		
	graph	draw a graph
	plot	graphics filter
	spline	interpolate smooth curve
	tk	paginate for the Tektronix 4014
n.a.	write	send message to another user
n.a.	mesg	permit or deny messages
tcs	sccs	test maintenance system
msg	mail	send/receive mail
	learn	computer-aided instruction about Unix
	lpr	print spooler
	make	maintain program groups
	cu	call another Unix machine
	uucp	Unix-to-Unix copy
	uux	Unix-to-Unix command execution
	stty	set terminal options
	tabs	set terminal tabs

Key:
n.a.—not applicable to single user/single process systems like CP/M.

The capabilities of a Software Tool and a Unix utility may not always be exactly the same.

Software Tools Shell (Carousel Microtool's CP/M Implementation)

The shell is a command-line interpreter; it reads lines from the terminal or a file and interprets them as requests to execute other programs.

Commands

In its simplest form, a command is the file name of a program to be run, followed by arguments given to the program. The command name may specify any file in the system. CP/M enables a user number to be part of the command (file) name. The command may be a Software Tool or any other program. The shell searches for the named file in a series of directories specified by the user in an environment file. When the command is located, it is loaded into memory and executed. When the command is finished, the shell resumes its own execution. For example, giving the command

sort file1 file2

causes the shell to locate and execute the command sort. *Sort in turn merges and sorts the contents of the two named files and puts the output on the user's terminal.*

I/O Redirection

Software Tools programs have three files automatically available to the user:

standard input
standard output
standard error output

All three are assigned to the user's terminal unless specifically redirected to disk files or other devices. Redirection is specified by preceding the desired device or file name with a special character:

<file	*read standard input from "file"*
>file	*send standard output to "file"*
?file	*send standard error output to "file"*
>>file	*append standard output to "file"*
??file	*append standard error output to "file"*

In the above example the sorted output could be saved on a file:

```
sort file1 file2 >sorted
```

or sent to the printer:

```
sort file1 file2 >/lst
```

(/lst *is the tools form of the name for the printer).*

I/O redirection is actually performed by each tool individually, rather than by the shell.

Pipes

A sequence of commands separated by vertical bars (|) causes the shell to execute each command in sequence and arranges to have the standard output of each command delivered as the standard input to the next command in the sequence. The sequence

```
sort list | uniq | crt
```

sorts the contents of file list. *The sorted output passes to* uniq, *which removes extra copies of duplicated lines. This output then goes to* crt, *which paginates output for viewing on a terminal.*

Command Separators

Commands need not be on different lines; instead they may be separated by semicolons:

```
ar -x program rtn ; e rtn
```

extracts the member rtn *from the archive file* program *and then enters the editor.*

Background Processes

Unix shells enable processes to be started and have control returned immediately to the shell. The new process continues running in the background, sharing resources with the shell process. This mechanism is impossible to implement on single-process systems such as those using CP/M. However, to simulate the mechanism in some reasonable way, the Carousel shell saves any commands indicated as background processes and executes them at the end of the session, when the user logs out of the shell. For example,

```
format doc >/lst &
```

formats the file doc *and sends it to the printer at the end of the session (the ampersand indicates a background process).*

Script Files

The real power of the Unix and Software Tools shells comes from the ability to generate new commands by combining existing commands. This feature is possible because the shell not only executes programs, but also treats script files (text files containing yet more commands) as commands. These scripts may participate in pipelines, have their I/O redirected, and appear in any context that a regular command may. Scripts may be nested by referencing scripts that may, in turn, reference other scripts.

Scripts are useful for creating new commands and for grouping commands together for multiple reexecution. For example, you could create a standard procedure by editing file fix *to fill it with the following commands for the shell:*

```
ar -x book chap1
e chap1
format chap1 | crt
ar -u book chap1
```

Then by typing fix *the system would extract* chap1 *from the archived file* book; *edit* chap1; *send* chap1 *to the formatter and display it page by page on the terminal; and finally update it in the archive file* book.

Arguments can also be passed to script files. Character sequences of the form $n, *where* n *is between 1 and 9, are replaced by the* nth *argument to the invocation of the script. If* book *has more than one section, the script could be written:*

```
ar -x book $1
e $1
format $1 | crt
ar -u book $1
```

Then you could type:

fix chap1
or fix chap7
or fix intro

to edit, view, and update the respective sections of book.

Script files can include inline explicit data that the tools can read as their standard input. The special input redirection notation << *is used to achieve this effect. For example, the editor takes its commands from standard input, normally the terminal. However, within a shell script, commands may also be embedded this way:*

e file <<!
(editing requests)
!

(The ! is arbitrary; any character can be used.) The lines between <<! *and ! are called, in Unix terminology, a "here document"; they are read by the shell and made available to the command as its standard input.*

Finally, as an indication of the power of script files, listing 1 shows an example of a script file to show changes that have been made to command files of dBASE II, a database-management program.

Environments

Like Unix, The Carousel shell maintains an environment file. This file contains information about the user's system and needs, such as the date, tab settings, and the directories in which to search for user programs or tools. The environment file is available to all tools and is modified by a few. In addition, users are free to adjust the information for their own needs.

Control Structures

Constructs of the nature:

```
if ... then ... else ...
while ... do ...
for ... in ... do ...
```

aid in reiteration and conditional execution within scripts. The Software Tools Users Group is currently standardizing the syntax for these shell control structures.

Listing 1: *The alterations to dBASE II command files.*

```
# Shell command file to show work done to
# dBASE II command files.
# usage: dbdiff dir
#    (where dir is a backup directory)
#    "dir" should be specified in tools form,
#    e.g. "/2/B"
# dbdiff will print all new dBASE command
# files and will print existing dBASE
# command files with any changes
# marked with a "|" in the right margin.

# Collect names of .cmd files in both
# directories.
ls .cmd >1.tmp
 ls $1 .cmd >2.tmp

# Find and print new dBASE commands.

#    Here comm reports lines in 1.tmp
#    which are not present in 2.tmp;
#    field changes that report into a series
#    of print commands;
#    and sh then executes those print
#    commands.
#    The "@" signs suppress the following
#    newline, effectively continuing the
#    shell command across several lines.
comm -1 1.tmp 2.tmp | @
    field "pr >/lst $1" | @
    sh

# Find existing dBASE commands and show
# changes.

#    Here comm reports files listed in both
#    1.tmp and 2.tmp;
#    e (the editor) changes each file name
#    reported by comm into a series of
#    commands to:
#       print the file name;
#       print the current date & time;
#       print the differences between the
#       versions in this directory
#       and in the other directory;
#    and cat puts a few formatter commands
#    into 4.tmp, to be called upon
#    by each line of 3.tmp.
comm -3 1.tmp 2.tmp >3.tmp
e 3.tmp <<!
1,$s~?*~echo & >/lst ; date >/lst ;
    diff -r $1/& & | format 4.tmp - >/lst~
w
q
!

cat >4.tmp <<!
.nf
.in 5
.rm 70
!

# Finally the shell runs the commands
# that e just prepared and
# rm removes all three scratch files.
sh 3.tmp $1
rm 1.tmp 2.tmp 3.tmp
```

Symbol Definitions (ratdef)

definitions	standard RATFOR definitions

File Manipulation

*amove	move (rename) a file
*close	close (detach) a file
*create	create a new file (or overwrite an existing one)
*gettyp	get type of file (character or binary)
*isatty	determine if a file is a terminal
*mkuniq	generate unique file name
*open	open an existing file for reading, writing, or both
*remove	remove a file from the file system

I/O

fcopy	copy one file to another
*flush	flush output buffer for file
getc	read character from standard input
*getch	read character from file
*getlin	read next line from file
*note	determine current file position
*prompt	prompt user for input
putc	write character to standard output
*putch	write character to file
putdec	write integer in field
putint	write integer in field on file
*putlin	output a line onto file
putstr	write string in field on file
*readf	binary read from a file
*remark	print single-line message
*seek	move read/write pointer
*setmod	set character device mode
*writef	binary write to a file

Process Control

*endst	close all open files and terminate program execution
*exec	execute task
*initst	initialize all standard files and common variables

Directory Manipulation

*closdr	close directory
*cwdir	change working directory
*gdraux	get auxiliary directory information
*gdrprm	get next directory entry
*gwdir	get name of current working directory
*opendr	open directory for reading

String Manipulation

addset	add character to array if it fits, increment pointer
addstr	add string to array if it fits, increment pointer
concat	concatenate two strings together
ctoc	copy string-to-string
equal	compare str1 to str2
gettok	parse tokens
getwrd	get nonblank word from array, increment pointer
index	find character in string
length	compute length of string
scopy	copy string from one array to another
sdrop	drop characters from a string
skipbl	skip blanks and tabs in array
sktok	skip over tokens
slstr	slice (take) a substring from a string
stake	take characters from a string
stcopy	copy string, increment pointer
stncmp	compare first n characters of strings
stncpy	copy n characters from one array to another
strcmp	compare two strings

Table 2: *The functions of the Software Tools library.*

Text continued from page 430:

The Tools or Unix?

Although the Software Tools provide many of the features of Unix, they are not an exact copy of Unix. They exist alongside the local operating system and provide many of the desirable aspects of Unix in situations where using Unix is impossible or inappropriate. For instance, if you don't want to pay Unix's high price, if you want to use software packages that aren't available in Unix versions, or if a Unix implementation is not available for your hardware, the Software Tools can provide the power and elegance of the Unix interface.

Let's look at the Software tools movement and considerations that have made the tools successful.

The Software Tools Movement

In 1976 Kernighan and Plauger wrote *Software Tools* (see reference 3). Their goal was to teach good programming style based on their experiences with Unix at Bell Laboratories. They used pared-down versions of Unix utilities rewritten in RATFOR (Rational FORTRAN), a C-like preprocessor language (see text box, "What Is RATFOR?"). The programs and the RATFOR preprocessor were made available on magnetic tape. The book and tape were the seeds from which the tools movement developed. The movement arose independently at several major research laboratories and universities.

The tools were of immediate interest to researchers and users, and the programs were implemented on numerous computers. As users began to experiment with and enhance the programs, they began to realize that the tools offered more than a useful set of utility programs. Researchers, primarily at Lawrence Berkeley Laboratory (LBL), expanded the original package to include a powerful subroutine library, a Unix-like shell, and many more of the Unix utilities. By providing all three levels (shell, utilities, and library) the tools now offered a portable, uniform interface with the functionality of Unix. The package was implemented on the diverse assortment of LBL machines and on many machines to which the researchers had network access. The result was Unix functionality on non-Unix systems and a consistent user interface across many different systems (see reference 1).

One reason the Software Tools have been so widely accepted is their portability. The tools can be implemented on virtually any machine. This portability was achieved by using a programming language that was available on all machines and by isolating system dependencies into "primitive" function calls that must be implemented separately for each different system.

With certain data-type manipulation conventions and other programming details, this portability has enabled the package to be imple-

strim	trim trailing blanks and tabs from a string
type	determine type of character

Character Conversion

clower	convert character to lower case
ctoi	convert string to integer, increment pointer
ctomn	translate ASCII control character to mnemonic
cupper	convert character to upper case
esc	check for escaped character
fold	convert string to lower case
gctoi	generalized character-to-integer conversion
gitoc	generalized integer-to-character conversion
itoc	convert integer to character string
lower	convert string to lower case
mntoc	convert ASCII mnemonic to character
upper	convert string to upper case

Pattern Matching

amatch	look for pattern matching regular expression
getpat	encode regular expression for pattern matching
makpat	encode regular expression for pattern matching
match	match pattern anywhere on line

Command Line Handling

*delarg	delete a command-line argument
*getarg	get command-line arguments
gfnarg	get next filename argument
query	print command usage information

Dynamic Storage Allocation

*dsfree	free a block of dynamic storage
*dsget	obtain a block of dynamic storage
*dsinit	initialize dynamic storage

Symbol Table Manipulation

delete	remove a symbol from symbol table
enter	place symbol in symbol table
lookup	get string associated with symbol from hash table
mktabl	make a symbol table
rmtabl	remove a symbol table
sctabl	scan all symbols in a symbol table

Linked List / Stack Handling

maklst	create and initialize linked list
frelst	remove a linked list and free allocated memory
push	push an item onto the top of the list/stack
pop	pop an item from the top of the list/stack
inject	inject a new item into a linked list
xtract	read an item from a linked list
prvnod	get previous node pointer
nxtnod	get next node pointer
remod	remove a node from a linked list

Date Manipulation

atodat	convert ASCII characters to integer date
fmtdat	convert date to character string
*getnow	get current date and time
wkday	get day-of-week corresponding to month-day-year

Error Handling

cant	print "name: can't open" and terminate execution
error	print single-line message and terminate execution

* indicates that the routine is system dependent and has been implemented by Carousel Microtools for CP/M and MS-DOS.

mented on more than 50 operating systems. Table 3 provides a partial list of manufacturers offering computers on which the tools have been implemented.

Which Language Is Best?

Computer languages are judged on their ability to solve specific problems; therefore, the best language for the Software Tools package was the one that could most adequately fill the following requirements:

- availability—the language had to be available on almost every machine
- suitability—the language had to be appropriate for textual (as opposed to numerical) applications; it had to be powerful enough to handle the support libraries that provide the necessary file access, I/O, process control, and other system-support services
- quality—the language had to be high-level, easy to read and understand, easy to learn, and powerful enough to solve applications problems

FORTRAN filled the first requirement, fell down a bit on the second, and provided little of the third. C met the second and third requirements but was not usually available on both microcomputers and larger machines. Pascal met the third requirement but was no more commonly available than C and was not appropriate to the support of large libraries and moderately complex bodies of code (see reference 2). Several other state-of-the-art languages were appealing but not generally available. Thus, no single language met all the requirements, and a compromise was necessary. The RATFOR language preprocessor was chosen because it provided the control structures, readability, and elegance of C and was translatable into FORTRAN (the language available on most systems). A C-like support library was developed to supplant FORTRAN's incomplete textual, file manipulation, and I/O capabilities. Even though FORTRAN is used at the RATFOR base level, the user is insulated from FORTRAN just as the user of any high-level language is insulated from the machine language.

The choice of language was not critical to the approach. In fact, for the person using the tools the implementation language is unimportant. Only the tools implementer and people developing new tools with the library ever need to use the language. Had the tools been designed solely for the microcomputer environment, C might have been a more appropriate choice. With the computer industry rapidly developing new machines and more elegant languages, the Software Tools community is now reevaluating the original choice of language and considering mechanisms for making the tools available in other languages as well.

What is RATFOR?

RATFOR (Rational FORTRAN) is the implementation language for the Software Tools. It is closely patterned after C in its control structures, but it is compiled into FORTRAN by the RATFOR preprocessor. The availability of FORTRAN allows RATFOR to be easily installed on a wide variety of systems. In addition to being a portable language suitable for implementing the Software Tools, RATFOR is a convenient language for program development. The control constructs of RATFOR are those of C, and the data structures are those of FORTRAN.

RATFOR's nature can most easily be described with examples of some actual code. A file of standard definitions is automatically processed by the RATFOR compiler to define new symbolic constants. A section of this file is:

```
define (EOF, -1)
define (EOS, 0)
define (MAXLINE, 128)
define (STDIN, 1)
define (STDOUT, 2)
define (character, integer)
```

Using these definitions, the following code is an example of a program in RATFOR that finds the length of the longest line read from standard input:

```
DRIVER
character line(MAXLINE)
integer getlin, length, len, size
size = 0
while (getlin(line, STDIN) != EOF)
  {
  len = length (line)
  if (len > size)
    size = len
  }
call putint (size, 5, STDOUT)
call putch (NEWLINE, STDOUT)
DRETURN
end
```

The macros DRIVER *and* DRETURN *are also defined in the standard definition file and are used to start and end all RATFOR programs.*

The following code is the same program written in C:

```
#include <stdio.h>
#define(MAXLINE,128)

main()
{
char line[MAXLINE];
int fgets(), strlen(), size=0, len;
while (fgets(line, MAXLINE, stdin))
  {
  len = strlen(line);
  if (len > size)
    size = len;
  }
fprintf (stdout, "%5d\n", size);
}
```

The similarity between the RATFOR and C versions is obvious. Notice that the RATFOR example consists almost entirely of standard FORTRAN statements, especially assignment statements and subroutine calls. The RATFOR compiler passes these statements through to the FORTRAN version almost unchanged. What RATFOR adds to FORTRAN are file inclusion, token substitution, macros for text replacement, and the following control constructs:

- if-else *for conditional execution,*
- while, for, *and* repeat-until *for looping,*
- break *and* next *for controlling loop exits,*
- switch-case-default *for selection of alternatives,*
- braces ({ }) *for statement grouping.*

RATFOR's syntax was intended to liberalize FORTRAN's syntax restrictions as much as possible. As a result, RATFOR source code is naturally concise and reasonably pleasing to the eye. RATFOR features are as follows:

- *free-form page layout*
- *unobtrusive comments*

Primitives Isolate Machine Dependencies

In the Software Tools package, system dependencies are isolated in the primitives, a set of routines that make up the tools' interface to the operating system. The primitives provide standardized system services such as file manipulation, I/O, process control, and dynamic memory allocation. The tools and their subroutines access system services through these primitives. Tool source code can be moved from system to system without change. When the tools package is moved to a new system, only the primitives must be changed or rewritten.

The original implementers of the tools issued two prime directives to assure compatibility among a wide variety of operating systems. First, they decided to use the file types of the operating system. Internal file formats specific to the machine are hidden from the user by the primitive functions, allowing both local utilities and Software Tools programs to read and write the same files and providing a standardized way to access files on all systems. Second, changes to the local system, or interference with it to implement the package, are discouraged. Such changes, combined with the local system's idiosyncrasies, would make the package unstable in new system releases.

The primitives address the issue of machine efficiency; they minimize the demands of the software upon scarce system resources like memory or central processor time. For example, the utilities of the Software Tools package are oriented toward text processing and program development (writing source code, documentation, data preparation, etc.). These utilities are characteristically limited by I/O rates. Because the I/O capabilities are isolated in the primitives, the effect of this problem can be reduced through efficient implementation of the I/O primitives. Because all utilities access resources through the primitives, they automatically benefit from such optimization.

The Software Tools Users Group

The need for cooperation among implementers and users of the tools led to the formation of the Software Tools Users Group at Menlo Park, California. It originated at the Lawrence Berkeley Laboratory and was initially funded by the Depart-

- *use of <, < =, >, > =, ==, != , etc. for comparison expressions*
- **string** *data type*
- *quoted character strings and character constants*
- **define** *statement for symbolic constants*
- **include** *statement for source-file inclusion*
- **macro preprocessor** *for textual manipulation*

RATFOR code is often easier to read and understand than the corresponding section of code as normally written in C. For example, the two following fragments of code each copy a string from one buffer to another:

```
# RATFOR version

for (i=1; from(i) != EOS; i=i+1)
   to(i) = from(i)
to(i) = EOS

/* C version */

char *t=to, *f=from;
while (*t++ = *f++);
```

One could argue that a good C compiler sometimes produces faster code, but in large programs the readability of the RATFOR style is often an advantage over the more terse C style.

ACOS
Amdahl
Apollo
AN/UYK
Burroughs
CDC
Cray
Data General
DEC
FACOM
GEC
HP
HITAC
Honeywell
IBM
Intel
Interdata
Modcomp
Multics
NCR
Perkin-Elmer
Prime
Rolm
SEL
Tandem
Univac
Wang
Xerox
Machines running CP/M
Machines running MS-DOS
Machines running Unix

Table 3: *A partial list of manufacturers on whose machines the Software Tools package has been implemented to varying degrees of sophistication.*

ment of Energy. Since its inception in 1978, the group has become an international body performing the following functions:

- establishing and publishing standards for the primitives and tools and supporting an ongoing standards committee
- collecting and distributing information on current developments to avoid duplication of effort
- collecting and evaluating new utilities, extensions, and variants
- holding semiannual meetings in conjunction with the Usenix Unix users group
- publishing a newsletter and software catalog
- distributing tapes containing collections of utilities from different organizations

Much of the tools' source code is now in the public domain and freely distributed. The primitives, however, are generally developed, licensed, and maintained by vendors.

The standardization procedure used by the tools group is unusual. New utilities are collected and distributed early in their development phase, allowing users to experiment with new ideas and reject those that prove unportable or functionally undesirable. Code sharing also allows users and developers to glean ideas from new offerings and incorporate them into their own developments. As ideas are distilled and utilities enhanced or extended, the utilities are redistributed, and those receiving popular support are eventually returned to the tools group. There they pass to the Implementers Committee, which makes final decisions on acceptance and standardization. Thus, standards are always based on ideas or utilities tested and proven by the community rather than on newly designed products or untested ideas.

The sharing of code and feedback from users enables developers of new tools to build on each other's work, creating an environment in which new ideas can be quickly and thoroughly tested. The sharing results in natural selection of useful tools that have been tried and accepted by a large number of users with varying needs on many different systems.

The Present and the Future

Development of the Software Tools is proceeding on two fronts: the basic package is being implemented on new systems, and user interfaces are being extended. The original package provided an environment for effective development of programs and manipulation of textual data and materials. However, the tools approach is applicable to most software projects, including those involving networks, database management, graphics, and word processing. Among the portable packages being developed are experimental shells, statistical analysis systems, electronic-mail systems, screen editors, data-management packages, data-analysis packages, and source-code-maintenance systems. The tools group is actively evaluating suggested enhancements and extending the primitive set to provide as dynamic and creative an environment as possible.

Some hardware manufacturers avoid the Software Tools package because easy portability to a competitor's hardware is obviously bad for business. Increasingly, however, independent companies are marketing specific system implementations of the tools. These firms typically implement the primitives and provide maintenance and upgrade support. The high-level source code (utilities and portable sections of the library) is left unlicensed, so the Software Tools Users Group handles variations, extensions, and standards (a compromise between the need for vendor support and the desire for user control).

The Software Tools package is already running on most minicomputer and mainframe systems, and extensions into the microcomputer world have begun.

Implementing the Tools

Writing programs in a language that is available on many systems is insufficient; you must also define an interface layer that isolates an application program from the details of any particular system. The primitives form the tools' interface layer and are the key to their success. They are the only allowed connection between the tools and the underlying operating system. Porting, or adapting, the tools to a new operating system involves writing the code for the primitives for that new system.

The primitives are more than just a collection of subroutines; they provide a complete environment for the tools. In a sense, they coordinate the "world view" of the tools with the

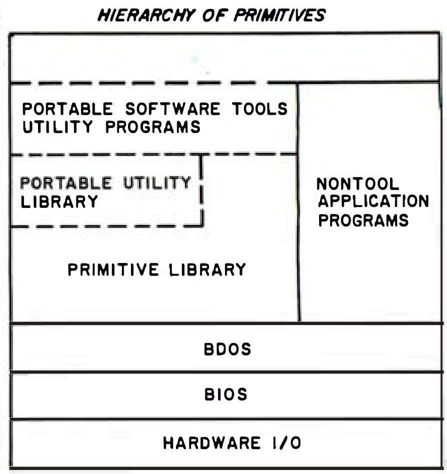

Figure 1: *The hierarchical dependence of interfaces in the CP/M-80 version of the tools. At the CP/M level only the BIOS (basic input/output system) knows how to do direct hardware input and output, and only the BDOS (basic disk operating system) knows how to talk to the BIOS. These clean divisions were the key to the early success in moving CP/M to many different types of hardware. The Software Tools are built in isolated layers in the same way. Note that only the primitive functions know how to talk to the BDOS. The primitives are the communication channel between the portable tools and a specific operating system, such as CP/M or MS-DOS. The tools themselves can use the primitives or the library of utility routines that are also part of the tools package. The clean boundaries between the various interface layers in a system such as this are very important for maintaining clean portable programs. Any time these separations are violated, the resulting program may prove expensive to maintain and difficult to move to new machines.*

world view of the host operating system. The task is simple if the tools and the new system have similar views of the programmer's environment; the task is difficult if the new system has a different view. For example, it took less than a week to write and test the tools' primitives for Unix because Unix's view of the programmer's environment is similar to that of the tools. But implementing the tools' primitives on CP/M and MS-DOS (which are based on very different views) took more than a year.

When implementing the primitives, it is essential to keep in mind the two prime directives: maintain correspondence of file types and

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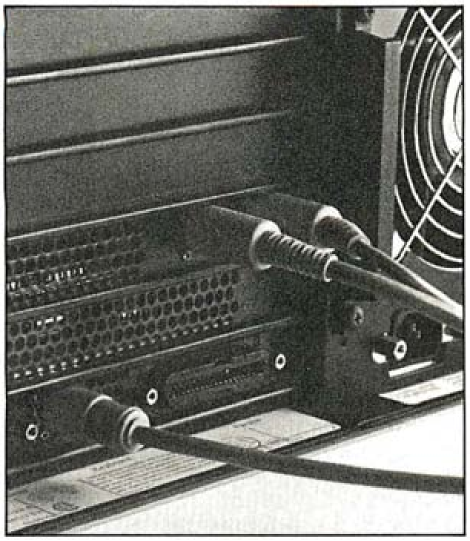

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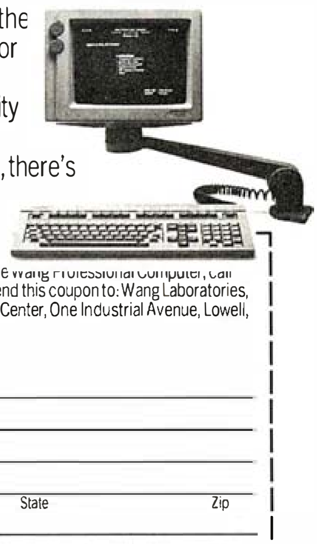

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avoid interfering with or changing the host system. An example of the relationship between the tools and the host system is illustrated in the implementation of the Carousel Toolkits on CP/M (see figure 1).

File and Directory Names

The Software Tools view all I/O operations as actions on named files. As in Unix, use of files from within programs must be as device independent as possible because the program does not know whether the I/O is being done with a terminal, file, or another program. The file to be used is specified when the program is run instead of when it is compiled. When the host provides some sort of directory structure, it should appear to the user as the Unix model of a hierarchical directory structure does. These requirements have effects at both the RATFOR library level and at the tools execution level. For example, some allowed file names with the tools on CP/M are:

data	the file "data" on the current directory
/b/data	the file "data" on drive B in the current user area
/2/a/data	the file "data" in user area 2 on drive A
/tty	the programmer's terminal
/nul	the "bit bucket," a place for unwanted output
/lst	the printer

File names of these forms can be used anywhere a file name is needed. For example, in the tools *open* primitive, the statement

```
fd = open
   ("/0/c/foobar.dat", READWRITE)
```

results in the file /0/c/foobar.dat being opened in a mode allowing random reads and writes. The command

```
diff  /1/b/prog.bas  prog.bas
```

displays the differences between the version of prog.bas on drive B in user area 1 and the version in the current directory. By putting CP/M's user-area number at the higher level in the hierarchy, a programmer can operate within a given area on several drives without specifying the user area. In accordance with the prime directive, a CP/M style of directory naming is also recognized (e.g., 1b:prog.bas). In addition, the temptation to further follow the Unix style and allow user-named subdirectories, as opposed to the hard-wired CP/M user/disk names, was tempered by the prime directive's requirement that all tools files be available on the host system with recognizably similar names.

Memory Allocation and Disk

The tools package includes primitives to dynamically allocate memory areas for temporary use within a program. This feature has proven easy to provide on single-user systems such as CP/M and MS-DOS, where the programmer has access to all memory not occupied by the program or operating system. However, bulk-storage I/O devices, usually floppy disks, are so slow that it is desirable to use as much high-speed memory as possible for a cache of recently used or soon-to-be-used data. These two requirements force the dynamic-storage primitives for CP/M to share the memory with the I/O primitives. This provides the tools with dynamically available storage while using all remaining memory to speed up disk operations.

The Software Tools package also enables a user to quickly access the large collection of the tools' utilities on a small system. Sixty nontrivial tools could easily occupy a large amount of disk space. Unlike integrated programs in which all functions are available to the user within one large complex program, the tools are a collection of single-purpose programs, each of which must be loaded into memory when needed. To provide both fast program load times and small disk-space usage on CP/M, the tools were stored on disk as overlays of each other. Because they all share the common primitives, the primitives need be loaded into memory only once. When a tool program is run, only the part of the program that is different from one tool to

another need be loaded. This has proved effective in reducing disk usage and program load time.

Process Control

The most difficult primitives to implement on single-user microcomputer operating systems are for process control. Unix views the world as process-rich—a place in which processes are created for each command. The single-user CP/M system, on the other hand, supports only one process. To provide a Unix-like environment in this case, the primitives must emulate multiple processes. The only practical way to simulate several parallel processes on a small-memory, floppy-disk-based system is by a sequence of programs that are not executed simultaneously.

Unix enables process creation and program execution by the function pair *fork* and *exec* (see reference 4). Fork creates a clone process and exec overlays the current process with a new program. The most common sequence in Unix is

```
fork - wait - continue
                (in the parent process)
fork - exec - die
                (in the child process)
```

The standard tools package provides a model of this sequence in the *spawn* primitive. Spawn executes a program by creating a child process and allowing the parent to wait for its completion. Because of the relatively slow, low-capacity disk storage available on the CP/M and MS-DOS systems, the spawn primitive has been simulated with a Unix-like exec. Therefore, the portable shell could not be used, and a new shell was written that uses only exec and creates a chain of programs that always end with a new invocation of itself. This new shell can also be used on other systems where process generation is allowed but is restricted or slow.

The spawn mechanism is different from those used by other command-interpreter replacements for CP/M that always expect to reside in memory. The Software Tools utilities are loaded quickly because they use the overlay technique.

Conclusion

The Software Tools package provides the features of Unix when Unix is not desirable, available, or appropriate. The tools incorporate many of the features of Unix: elegance achieved through simplicity of style, consistency of use, modularity, and a common-sense approach to programming tasks. A large and active Software Tools Users Group has brought these tools to most operating systems.

Software Tools packages are available from several sources. A source code for the utilities and specifications for the primitives is available from the Software Tools Users Group for a nominal charge. If you choose to purchase this code, you must write your own primitives, which may be difficult.

You may be able to obtain a complete tools implementation for your system from someone who has already done it for a similar system. The tools group distributes versions for a few minicomputers and mainframe systems. These are provided without support.

You may also purchase specific implementations of the Software Tools from a vendor. If you do so, you should expect a version of the primitives optimized for your system, with continuing support and contact with the Software Tools Users Group. ■

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1. Hall, Dennis, Deborah Scherrer, and Joe Sventek. "A Virtual Operating System," Communication of the Association of Computing Machinery, volume 23, number 9, pages 495–502.
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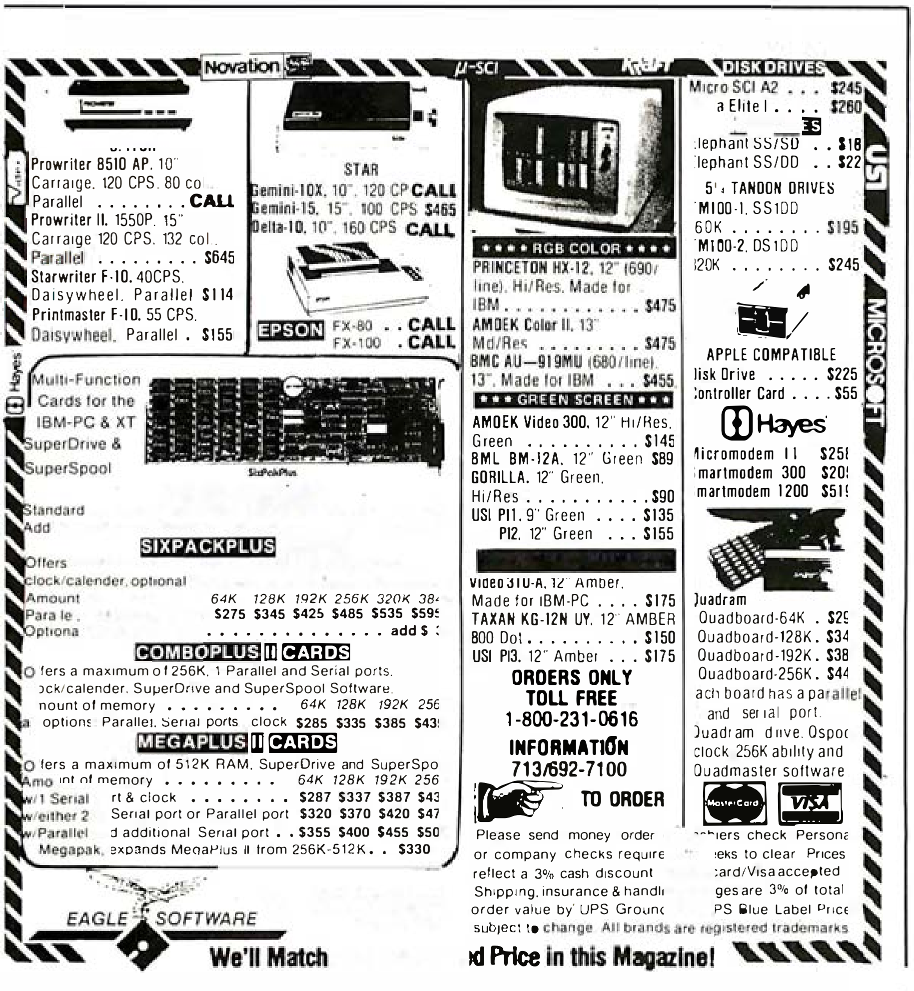
3. Kernighan, Brian W., and P. J. Plauger, Software Tools. North Reading, MA: Addison-Wesley, 1976.
4. The Bell System Technical Journal, volume 57, number 6, part 2 (July–August 1978).

Deborah K. Scherrer, Philip H. Scherrer, Thomas H. Strong, and Samuel J. Penny can be reached at Carousel Microtools, Inc., 609 Kearney St., El Cerrito, CA 94530.



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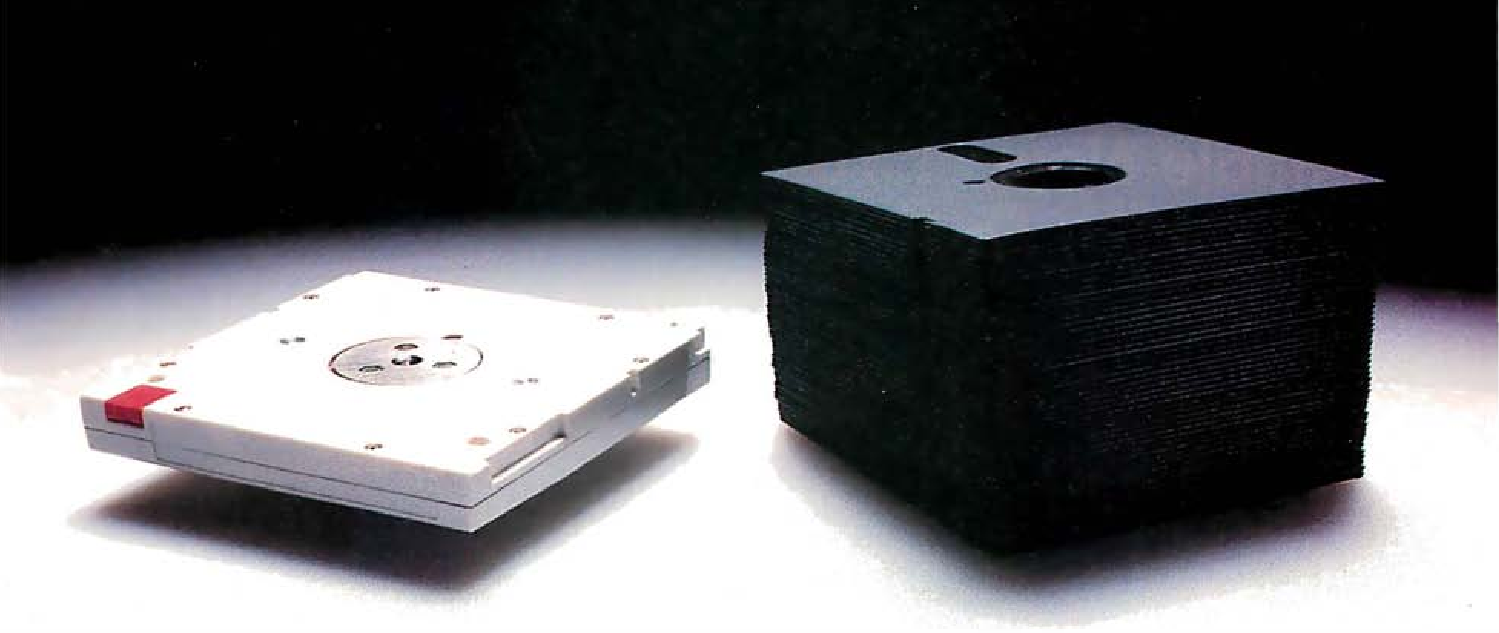

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Settling Time	15 milliseconds	
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Depth	16.5"	16.5"
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Double the Apple II's Color Choices

By understanding how the Apple II generates color, you can extend the number of colors available in high- and low-resolution modes

by Robert H. Sturges Jr.

"That's a great Pac-Man program!" Mark said, finally ready to call it quits after his fifth game page, as I sat amazed at the skill he demonstrated using my new joystick. "But it's too bad it doesn't have all the computer's original colors."

"That's true; four colors is all you get in the Apple's hi-res mode," I replied. Then we began musing over how we could solve the problem.

A software "painting" package, we knew, could provide a wide selection of colors but at the expense of resolution. Such a program would alternate the four Apple colors (green, violet, blue, and orange) plus white or black, yet reduce the number of pixels (individual colored dots or picture elements) by a factor of 2, 4, or more. This approach would provide graphics resolution somewhere between Apple's low- and high-resolution modes.

Color selection can also be improved through hardware; peripheral cards provide a wide range of color, graphics, and animation capabilities (see "High-Resolution Sprite-Oriented Color Graphics," by Steve Ciarcia, August 1982 BYTE, page 57). The hardware approach to solving the problem, however, requires machine- or assembly-language programming and does not employ the usual Applesoft BASIC instructions.

"I can see the advantage of all these methods," Mark said, settling back on the couch, "but none of them provides full high-resolution color or allows me to write HCOLOR=13 in a BASIC program."

Our discussion led me to think about how the Apple produces color and the way color monitors (or televisions) work. Theories on both have been covered many times (see "More Colors for Your Apple," by Allen Watson III, June 1979 BYTE, page 60), so I'll only mention the key points to understanding how I doubled the size of the Apple palette.

Phase Shift = Position = Color

To understand how the Apple II uses color, consult figure 1, which represents the spectrum of a color monitor. Only the more basic colors (the primaries and a few close derivatives) are shown for several reasons. The saturation of the colors and their intensity is normally determined by a signal not present in the Apple video output: the color subcarrier. By sending out a string of sharply rising pulses and the 3.58-MHz color references, the monitor reacts as if a constant-amplitude subcarrier were present. Thus, in low-res mode, many colors can be created.

The basic colors themselves, however, are determined in a more subtle way: the relationship between the position of a dot and the 3.58-MHz reference that is a part of every horizontal scan determines the hue. The reference signal can be pictured as a sine wave stretching from the left to the right edge of the usable screen area (see figure 2), with 140 cycles. Each cycle (a peak and a valley) corresponds to 360 degrees of the color wheel, and the tint setting on the monitor controls the wheel's rotation.

To illustrate, let's say that 0 degrees corresponds to violet and 180 degrees to green. If we start from the left edge and place a dot there, that dot would appear violet. If we instead place the dot one-half cycle to the right of that point (at 180 degrees), it would appear green. Similarly, a dot located one-quarter cycle away from the green dot's position would appear blue at 90 degrees and orange at 270 degrees.

Because the saturation or intensity of the color signal in the hi-res mode

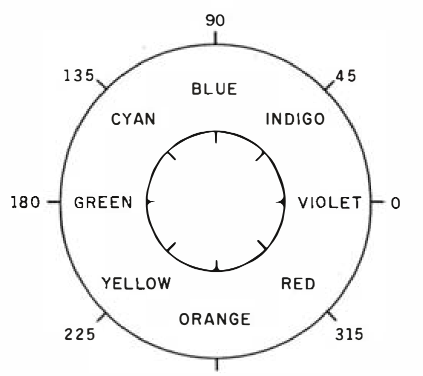

Figure 1: *The Apple II's color monitor responds to the phase shift of the color subcarrier.*

cannot be controlled, only these four colors are usable. White is just a pair of dots side by side that cover half of the 360-degree cycle. Most monitors do not discriminate this signal as any color.

What HCOLOR Does

When Applesoft encounters an HPLOT statement, which places a dot or draws a line of color on the hi-res graphics screen, it determines which horizontal position should be used based on the current HCOLOR= value. (The HCOLOR statement is used to select a color.) For example, HCOLOR=1 forces all dots making up a line to go to odd-numbered *x*-coordinates, and the line appears green. Note that any colored line must alternate on and off dots because adjacent dots appear white. HCOLOR=2 causes the dots of the same line to plot in even-numbered positions, producing violet. On revision 1 and more recently released Apple II boards, an additional 90-degree phase shift is possible, corresponding to the HCOLOR=4 through HCOLOR=7 values. When these values are encountered, the dot pattern is shifted to the right by half a dot position. This shift is accomplished automatically in hardware whenever the high-order bit of a color byte is set (see figure 3).

As the *Apple II Reference Manual* (Cupertino, CA: Apple Computer Inc., 1979) explains, each color byte (7 bits in a row) can be either green, violet, orange, or blue, with white or black mixed in. This choice restriction is based on the way color data is converted into a video signal.

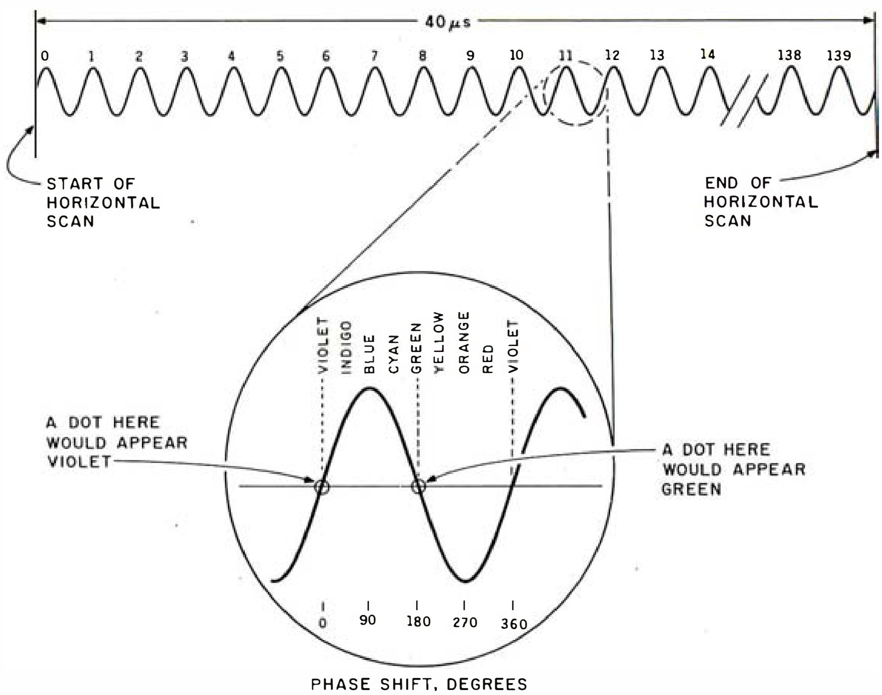

Figure 2: *A representation of the phase relationship of a pixel.*

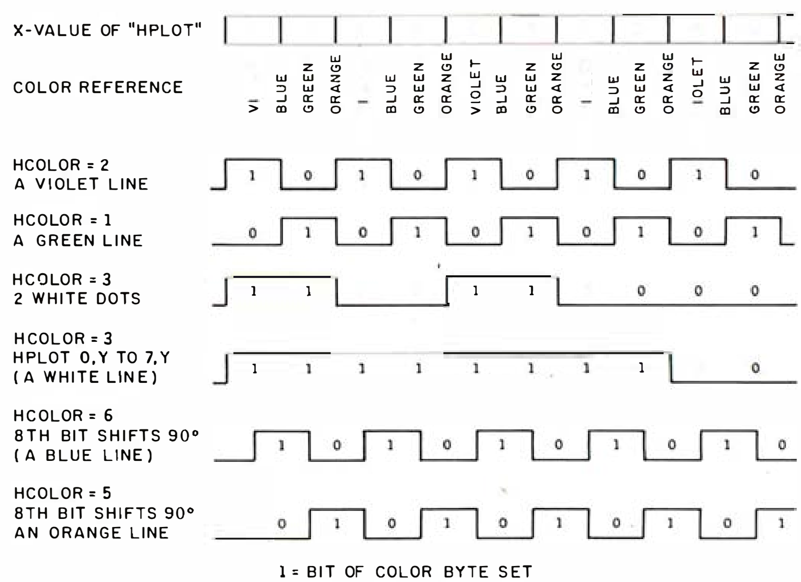

Figure 3: *The hi-res bit patterns for various HCOLOR= values.*

From Data to Video Signal

A byte of data from either hi-res screen area appears on the Apple's data bus during the low-transition of the phase-0 clock (see figure 4). During this time, the computer's 6502 microprocessor is performing internal housekeeping chores, and a section of logic is busy refreshing the memory and ensuring that the data appears on the bus at the right time. The data is latched by the row address select ($\overline{RAS}$) line and loaded into a pair of shift registers at board locations B4 and B9. The signal used to load the data byte is labeled LD194; it originates in the timing chain. The data bits are shifted out one by one on every 7-MHz clock pulse into the multiplexer at A9 and finally through the latch at B10. This latch uses the 14-MHz clock to "trim up" the timing of the data bits. At the base of Q3, the video stream is mixed with a horizontal synchronization pulse and the 3.58-MHz color reference.

The high-order bit of each color byte is treated somewhat differently from the other bits in order to effect the phase shift of the data byte. In hi-res mode, this bit controls the appearance of data at the output of the multiplexer at A9 and delays the bit stream by one cycle of the 14-MHz

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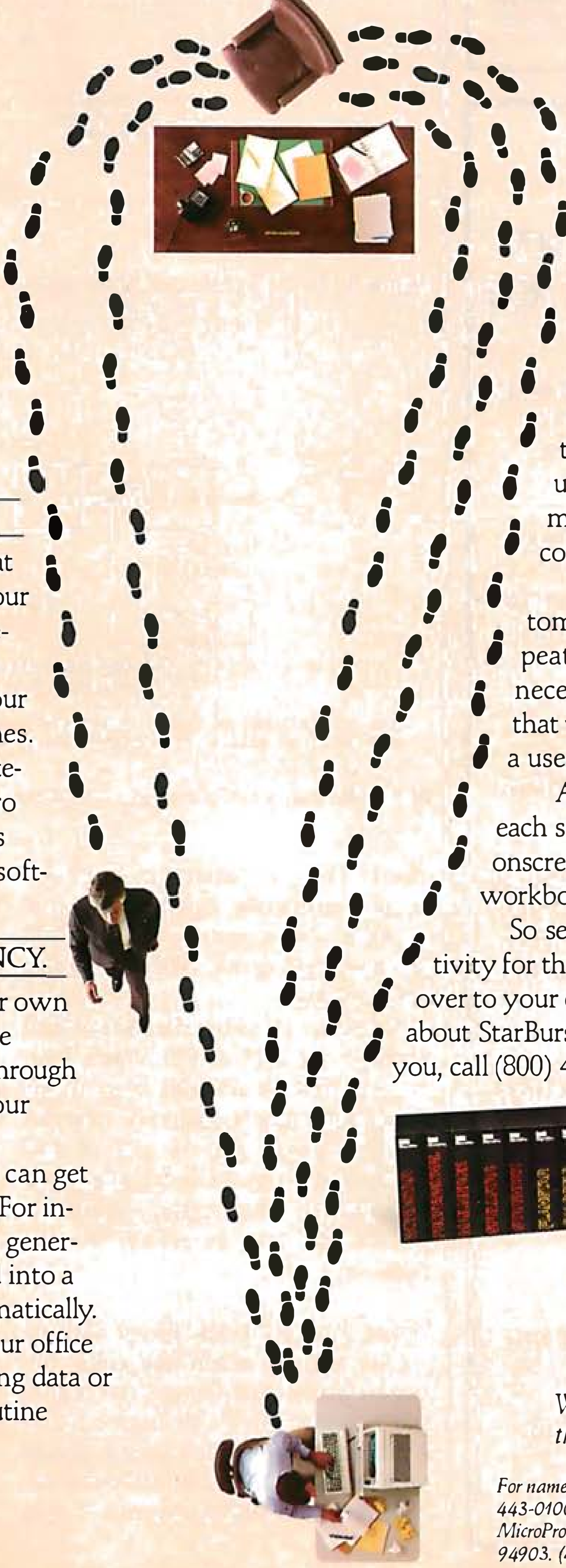

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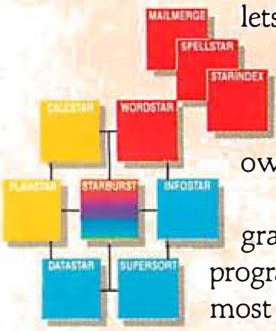

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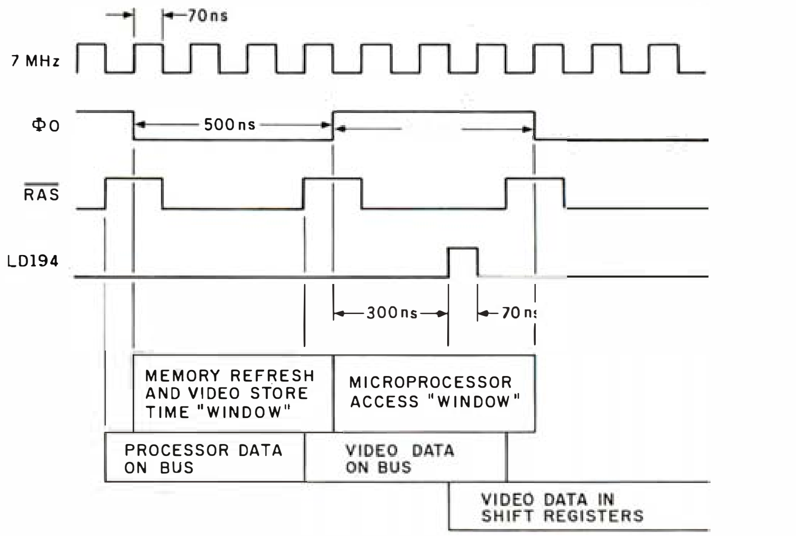

Figure 4: *Timing signals used by the Apple II to interleave video data and processor data.*

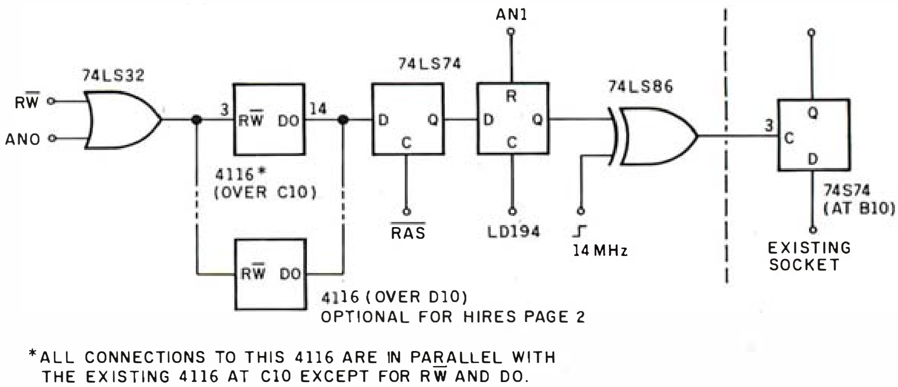

Figure 5: *Logic for introducing a programmable 45-degree phase shift.*

clock. Thus, a pattern of dots that would ordinarily appear green is shifted 90 degrees (about 70 nanoseconds or ns) and instead appears orange.

Note that all video data is clocked through the latch at B10: hi-res, low-res, and text-bit streams. Also, in the black-and-white hi-res mode, you can place a single dot in any of 560 horizontal positions by choosing the HCOLOR= that either shifts or passes the byte in which the bit appears.

More Phase Shifts, More Colors

One way to attain the color between green and orange, for example, is to introduce a 45-degree phase shift into the Apple's video circuit and provide a means to store this extra data bit (to shift 45 degrees or not) with the corresponding hi-res byte. The circuit shown in figure 5 accomplishes this shift and adds four more colors to the hi-res palette: red, yellow, cyan, and indigo. Also, because low-res data passes through the same circuit, 12 distinct new colors are added for use in low-res mode.

Here's how it works: the phase of the 14-MHz clock normally present at pin 3 of the 74LS74 at B10 is now controlled by an exclusive-OR gate. If the clock appears inverted at this point, all signals will be clocked through 35 ns early (45 degrees). Because of variations in the propagation delay of the 74LS194 shift registers, it is necessary to replace the 74LS74 at B10 with the faster 74S74.

The data bits that control the inversion of the 14-MHz clock are stored

Decimal	Hexadecimal	Function
−16293	C05B	enable phase shifting
−16294	C05A	disable phase shifting
−16295	C059	disable ninth-bit access
−16296	C058	enable ninth-bit access

Table 1: *The address references used to control the Color II board.*

in the 4116 device of figure 5. This 16K- by 1-bit RAM (random-access read/write memory) is wired in parallel with the existing 4116 in location C10, except for the $\overline{RW}$ line and the DO line. To the programmer, it appears that a ninth bit has been added to all locations in the lower 16K bytes of the Apple II. The AN0 line is used to control access to the bit through the 74LS32. The output of the RAM is latched by the $\overline{RAS}$ line during memory refresh and stored when the data bits of a graphics byte are being shifted out. The storage time is controlled by the LD194 line and can be inhibited by AN1, effectively turning off the phase shift. Because there is no other access to the data bits by the microprocessor, the 4116 is used as a write-only memory.

Extending the circuit of figure 5 to include hi-res page 2 is easy: another 4116 wired in parallel with the existing one at D10 does the trick. The $\overline{RW}$ and DO lines of both new 4116s are also paralleled; Apple's built-in refresh logic feeds the bit streams to the new phase-shift circuit.

Using the Colors from Applesoft

The screen shown in photo 1 illustrates that all eight colors can be used with no loss of resolution. The tint control is adjusted to put the cyan midway between green and blue. The actual colors that appear depend on your monitor or TV and its brightness and contrast settings.

The four memory locations that refer to the AN0 and AN1 switches are shown in table 1. A reference to location −16293 allows the phase shift of the 14-MHz clock to be controlled by data in the added memory. A POKE or PEEK to −16294 restores normal four-color operation,

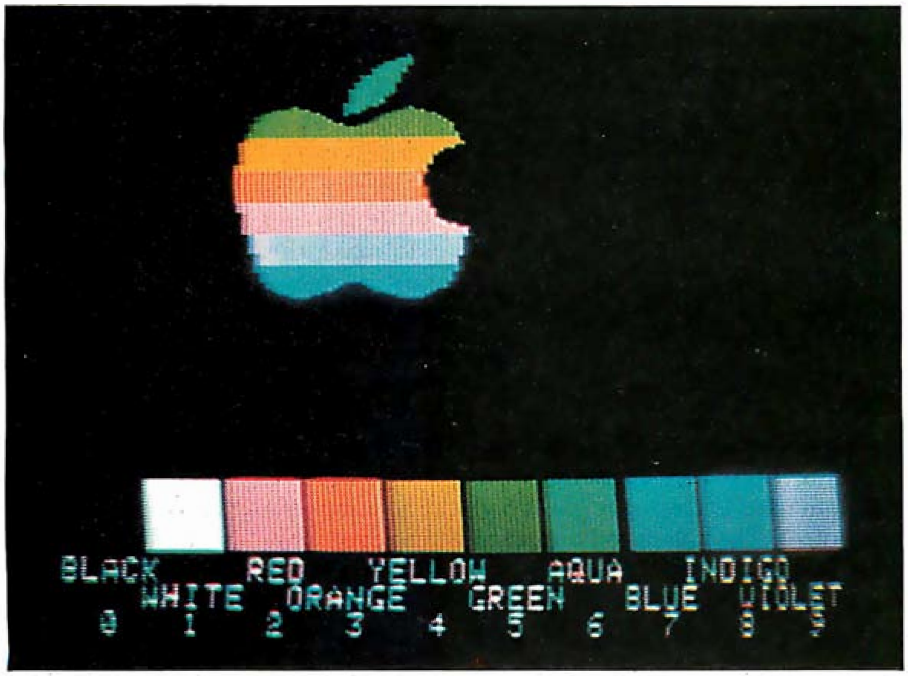

Photo 1: *The Apple Computer Inc. logo displayed with the colors of the expanded hi-res palette.*

Desired Color		Enabled Color		Disabled Color	
HCOLOUR =	Name	HCOLOR =	Name	HCOLOR =	Name
0	black1	0	black1	0	black1
1	green	1	green	1	green
2	violet	2	violet	2	violet
3	white1	3	white1	3	white1
4	black2	0	black1	4	black2
5	orange	1	green	5	orange
6	blue	2	violet	6	blue
7	white2	3	white1	7	white2
8	black3	4	black2	0	black1
9	cyan	5	orange	1	green
10	red	6	blue	2	violet
11	white3	7	white2	3	white1
12	black4	4	black2	4	black2
13	yellow	5	orange	5	orange
14	indigo	6	blue	6	blue
15	white4	7	white2	7	white2

Table 2: *The hi-res key color sequence table.*

Listing 1: *This program was used to produce the lower half of photo 1.*

```
10  HOME
20  POKE  - 16293,0: POKE  - 16296,0: HGR : POKE  - 16295,0
30 Y = 138:L = 28:H = 20 + Y
40  FOR X = 1 TO L - 2
50  HCOLOR= 3
60  HPLOT X,Y TO X,H
70  POKE  - 16296,0
80  HCOLOR= 4
90  HPLOT X + 2 * L,Y TO X + 2 * L,H
100  POKE  - 16295,0
110  HCOLOR= 2
120  HPLOT X + 2 * L,Y TO X + 2 * L,H
130  HCOLOR= 5
140  HPLOT X + 3 * L,Y TO X + 3 * L,H
150  POKE  - 16296,0
160  HPLOT X + 4 * L,Y TO X + 4 * L,H
170  HCOLOR= 1
180  HPLOT X + 5 * L,Y TO X + 5 * L,H
190  POKE  - 16296,0
200  HCOLOR= 4
210  HPLOT X + 6 * L,Y TO X + 6 * L,H
220  HCOLOR= 1
230  POKE  - 16295,0
240  HPLOT X + 6 * L,Y TO X + 6 * L,H
250  HCOLOR= 6
260  HPLOT X + 7 * L,Y TO X + 7 * L,H
270  POKE  - 16296,0
280  HPLOT X + 8 * L,Y TO X + 8 * L,H
290  HCOLOR= 2
300  HPLOT X + 9 * L,Y TO X + 9 * L,H
310  POKE  - 16295,0
320  NEXT
330  VTAB (21): PRINT "WHITE    RED   YELLOW   CYAN   INDIGO"
340  VTAB (22): PRINT "    BLACK  ORANGE   GREEN   BLUE  VIOLET"
350  VTAB (1): END
```

regardless of the data stored in the new ninth-bit locations. Access to the new bit is possible after a reference to −16296: all data written to the eighth bit of a byte will be copied into the ninth bit. If the eighth and ninth bits are to be different, a POKE or PEEK to −16295 is needed to disable access to the new bit. Then the eighth bit can be set as desired.

Listing 1 provides the segment of program used to create the lower half of photo 1. The colors red and cyan require each HPLOT to be executed twice: once to set the ninth bit to 1, and again to set the eighth bit to 0. Table 2 shows a useful set of key colors that, when used in sequence, create the extended hi-res color set from Applesoft. To plot in a particular color, plot the "enabled" color first, then the "disabled" color in the same location. To prepare a screen image for BSAVE command (saving a binary image on disk), plot all the enabled colors on one hi-res screen and all the "disabled" colors on the other. The screens can then be combined to yield the full-color image through the following procedure:

1. Disable the extended color features with the statements POKE −16294,0 and POKE −16295,0 (which place the value 0 to hexadecimal memory locations C05A and C059, respectively).
2. Plot your data, substituting the enabled colors for the desired colors. Plotting can be done with Applesoft, the Programmer's Aid in Integer BASIC, or any commercial software graphics package.
3. Use the BSAVE command to save the image, calling it IMAGE1.
4. Clear the screen and plot your data again, using the disabled colors in place of the desired colors.
5. Use BSAVE to save this image under another name; for example, IMAGE2.
6. Combine the images by using the statements POKE −16293,0 and POKE −16296,0 and then retrieving IMAGE1 with the BLOAD command. Then use POKE −16295,0 and the BLOAD command to load IMAGE2 into the *same* space.

Implementing HCOLOR = 13

To make the use of table 2 more transparent and simplify the BSAVE process, a preprocessor can be used to interpret otherwise innocuous Applesoft statements as special functions. Listing 2 was prepared to produce the same results after preprocessing as listing 1 does. When run as is, it causes all the colored squares to appear white. Note that in listing 2 HCOLOR = is spelled differently—HCOLOUR = —except for its first appearance. Applesoft will ignore HCOLOUR = as a keyword and recognize it as the variable HC. The

preprocessor uses the variable HC to set the HCOLOR= values needed to satisfy table 2's color sequence. All statements involving HPLOT, DRAW, and XDRAW are duplicated, POKE statements are added to enable and disable the phase shifts, and the correct HCOLOR= values are inserted. Because these keywords are recognized by the preprocessor anywhere in the source program, conditional plotting in an IF statement is supported, but a remark statement that carries a keyword can produce strange results.

After preprocessing, the new program can be run, listed, and otherwise used as desired. It can even be compiled to improve its running time. For long programs, be careful to avoid overwriting the hi-res memory areas. Listing 3 shows the results of preprocessing the program of listing 2.

Preparing a screen for a BSAVE command is also supported by the preprocessor. To invoke this feature, a digit from 1 to 5 is appended to the name of the source program. The enabled colors are stored in memory according to table 3 and the disabled colors are on the hi-res screen (1 or 2) specified by the source program. After running the preprocessed program and storing the images with BSAVE, the full-color screen can be recreated as outlined in step 6 above.

Listing 2: *Listing code ready for preprocessing.*

```
10  HOME
20  POKE  - 16293,0: POKE  - 16296,0: HGR : POKE  - 16295,0
30 Y = 138:L = 28:H = 20 + Y: HCOLOR= 3
40  FOR X = 1 TO L - 2
50  READ HCOLOUR
60  HPLOT X,Y TO X,H
70  FOR K = 2 TO 9
80  READ HCOLOUR
90  HPLOT X + K * L,Y TO X + K * L,H
100  NEXT
110  RESTORE
120  NEXT
130  VTAB (21): PRINT "WHITE    RED   YELLOW   CYAN   INDIGO"
140  VTAB (22): PRINT "    BLACK  ORANGE   GREEN   BLUE  VIOLET"
150  VTAB (1): END
160  DATA  3,10,5,13,1,9,6,14,2
```

Listing 3: *The results of preprocessing on listing 2.*

```
10  HOME
20  POKE  - 16293,0: POKE  - 16296,0: HGR : POKE  - 16295,0
30 Y = 138:L = 28:H = 20 + Y
40  FOR X = 1 TO L - 2
50  READ HCOLOUR
60  GOSUB 63004
70  FOR K = 2 TO 9
80  READ HCOLOUR
90  GOSUB 63006
100  NEXT
110  RESTORE
120  NEXT
130  VTAB (21): PRINT "WHITE    RED   YELLOW   CYAN   INDIGO"
140  VTAB (22): PRINT "    BLACK  ORANGE   GREEN   BLUE  VIOLET"
150  VTAB (1): END
160  DATA  3,10,5,13,1,9,6,14,2
63001  END
63002  POKE  - 16296,0: HCOLOR= 4 * (HC > 7): RETURN
63003  POKE  - 16295,0: HCOLOR= HC - 8 * (HC > 7): RETURN
63004  GOSUB 63002: HPLOT X,Y TO X,H: GOSUB 63003: HPLOT X,Y TO X,H
63005  RETURN
63006  GOSUB 63002: HPLOT X + K * L,Y TO X + K * L,H: GOSUB 63003: HPLOT X + K *
 L,Y TO X + K * L,H
63007  RETURN
```

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Last Character of Name	Hexadecimal Address of Picture
1	2000 - 3FFF
2	4000 - 5FFF
3	6000 - 7FFF
4	8000 - 9FFF
5	A000 - BFFF

Table 3: *Preprocessor BSAVE locations. (Note: Specify 4 or 5 with caution; this will overwrite the DOS.)*

The preprocessor is written in Applesoft and consists of three passes. Listing 4 shows Pass 1, which requests from the user the name of the Applesoft source program, which is then captured in a text file. Pass 1 invokes Pass 2 (listing 5), which creates a modified version of the source program and appends ".PP" to the name. Pass 3 is then invoked to delete the temporary files needed for the processing (listing 6). The text screen displays each function of the preprocessor as it occurs. The hi-res pages can be written over during processing, but DOS and memory errors are not trapped. A single disk-drive environment is assumed.

Conclusion

Doubling the available low-res colors involves the same POKE statements listed in table 1, and the two-step plotting process is similar. To select a new phase-shifted color, use the statement POKE −16296,0 to enable the color hardware, then plot any color from 8 to 15 (high-bit set). Next, disable the color hardware with POKE −16295,0 and plot the color according to table 4. Because the low-res mode treats a single byte as two color nibbles (half-bytes) and only one "extra" bit exists per byte, both nibbles are either shifted or unshifted in color. Photo 2 shows the 32 addressable low-res colors.

Another use for hi-res phase shifting is to double the number of horizontal dot locations in black-and-white plots. A total of 1120 horizontal positions become addressable, subject to the restriction that any phase shift applies to a full byte. The left half of photo 3 was plotted by invok-

Text continued on page 463

Listing 4: *Pass 1 of the preprocessor.*

```
10  REM  PASS1
20 D$ =  CHR$ (4)
30  HOME : INVERSE : PRINT "   COLOR " +  CHR$ (93) +  CHR$ (91) + " PRE-PROCESS
OR READY   "
40  NORMAL
50  INPUT "PLEASE ENTER PROGRAM NAME ";A$
60  VTAB (2): PRINT "CAPTURING FILE ";A$; SPC( 25)
70  PRINT : PRINT : POKE 34,3
80  REM  CREATE A TEXT FILE (PASS1.EXEC) WHICH WILL CAPTURE THE
90  REM NAMED  FILE FROM BASIC INTO A TEXT FILE
100  PRINT D$"OPEN  PASS1.EXEC"
110  PRINT D$"WRITE PASS1.EXEC"
120  PRINT "LOAD "A$: REM  GET IT INTO MEMORY
130  PRINT "LIST": REM  PU  IT ON THE SCREEN
140  REM  ADD THE 'CAPTURING' STATEMENTS
150  PRINT "1 PRINT CHR$(4)" +  CHR$ (34) + "OPEN" + A$ + ".TEXT" +  CHR$ (34)
160  PRINT "2 PRINT CHR$(4)" +  CHR$ (34) + "DELETE" + A$ + ".TEXT" +  CHR$ (34)

170  PRINT "3 PRINT CHR$(4)" +  CHR$ (34) + "OPEN" + A$ + ".TEXT" +  CHR$ (34)
180  PRINT "4 PRIN  CHR$(4)" +  CHR$ (34) + "WRITE" + A$ + ".TEXT" +  CHR$ (34)
190  PRIN  "5 POKE33,30"
200  PRINT "6 LIST 10,"
210  PRINT "7  PRINT CHR$(4)" +  CHR$ (34) + "CLOSE" + A$ + ".TEXT" +  CHR$ (34)

220  PRINT "8 POKE 33,39:END"
230  PRINT "63999 REM LAST STATEMENT": REM JUST IN CASE IT WASN'T INCLUDED
240  PRINT "RUN": REM  START THE CAPTURING PROCESS
250  PRINT "RUN PASS2": REM  LINK TO THE NEXT PASS
260  PRINT A$: REM  PASS THE PROGRAM NAME
270  PRINT D$"CLOSE PASS1.EXEC"
280  PRINT D$"EXEC PASS1.EXEC": REM  NOW GO DO IT, ALREADY
```

Listing 5: *Pass 2 of the preprocessor.*

```
10  REM  PASS2 - PRE-PROCESSOR
20  DIM ST$(100): REM  ALLOW UP TO 100 'HPLOT' STATEMENTS
30 O1$ = "GOSUB63002:"
40 O2$ = ":GOSUB63003:"
50 D$ =  CHR$ (4):T$ =  CHR$ (1):EN$ = "63999":R$ =  CHR$ (13):RT$ = ":RETURN"
60  INPUT "LOAD FILE ";A$: REM  MAGIC TRICK - PASS1 EXEC SUPPLIES THIS DATA
70  REM  CHECK FOR BSAVE PAGE#
80 SW$ =  RIGHT$ (A$,1): REM  GET LAST CHAR OF NAME
90 SW = 0: REM  RESET THE SWITCH
100  IF SW$ > "0" AND SW$ < "6" THEN SW = 1: REM  SET THE SWITCH
110  POKE 34,0: VTAB (2): PRINT "SCANNING FILE ";A$;".TEXT"
120  PRINT : PRINT : POKE 34,3
130  PRINT D$"OPEN"A$".TEXT"
140  PRINT D$"READ"A$".TEXT"
150 S$ = "": REM  START OF GET-LOOP
160  GET B$: IF B$ <  > R$ THEN S$ = S$ + B$: GOTO 160
170  PRINT T$S$: IF  LEN (S$) = 0 THEN 150
180  IF  LEFT$ (S$,5) = EN$ THEN 320: REM  ALL DONE WITH INPUT
190  REM   SCAN FOR "H" - A PRELIMINARY LOOK
200 LN =  LEN (S$) - 5:I = 2: REM  MAX SCAN RANGE
210 MS$ =  MID$ (S$,I,1)
220  IF MS$ = "H" OR MS$ = "X" OR MS$ = "D" THEN 250
230 I = I + 1: IF I = LN THEN 150
240  GOTO 210
250  REM  GOT ONE; IS IT "HPLOT"
260 MS$ =  MID$ (S$,I,5)
270  IF MS$ = "HPLOT" OR MS$ = "XDRAW" OR MS$ = "DRAW " THEN 290
280  GOTO 150
290  REM  YES, IT'S AN HPLOT
300 K = K + 1:ST$(K) = S$
310  IF K < 100 THEN 150
320  PRINT D$"CLOSE"A$".TEXT"
330  POKE 34,0: VTAB (2): PRINT "ANALYZING FILE ";A$;".TEXT            "
340  PRINT : PRINT : POKE 34,3
350  REM  CREATE THE PRE-PROCESSED PROGRAM IN A TEXT FILE
360  PRINT D$"OPEN  OUT.TEXT"
370  PRINT D$"WRITE OUT.TEXT"
380  PRINT : PRINT "LOAD" + A$
390 KMAX = K:K = 0:GSN = 3003
400  REM  'GSN' IS A GENERATED STATEMENT NUMBER
410  PRINT "63001 END": REM  JUST TO BE SURE
412  PRINT "63002 POKE-16296,0:HCOLOR=4*(HC>7):RETURN"
414  PRINT "63003 POKE  - 16295,0: HCOLOR= HC - 8 * (HC > 7): RETURN"
420 K = K + 1: IF K > KMAX THEN 650
430 S$ = ST$(K):I = 2:LS =  LEN (S$)
440 I = I + 1: IF I > LS THEN  PRINT S$: GOTO 420: REM  DONE WITH THIS STATEMENT
```

Listing 5 continued on page 460

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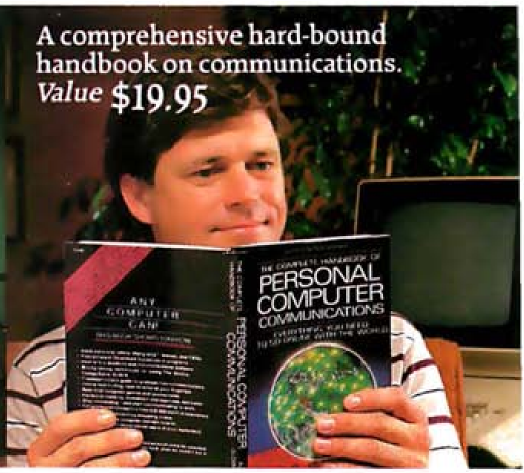

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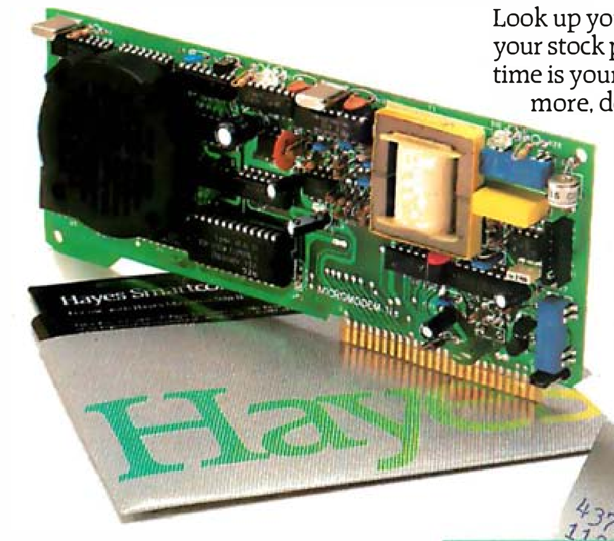

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Listing 5 continued:

```
450 MS$ =  MID$ (S$,I,1)
460  IF MS$ = "H" OR MS$ = "X" OR MS$ = "D" THEN 480
470  GOTO 440
480 MS$ =  MID$ (S$,I,5)
490  IF MS$ = "HPLOT" OR MS$ = "XDRAW" OR MS$ = "DRAW " THEN 510
500  GOTO 440
510  REM  GOT IT, NOW SCAN FOR ":" OR END
520 J = I + 5:GSN = GSN + 1
530 J = J + 1: IF J > LS THEN 550
540  IF  MID$ (S$,J,1) <  > ":" THEN 530
550 LH = J - I:H$ =  MID$ (S$,I,LH): REM  H$=THE HPLOT SEGMENT
560 TAIL$ = "": IF J < LS THEN TAIL$ =  MID$ (S$,J)
570 S$ =  LEFT$ (S$,I - 1) + "GOSUB6" +  STR$ (GSN) + TAIL$:LS =  LEN (S$)
580 LT = LH + LH + 74: REM  LENGTH OF THE NEW STRING
590  IF LT < 239 THEN OUT$ = "6" +  STR$ (GSN) + O1$ + H$ + O2$ + H$: PRINT OUT$
: GOTO 620
600  REM IF H$ IS TOO BIG WE WILL NEED MORE THAN ONE LINE
610  IF LT > 238 THEN OUT$ = "6" +  STR$ (GSN) + O1$ + H$: PRINT OUT$:GSN = GSN
+ 1:OUT$ = "6" +  STR$ (GSN) + O2$ + H$: PRINT OUT$
620  IF SW = 0 THEN GSN = GSN + 1:OUT$ = "6" +  STR$ (GSN) + "RETURN": PRINT OUT
$:I = I + 10: GOTO 440
630  REM  EXERCISE BSAVE OPTION
640 GSN = GSN + 1:OUT$ = "6" +  STR$ (GSN) + "POKE 8,PEEK(230):POKE 230," +  STR
$ (32 *  VAL (SW$)) + ":HCOLOR=4*(HC>7):" + H$ + ":POKE230,PEEK(8)" + RT$: PRINT
OUT$:I = I + 10: GOTO 440
650  REM  NORMAL EXIT
660  PRINT "LIST"
670  PRINT "SAVE" + A$ + ".PP"
680  PRINT "DELETE" + A$ + ".TEXT"
690  PRINT "RUN PASS3": REM  LINK TO LAST PASS
700  PRINT D$"CLOSE OUT.TEXT"
710  POKE 34,0: VTAB (2): PRINT "CREATING FILE " + A$ + ".PP            "
720  PRINT : PRINT : POKE 34,3
730  REM  THERE'S A HIDDEN CNTRL-D IN THE NEXT STATEMENT
740  PRINT "EXEC OUT.TEXT"
```

Listing 6: *Pass 3 of the preprocessor.*

```
10  REM  PASS3 - CLEAN UP UNNEEDED FILES
20 D$ =  CHR$ (4)
30  PRINT D$"DELETE OUT.TEXT"
40  PRINT D$"DELETE PASS1.EXEC"
50  POKE 34,0: HOME
60  PRINT "PROCESSING COMPLETE"
70  PRINT D$"CATALOG"
80  NEW
```

Color Number	Normal Color	Shifted Color
0	black	black
1	magenta	red
2	dark blue	blue-violet
3	violet	rose
4	dark green	steel blue
5	gray	blue gray
6	medium blue	violet blue
7	light blue	red violet
8	brown	forest green
9	orange	tan
10	gray	red gray
11	pink	orange yellow
12	kelly green	medium green
13	yellow	light green
14	aqua	sky blue
15	white	white

Table 4: *The extended palette of low-res colors.*

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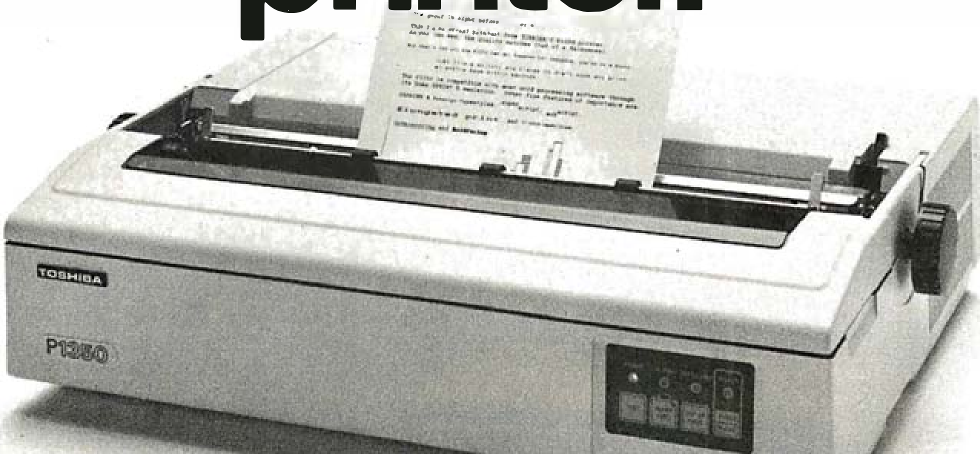

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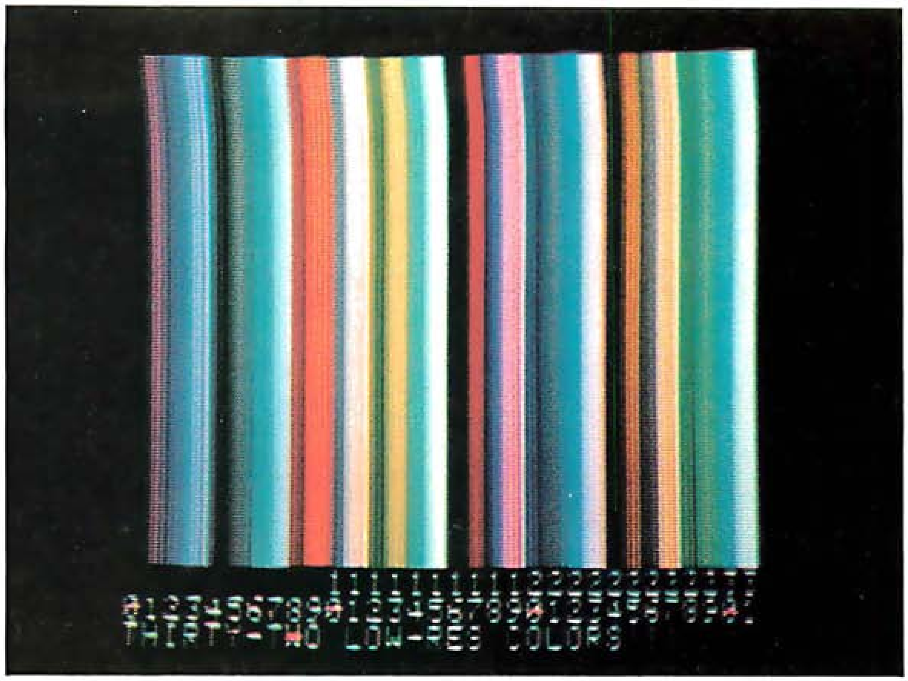

Photo 2: *The 32 addressable low-res colors.*

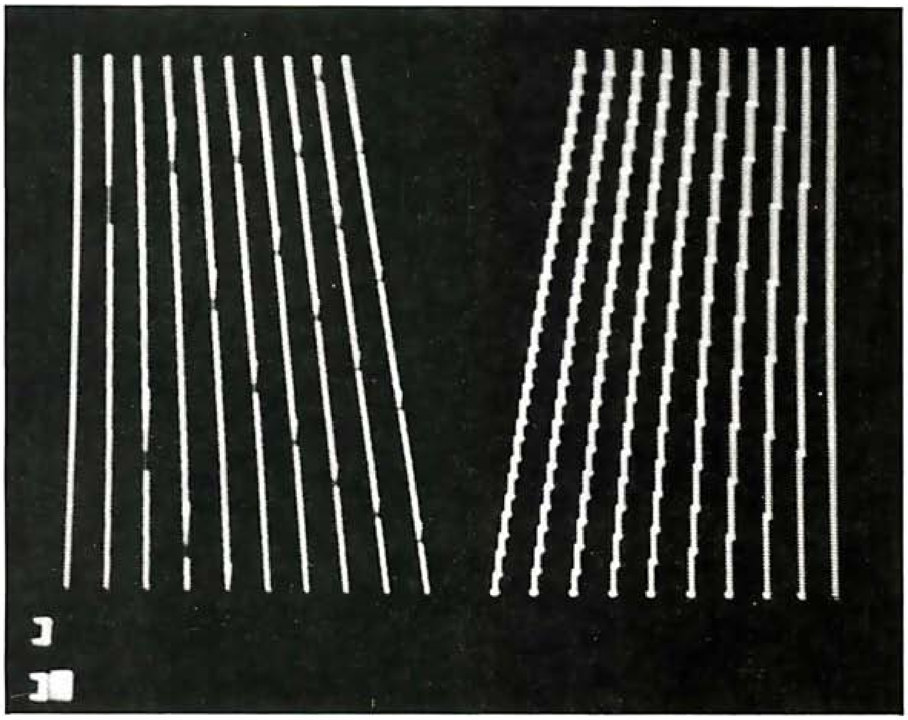

Photo 3: *A black-and-white example, created using phase-shifted plotting. The left side was drawn using selected HCOLOUR= values; the right half was plotted with the standard HCOLOR=3 (white).*

Text continued from page 458

ing the appropriate colors to smooth out the lines; the right half was plotted using the usual HCOLOR=3 (white).

Writing a Pac-Man game in all the original colors is now a little closer to reality, but it will have to wait. What we really need is an eight-color hi-res screen dump for one of those new color printers. . . . ■

Robert H. Sturges Jr. (134 Markham Dr., Mt. Lebanon, PA 15228) is a senior engineer at Westinghouse Electric Corp.

To receive a 5¼-inch disk with the source code for the preprocessor described in this article and 12 demonstration programs, send $14.95 to Robert H. Sturges Jr., POB 83, Oakdale, PA 15071.

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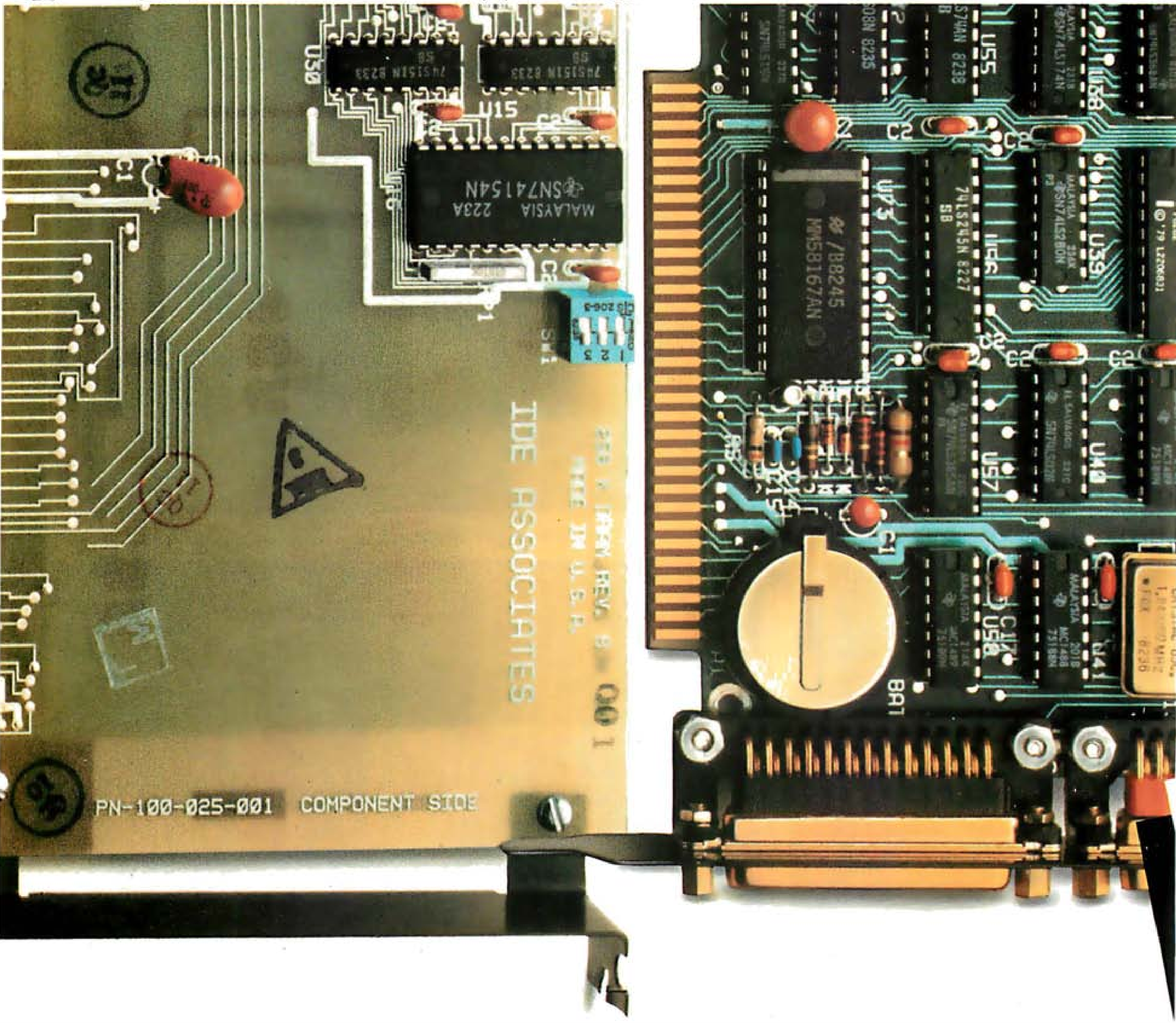

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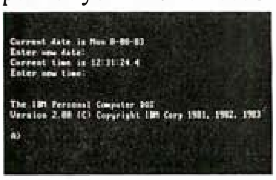

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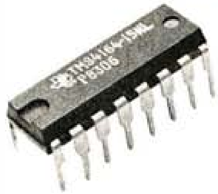

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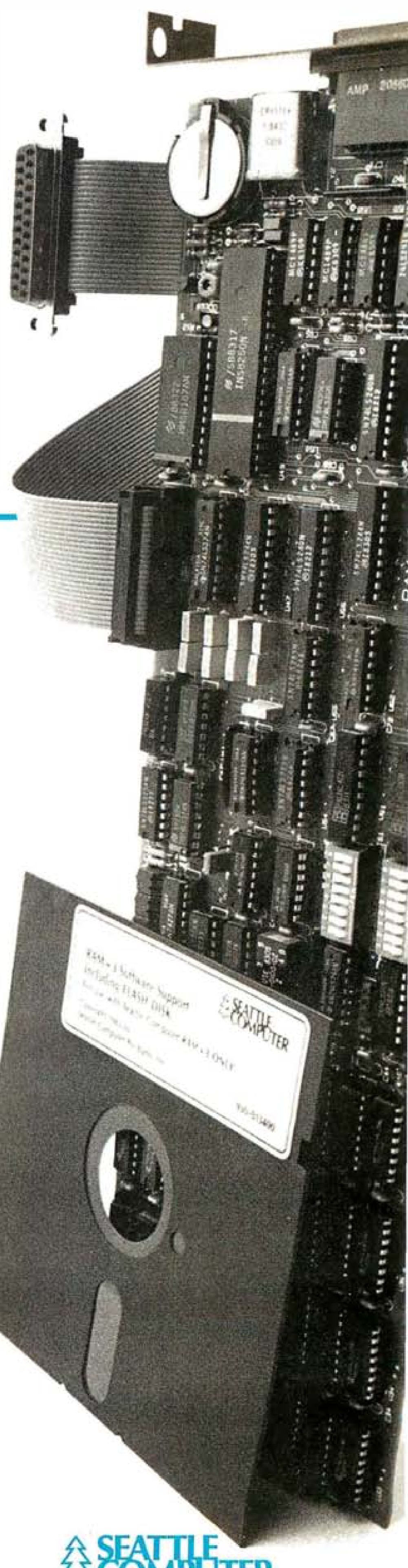

SEATTLE COMPUTER

Seattle Computer Products, Inc., 1114 Industry Drive, Seattle, WA 98188

Circle 411 on inquiry card.

A Character Editor for the IBM PC

The Font program replaces part of the IBM PC's character set with user-defined symbols

by Raymond A. Diedrichs

Designed to display musical notation on the IBM Personal Computer's screen, a BASIC program called Font lets you substitute custom symbols for a portion of the computer's standard character set. And even if you're not interested in character-set design and manipulation, you might still find this article of interest—Font makes heavy use of softkeys (assignable keys) and softkey trapping, thus demonstrating techniques you can use in a wide variety of programming chores.

Hardware Requirements

Font is designed to run on an IBM Personal Computer (PC) with 64K bytes of RAM (random-access read/write memory), an 80-character by 25-line high-resolution monitor, a color-graphics-monitor adapter, a 5¼-inch disk-drive adapter, and BASICA (the advanced BASIC interpreter); you can, however, modify it to run with less equipment.

Before considering Font's operation in detail, consider how the IBM PC handles character display during normal operation. It features a standard font consisting of 256 characters (listed in reference 1, appendix G), each of which is assigned a code ranging from 0 to 255. The decimal code 65, for example, signifies the capital letter A. The computer displays each character within an 8- by 8-dot box on its screen, and displaying A, for instance, is merely a matter of illuminating specific dots within the box. An integrated circuit called a character generator stores the box patterns for all 256 characters; to display a character, the computer's display electronics looks up that character's code in the character generator and illuminates the corresponding dots on the screen.

The IBM Personal Computer displays 256 standard characters using an on-board character generator.

The computer isn't limited to displaying the patterns stored in the character generator, however. It has two graphics modes—Screen Modes 1 and 2—that allow substitution of custom patterns for the upper 128 standard patterns (the ones above hexadecimal 80). Reference 2 (pages 3 through 6) provides a terse discussion of the substitution mechanics.

Essentially, to substitute your own patterns when the computer is in Screen Mode 1 or 2, you need only write the starting memory location of your custom set of box patterns into the 8088 microprocessor's interrupt vector 1F hexadecimal, located at memory location 125 (decimal). You can think of this vector as a flag variable that the computer tests when it's in a graphics mode and commanded to print a character whose code is greater than 127. If the variable is not 0, the computer assumes that the value is a pointer to the custom pattern table, and it displays the custom pattern rather than the standard one.

In summary, then, redefining characters when using the PC requires placing the computer in a graphics mode, storing the address of a replacement pattern table in interrupt vector 1F hexadecimal, and generating and loading the pattern table that reflects your custom character set.

Font Generation Using Softkeys

When you design a character set, the effort divides into three parts: character design, experimentation with designed characters, and design refinement.

Reflecting this division of effort, Font offers the following functions:

- character editing
- experimental use of characters
- experiment saving
- experiment loading
- character-pattern saving
- character-pattern loading

The first two functions further divide into subfunctions. The character-editing function, for example, includes four subfunctions:

- defining a character as edited
- copying a pattern from some other character
- erasing a character pattern
- aborting the current edited version of a character

The PC's softkeys make programs divided into functions and subfunctions easy to implement and use. The Font user is guided from function to subfunction by means of the softkeys and the softkey menu displayed on the bottom (twenty-fifth) screen line, or menu line. Also, the softkey technique prevents confused users from trying to use features of one function after invoking another function. Only those operations displayed on line 25 can be selected; the computer thus ensures that only appropriate features can be chosen.

Font uses softkeys (both function and cursor) in the trap mode, as opposed to the generate-character-string mode. In the trap mode, each enabled softkey is assigned both a trap subroutine and a menu phrase that's displayed on the screen's menu line. When an enabled softkey is pressed, the assigned subroutine is executed regardless of any other program line that is executing. No INPUT statements are required here, thus eliminating the insatiable prompting "?" and "Redo from start" command.

Lines 1000-1999	Softkey routines
Lines 2000-2999	Character-edit utilities
Lines 3000-3999	General utilities
Lines 4000-4999	Character-pattern load/save
Lines 5000-5999	Character edit
Lines 6000-6999	Character experimentation
Lines 7000-7999	Experiment load/save
Lines 8000-8999	Initialization
Lines 9000-9999	MAIN

Table 1: *Memory assignments for the subroutines in the program shown in listing 1.*

Softkeys in Use

Let's see how Font manipulates softkeys. The program is given in listing 1, and Font's road map is shown in table 1. The table indicates that Font's module MAIN starts at line 9000 of listing 1.

MAIN executes an infinite loop:

```
DO FOREVER
  IF SUBROUTINE__HAS__RUN
  IS TRUE
    PERFORM MAIN SOFTKEY
    INITIALIZATION
    SHOW SCREEN PROMPTS
  ENDIF
ENDDO
```

The SUBROUTINE__HAS__RUN flag (variable FSUBR) is set true during initialization and by any function module that is executed. MAIN loops patiently and does very little work.

So what happens when a softkey is pressed? To answer that, first look at the subroutine MAIN uses to set up the softkeys for its functions. Listing 2 is a simplified version of this subroutine, showing only the setup for the F1 key. Softkey F1 is assigned the word "STOP" and a trap subroutine starting at line 1040. When MAIN is executing and you select the STOP function by hitting F1, the PC's BASIC interpreter instantly ceases to execute MAIN's program statements (it remembers where it left off, however) and begins executing F1's trap-routine statements beginning at line 1040. If you glance at line 1055 in listing 1, you'll see that this is in fact the driver for the STOP function—it closes all files and executes a STOP

Text continued on page 476

Listing 1: *The Font character editor for the IBM PC.*

```
100 REM                FONT EDITOR V1.0
105 REM
110 REM       R. A. DIEDRICHS 12 APRIL, 1982
115 REM
120 GOTO 8005
1000 REM
1005 REM SOFTKEY ROUTINES
1010 REM
1015  IF ER>MINR THEN ER=ER-1             'CURSOR UP
1020  RETURN
1025  IF EC>MINC THEN EC=EC-1: FCHNG=1   'CURSOR LEFT
1030  RETURN
1035  IF EC<MAXC THEN EC=EC+1: FCHNG=1   'CURSOR RIGHT
1040  RETURN
1045  IF ER<MAXR THEN ER=ER+1             'CURSOR DOWN
1050  RETURN
1055  CLOSE: STOP: RETURN                 'STOP
1060  FSUBR=1: RETURN                     'RETURN
1065  FABORT=1: RETURN                    'CEDIT ABORT
1070  FDEFINE=1: RETURN                   'CEDIT DEFINE
1075  FCOPY=1: RETURN                     'CEDIT COPY
1080  FERASE=1: RETURN                    'CEDIT ERASE
1085  FREPEAT=1: RETURN                   'CUSE REPEAT
1090 REM DISPLAY PSEUDO CURSOR AT (ER,EC) UNTIL USER DATA ENTRY OCCURS
1095  X=(EC+COFF)*8: Y=(ER+ROFF)*8: GET (X,Y)-(X+7,Y+7),CUR: R$=""
1100  WHILE R$="" AND FSUBR=0 AND FABORT=0 AND FDEFINE=0 AND FREPEAT=0
      AND FCOPY=0 AND FERASE=0 AND FDUMP=0
1105   PUT (X,Y),CURSOR,PSET: R$=INKEY$: PUT (X,Y),CUR,PSET
1110   X=(EC+COFF)*8: Y=(ER+ROFF)*8: GET (X,Y)-(X+7,Y+7),CUR
1115  WEND
1120  RETURN
1125 REM NULL ALL SOFTKEYS
1130  FOR I=1 TO 10: KEY I,"": KEY(I) OFF: NEXT I
1135  FOR I=11 TO 14: KEY(I) OFF: NEXT I
1140  RETURN
1145 REM MAIN MODE SOFT KEY SETUP
1150  GOSUB 1125
1155  KEY 1,"STOP": KEY 2,"CLOAD": KEY 3,"CSAVE": KEY 4,"CEDIT"
1160  KEY 5,"CUSE": KEY 6,"ELOAD": KEY 7,"ESAVE"
1165  ON KEY(1) GOSUB 1055: ON KEY(2) GOSUB 4015: ON KEY(3) GOSUB 4055
1170  ON KEY(4) GOSUB 5010: ON KEY(5) GOSUB 6010: ON KEY(6) GOSUB 7005
1175  ON KEY(7) GOSUB 7070
1180  FOR I=1 TO 7: KEY(I) ON: NEXT I: DEF SEG: POKE 106,0
1185  RETURN
1190 REM CEDIT MAIN SOFKEY SETUP
1195  GOSUB 1125
1200  KEY 1,"RETURN"
1205  ON KEY(1) GOSUB 1060
1210  KEY (1) ON
1215  RETURN
1220 REM CEDIT CHARACTER SOFTKEY SETUP
1225  GOSUB 1125
1230  KEY 2,"COPY": KEY 3,"ERASE": KEY 4,"DEFINE": KEY 5,"ABORT"
1235  ON KEY(2)  GOSUB 1075: ON KEY(3) GOSUB 1080: ON KEY(4) GOSUB 1070
1240  ON KEY(5)  GOSUB 1065: ON KEY(11) GOSUB 1015: ON KEY(12) GOSUB 1025
1245  ON KEY(13) GOSUB 1035: ON KEY(14) GOSUB 1045
1250  KEY(2) ON: KEY(3) ON: KEY(4) ON: KEY(5) ON
1255  KEY(11) ON: KEY(12) ON: KEY(13) ON: KEY(14) ON
1260  DEF SEG: POKE 106,0
1265  ER=0: EC=0: FCHNG=0: FREPEAT=0: FCOPY=0: FERASE=0
1270  MINR=0: MAXR=7: ROFF=CEDROW+1
1275  MINC=0: MAXC=7: COFF=CEDCOL+30
1280  RETURN
1285 REM CUSE SOFKEY SETUP
1290  KEY 1,"RETURN": KEY 2,"REPEAT"
1295  ON KEY(1)  GOSUB 1060: ON KEY(2) GOSUB 1085
1300  ON KEY(11) GOSUB 1015
1305  ON KEY(12) GOSUB 1025: ON KEY(13) GOSUB 1035: ON KEY(14) GOSUB 1045
1310  KEY(1) ON: KEY(2) ON: KEY(11) ON: KEY(12) ON: KEY(13) ON: KEY(14) ON
1315  DEF SEG: POKE 106,0
1320  ER=0: EC=0: FCHNG=0: FFREPEAT=0: FCOPY=0: FERASE=0
1325  MINR=0: MAXR=EXPROW: ROFF=CUSROW
1330  MINC=0: MAXC=EXPCOL: COFF=CUSCOL
1335  RETURN
2000 REM
2005 REM CHARACTER EDIT UTILITIES
2010 REM
2015 REM REMEMBER CHARACTER DATA
2020  DEF SEG= 0
2025  FOR I=0 TO 7
2030   OLD(I)=PEEK(TABLEADDR+(CHAR-128)*8+I)
2035  NEXT I
2040  RETURN
2045 REM RESTORE OLD CHARACTER DATA
2050  DEF SEG= 0
2055  FOR I=0 TO 7
2060   POKE (TABLEADDR+(CHAR-128)*8+I),OLD(I)
2065  NEXT I
2070  RETURN
2075 REM DISPLAY A CHARACTER AND ITS DATA
2080  DEF SEG= 0: GOSUB 2215
2085  FOR I=0 TO 7
2090   VALUE=PEEK(TABLEADDR+(CHAR-128)*8+I)
```

Listing 1 continued on page 472

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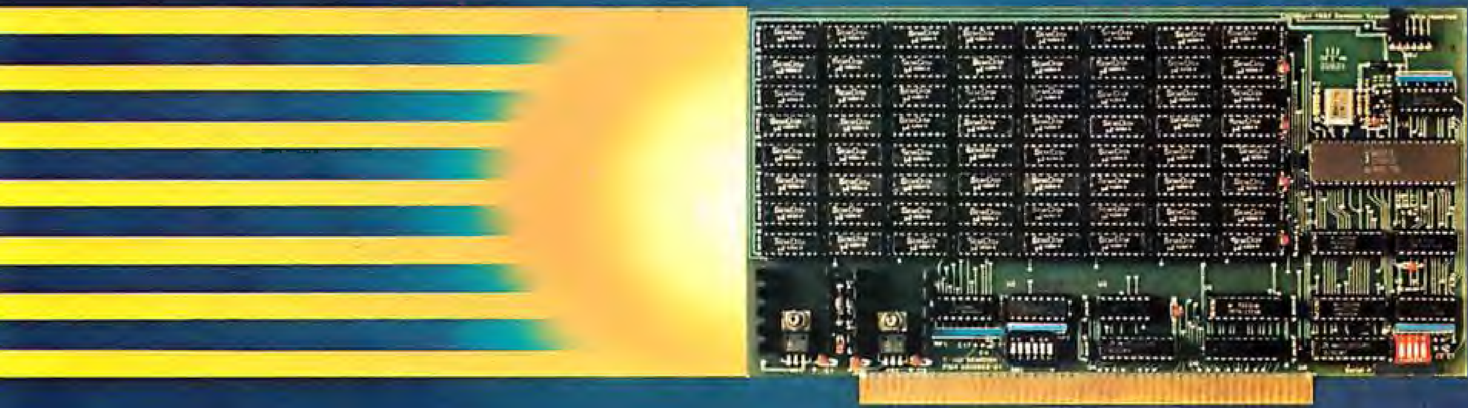

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Listing 1 continued:

```
2095   GOSUB 2115
2100  NEXT I
2105  LOCATE CEDROW+11,CEDCOL+31: PRINT "01234567"
2110  RETURN
2115 REM DISPLAY PIXELS IN A CHARACTER ROW
2120  ROW$=""
2125  CHARSH=VALUE
2130  FOR J=1 TO 8
2135  IF (CHARSH MOD 2)=1 THEN PIXEL$="-" ELSE PIXEL$=" "
2140   ROW$=PIXEL$+ROW$
2145   CHARSH=INT(CHARSH/2)
2150  NEXT J
2155  LOCATE CEDROW+2+I,CEDCOL+27: PRINT I;" ";ROW$
2160  RETURN
2165 REM PUT EDIT PATTERN IN THE CHARACTER TABLE
2170  VALUE=●
2175  ADDR=TABLEADDR+INT(CHAR-128)*8+CROW
2180  IF ADDR>ADDRMAX THEN RETURN
2185  DEF SEG =0:
2190  VALUE=PEEK(ADDR): VALUE=VALUE OR 2↑(7-EC)
2195  IF R$=EDCHAR$ THEN VALUE=VALUE OR 2↑(7-EC)
     ELSE VALUE=VALUE AND NOT(2↑(7-EC))
2200  POKE ADDR,VALUE
2205  I=ER: LOCATE CEDROW,CEDCOL+35: PRINT CHR$(CHAR): GOSUB 2115
2210  RETURN
2215 REM DISPLAY A CHARACTER
2220  LOCATE CEDROW,CEDCOL+34: PRINT SPACE$(25)
2225  LOCATE CEDROW,CEDCOL+34: PRINT "]";CHR$(CHAR);"[",CHAR-128;"  <";CHAR;">"
2230  RETURN
2235 REM COPY A CHARACTER
2240  FCOPY=●
2245  BCASK$=SPACE$(17)+CHR$(13)+SPACE$(16): FCURSOR=0
2250  ASK$="COPY FROM CHARACTER"+CHR$(13)+"CODE (0-126)"
2255  ENPROW=14: ENROW=15: ENCOL=14: GOSUB 3015
2260  LOCATE ENPROW,1: PRINT BCASK$
2265  IF ENTRY$="" THEN RETURN
2270  FROM%=VAL(ENTRY$): IF FROM%<0 OR FROM%>127 THEN 2255
2275  DEF SEG= 0
2280  FOR I=0 TO 7
2285   VALUE%=PEEK(TABLEADDR+(FROM%)*8+I)
2290   POKE (TABLEADDR+(CHAR-128)*8+I),VALUE%
2295  NEXT I
2300  GOSUB 2075
2305  RETURN
2310 REM ERASE A CHARACTER
2315  FERASE=0
2320  DEF SEG= 0
2325  FOR I=0 TO 7
2330   POKE (TABLEADDR+(CHAR-128)*8+I),0
2335  NEXT I
2340  GOSUB 2075
2345  RETURN
2350 REM CHANGE ONE DISPLAYED CHARACTER CODE
2355  R=2
2360  IF CHAR>247 THEN R=8 ELSE IF CHAR>207 THEN R=6 ELSE IF CHAR>167 THEN R=4
2365  C=((CHAR-128) MOD 40)*2 + 1
2370  LOCATE R,C: PRINT CHR$(CHAR);: RETURN
3000 REM
3005 REM GENERAL UTILITIES
3010 REM
3015 REM POSITION CURSOR AND INPUT ENTRY$
3020  ENTRY$="": R$=""
3025  LOCATE ENPROW,1: PRINT ASK$:LOCATE ENROW,ENCOL: PRINT SPACE$(4)
3030  WHILE R$<>CHR$(13) AND FSUBR=0 AND FREPEAT=0 AND FDUMP=0
3035   IF FCURSOR=1 THEN GOSUB 1070 ELSE R$=INKEY$
3040   IF R$>="0" AND R$<="9" THEN ENTRY$=ENTRY$+R$ ELSE GOSUB 3065
3045   LOCATE ENROW,ENCOL: PRINT ENTRY$
3050   IF LEN(ENTRY$)>3 THEN LOCATE ENROW,ENCOL: PRINT SPACE$(4):ENTRY$=""
3055  WEND
3060  RETURN
3065 REM DELETE LAST CHAR FROM ENTRY$
3070  IF LEN(R$)=2 THEN IF ASC(RIGHT$(R$,1))<>83 THEN RETURN
3075  IF LEN(R$)=1 THEN IF ASC(R$)<>8 THEN RETURN
3080  IF LEN(ENTRY$)=0 OR LEN(R$)=0 THEN RETURN
3085  ENTRY$=LEFT$(ENTRY$,LEN(ENTRY$)-1)
3090  LOCATE ENROW,ENCOL: PRINT SPACE$(4)
3095  RETURN
3100 REM DISPLAY CURRENT EXPERIMENT
3125  FOR I=0 TO EXPROW
3130   LOCATE CUSROW+I+1,CUSCOL-3: PRINT I
3135   LOCATE CUSROW+I+1,CUSCOL: PRINT ":";
3140   REM LOCATE CUSROW+I+1,CUSCOL+1
3145   FOR J=0 TO EXPCOL
3150     PRINT CHR$(EXPERIMENT(I,J));
3155   NEXT J
3160   PRINT ""
3165  NEXT I
3170  RETURN
3175 REM DISPLAY ALL CHARACTER CODES
3180  LOCATE DISPROW,1: PRINT SPACE$(80): LOCATE DISPROW,1
3185   PRINT ROWLABEL$;" ";ROWLABEL$;" ";ROWLABEL$;" ";ROWLABEL$
3190  FOR I=0 TO 2
3195   FOR J=0 TO 39
3200    PRINT CHR$(40*I+J+128);" ";
3205   NEXT J
3210   PRINT ""
```

Listing 1 continued on page 474

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Listing 1 continued:

```
3215  NEXT I
3220  FOR I=120 TO 127: PRINT CHR$(I+128);" ";: NEXT I: PRINT " "
3225  RETURN
3230 REM OBTAIN FILENAME FROM USER
3235  GOSUB 1125: FSUBR=1: CLS
3240  LOCATE FILEPROMPTROW,1: PRINT LABEL$
3245  LOCATE FILEPROMPTROW+2,1: PRINT ASK$;: INPUT RESPONSE$
3250  RETURN
4000 REM
4005 REM CHARACTER FILE LOAD/SAVE
4010 REM
4015 REM CHARACTER FILE LOAD
4020  LABEL$="LOAD A CHARACTER FILE": ASK$="ENTER FILENAME"
4025  GOSUB 3230
4030  IF RESPONSE$="" THEN CLS: RETURN
4035  DEF SEG=0
4040  BLOAD RESPONSE$,TABLEADDR
4045  CFILE$=RESPONSE$
4050  CLS: RETURN
4055 REM CHARACTER FILE SAVE
4060  LABEL$="SAVE THE CHARACTER FILE       CURRENT FILENAME="+CFILE$
4065  ASK$="ENTER FILENAME"
4070  GOSUB 3230
4075  IF RESPONSE$="" THEN CLS: RETURN
4080  CFILE$=RESPONSE$: DEF SEG=0
4085  BSAVE RESPONSE$,TABLEADDR,1024
4090  CLS: RETURN
5000 REM
5005 REM CHARACTER EDIT
5010 REM
5015  CLS: GOSUB 1125: GOSUB 3175: CROW=0: FREPEAT=0: FCURSOR=0
5020  BASK$=SPACE$(15)+CHR$(13)+SPACE$(21)
5025  WHILE FSUBR=0
5030   GOSUB 1190: FABORT=0: FDEFINE=0
5035   ASK$="ENTER CHARACTER"+CHR$(13)+" CODE (0-126) "
5040   WHILE ENTRY$=""
5045     ENPROW=16: ENROW=17: ENCOL=15: GOSUB 3015
5050     LOCATE ENPROW,1: PRINT BASK$
5055     IF FSUBR=1 THEN GOTO 5125
5060     CHAR=VAL(ENTRY$): IF CHAR<0 OR CHAR>127 THEN ENTRY$=""
5065   WEND
5070   CHAR=CHAR+128
5075   GOSUB 2015: GOSUB 1125: GOSUB 2075: GOSUB 1220
5080   WHILE FABORT=0 AND FDEFINE=0
5085    GOSUB 1090
5090    IF R$=EBCHAR$ OR R$=EDCHAR$ THEN CROW=ER: GOSUB 2165
5095    IF FCOPY=1 THEN GOSUB 1125: GOSUB 2235: GOSUB 1220
5100    IF FERASE=1 THEN GOSUB 1125: GOSUB 2310: GOSUB 1220
5105   WEND
5110   IF FABORT=1 THEN GOSUB 2045
5115   IF FDEFINE=1 THEN GOSUB 2350
5120   ENTRY$=""
5125  WEND
5130  CLS: RETURN
6000 REM
6005 REM CHARACTER PATTERN USE
6010 REM
6015  CLS: GOSUB 1125: GOSUB 3175: GOSUB 3100: GOSUB 1285: RCODE=0: CODE=0
6020  ASK$="ENTER CHARACTER"+CHR$(13)+"CODE (0-126)": FCURSOR=1
6025  ENPROW=18: ENROW=19: ENCOL=14
6030  WHILE FSUBR=0
6035   GOSUB 3015: IF FSUBR=1 THEN 6050
6040   IF FREPEAT=1 THEN LOCATE CUSROW+8,CUSCOL-7: PRINT RCODE: FREPEAT=0
      ELSE RCODE=VAL(ENTRY$): LOCATE CUSROW+8,CUSCOL-7: PRINT "     "
6045   IF RCODE>=0 AND RCODE<=127 THEN LOCATE ER+CUSROW+1,EC+CUSCOL+1,1:
      PRINT CHR$(RCODE+128);:EXPERIMENT(ER,EC)=RCODE+128
6050  WEND
6055  CLS: RETURN
7000 REM
7005 REM EXPERIMENT LOAD/SAVE
7010 REM
7015 REM EXPERIMENT LOAD
7020  LABEL$="LOAD AN EXPERIMENT ": ASK$="ENTER FILENAME ".
7025  GOSUB 3230: IF RESPONSE$="" THEN CLS: RETURN
7030  EFILE$=RESPONSE$
7035  OPEN EFILE$ FOR INPUT AS #1
7040  FOR I=0 TO EXPROW
7045   FOR J=0 TO EXPCOL
7050    INPUT#1, EXPERIMENT(I,J)
7055   NEXT J
7060  NEXT I
7065  CLOSE 1: CLS: RETURN
7070 REM EXPERIMENT SAVE
7075  LABEL$="SAVE AN EXPERIMENT       CURRENT EXPERIMENT IS "+EFILE$
7080  ASK$="ENTER FILENAME "
7085  GOSUB 3230: IF RESPONSE$="" THEN CLS: RETURN
7090  EFILE$=RESPONSE$
7095  OPEN EFILE$ FOR OUTPUT AS #1
7100  FOR I=0 TO EXPROW
7105   FOR J=0 TO EXPCOL
7110    PRINT #1,EXPERIMENT(I,J)
7115   NEXT J
7120  NEXT I
7125  CLOSE 1: CLS: RETURN
8000 REM
8005 REM INITIALIZATION
```

Listing 1 continued on page 476


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Text continued from page 470:

statement.

Pattern editing demonstrates a more complicated (and powerful) use of a softkey. MAIN uses F4 as the CHARACTER PATTERN EDIT (CEDIT) function; the subroutine starting at line 5000 of listing 1 is the trap routine for this key. But this routine is actually the entire character-edit module, and it acts like a "mini-MAIN" routine—the module sets up the softkeys for its own subfunctions, obtains your input, and lets you push a cursor around a character's dot pattern. When you signal "no more" by replying with a carriage return to an input prompt, CEDIT sets the flag variable FSUBR true and executes a RETURN statement.

Where does the computer's BASIC interpreter return to? Back to MAIN, picking up execution exactly where it left off. MAIN detects that the flag variable FSUBR is true (meaning that some function has executed), and MAIN therefore sets up the softkeys and screen to restore its function offering.

When softkeys are used in this manner, you quickly become used to pressing certain keys to obtain certain functions. For this reason, it's a good idea to retain certain softkeys for the same general use. Key F1, for example, is always used within Font to return to the next highest function level.

It also pays to consider the layout of the softkeys; placing a Kill All softkey next to a Save File key that is heavily used is an invitation to disaster.

Font softkey manipulation routines always call a central module that flushes all old softkey definitions before any manipulation routine proceeds to set up for new definitions. Experience shows that this approach is the safest and most reliable way to ensure that only currently meaningful softkeys are enabled. Control of the keys is simplified by this technique; if all keys are flushed before setup, then only those keys to be used need further attention.

Listing 1 continued:

```
8010 REM
8015  CLEAR ,28804
8020  DEFINT C,E,F,I,J,M,O,P,R,V,X,Y
8025  PROMPTROW=10: PROMPTCOL=30: CEDROW=10: CEDCOL=1: EXPROW=14: EXPCOL=55
8030  DISPROW=1: CUSROW=8: CUSCOL=22: FILEPROMPTROW=1
8035  CLS: LOCATE PROMPTROW,PROMPTCOL: PRINT "FONT  EDITOR  V1.0": PRINT:
       PRINT SPACE$( 31 );"INITIALIZING..."
8040  DIM EXPERIMENT( EXPROW,EXPCOL ),CUR( 5 ),CURSOR( 5 ),PREV( 7 )
8045  CFILE$="": EFILE$="": ROWLABEL$="0 1 2 3 4 5 6 7 8 9"
8050  EBCHAR$=" ": EDCHAR$="D"
8055  FOR I=2 TO 5: CURSOR( I )=-1: NEXT I: CURSOR( 0 )=8: CURSOR( 1 )=8
8060  SCREEN 2: KEY OFF
8065  ADDRMAX = 65535!: TABLEADDR=ADDRMAX-1024
8070  DEF SEG= 0: POKE 125,( TABLEADDR/256 )
8075  FOR I=0 TO 1023: POKE TABLEADDR+I,0: NEXT I
9000 REM
9005 REM MAIN
9010 REM
9015  CLS: FSUBR=1
9020  WHILE 1=1
9025   IF FSUBR=1 THEN FSUBR=0: GOSUB 1145: KEY ON:
       LOCATE PROMPTROW,PROMPTCOL: PRINT "FONT  EDITOR  V1.0": PRINT:
      PRINT SPACE$( 27 );"   SELECT  A  MODE"
9030   DUMMY$=INKEY$: DEF SEG: POKE 106,0
9035  WEND
```

Listing 2: *A simplified version (showing only the setup for the F1 function key) of the figure 1 subroutine that sets up softkeys.*

```
1130 REM MAIN MODE SOFT KEY SETUP
1140  KEY 1,"STOP"                 'DEFINE 25TH LINE MENU PHRASE
1150  ON KEY( 1 ) GOSUB 1040       'ASSIGN TRAP SUBROUTINE
1165  KEY( 1 ) ON                  'ENABLE THE KEY FOR TRAPPING
1170  RETURN
```

Listing 3: *A program segment that installs a designed and tested character set.*

```
100 REM INSTALL A CHARACTER PATTERN TABLE
110  CLEAR ,28804                  'RESERVE 128 8 BY 8 TABLE ENTRIES
120  SCREEN 2                      'DECLARE HIGH RES GRAPHICS MODE
125  SADDR = 64512!                'DEFINE PATTERN TABLE START ADDRESS
130  BLOAD "filename",SADDR!       'LOAD THE PATTERNS INTO THE TABLE
140  DEF SEG= 0: POKE 125,SADDR/256 'DEFINE TABLE ADDRESS IN INT 1FH
```

A Font Work Session

Let's walk through a Font work session so that you get the idea. You've keyed Font into your PC and now you boot BASICA from DOS (disk operating system). When you load and run Font, you see the initialization announcement appear. The pattern table is now blanked and characters can be user-defined. You next see "SELECT A MODE," and the functions available appear on the bottom line—at this point, you are observing Font's module MAIN as it executes. MAIN offers you the following functions:

F1 — STOP (terminate Font)
F2 — CLOAD (load a character pattern set from disk)
F3 — CSAVE (save a character pattern set on disk)
F4 — CEDIT (edit a character pattern)
F5 — CUSE (use a pattern set experimentally)
F6 — ELOAD (load an experiment)
F7 — ESAVE (save an experiment)

During your first session you have no patterns to load. You therefore hit F4 to choose the CEDIT function. The screen clears, and CEDIT displays a new screen; it shows a reference ruler and all 128 characters in five rows (because you haven't defined any yet, they are all still blank). CEDIT then prompts you to input the numeric code of the character you want to edit. It asks for a code between 0 and 127, rather than 128 and 255, because

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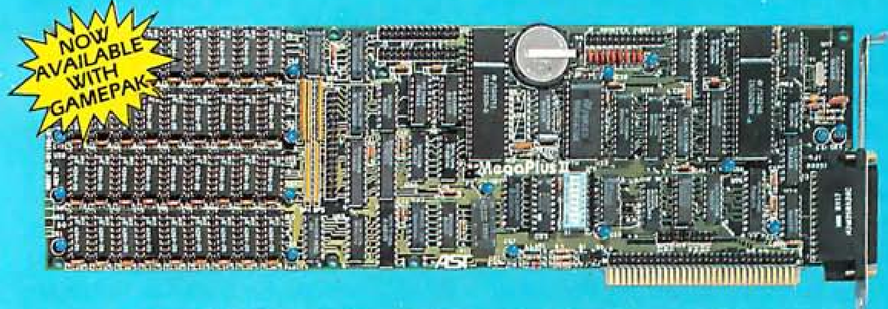

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it is easier to deal with numbers that start from 0 (quick, what's the fifty-third character above 128?). The characters are still handled everywhere else in Font in their proper order, from 128 to 255.

You enter a character code, and CEDIT sets up to edit that character. First, the input prompt is erased. Then the current character definition is displayed in actual size in the middle of the screen, and a magnified definition is displayed below. Also, a new set of subfunction softkeys appears:

F2 — COPY A PATTERN FROM SOME CHARACTER INTO THIS CHARACTER
F3 — ERASE THIS CHARACTER
F4 — DEFINE THIS CHARACTER
F5 — ABORT EDIT OF THIS CHARACTER

The magnified pattern box has 8 rows of 8 columns and a blinking cursor that can be moved to any of the 64 positions in the box. Each position in the magnified box corresponds to a matching dot in the actual-size character. By typing a "D" (for dot) in any position in the magnified box, you turn on the corresponding dot in the actual character; by typing a blank, you turn off a dot. You use the four cursor keys to move the cursor around the pattern, placing dots where you wish.

When you've formed the character to your satisfaction, you hit F4 to select the DEFINE function, and your character now exists in the pattern table. It is displayed in its proper place in the upper part of the screen.

On the other hand, perhaps you don't like what you've done; if so, hit F3 to erase your pattern and begin anew or hit F5 to abort the edit of this character altogether and choose a new character code. If you are working with many similar characters, you can use F2 to copy from another pattern into the one you are editing.

You form characters in this mode, and at some point you've formed as many as you want. The next time you are prompted to "INPUT CHARACTER CODE," use the F1 RETURN function and CEDIT will return you to MAIN. You can now save on disk the patterns you have created by selecting F3 for CHARACTER SAVE. Having done that, you can move to the CHARACTER USE function (CUSE) by means of the F5 softkey and experiment with your new characters.

Experimenting with characters is useful when symbols are to be made up of multiple characters. In a Dungeons and Dragons monster, for example, CUSE lets you combine characters and test alignment, suitability, and visual effectiveness. CUSE displays all 128 character codes in the upper area of the screen and defines a 14-row by 55-column work area in the middle of the screen. You can push a blinking cursor around this area and insert any characters you wish—defined or as yet undefined. You are asked to input the character code you want to place at the current cursor position, and you enter a code between 0 and 127. The actual-size character is placed there, and you can use the four cursor keys to move to other printing positions in the work area and to place other characters there.

The CHARACTER USE function combines characters and lets you test visual effectiveness.

Having supplied a character code, you can also use the F2 REPEAT function to continue inserting the same code as you move the cursor around; this is handy for repetitive functions such as placing the character that forms the stave for musical notation. You leave CUSE submode by means of F1 RETURN.

Your designed and tested character set is now ready for use. Your applications program—a fast-paced video game, perhaps, or a choral-music copier—must now install your custom characters. Listing 3 is a program snippet that performs the installation. When your program has incorporated these program statements, it prints to the screen using your own characters in all their glory.

Enhancements, Modifications, and Bugs

A secondary but elegant feature of a softkey-based program is the ease of installing new features. No "path" needs to be established for a new feature; rather, another softkey is allocated in the properly set-up module, and the new feature is thereby made available.

A screen-dump-to-printer function could be added in this manner. Because a file of character patterns could be manipulated in a sense similar to a file of text, it would also be elegant to work with patterns across a file boundary: append, delete *n* characters, block move, and other text-processing features would be offered in an advanced character editor for which Font is the basis.

For machines that don't have an 80-character by 25-line high-resolution monitor, Font can still be installed. Within the initialization, all screen coordinates are expressed as variables; change all 80-character sizing to 40-character sizing, and Font adjusts accordingly.

If you have at least 48K bytes of memory, Font still fits in, although you must forgo all comments and tighten up the line structure. Reserve 1024 decimal bytes of storage using the CLEAR statement, and redefine the end of memory-address variable ADDRMAX to the end of a 48K-byte machine (49151 decimal).

In closing, it is only fair to mention a bug in Font: it does not edit or use character code 255. I believe that the BASIC interpreter handles character code 255 in some "special" way that precludes redefinition. Perhaps an alert reader can discover the root of this bug.■

References

1. *IBM BASIC Manual.* First edition (August 1981), IBM part number 6025013.
2. *IBM Technical Reference Manual.* First edition (August 1981), IBM part number 6025008.

Raymond A. Diedrichs (300 Livingston Court, North Wales, PA 19454) is a real-time process-control programmer and has been involved in personal computing since 1976.

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How to Pass and Scan a CP/M Command Line

by Daniel S. Hunt

Few compiler languages running under CP/M have the built-in capability to get arguments from a system command and pass them to the program. This feature enables you to type things like SORT SOURCE.DAT DEST.DAT and have the called program busy itself with a sort program between a source and destination file, with no further communication from the user.

Listing 1, a file-to-file line-sort program written in BASIC-80, illustrates the two short routines that make this useful feature possible.

How It Works

When you type a command for CP/M, it automatically transfers anything following the first word to the 128-byte I/O (input/output) buffer at location 80 hexadecimal. You may use the information in the buffer as long as you haven't read or written the disk since you called your program. The first byte in the buffer contains the length of the argument transferred. The subroutine get cp/m cmd (line 4000) looks at this length byte to find how much of the buffer must be transferred to the command string, a$. The buffer pointer, p, is incremented and each location is peeked and its character added to a$, until a$ contains the full length of the command line.

At this point, a second routine, gnt (for get next token), is needed to break up a$ into separate words. You may give this routine any set of rules you like for scanning a$. The rules in listing 1 require that command arguments be separated by commas, tabs, or spaces. The program skips past these separators until it finds alphanumeric characters, then builds a word, token$, character by character until the next separator is found. The gnt routine keeps track of where it is in the command line with the variable psn, so that when it is called by the main program a second time it can start where it left off.

The token$ in this program is simply the name of source and destination files used to load and unload the sort routine. The sorting routine in line 2010 is an almost literal Pascal-to-BASIC translation of the nonrecursive quicksort from Niklaus Wirth's fine book, *Algorithms + Data Structures = Programs* (Englewood Cliffs, NJ: Prentice-Hall, 1976).■

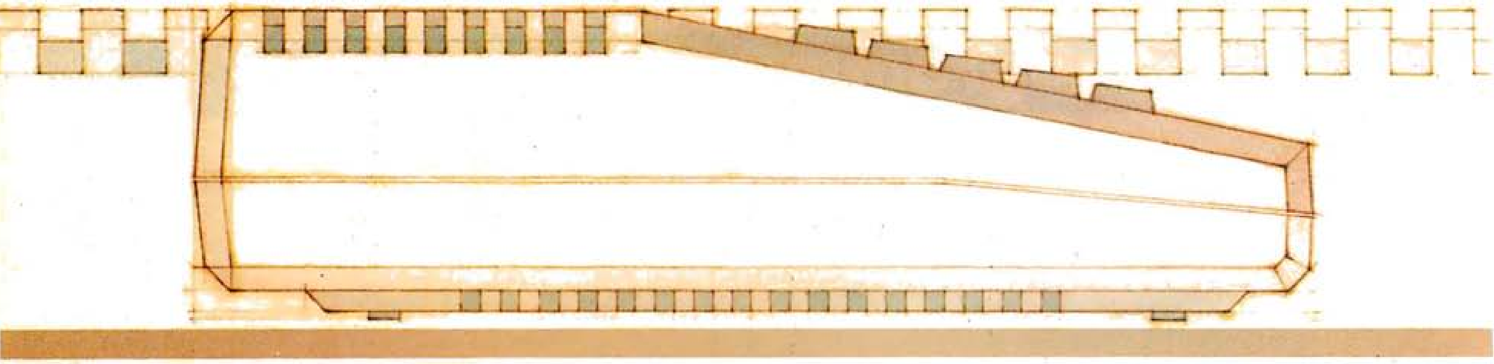
Listing 1: *This sort program illustrates the routines used to pass (i.e., merge) and scan a command line. In this example, the command arguments (token$) are the names for the source and destination files.*

```
rem Command line demo for BASIC-80 compiler /c option
rem by Daniel S. Hunt '82

defint i-s
true% = -1                                 :'loop control
dim ln$(700)                               :'max # lines in sort
dim stackl(700),stackr(700)                :'quicksort stacks

rem begin main
'
gosub 4000 :'get cp/m cmd(a$)
psn = 1 : token$ = "" : gosub 5000 :'gnt(token$;a$,psn)
f1$ = token$
token$ = "" : gosub 5000 :'gnt(token$,a$,psn)
f2$ = token$
on error goto 99
open "I",1,f1$
on error goto 0
'
rem read unsorted data into strings
i = 1
while true%
    line input #1, ln$(i)
    print ln$(i)
    if eof(1) then 1220
    i = i + 1
    wend
'
1220 close
n = i
gosub 2010:'qsort(n,ln$() )
'
on error goto 99
open "o",1,f2$
on error goto 0
```

Listing 1 continued on page 483



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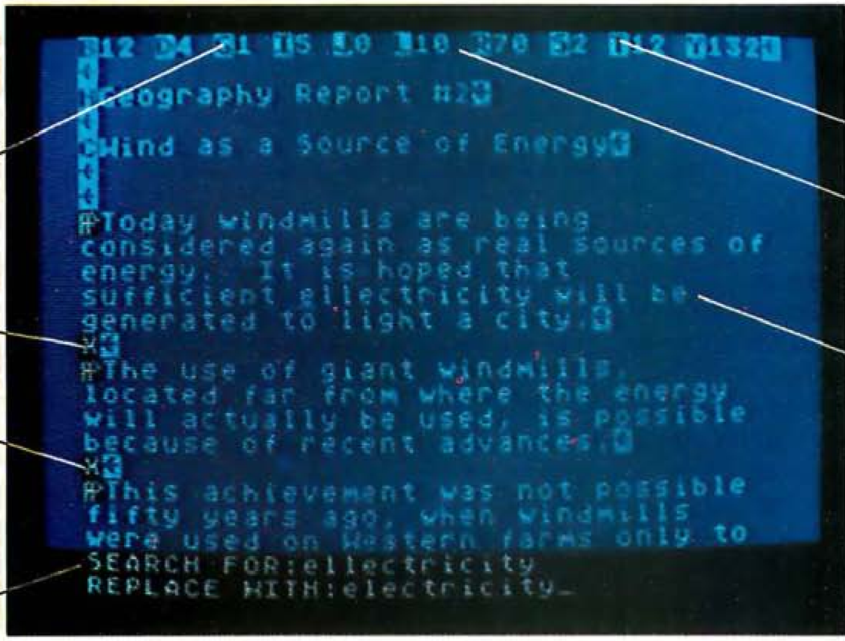

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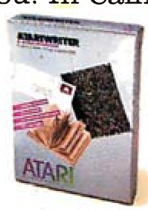

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Listing 1 continued:

```
for i = 1 to n
        print #1,ln$(i)
next
print #1,chr$(26)
close
end :'  main

 2010  rem non-recursive quicksort(var ln$(1..n),n:integer)
 s = 1 : stackl(1) = 1 : stackr(1) = n
 while s > 0
     l = stackl(s) : r = stackr(s) : s=s-1
 '
     while l < r
             i = l : j = r : x$ = ln$( (l+r)\2)
             while i <= j
                     while ln$(i) < x$ : i= i+1 : wend
                     while x$ < ln$(j) : j= j-1 : wend
                     if i <= j then
                           swap ln$(i),ln$(j):
                           i = i + 1 : j = j - 1
                     wend
             if i < r then
                        s = s + 1:
                        stackl(s) = i: stackr(s) = r
             r = j
             wend
     wend
 return
5000 rem gnt(var a$,token$; var psn : integer);
'
rem scan through delimiters until 1st token char found
ch$ = mid$(a$,psn,1)
while (ch$ = " " or ch$ = chr$(9) or ch$ = ",")
     ch$ = mid$(a$,psn,1)
     psn = psn + 1
     wend
'
rem unget last character
if psn > 1 then psn = psn - 1
'
rem beginning at 1st char of symbol, scan to next delimiter
while true%
     ch$ = mid$(a$,psn,1)
     if ch$ = " " or ch$ = chr$(9) or ch$ = ","
            then return
     token$ = token$ + ch$
     psn = psn + 1
'
     rem  at end of string, nul it and set to position 1
     if psn > len(a$) then
               psn = 1: a$ = "":
               return
     wend
return


4000 rem get cp/m command line(var a$);
'
rem set pointer to cp/m default io buffer
p = &h80
rem get length of command line at first byte
la = peek(p)
'
rem advance pointer and transfer command to a$
p = p + 1
a$ = "" : nc = 0
while nc < la
        ch$ = chr$(peek(p))
        a$ = a$ + ch$
        p = p + 1 : nc = nc + 1
        wend
return

rem error exit for bad file name
99 resume 100
100 print "Bad file name(s)": close : end
```

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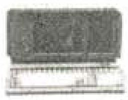

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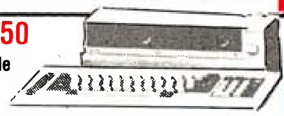

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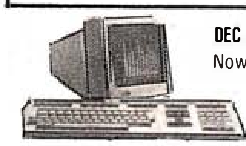

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Make Fast and Simple Contour Plots on a Microcomputer

Condot employs an algorithm that simplifies creation of plots without requiring complicated code

by Sedgwick L. Simons Jr.

Contour-plotting programs for desktop microcomputers are scarce indeed. And programmers who approach too lightly the task of creating one are naive. At last, however, a real solution has been found. The program outlined in this article eases the task of generating contour plots; in spite of or more likely because of the lack of intelligence of the algorithm involved, the program seems foolproof.

Ostensibly, contour plotting is not complicated. You need only find and follow all the contour lines through a data array. Certainly the program will have to handle occasional saddle points, situations of low data surrounded by high data, or a few missing values. And, of course, you must avoid tracing the same contour twice or taking a shortcut across a different contour. Suddenly, the magnitude of this programming task is evident—this traditional approach to contour plotting takes an awfully intelligent program. And you know what intelligent means: lots of complicated code and lots of run time. And that means bad news for microcomputer users.

Some clever shortcuts to the traditional approach do exist. But some highly mathematical algorithms would require a couple of hundred FORTRAN cards.

There *is* a solution. I offer figure 1 as evidence of an easy, though devious, way to do top-quality contouring on a microcomputer. The algorithm discussed in this article makes no attempt to solve the intricate problems of traditional contour plotting. Instead of finding and following contour lines, it just looks through the data array and draws dots whenever it crosses a contour line (hence the name Condot). With sufficiently fine interpolation, the dots run together and *voilà*—contour lines.

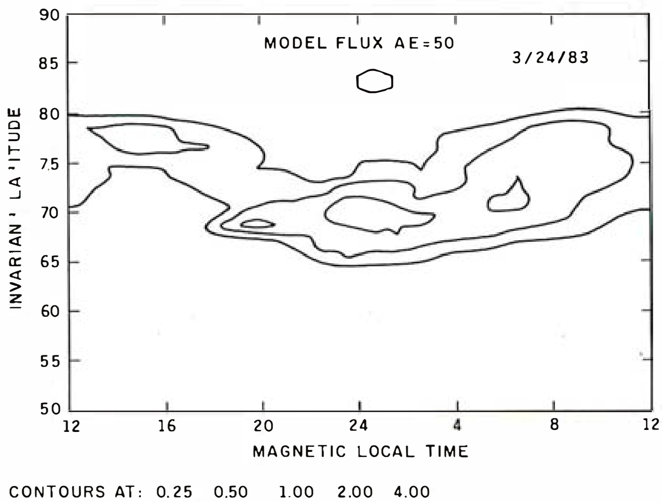

Figure 1: *This contour plot, based on an array of 960 observations (24 by 40), was made using Condot. The program was run on a Tektronix 4052, and the output was sent to a Tektronix 4662 pen plotter. It took about 10 minutes to generate the plot.*

Listing 1: *The Condot program, an algorithm for plotting contours. If you leave out the remarks, the core contains only 57 commands.*

```
40 REM  -------------------  C O N D O T  ---------------------------
50 REM
60 REM  --  SIMPLIFIED CONTOUR PLOTTING ALGORITHM FOR MICROCOMPUTERS  --
70 REM
80 REM  BY :           DR. S. L. SIMONS, JR.              RICE UNIVERSITY
90 REM
100 FOR I=1 TO A2-1
110 FOR J=1 TO A1-1
120 REM  ---------------------------------------------------------------
130 REM  -------------------- DEFINE THE FOUR CORNERS OF A CELL --
140 X1=F(I,J)
150 X2=F(I,J+1)
160 X3=F(I+1,J)
170 X4=F(I+1,J+1)
180 REM  ---------------------------------------------------------------
190 REM  -- IF ALL FOUR CORNERS ARE LESS THAN THE LOWEST CONTOUR OR
200 REM  -  IF ANY CORNER HAS A MISSING VALUE GO TO THE NEXT CELL.
210 IF X1<C0 AND X2<C0 AND X3<C0 AND X4<C0 THEN 600
220 IF X1=M0 OR X2=M0 OR X3=M0 OR X4=M0 THEN 600
230 REM  ---------------------------------------------------------------
240 REM  ------------------  I-DIMENSION INTERPOLATION OVER THE CELL --
250 FOR K=0 TO 1-S2 STEP S2
260 Z1=X1-K*(X1-X3)
270 Z2=X2-K*(X2-X4)
280 IF Z1<C0 AND Z2<C0 THEN 420
290 GOSUB 650
300 REM  ------   650 RETURNS THE SUBSCRIPTS OF THE CONTOURS CROSSED
310 IF C4<C3 THEN 420
320 M=Z2-Z1
330 R2=I+K
340 B=Z1-M*J
350 R2=I+K
360 REM  ---------   COMPUTE R1, THE J-DIMENSION CROSSING COORDINATE
370 FOR C5=C3 TO C4
380 R1=(C(C5)-B)/M
390 MOVE R1,R2
400 DRAW R1,R2
410 NEXT C5
420 NEXT K
430 REM  ---------------------------------------------------------------
440 REM  ---------------------------------   J-DIMENSION INTERPOLATION --
450 FOR K=0 TO 1-S3 STEP S3
460 Z1=X1-K*(X1-X2)
470 Z2=X3-K*(X3-X4)
480 IF Z1<C(1) AND Z2<C(1) THEN 590
490 GOSUB 650
500 IF C3>C4 THEN 590
510 M=Z2-Z1
520 B=Z1-M*I
530 R1=J+K
540 FOR C5=C3 TO C4
550 R2=(C(C5)-B)/M
560 MOVE R1,R2
570 DRAW R1,R2
580 NEXT C5
590 NEXT K
600 NEXT J
610 NEXT I
620 END
630 REM  ---------------------------------------------------------------
640 REM                             -- SUBROUTINE --
650 REM  --------------- CHECK FOR CONTOUR CROSSINGS BETWEEN Z1 & Z2 --
660 IF Z1>Z2 THEN 700
670 Y1=Z1
680 Y2=Z2
690 GO TO 720
700 Y1=Z2
710 Y2=Z1
720 FOR C3=1 TO C1
730 IF Y1<=C(C3) THEN 770
740 NEXT C3
750 C4=0
760 RETURN
770 FOR C4=C3 TO C1
780 IF Y2<=C(C4) THEN 800
790 NEXT C4
800 C4=C4-1
810 RETURN
```

The core of Condot, shown in listing 1, was written for a Tektronix Inc. 4050 series graphics computer and uses reasonably conventional BASIC. If you leave out the remarks, the core contains only 57 commands. In addition to the core, you'll need routines to get your data array into memory, set up the graphics parameters (such as window or viewport), and draw the axis and legends.

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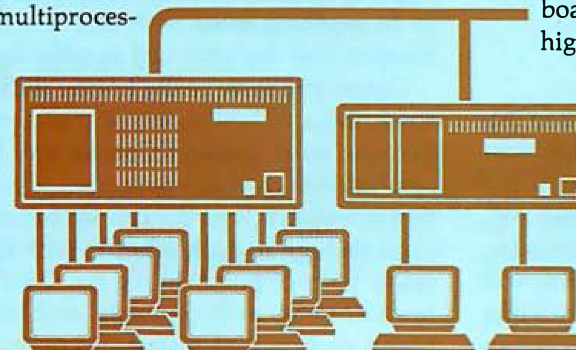

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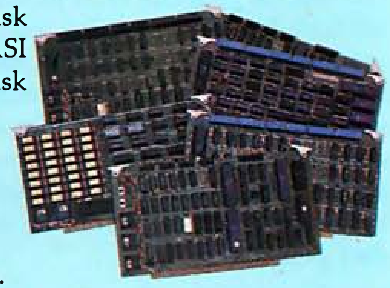

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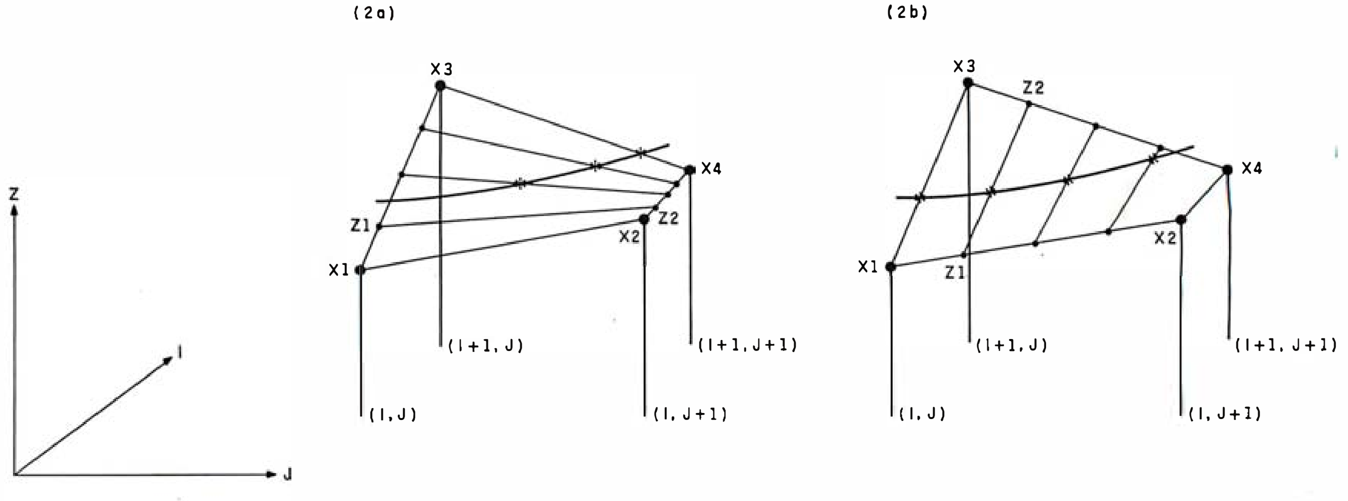

Figure 2: *Parts (a) and (b) represent two different interpolations through one cell of data. The cell is defined by the four adjacent observations X1, X2, X3, and X4, and the relative values of the I and J subscripts. The asterisks represent the dots that are plotted to produce a contour line. Each cell requires interpolation through the I dimension (a) and the J dimension (b). Note that the leftmost part of the contour line in (a) falls between interpolation steps and was not plotted until the second dimension (b) was addressed.*

One fully loaded Condot program in use at Rice University has routines for smoothing data, recovering data from tape, interactive polling values on a finished plot, and zooming to plot a selected part of a data array.

Even in BASIC, Condot is not unacceptably slow. It took me about 10 minutes to plot figure 1 with a Tektronix 4052 computer driving a Tektronix 4662 plotter. The same plot can be done on a CRT (cathode-ray tube) in about half that time. The data used for figure 1 was in an array of 960 points, 24 across by 40 high. The run time is not extremely sensitive to the size of the array because large arrays decrease the amount of interpolation that the program must perform. (Note that the 4052 is a fairly fast 16-bit machine using 6800s for bit-slice processing and a high-resolution storage tube for display.)

If you are really short of memory, you can nevertheless use this program. The Condot algorithm does not require that all the data be in memory at once. With some simple tricks, even a very modest home computer can be programmed to contour an array of 10,000 or more data points.

Algorithm and Program

A stripped-down version of Condot is provided in listing 1. You should be able to build your own custom contour plotter around this core. You'll need to provide the core with an ordered array of observations, F(A2,A1), and a vector, C(C1), of the contour values in increasing order. Set C0 equal to C(1), the lowest contour value, and M0 equal to some constant that represents missing values in the data array F(A2,A1). The ordering of F(A2,A1) is such that F(1,1) will be plotted at the lower left, and F(1,A1) will be plotted at the lower right.

The actual mechanics of the Condot algorithm are illustrated in figure 2. Don't worry about part b of the figure yet. I use four adjacent points from data array F to define a data cell. The subscripts of F define the relative values of the two independent variables (X and Y or I and J). The actual values in array F are observation data and define the "height" (Z value) at each corner of the data cell. This is the information to be contoured. Now, try to read this explanation with one eye on figure 2a and the other on the program listing.

Condot starts at the lower left corner of the data (F(1,1)) and works out along a pair of rows (J direction) before moving up to the next row. Each pair of rows defines A1 − 1 different cells. Therefore, the array of A1 points across by A2 points high defines (A1 − 1) × (A2 − 1) different cells to be contoured. Statements 100 and 110 start the cell-plotting loops. All the contours in one cell are plotted before Condot goes on to the next cell.

For convenience, the data points at the four corners of the cell under consideration are set equal to X1, X2, X3, and X4 in statements 140 to 170. Next, a check is made to see if all the corners are below the lowest contour value (C0), or if any of the corners contain the missing value flag M0. In either of these cases, because there is no need to do anything more with this cell, the loops are incremented and the next cell is considered.

Unless you have really boring data, the program will soon find a cell with one or more contours through it. Because most users of Condot will have better plotter resolution than data resolution, a systematic interpolation is begun across the cell so that the dots plotted fall close enough to each other to look like lines. First, calculate pairs of points along the lines from X1 to X3 and from X2 to X4, as in figure 2a, and look for contours between each pair of points. Later, follow the same procedure through the other dimension, as in figure 2b.

Statement 250 starts the interpolation loop corresponding to figure 2a. The step size, S2, should be between 0 and 1 and can be computed from the ratio of data resolution to plotter (or CRT) resolution in the I dimension. In other words, S2 relates to the width of a dot on the

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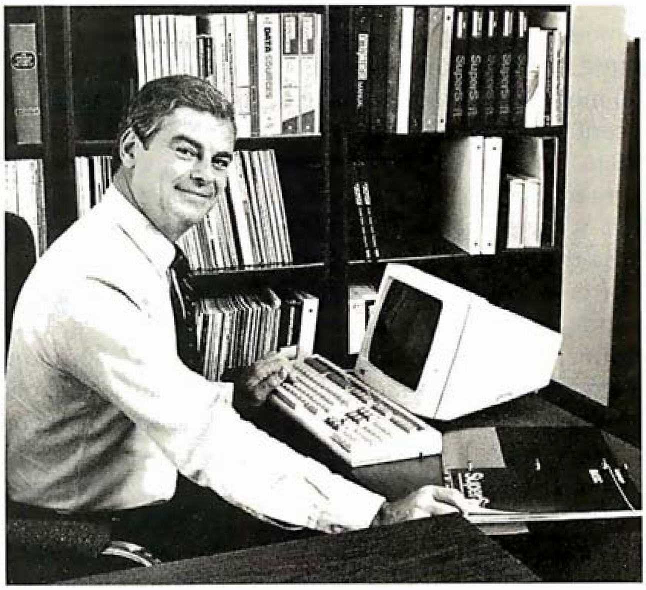

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plotter. As the interpolation loop steps from X1 toward X3 and from X2 toward X4, calculate Z1 and Z2 (the end points defining the line segment on which contour crossings will be plotted).

Condot uses a short subroutine, starting at line 650, to find all of the contour crossings on the Z1 to Z2 segment. The subroutine returns two numbers, C3 and C4, which are the lower and upper subscript values of the contours crossing the line segment. If no crossings are found, C4 ends up being less than C3, and statement 310 moves the program along to the next interpolation. If contour crossings are found between Z1 and Z2, lines 320 to 350 compute the parameters defining the line segment from Z1 to Z2. Then, the loop starting at 370 draws dots at the points where contours C(C3) through C(C4) cross the Z1 to Z2 line segment.

In case you haven't seen MOVE and DRAW commands, here's an explanation of how they work. Each command takes two arguments, the X and Y locations of a point on the screen or plotter. MOVE causes the pen to come up (if it is down) and move to the specified coordinate. DRAW lowers the pen (if it is up) and draws a line to the specified coordinates. Statement 560 first moves the pen, without drawing anything, to the coordinate R1, R2. Statement 570 lowers the pen and orders a line drawn to R1, R2. But because the pen is already at R1, R2, the result is simply a dot.

By now you probably have a good idea of how Condot works but might not see the reason for the two parts of figure 2. Suppose you had part 2a (interpolation through the I dimension) only. A contour line parallel to the J axis could fall between interpolation steps and never be found. To be sure no contour lines escape, you must interpolate through both the I dimension (2a) and the J dimension (2b) for every data cell.

Enhancements

You should be sure to build into your driver routine an input for the interpolation steps S2 and S3 in lines 250 and 440. Knowing your array dimensions and screen (or plotter) resolution, you can calculate the largest steps that will cause the dots to merge together. Being able to run Condot with interpolation steps of four to six times these values is a useful option. The larger steps give a preview of the final plot by making dotted instead of solid lines. Best of all, this preview runs in a fraction of the time the normal plot takes.

As mentioned earlier, Condot does not need an entire data array in memory at any one time. If you've got a whopping big array of data, or an 8K-byte computer, your best bet may be to work with only two rows of data in memory at a time. Specifically, read the first row of data into memory before reaching statement 100. Then, at statement 105, read row I + 1. At 605, after plotting the cells defined by this pair of rows, set the first row equal to row I + 1. In this way, you'll first use rows 1 and 2 to define the data cells, then use 2 and 3, 3 and 4, and so on.

Users of this routine should be aware of two things. First, you may have noticed that the interpolations in different dimensions in figures 2a and 2b actually define two slightly different surfaces through the data points that define the four corners of the cell. The only time you will notice this difference is when you try to plot a very small (for example, a 4 by 6) array of data. The second potential problem applies to users who employ conventional pen plotters for output. Because this algorithm draws dots, it generates a lot of PEN UP and PEN DOWN commands, which means wear and tear on the pen tip; also, some users may find their ears and sanity adversely affected. If a hard copy from your display is acceptable, you would probably be better off with it. Otherwise, just pretend the plotter is your mother's old sewing machine.■

Acknowledgments

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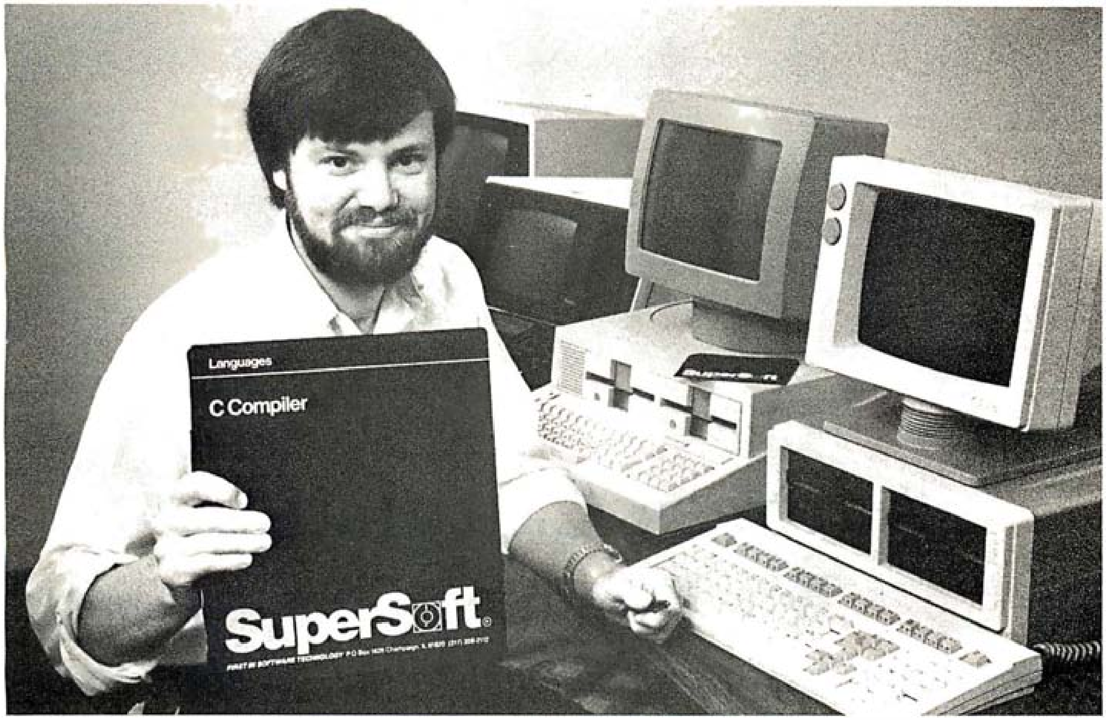

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Address Calculation
The Forgotten Sort

Sorting speed is directly proportional to the number of elements

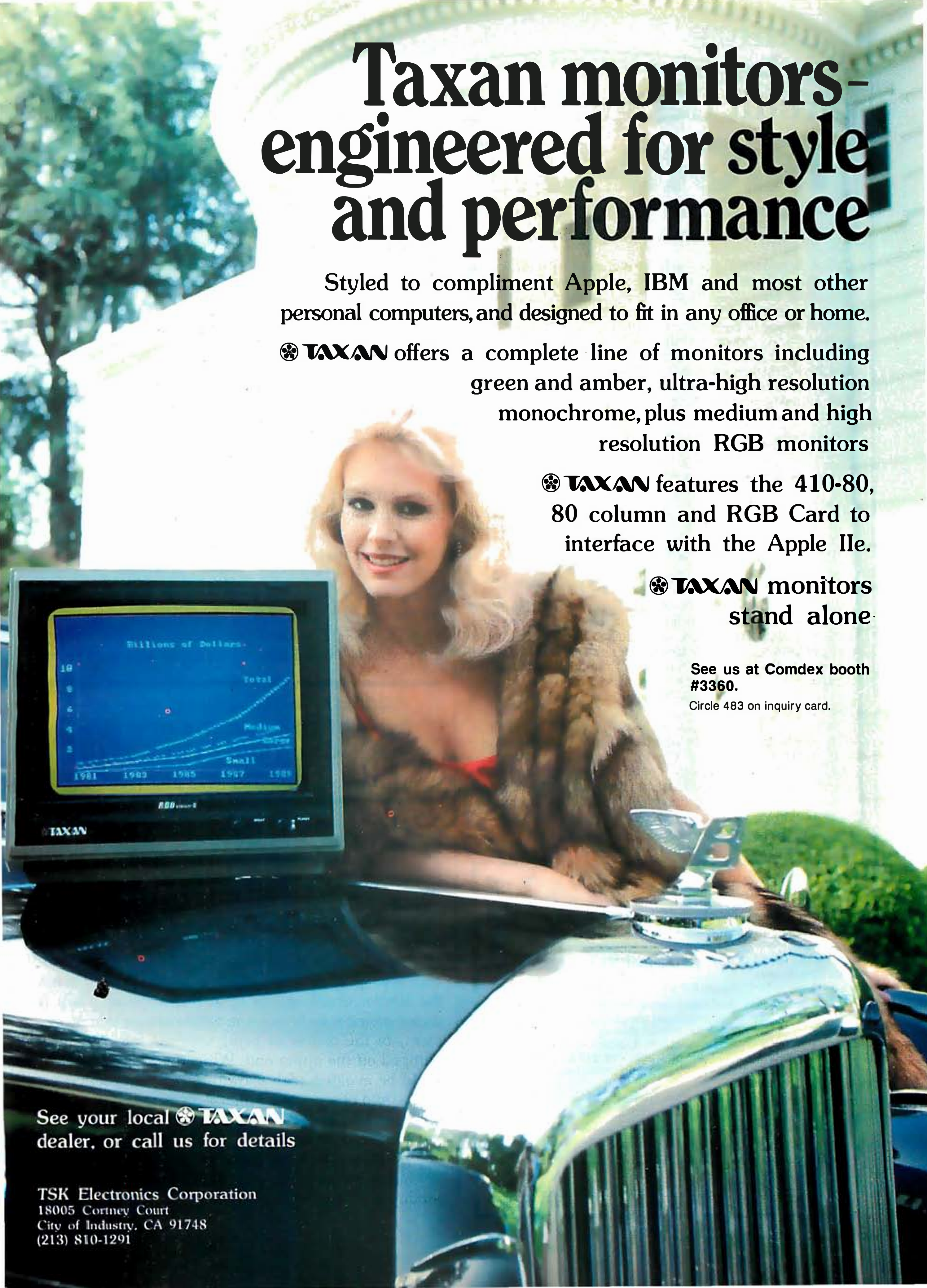
by Douglas Davidson

Most amateur programmers know a few sorting algorithms—bubble sort certainly, probably the maximum-minimum methods, and, on a slightly more advanced level, the shell sort. Some know the more efficient sorts, such as shuttle or tree sorts. The best of these sorting algorithms require time proportional to the number of elements to sort ($n*\log n$). What is not so well known is a sorting algorithm—and not a terribly complex one, either—that finishes in a time proportional to n (the number of elements to be sorted). Therefore, for some values of n, this sort must be faster than any of the other types. It generally goes by the name of "address calculation."

To be fair, some good reasons account for its lack of popularity. First, this method takes more than the minimum necessary amount of memory space to sort any given list; it requires additional storage proportional to n. However, in most microcomputer BASIC operations, storage requirements are not excessive, and the time savings may outweigh storage considerations. The second and more fundamental objection is that an address-calculation sort depends on the nature of the sorting keys. Most sorts use the key values only for comparison, simply checking whether one key is greater than another. This sort uses the actual value of the key.

For example, the address-calculation sort operates by first reserving a large range of memory for storage. It goes through its input list in order and, for each element, uses the key value to calculate an address within the reserved range. This mapping of keys to addresses is crucial. The operation is most efficient when the mapping is one-to-one (one element to one address), but practically it will be many-to-one. The only absolute restriction on the mapping is that it be nondecreasing, but it is important to the sort's efficiency that the greatest possible dispersion of the list elements into the range be achieved, or at least that the fewest possible collisions (mappings of two list elements onto one address) occur. These considerations require knowledge of the range and distribution of the keys. Because commercial programmers must make sorts as general as possible, address calculation is neglected. If the key distribution differs substantially from the rectilinear (from an even distribution, such as might be obtained from random generation), then the function to map keys onto addresses must become much more complex. But for microcomputer programming, often the key distribution is close to random, making the address-calculation sort a good choice.

With the appropriate address calculated, that location is checked to determine its status. If it is empty, the current list element is placed there, and the algorithm continues. If it is already occupied, then the element must be inserted in such a manner as to maintain proper order. When all list elements have been placed in the range, the program simply reads them off in order, ig-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Listing 1: *The address-calculation sort program. Written for the Apple II computer, the program will generate a list of random numbers, sort the list, and print the sorted list.*

```
10  INPUT N
20  DIM N%(N)
     :REM *** GENERATE RANDOM NUMBERS
30  HOME : INVERSE : PRINT " ";N;" RANDOM NUMBERS": NORMAL
40  FOR J = 1 TO N
50    N%(J) =  INT (65535 *  RND (1)) - 32767
60    PRINT J"."N%(J)
70  NEXT J
80  PRINT : INVERSE : PRINT " SORTED LIST ": NORMAL
     :REM *** SORT ROUTINE
90  I = 2.36 * N
100  BP = I / 65535
110  DIM A%(I + N)
      :REM *** MAIN LOOP
120  FOR X = 1 TO N
130    XA = X
140    V = (32767 + N%(X)) * BP
150    IF A%(V) = 0 THEN A%(V) = XA: GOTO 190
160    IF N%(A%(V)) > N%(XA) THEN XB = XA:XA = A%(V):A%(V) = XB
170    V = V + 1
180    GOTO 150
190  NEXT X
      :REM *** PRINTOUT
200  C = 0
210  FOR J = 0 TO I + N
220    IF A%(J) THEN PRINT C"."N%(A%(J)):C = C + 1
230  IF C <= N THEN NEXT J
240  END
```

noring unused elements of the range, and places them in the output list.

Test Program

Listing 1 is a formatted listing of an Applesoft version of a test model address-calculation sort. The loop in lines 40 through 80 generates *n* random integer variables (−32767 to +32767) and prints them out. The variable I represents the number of locations allocated to the

Address calculation is one of a type of sorts whose operation depends on the nature of the sorting keys.

range (more about the 2.36 later). The address-mapping function is a simple linear one; keys are multiplied by a constant BP to linearly map them onto the range 0 to I. A sort of string variables would compute a numerical value from the first so many characters, weighting them by position. Significantly, the actual list elements are not placed in the array A%; rather, indexes representing their location in the input list N% are used. A considerable space saving for lists in which the key is not the whole record results from this approach. A% is dimensioned at I+N (see line 110) to ensure that no element, in the course of being inserted into A%, gets bumped off the upper end. While this wastes space, it could be avoided with extra programming; however, that would obscure the primary ideas in this example. The main loop goes through the list in order, computing the address V from the key. If the location is vacant, line 150 places the index there. Otherwise, lines 160 and 170 insert the index in a higher location. The process produces a "ripple" up the line, exchanging smaller

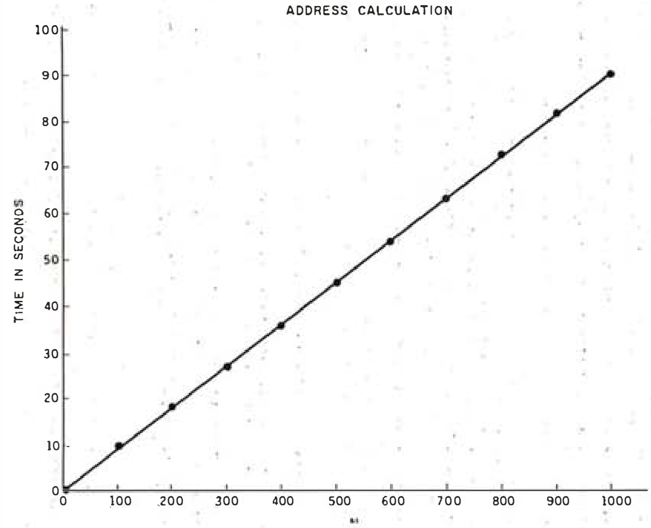

Figure 1: *The Address Calculation Response Chart. The amount of time required to sort a list is directly proportional to the number (n) of elements in the list.*

elements into place so that the highest element encountered gets placed in the next vacant location by line 150. Once all the indexes are in place, lines 200 through 230 print the results. You could just as easily place them in another array. The counter C saves time by halting the printout upon locating all the elements.

Efficiency vs. Speed

I still have not justified my grandiose claims for the sort's speed. While the full mathematical treatment is unnecessary, some discussion is in order. Note first that the time used by the printout loop remains proportional to the value of I (the number of locations assigned to the range). This provides a motive for keeping I as small as possible, and if I is made proportional to *n*, then the time taken by this loop will also be proportional to *n*.

The time taken by the main loop would be proportional to *n* if there were no collisions (that is, if lines 160 and 170 went unused). The number of collisions decreases as I increases, providing a reason for wanting I to be as large as possible. Counterbalancing the two considerations shows that the optimum value for I will be proportional to *n*; the time taken in the main loop then also turns out to be proportional to *n*. The actual constants of proportionality depend on the implementation. These arguments are validated experimentally by figure 1, based on numerous timings of a stripped-down version of listing 1 run on an Apple II Plus. The diagram consists of a line plotted on top of points representing averages of several runs at near-optimum I. The optimum time turned out to be slightly greater than 9 seconds per 100 *n*. The optimum value for I was calculated to be about that used in listing 1; namely 2.36*N. Regardless of the implementation, the optimum ratio of I to *n* should be about 2.5 $\pm .5$, with little variation of time within that range.

Summary

The address-calculation sorting algorithm provides a fast, not terribly complicated sort for lists the nature of whose keys and distribution is generally known. For special purposes, it can provide the most efficient sorting available.■

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Smartmodem 1200 [5]	699	509
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NEC		
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CBASIC 86	*200*	*150*
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Despool	50	38
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Smartmodem 1200	699	499
Smartmodem 300	279	209
NEC		
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Fast Loading with Apple DOS 3.3

by John Williams

Apple DOS 3.3 normally takes considerable time to load a large file. You can improve the DOS (disk operating system) file-loading operation, however, by using a program called Loader that increases by as much as five times the speeds of the LOAD and BLOAD (used for binary files) procedures. Loader also quickens RUN and BRUN operations, which execute the program in memory. (DOS's file-saving operation is also slow; that rate is less crucial, however, because most files are saved only once but might be loaded many times.)

DOS modified by the Loader program works with any standard 16-sector disk and stores files on a disk the way standard DOS does. With this enhanced system, files can be read from disks written with regular DOS or from commercial disks that use the standard DOS format.

Tracks and Sectors

Before I describe how Loader works, let's consider the operation of standard DOS. DOS stores data on disks that contain 35 concentric tracks; each track includes 16 sectors. A sector contains 256 bytes of code (or data). The DOS routine RWTS (read or write track and sector) can be used to read or write any complete sector but cannot read a partially filled sector.

When a sector is to be read or written, RWTS starts up the disk drive, moves the disk-drive head to the appropriate track, and waits for the sector to arrive at the disk-drive head. If the disk is already running and the head is on the appropriate track, there's just a short delay while the head waits for the sector.

DOS writes a file to disk filling one track at a time, using sector 15 first, sector 14 next, and so on down to sector 0. If a sector is already filled, DOS skips it and fills the next one.

At first, such a scheme appears inefficient; if you want sector 15 read first and sector 14 read next, you'll have to wait 14/16 of a disk revolution for that sector to come around. To speed the process, the designers of DOS arranged RWTS so it does not handle the disk sectors in the ordinary numerical sequence.

Instead, RWTS uses a look-up table to translate the sector number it receives into a number that indicates that sector's actual position on the disk. Table 1 illustrates how the sector and position numbers correspond. (Position 0 immediately follows position 15.) Thus, the sectors in a normal DOS file are arranged such that there is always a spare sector position between one file sector and the next, which gives the RWTS routine sufficient time to read a file sector, process it (while the 256 bytes in the next position pass unread under the disk head), and return just in time to catch the next file sector. Consequently, RWTS can read a complete track in slightly more than two disk revolutions, starting at position 15 and ending at position 0. At this rate, in fact, the routine can read an entire file at three revolutions per track: two revolutions to read and less than one revolution to move the head to the next track.

DOS Files

Because the RWTS routine determines the position of each sector in a track, you might reasonably expect that DOS file operations are carried out as quickly as possible. Unfortunately, a snag delays the procedure. Although RWTS reads sectors efficiently, it reads only complete sectors: that is, sectors containing 256 bytes. Most files, however, do not completely fill all sectors allocated to them; the last sector of each file probably includes some unused bytes. Moreover, the first few bytes of such files contain control information, which should be intercepted and not transferred to user memory.

Programs, therefore, often use DOS to read files one line or one record at a time, which results in proper handling of control information without cluttering user memory. Furthermore, this capability to read one line or record at a time can prevent transfer of unused bytes to user memory at the end of a file's final sector.

To provide such capability, however, DOS gives up some of the efficiency of RWTS. For example, to read the first record of a file, DOS must transfer (using RWTS) the complete first sector of the file into a DOS buffer area and copy the record to the user-program buffer. Then, to read the next record, DOS simply copies subsequent bytes from the DOS buffer to the user-program buffer. When the DOS buffer is empty, DOS goes to the next sector. The process continues until the entire file is read. Because DOS copies from a buffer, only the exact amount of data needed is written to the chosen locations in user memory; the areas adjacent to those locations are not disturbed.

The procedure I've just described solves the problem of reading less than a complete sector; however, it is time-consuming. Because copying each file in and out of the fixed DOS buffer slows the reading process, DOS gets back to RWTS too late to catch the next sector; RWTS must wait nearly an entire disk revolution for the sector to come around again. Consequently, instead of requiring three disk revolutions to read a file, DOS 3.3 needs 18 revolutions (i.e., it's six times slower).

Sector	Position
15	15
14	2
13	4
12	6
11	8
10	10
9	12
8	14
7	1
6	3
5	5
4	7
3	9
2	11
1	13
0	0

Table 1: *The RWTS routine uses this look-up table to determine each sector's actual position on the disk.*

Fast DOS

LOAD and BLOAD use such a procedure in DOS to transfer from disk to memory the body of a file as well as the first and final sectors. By placing a jump command in the proper place, however, you can bypass this procedure and substitute the Loader routine, which affects only LOAD, BLOAD, RUN, and BRUN.

With Loader implemented, these commands start as they usually would: DOS performs all of the normal syntax checks, reads the first sector of a file into the DOS buffer, and sorts out the file address and length. Loader then takes over, copying bytes from the DOS buffer containing the first sector of the file. If the file is sufficiently short to be contained in that one sector, the job is done; Loader returns to DOS, which furnishes a prompt or runs the file. However, a file usually fills additional sectors.

As long as there are 256 bytes or more to be read in the file, Loader calls RWTS, which in turn transfers the next sector directly to memory, repeating this process until fewer than 256 bytes remain. Because Loader places the sectors directly in memory, it need not do any copying and can get back to RWTS in time for RWTS to catch the next file sector. As a result, RWTS does not have to wait one disk revolution, and Loader reads the bulk of the file at full speed.

At the end of the file, there usually remains a partially filled sector (of 255 bytes or less) to be read. Loader uses RWTS to read such a sector to the DOS buffer area and then copies the correct number of bytes into the appropriate place in memory. Therefore, as with normal DOS, only the exact memory area involved in the LOAD or BLOAD operation is disturbed.

The Loader program itself is small, containing about 250 bytes. It uses the same locations in page-zero that

Programming Quickies

Listing 1: *A numeric listing for the Loader program, which speeds loading times under Apple DOS 3.3. The program is for use on the 48K-byte version of the Apple II.*

```
BEAF: A9 00 4C 43 BE AD C9 B5 8D 6C BF 8D 75 BF AD CA
BEBF: B5 8D 6D BF 8D 76 BF AD CB B5 8D F8 BE AD CC B5
BECF: 8D F9 BE EE BD B5 38 AD C3 B5 ED BD B5 85 42 AD
BEDF: C4 B5 E9 00 85 43 AC BD B5 AE C1 B5 8A D0 08 AD
BEEF: C2 B5 F0 53 CE C2 B5 CA B9 00 96 91 42 C8 D0 EC
BEFF: 8C E8 B7 8E C1 B5 A9 0E 8D C6 B5 E6 43 AE C2 B5
BF0F: F0 1A A5 42 8D BF B5 A5 43 8D C0 B5 20 49 BF EE
BF1F: C0 B5 CE C2 B5 D0 F5 AD C0 B5 85 43 AD CB B5 8D
BF2F: BF B5 AD CC B5 8D C0 B5 AE C1 B5 F0 04 20 49 BF
BF3F: AE C1 B5 A0 00 F0 A5 4C EA A2 AC C6 B5 D0 0D AD
BF4F: C9 B5 AE CA B5 A0 01 20 65 BF A0 0C AD BF B5 AE
BF5F: C0 B5 20 65 BF 60 8D F0 B7 8E F1 B7 B9 00 97 F0
BF6F: 18 8D EC B7 C8 B9 00 97 8D ED B7 C8 8C C6 B5 A9
BF7F: B7 A0 E8 20 B5 B7 B0 08 60 20 EA A2 A2 05 D0 05
BF8F: 20 EA A2 A2 08 68 68 68 68 8A 4C D2 A6
A477: 4C B4 BE
```

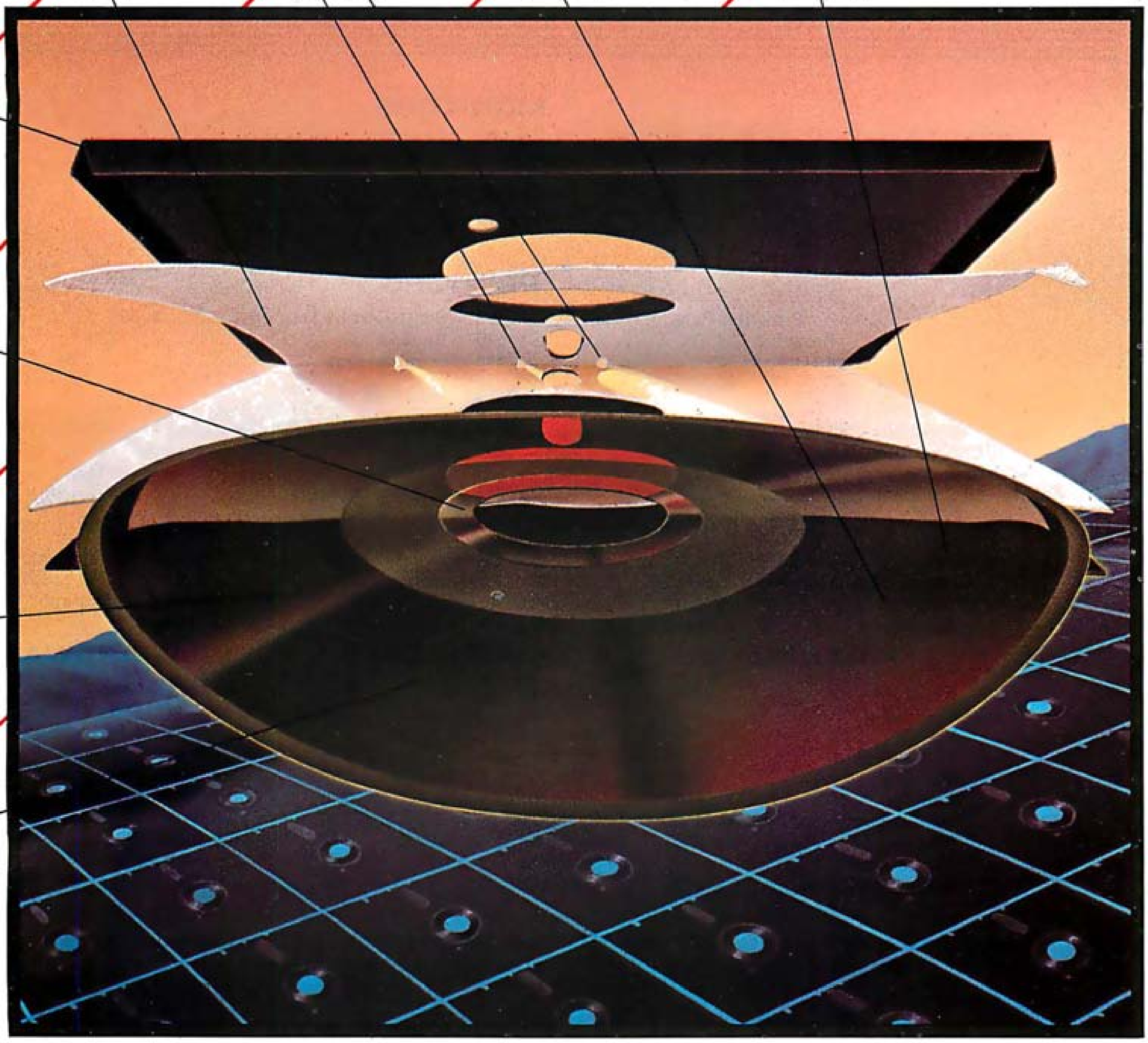
normal DOS routines use. But where is the best place to keep these 256 bytes so they won't affect user programs?

Loader fits in the area usually taken up by the disk formatter. The DOS formatting routines that make up the formatter are used to initialize a disk, and you don't really need a copy of them on every program disk.

The DOS modified to contain Loader cannot format an unused disk, but the INIT command works if the disk being written has already been initialized. INIT clears the catalog on the disk, then writes onto the disk a copy of DOS that includes Loader. The modified DOS cannot change the disk's volume number, however, so you must maintain the same volume number, set with the V option. Otherwise, DOS signals a VOLUME MISMATCH error.

You can modify DOS in memory by entering the Apple Monitor and typing in the code provided in listing 1. (The code was written for a 48K-byte Apple II.) When you have finished typing, reenter DOS using Ctrl-C, set up a Hello program, insert a previously initialized disk, and type INIT HELLO, followed by the disk's volume number (e.g., V254). This procedure stores a copy of the modified DOS on the disk. After you have one copy on disk, you can either read it in and initialize other disks in the same way or use a disk-copying utility. Make sure you have an initialized disk that you are prepared to reinitialize with the modified DOS before you complete all the necessary typing.■

John Williams spent many years working for British computer companies. He now works for Bell Northern Research in Ottawa, Canada. He can be reached at 18 Banting Crescent, Kanata, Ontario, Canada K2K 1P4.



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A Simplified Algorithmic Approach to Decision Tables

Decision tables can yield structured programs suitable for use on personal computers

by Joe Celko

Decision tables—a system-analysis technique whose time has come and gone and come back again—are graphic representations of logic problems.

They take the form of a table or array and are made up of lists of conditions and lists of possible actions. A proper action is selected by reading the decision table to see which conditions control that action. When the set of conditions meets the requirements for an action, then that action is taken.

Decision-table techniques were developed in the late 1950s and early 1960s to solve manufacturing problems. By 1961 and 1962, computer programs could operate on decision tables, but by the middle 1960s interest died out.

Decision-table techniques fell out of use because flowcharts became popular, and the amount of computer resources required to handle small decision tables for individual programmers was not worth the cost in terms of storage and execution time. Applications for the really huge decision tables were not found all that often, either.

The main reason for the renewed interest in decision tables is that they are a good tool to use with structured programs. They can represent the complex logical expressions that can appear in structured programs in a compact space and in a form that can be manipulated to produce optimized, structured code using CASE or nested IF. . .THEN. . .ELSE statements. Computer time and storage are now much cheaper, and I recommend that any professional programmer have a decision-table package for his or her personal computer.

The method presented here is a shortened and simplified form of other techniques. Although no programs are given here, the method is designed with ease of programming implementation in mind. The use of +1 and −1 makes it easy to perform the operations of decision tables discussed here.

The Decision-Table Format

A decision table is made up of three areas: conditions, which are labels on the rows; actions, which are labels on the columns; and rules. A rule is the collection of conditions for one action or, put another way, the vertical grouping of values in the array formed by rows and columns.

The conditions are Boolean expressions that can be true or false. They should be independent of each other and as simple as possible. Conditions such as "sex is male" and "sex is female" should not both appear because one is simply the negative of the other. On the other hand, a compound condition such as "(A>1) AND (A<5)" might be better written as the two simple conditions "(A>1)" and "(A<5)."

The actions can be procedure calls, code modules, pseudocode, or some other action to be taken by the program being designed. The actions do not have to be unique. In fact, it is quite likely that an action can be triggered by several sets of conditions in a complex pro-

C1: CORNER HAS LIGHT	+1	+1	−1	−1
C2: CORNER HAS TREE	+1	−1	+1	−1
	A1: DRIVE AHEAD	A2: TURN LEFT	A3: TURN RIGHT	A1: DRIVE AHEAD

Figure 1: *A decision table for a set of traffic directions: "Drive straight ahead until you come to an intersection with a traffic light but no tree, then turn left. When you come to an intersection with a tree and no light, turn right."*

gramming problem. Decision-table programs should include an action that reports errors; that is, condition sets that aren't expected to occur but that might appear during decision-table manipulation because of programming mistakes or other such problems. The action ''do nothing'' could be another possible outcome in any decision table. Just be aware that to perform the ''do nothing'' action is to do something, as far as a program is concerned.

The decision-table rules have one of three symbols in them; +1 means ''yes'' or true, −1 means ''no'' or false; and 0 means ''don't care.'' The use of the numbers 1 and 0 instead of letters like Y and N or T and F makes the table operations easy to program.

Figure 1 is a decision table for a set of traffic directions: ''Keep driving straight ahead until you come to an intersection with a traffic light but no tree, then turn left. When you come to an intersection with a tree and no light, turn right.''

Transformations for Decision Tables

Some obvious transformations can be performed on decision tables to keep them simple. The conditions for these transformations do not often appear explicitly but show up after an expansion is performed on the decision table. The transformations are:

1. Remove any duplicate columns. Such duplicates have the same rules and actions as another column in the decision table. In practice, this condition does not occur very often.
2. Remove any duplicate rows. In practice, this condition does not happen very often, either.
3. Remove any condition with all 0 rules. Because such conditions indicate a ''don't care'' state, they can't influence whether an action is performed.
4. Remove any action with all 0 rules. Such an action is always to be performed; thus, you need not make a decision regarding it in the first place.

Note that if two different actions have the same rules, then they are in contradiction. Figure 2 shows a decision table that has some contradictions in it.

For example, the condition C1= +1, C2= 1, and C3= +1, written as the vector (+1, −1, +1), satisfies the left-hand-column requirements for A1 as well as the right-hand-column requirements for A2. Representing the rules as vectors in the form (C1, C2, C3), the two actions A1 and A2 can both be triggered by inputs of (+1, −1, +1), (−1, +1, −1), (−1, +1, +1), and (+1, +1, +1).

Such errors most likely show up when a decision table is expanded (a transformation that I'll discuss in the next section). Contradictions are often introduced when a system is used by two or more groups of people. Having no overall picture of the system, each group makes different assumptions, and contradictions result. The decision table is a good tool for detecting such problems and explaining them to users.

Expansion and Contraction Transformation

Two important transformations can be performed on a decision table: expansion and contraction. The other transformations discussed so far were really just housekeeping. These two major transformations allow us to test a decision table for correctness and to rewrite it in the best possible form.

The expansion transformation can be defined as follows:

1. Replace every column having a 0-valued rule with two columns. For a column having more than one 0, pick one particular 0 in that column with which to work. The two resulting columns are identical to the old except that one has a +1 in the position where the 0 was and the other has a −1 in the position where the 0 was. The action stays the same.
2. Repeat step 1 until the decision table has no 0 rules left.
3. If all possible values of true and false are not represented, add to the decision table new columns that have the missing combinations and an error (or undefined) action.

The purpose of expansion is to see that there are no contradictions in the decision table and to show programmers any rules they may have overlooked.

The contraction transformation is just the opposite of expansion, and it can be defined as follows:

1. If two columns are identical except that one has a +1 in one and only one position and the other has a −1 in that same position, then replace both of them with a single column that has a 0 in the position.
2. Repeat step 1 as often as is possible.

C1:	+1	−1	0	0
C2:	0	0	+1	0
C3:	0	0	0	+1
	A1	A2	A1	A2

Figure 2: *A decision table with four hidden contradictions. A contradiction occurs when one set of conditions satisfies the rules for two different actions. When the rules are represented as a vector of the form (C1, C2, C3), the contradictions in this table are (+1, −1, +1), (−1, +1, −1), (−1, +1, +1), and (+1, +1, +1). Note that the 0s in the decision table represent "don't care" conditions. Thus, for example, the first contradiction (+1, −1, +1) satisfies the left-hand-column rules for A1 (the first +1 satisfying the upper left-hand-corner entry and the −1 and second +1 satisfying the left-hand column's 0 entries) and the right-hand-column rules for A2 (the second +1 satisfying the bottom right-hand-corner entry, and the first +1 and the −1 satisfying the right-hand column's 0 entries).*

(3a)

C1:	+1	+1	+1	−1	0	0
C2:	+1	−1	−1	0	+1	+1
C3:	0	+1	0	+1	+1	−1
C4:	0	0	+1	+1	0	+1
	A1	A2	A2	A3	A1	A4

(3b)

C1:	+1+1+1+1	+1 +1	+1+1	−1−1	−1+1−1+1	+1−1	+1−1−1−1−1
C2:	+1+1+1+1	−1−1	−1−1	+1−1	+1+1+1+1	+1+1	−1+1−1−1−1
C3:	−1+1−1+1	+1 +1	+1−1	+1+1	+1+1+1+1	−1−1	−1−1+1−1−1
C4:	+1+1−1−1	+1 −1	+1+1	+1+1	+1+1−1−1	+1+1	−1−1−1−1−1
	A1	A2	A2	A3	A1	A4	ERROR

Figure 3: *A decision table (3a) and its expanded form (3b). Note that none of the five error columns is duplicated elsewhere in the table; the condition combinations represented by these error columns should not occur in the real-world situation modeled by the decision table.*

(4a)

C1:	+1	+1	0	0
C2:	+1	−1	0	0
C3:	0	0	−1	+1
C4:	0	0	+1	+1
	A1	A2	A3	A4

(4b)

C1:	+1	+1		0	0
C2:	+1	−1		0	0
C3:	0	0		−1	+1
C4:	0	0		+1	+1
	A1	A2		A3	A4

(4c)

C1:	+1	+1
C2:	+1	−1
	A1	A2

C3:	−1	+1
C4:	+1	+1
	A3	A4

Figure 4: *Because of the arrangement of its zero entries, the decision table in figure 4a can be split into subtables (4b) to yield two independent decision tables (4c).*

The purpose of contraction is to reduce the physical size of the decision table. This serves two purposes. First, a person can handle a smaller table more easily than a large one. Second, it simplifies the application of algorithms to generate programs from the decision table. Very often, columns can be contracted in several ways. This is especially true for the error conditions, but if too many error conditions can be reduced, then the conditions might have been less independent than possible.

Figure 3 serves as an example. First, it is expanded and then inspected. Rules 1 and 6 are contradictory, as are rules 4 and 5. Rules 1 and 6 both expand to include the rule (+1, +1, −1, +1). Rules 4 and 5 both expand to include the rule (−1, +1, +1, +1).

Furthermore, there are five missing rules that have to be assigned error actions. These are shown as extra columns on the right-hand edge of the expanded decision table.

Rules 1 and 5 have redundancies, as do rules 2 and 3. Rules 1 and 5 both lead to action A1 for rules (+1, +1, +1, +1) and (+1, +1, +1, −1). Rules 2 and 3 both lead to action A2 for rule (+1, −1, +1, +1).

Redundancy can be handled by ignoring it because it is harmless or by carefully replacing a 0 value in one of the rules with a +1 or −1. For example, if we decide to leave rule 1 alone, we can replace the present rule 5, which is (0, +1, +1, 0), with (−1, +1, +1, 0). It's wise to remove the extra rules because they make the decision table bigger than it needs to be.

Independent Subtables

Many times a decision table really is a collection of several separate decision tables with no logical relationship among all the conditions. Combining several independent decision tables into one is not a good way to draw a decision table, but it often happens in the real world because of the way people specify program requirements. Conditions are often considered to be related because they occur in the same place and at the same time. This means that two sets of actions and two sets of conditions have ''don't care'' values in the rules where they overlap. A sample decision table is shown in figure 4.

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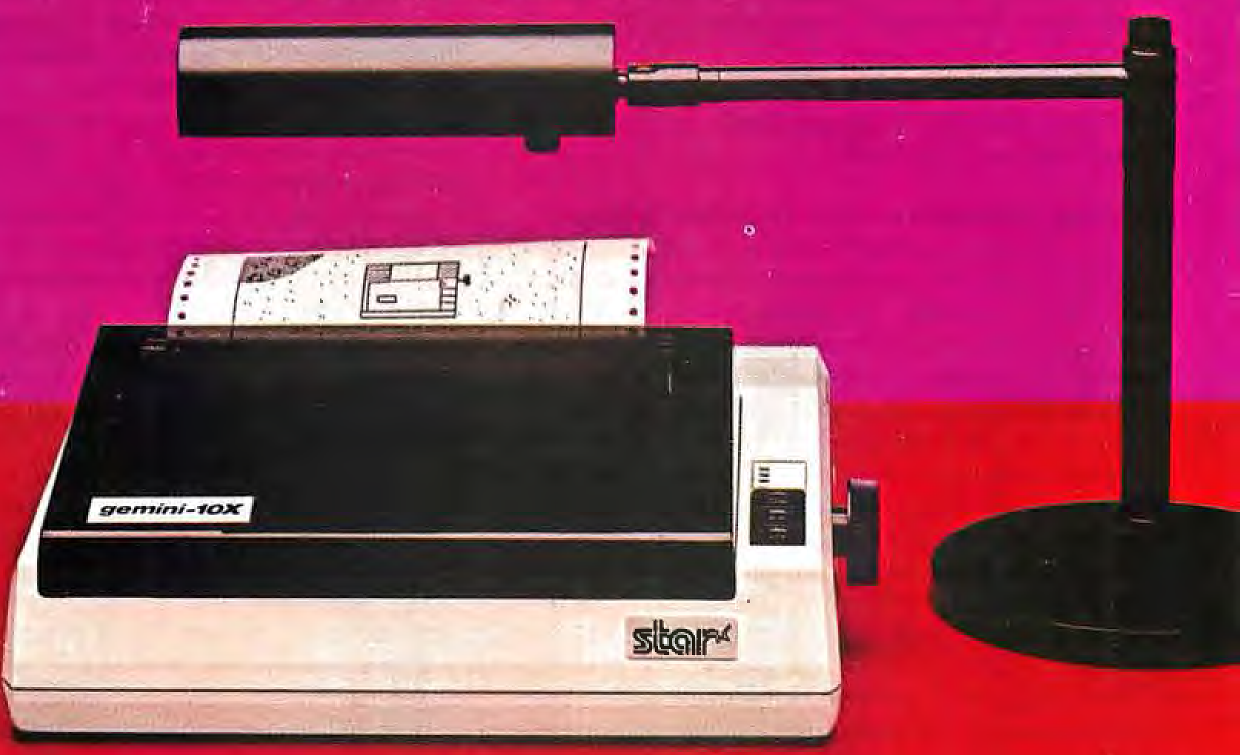

					ROW TALLY
C1:	+1	+1	-1	-1	0 ← LOWEST
C2:	0	-1	+1	-1	4
C3:	+1	-1	0	0	4
C4:	0	0	+1	+1	6
	A1	A2	A3	A4	
COLUMN TALLY	4	2	2	2	

Figure 5: *Column tallies are computed by counting the number of 0s in a column and raising 2 to that power. To compute a row's tally, add the column tallies corresponding to each 0 entry in that row.*

Listing 1: *The program corresponding to the figure 5 decision table.*

```
IF C1
THEN IF C3
     THEN A1
     ELSE IF C2
          THEN Error
          ELSE A2
ELSE IF C2
     THEN IF C4
          THEN A3
          ELSE Error
     ELSE IF C4
          THEN A4
          ELSE Error
```

Here is a simple transformation to split out the independent subtables:

1. Rearrange the rules of the decision table (either rows or columns) so that it can be partitioned into subarrays with zero subarrays on the minor diagonal.
2. Split the decision table into four separate and independent decision tables that correspond to the subarrays.
3. Throw out the two decision tables with all 0s.
4. Repeat the procedure, if applicable, on the two remaining decision tables.

This transformation gives you much smaller decision tables with which to work.

Program Generation from Decision Tables

When the decision table is finally free of redundancy and contradictions, you'll want to convert it into nested series of IF. . .THEN. . .ELSE statements. These statements give you part of a structured program. If you can make this conversion automatically, so much the better.

The quick way to do this task is to pick one condition and use it as the control expression in an IF. . .THEN . . .ELSE statement. The two branches of the IF. . . THEN. . .ELSE statement are subtables made up of the conditions and actions for which the first condition is true and false, respectively. This procedure is continued for each subtable until the entire decision table has been converted into a nest of IF. . . THEN. . .ELSE statements.

The problem with this approach is that there are many ways to generate a program from a single decision table. This is a blessing in a way because it means that a decision table represents all possible valid programs. By having the decision table in the program documentation, should anything change you can restructure the program without having to mess with horrible nested IF. . .THEN. . .ELSE statements.

Unfortunately, the number of possible generated statements is huge. If there are n conditions, you have n possible ways to pick the highest level control expression. Each of the two branches of the highest level control expression has $n-1$ possible control expressions, and so on. For two conditions this is simply two possible arrangements, and three conditions have 12 possible arrangements. But four conditions have 576 possible arrangements. It gets worse as n gets bigger.

It would be nice to know that you are generating the optimal program code from the decision table. Obviously a brute force approach will not work, simply because of the number of possible statements.

There is a fairly simple procedure that provides good results most but not all of the time. When it fails to produce the best possible program code, it at least produces something close. The algorithm is illustrated by the table in figure 5 and the code in listing 1. The steps of the algorithm are:

1. Contract the decision table and presume that any rule not in the decision table will result in an error action.
2. For each column, compute a column tally by counting the number of 0s and raising 2 to that power. If it has no 0s, its tally is 1; if it has one 0, its tally is 2; if it has two 0s, its tally is 4, and so forth.
3. For each row, compute a row tally by adding the column tallies corresponding to the row's 0 values.
4. Split the decision table on the condition with the smallest row tally. In the event of a tie between two or more conditions, use the condition with the most equal distribution of +1s and −1s. This results in a more balanced nesting of statements.
5. Repeat this procedure on each subtable until it halts.

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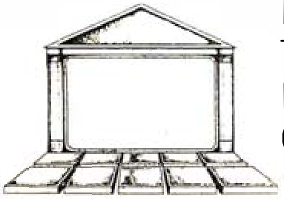

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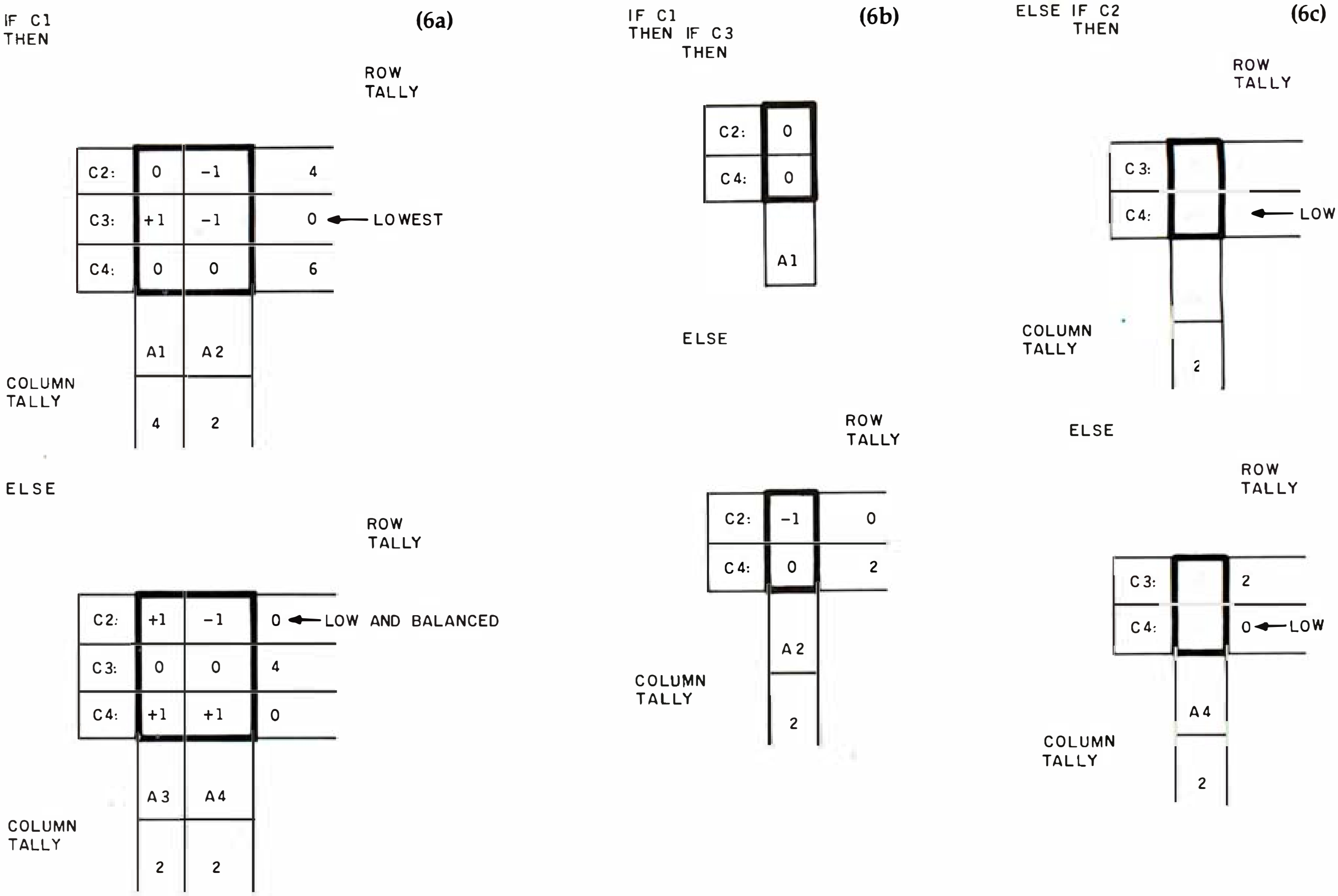

Figure 6: *Program development for the figure 5 decision table. To start, select the row with the lowest row tally (the C1 row in figure 5) and construct a new decision table out of the figure 5 table entries for which C1 is true (see figure 6a). Note that if C1 is true, then A1 or A2 must be performed; A3 and A4 are eliminated. Then, construct a new table out of the figure 5 table entries for which C1 is not true (which dictates A3 or A4, eliminating A1 and A2). Similarly, construct new tables from each resulting table until each action is specified. Figure 6b shows the transformation of the first subtable and 6c shows the transformation of the second subtable.*

A subtable with all 0s can be replaced immediately with a call to its action procedure. A subtable with only one condition can be translated immediately into an IF. . .THEN. . .ELSE statement; just remember that any rule not explicitly given is an error.

Figure 6 works out a table into code, showing the subtables as part of the code. Note that the branches of the different IF. . .THEN. . .ELSE statements do not both pick the same condition for the next application of the algorithm. Many people tend to write code that uses the same condition for the next level at each branch just because it looks symmetrical.

This procedure can be modified to take care of situations in which the programmer has special knowledge of the data. This is done by adding weights to the tallies. For example, imagine a decision table with only three conditions, C1, C2, and C3. If C1 requires 10 units of computer time, C2 requires 5 units, and C3 requires 1 unit, then C3 should be the highest control expression of the IF. . .THEN. . .ELSE statement. It's easy to see why with a little thought. If we have to test all three conditions, then it is going to cost 16 units of computer time no matter what we do. However, if we can arrive at an action by testing just C3, then we have spent only 1 unit. If we can arrive at an action by testing just C2 and C3, then we have spent only 6 units. By arranging the statement carefully, we can save a lot of computer time.

Hints for Program Design

The use of −1, 0, and +1 in this article was planned to allow reduction operations to be performed by simple arithmetic.

Clearly the rules can be represented as an array in a program. The columns can be expanded, then sorted. Once sorted, the contradictions and redundancies will show up. Finally, the array can be compared to all possible rules, generated by nested loops.

In real applications, a program that can handle a dozen conditions is probably quite large enough. This would require only a little over 4K bytes to store, which is no trouble for a small computer.■

Joe Celko (POB 10558, Atlanta, GA 30310) is a research scientist at the US Army Institute for Research in Management, Information, and Computer Science. Educated at Georgia Tech, he is a science-fiction fan and a computer columnist.

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Subscripts and Superscripts for the Atari

You can use ANTIC 3 mode to create specialized character sets

by Tim Kilby

The Atari computers give you tremendous flexibility in defining your own character sets and providing a practical mode in which to use them. One special mode, ANTIC 3, allows for characters with true descenders, superscripts, and subscripts. This means that you can create a specialized character set for many applications, including chemical and mathematical formulas (see listing 1).

Starting from GRAPHICS 0

ANTIC 3 cannot be addressed directly; you must modify a GRAPHICS 0 display list to use this mode. A simple routine to do that is shown in listing 2. Run this routine and you will see that you now have 19 lines of text, each line capable of holding 40 characters. The format looks like a GRAPHICS 0 display, just spaced farther apart.

If you try displaying lowercase letters on the screen, you'll see something definitely different about this mode. In ANTIC 3, the first 2 bytes of character data are read last. (Remember, there are 8 bytes of shape data per character.)

That's right. The computer reads the third shape byte first, then the fourth, fifth, and so on. After the eighth byte, it reads the first and second bytes. This only happens for the 32 lowercase characters and symbols, characters 96 through 127.

Why, you are probably asking, this strange way to read character data? Each mode line in ANTIC 3 is actually 10 scan lines tall, unlike the 8 lines in GRAPHICS 0 mode. For all characters, except the last 32 in the set, the system prints the character using the top 8 scan lines in the stack of 10. ANTIC 3 was designed to display lowercase descenders, the tails on *y*s, *g*s, etc. So for those last 32 characters, each is printed in the unusual sequence of bytes illustrated in figure 1. Not all the lowercase internal characters will work. With specially designed lowercase letters, however, descenders really look descended.

Listing 1: *This output from the ANTIC 3 Demonstration Program displays the use of lowercase descenders, superscripts, and subscripts.*

$AgNO_3 \quad + \quad KBr \quad \rightarrow \quad AgBr\downarrow \quad + \quad KNO_3$

$(x^2+y^2)^2=4(x^2-y^2)$

READY

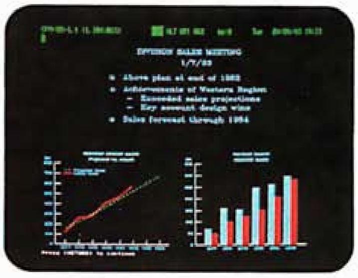
Listing 2: *The GRAPHICS 0 Display List Modification Routine.*

```
10 GRAPHICS 0
20 DL=PEEK(560)+256*PEEK(561)
30 POKE DL+3,67
40 FOR I=0 to 17:POKE DL+I+6,3:NEXT I
50 POKE DL+24,65:POKE DL+25,PEEK(560):
POKE DL+26,PEEK(561)
```

The quick and easy way to redesign this last quarter of the character set is to use one of the several published or commercially available character-set editors. Characters that are so tall as to have dots in the second byte, the second row from the top, will have to be lowered. The *b*, *l*, *t*, *i*, and *h* characters are examples. I suggest lowering all lowercase characters by using the shift-down option of your editor. If your editor doesn't have that option, you will have to do the shifting manually. Shift all lowercase characters down 1 byte.

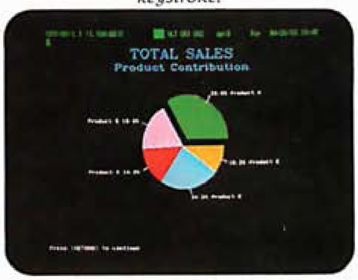
For true descenders, redesign characters that have descenders so that the last 2 bytes to be displayed ap-

We've got a hit on the charts.

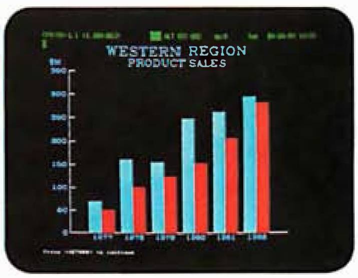


Multiple graphs on a single page

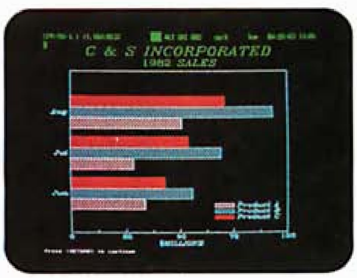
Combine bar and line graphs with a simple keystroke.



Pie charts with exploding slices add impact.



Create clustered bar graphs.



Tap a key and vertical bars turn horizontal.

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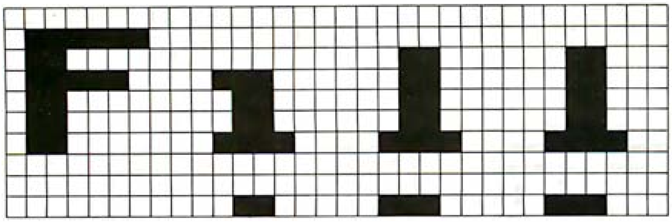
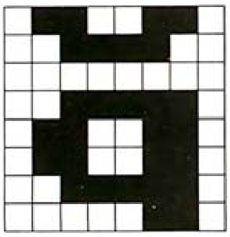


Figure 1: *Some standard characters as displayed in the ANTIC 3 mode. Note that the uppercase character is unaffected while the lowercase characters are distorted.*

(2a)



(2b)

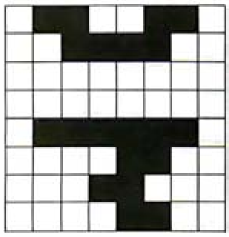


Figure 2: *Redefined characters for use with the ANTIC 3 mode. The lowercase g (2a) will have a descending tail, and the 3 (2b) can be used as a subscript character.*

pear as the first 2 bytes. It will look crazy, but that's what is necessary for ANTIC 3. Figure 2a shows the *g* character redesigned to be used for this mode.

Subscripts and Superscripts

The real power with ANTIC 3, however, is in the ability to display superscripts and subscripts. Just imagine printing chemical or mathematical equations on screen with the superscripts or subscripts just where they should be. For subscripts, simply replace the lowercase characters with numerals or other characters using your editor's copy option, or design your own special symbols. Then shift those characters 3 bytes lower for maximum descent. The number 3 would appear as it does in figure 2b for use as a subscript.

Listing 3: *The ANTIC 3 Demonstration Program incorporates the routine in listing 2 to produce the output shown in listing 1.*

```
5 REM ANTIC 3 Demo Program
6 REM
7 REM First relocate all 128
  characters to a RAM location:
8 GOSUB 1000
9 REM Modify the display list:
10 GRAPHICS 0
20 DL=PEEK(560)+256*PEEK(561)
30 POKE DL+3,67
40 FOR I=0 TO 17:POKE DL+I+6,3:NEXT I
50 POKE DL+24,65:POKE DL+25,PEEK(560):
POKE DL+26,PEEK(561)
58 REM
59 REM Change character set pointer to
  the RAM location of modified set:
60 POKE 756,CADR/256
68 REM
69 REM Print equations in ANTIC 3 mode
  using new characters:
70 PRINT :PRINT "AgNOa   +   KBr   c   AgB
rb   +   KNOa"
80 PRINT :PRINT "(x$+y$)$=4(x$-y$)"
90 END
1000 POKE 106,PEEK(106)-5:GRAPHICS 0:P
RINT "Transferring characters from ROM
 to    RAM . . . ."
1010 CADR=256*(PEEK(106)+1)
1020 FOR I=0 TO 1023:POKE CADR+I,PEEK(
57344+I):NEXT I
1030 ? :? "Redefining 8 characters . .
 . ."
1038 REM
1039 REM Replace data for 8 characters
     - a, b, c, g, r, x, y, and $ - :
1040 FOR I=0 TO 23:READ X:POKE 776+CAD
R+I,X:NEXT I
1050 DATA 102,60,0,0,126,12,24,12
1060 DATA 60,24,24,24,24,24,219,126
1070 DATA 24,0,24,12,6,255,6,12
1080 FOR I=0 TO 7:READ X:POKE 824+CADR
+I,X:NEXT I
1090 DATA 102,60,0,62,102,102,62,6
1100 FOR I=0 TO 7:READ X:POKE 912+CADR
+I,X:NEXT I
1110 DATA 0,0,0,124,102,96,96,96
1120 FOR I=0 TO 15:READ X:POKE 960+CAD
R+I,X:NEXT I
1130 DATA 0,0,0,102,60,24,60,102
1140 DATA 108,56,0,102,102,102,62,12
1150 FOR I=0 TO 7:READ X:POKE 32+CADR+
I,X:NEXT I
1160 DATA 60,102,12,56,126,0,0,0
1170 RETURN
```

Superscripts are handled differently. Replace the lowercase letters with uppercase letters, shifting them down 3 bytes also. Replace rarely used letters and the three symbols with numerals, if you wish. (Do not edit the three screen-editing symbols. Trying to print them would still cause the function to be performed.) Now the lowercase letters become the standard alphabet and all other characters will appear as superscripts.

For those of you without a character editor, the ANTIC 3 Demonstration Program in listing 3 will transfer the internal character set from ROM (read-only memory) to RAM (random-access read/write memory) and redefine several characters for a demonstration of this outstanding mode. Try it!■

Editor's Note: *For more information on using Atari graphics, please consult the following articles: "An Introduction to Atari Graphics" by Chris Crawford and Lane Winner (January 1982 BYTE, page 18), "The Atari Tutorial, Part 2: Graphics Indirection" by Chris Crawford (October 1981 BYTE, page 70), and "Character Editor for the Atari" by Tim Kilby (December 1982 BYTE, page 167).*

Tim Kilby (RR 1, Box 288-B, Sperryville, VA 22740), a former college professor, is now an independent microcomputer consultant.

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A Date/Time Stamp for Disks

These date/time programs aid disk organization by keeping a record of when each disk was last used

by William Murray

The problem with organizing any set of programs and disks is determining which ones you use most frequently. It is difficult to keep track of how often a utility or data file is used. Your programming could become substantially easier if you could put on one disk the programs you use repeatedly. There is a solution to the problem of disk organization.

The date/time programs described in this article aid disk organization by stamping each disk with the date and time it was last used. Then each time you run the disk you know the elapsed time between uses because both the previous and the current date and time are listed.

These programs, written on an Apple II computer with 48K bytes of memory, use the California Computer System (CCS) clock/calendar card to provide the date and time information. Although this software is system dependent, adapting these programs to other systems with available clock/calendar cards should not prove difficult.

The CCS card uses a 5832 microprocessor real-time clock/calendar, which is crystal controlled at 32.768 kHz to maintain information from seconds to years. The data is stored in binary-coded decimal form in the selected memory locations. Battery backup keeps the card running when the Apple is off or during a power failure.

The only necessary modifications for the clock/calendar board are: the installation of two 2112 RAM (random-access read/write memory) chips in the provided sockets; the installation of the RAM jumper; and the setting of the interrupt request to a 1-second interval. These modifications are covered in the documentation for the board. The clock/calendar board must reside in slot #4 because the machine-language program is slot dependent.

The three-part software includes the TIME/DATE.BAS program entered when you initialize the disk (see listing 1), the TIME/DATE.OBJ machine-language program that requests and stores the date from the clock/calendar card (see listing 2), and a very short machine-language program to store the date and time on the disk. The storage program is created initially by typing

```
BSAVE TIME/DATE,A$3B8,L$19
```

Normally you enter the TIME/DATE.BAS program when initializing a disk. Another technique is used for disks that are already in use. Simply load the program and save it under the name of the initialization file (typically HELLO for loyal Apple users). TIME/DATE.BAS calls up the TIME/DATE.OBJ and storage programs, samples the date, stores it and displays it, then turns over the control of the Apple to you. Information on the old date and time is stored in locations 3B8 to 3CA hexadecimal. The clock/calendar card, meanwhile, stores the current date and time in locations 2F5 to 300 hexadecimal. This information is finally formed as the string A$. You can enter a message in lines 110 and 120 in TIME/DATE.BAS that will be displayed when the disk is called up.

The first machine-language program requests information from the clock/calendar card by addressing the proper memory address (see line 19 in DATE/TIME.OBJ for an example). After getting the information, the program stores it at a memory location in RAM (see line 22). This process continues byte by byte until all date and time data is collected. The information is refreshed once a second with every interrupt request. Notice that this program is stored, starting at RAM location C400 hexadecimal, making the clock/calendar card slot dependent.

The second machine-language program stores the data, written by the Apple, when it becomes necessary to transfer the data from the "current date/time" to the "past date/time." You create the file by typing

```
BSAVE DATE/TIME,$A3B8,L$19
```

before running the TIME/DATE.BAS program.

After you enter all of the software, simply insert the disk into the drive and turn on the Apple. You must do this twice the first time the disk is run because the old date and time don't exist in the beginning.

By keeping track of those dates and times, you should find disk and program organization to be much easier.■

The clock/calendar card for Apple computers is available for $120 from California Computer Systems, 250 Carribean Dr., Sunnyvale, CA 94086.

Dr. William Murray is a professor of Computer Science at Broome Community College, Binghamton, NY 13902.

Listings begin on page 526

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Listing 1: *The TIME/DATE.BAS program.*

```
10   TEXT : HOME :D$ =  CHR$ (4)
20   REM : LOAD CLOCK/CALENDAR CON
      VERSION ROUTINE
30   PRINT D$;"BLOAD DATE/TIME.OBJ
      0"
40   REM : START CLOCK/CALENDAR RO
      UTINE
50   CALL 50368
60   REM : LOAD PREVIOUS DATE/TIME

70 F$ = "DATE/TIME"
80   PRINT D$;"NOMON C,I,O"
90   PRINT D$;"BLOAD ";F$;",A$3B8"

100   REM : DISKETTE INITIALIZATIO
      N MESSAGE
110   VTAB 1: PRINT "DOS 3.3 WORKI
      NG DISKETTE"
120   VTAB 2: PRINT "BY WILLIAM MU
      RRAY 3/1/81"
130   VTAB 5: PRINT "LAST DATE/TIM
      E RUN:"
140   VTAB 7: HTAB 1
150   REM : GET AND PRINT OLD DATE
      /TIME ON SCREEN
160   FOR I = 952 TO 970: PRINT  CHR$
      ( PEEK (I));: NEXT I
170   VTAB 11: HTAB 1: PRINT "CURR
      ENT DATE/TIME:"
180   REM : GET AND PRINT NEW DATE
      /TIME ON SCREEN
190  TA = PEEK (768):TB =  PEEK (
      767):TC = PEEK (766):TD =  PEEK
      (765):TE =  PEEK (764):TF =
       PEEK (763)
200  TK =  PEEK (762):TL =  PEEK (
      761):TG = PEEK (760):TH =  PEEK
      (759):TI =  PEEK (758):TJ =
       PEEK (757)
210   REM : CHECK FOR A COMPLETE C
      ONVERSION
220   IF (TF + TE + TD + TC) > 36 THEN
      190
230   REM : DATE STRING
240  C$ =  STR$ (TH) +  STR$ (TG) +
      "/" +  STR$ (TL) +  STR$ (TK
      ) + "/" +  STR$ (TJ) +  STR$
      (TI)
250   REM : TIME STRING
260  B$ =  STR$ (TF) +  STR$ (TE) +
      ":" +  STR$ (TD) +  STR$ (TC
      ) + ":" +  STR$ (TB) +  STR$
      (TA)
270   REM : SPACE STRING
280  E$ = "    "
290   REM : TOTAL DATE/TIME STRING

300  A$ = C$ + E$ + B$
310   VTAB 13: HTAB 1: PRINT A$
320   REM :PLACE CURRENT DATE/TIME
       IN F$
330   FOR I = 1 TO 19: POKE 951 +
      I, ASC ( MID$ (A$,I,1)) + 12
      8: NEXT I
340   PRINT D$;"BSAVE ";F$;",A$3B8
      ,L$19
350   VTAB 23: HTAB 1
360   END
```

Listing 2: *The TIME/DATE.OBJ program.*

```
C400:                ORG  $C400      LOAD AT SLOT 4
C400:A5 45           LDA  $45
C402:20 4A FF        JSR  $FF4A      SAVE REGISTERS
C405:BA              TSX
C406:BD 00 01        LDA  $0100,X
C409:0A              ASL  A          MULT BY 2
```

Listing 2 continued on page 528

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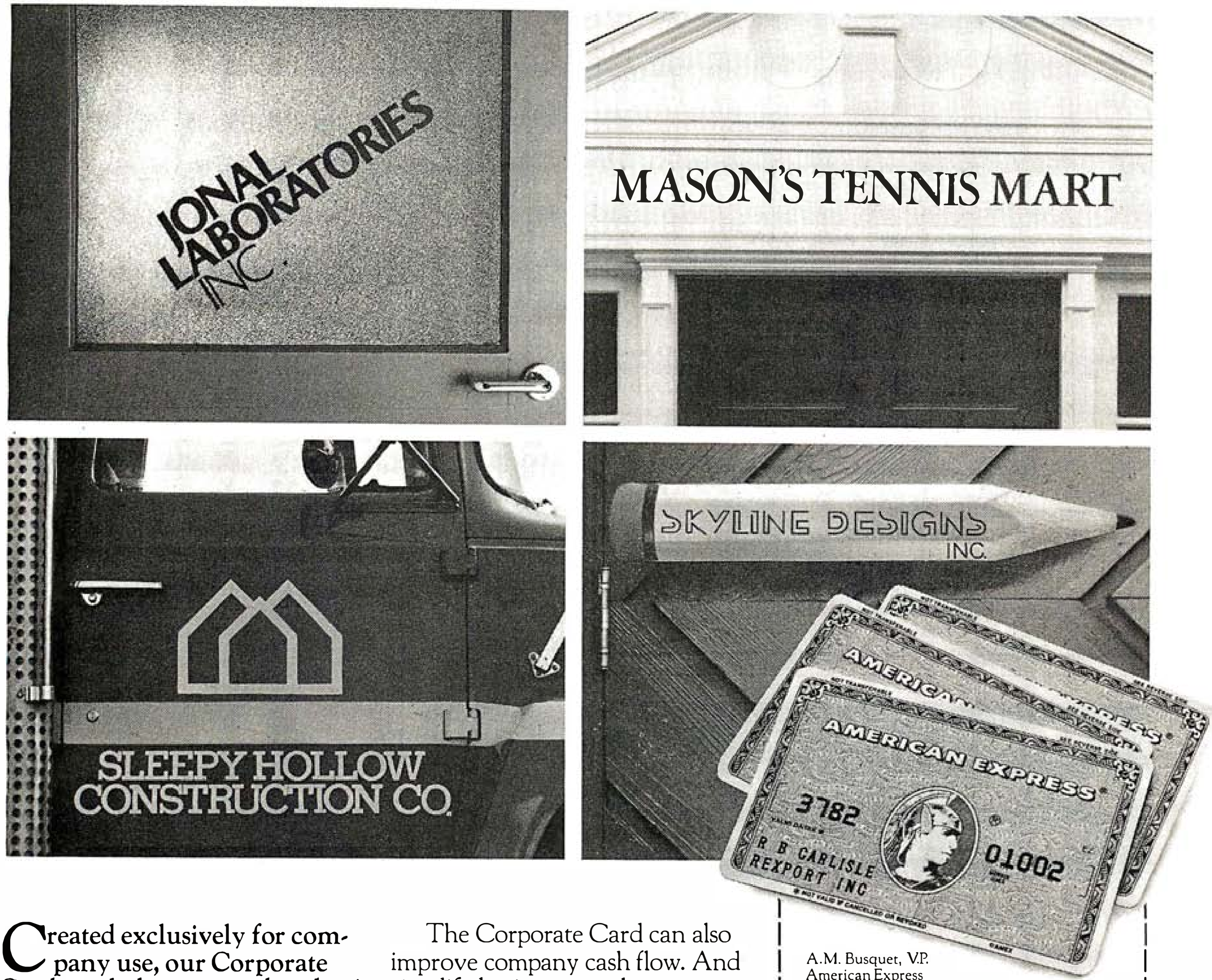

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Listing 2 continued:

```
C40A:0A              ASL   A              MULT BY 2
C40B:0A              ASL   A              MULT BY 2
C40C:0A              ASL   A              MULT BY 2
C40D:A8              TAY                   PUT IN Y
C40E:A2 40           LDX   #$40           PUT 40 IN X
C410:A9 20           LDA   #$20
C412:99 81 C0        STA   $C081,Y        GET SEC
C415:B9 80 C0        LDA   $C080,Y
C418:29 0F           AND   #$0F
C41A:9D C0 02        STA   $02C0,X
C41D:CA              DEX
C41E:A9 21           LDA   #$21
C420:99 81 C0        STA   $C081,Y        GET SEC
C423:B9 80 C0        LDA   $C080,Y
C426:29 0F           AND   #$0F
C428:9D C0 02        STA   $02C0,X
C42B:CA              DEX
C42C:A9 22           LDA   #$22
C42E:99 81 C0        STA   $C081,Y        GET MIN
C431:B9 80 C0        LDA   $C080,Y
C434:29 0F           AND   #$0F
C436:9D C0 02        STA   $02C0,X
C439:CA              DEX
C43A:A9 23           LDA   #$23
C43C:99 81 C0        STA   $C081,Y        GET MIN
C43F:B9 80 C0        LDA   $C080,Y
C442:29 0F           AND   #$0F
C444:9D C0 02        STA   $02C0,X
C447:CA              DEX
C448:A9 24           LDA   #$24
C44A:99 81 C0        STA   $C081,Y        GET HOUR
C44D:B9 80 C0        LDA   $C080,Y
C450:29 0F           AND   #$0F
C452:9D C0 02        STA   $02C0,X
C455:CA              DEX
C456:A9 25           LDA   #$25
C458:99 81 C0        STA   $C081,Y        GET HOUR
C45B:B9 80 C0        LDA   $C080,Y
C45E:29 03           AND   #$03
C460:9D C0 02        STA   $02C0,X
C463:CA              DEX
C464:A9 27           LDA   #$27
C466:99 81 C0        STA   $C081,Y        GET DAY
C469:B9 80 C0        LDA   $C080,Y
C46C:29 0F           AND   #$0F
C46E:9D C0 02        STA   $02C0,X
C471:CA              DEX
C472:A9 28           LDA   #$28
C474:99 81 C0        STA   $C081,Y        GET DAY
C477:B9 80 C0        LDA   $C080,Y
C47A:29 0F           AND   #$0F
C47C:9D C0 02        STA   $02C0,X
C47F:CA              DEX
C480:A9 29           LDA   #$29
C482:99 81 C0        STA   $C081,Y        GET MONTH
C485:B9 80 C0        LDA   $C080,Y
C488:29 0F           AND   #$0F
C48A:9D C0 02        STA   $02C0,X
C48D:CA              DEX
C48E:A9 2A           LDA   #$2A
C490:99 81 C0        STA   $C081,Y        GET MONTH
C493:B9 80 C0        LDA   $C080,Y
C496:29 0F           AND   #$0F
C498:9D C0 02        STA   $02C0,X
C49B:CA              DEX
C49C:A9 2B           LDA   #$2B
C49E:99 81 C0        STA   $C081,Y        GET YEAR
C4A1:B9 80 C0        LDA   $C080,Y
C4A4:29 0F           AND   #$0F
C4A6:9D C0 02        STA   $02C0,X
C4A9:CA              DEX
C4AA:A9 2C           LDA   #$2C
C4AC:99 81 C0        STA   $C081,Y        GET YEAR
C4AF:B9 80 C0        LDA   $C080,Y
C4B2:29 0F           AND   #$0F
C4B4:9D C0 02        STA   $02C0,X
C4B7:A9 6F           LDA   #$6F
C4B9:99 81 C0        STA   $C081,Y
C4BC:20 3F FF        JSR   $FF3F
C4BF:40              RTI
C4C0:08              PHP
C4C1:48              PHA
C4C2:8A              TXA
C4C3:48              PHA
C4C4:20 CB FF        JSR   $FFCB
C4C7:BA              TSX
C4C8:BD 00 01        LDA   $0100,X
C4CB:8D FF 03        STA   $03FF
C4CE:0A              ASL   A              MULT BY 2
C4CF:0A              ASL   A              MULT BY 2
C4D0:0A              ASL   A              MULT BY 2
C4D1:0A              ASL   A              MULT BY 2
C4D2:AA              TAX
C4D3:A9 00           LDA   #$00
C4D5:8D FE 03        STA   $03FE
C4D8:A9 6F           LDA   #$6F
C4DA:9D 81 C0        STA   $C081,X
C4DD:68              PLA
C4DE:AA              TAX
C4DF:68              PLA
C4E0:28              PLP
C4E1:58              CLI
C4E2:60              RTS
C4E3:78              SEI
C4E4:60              RTS
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Programming the IBM Personal Computer: BASIC

Neill Graham
Holt, Rinehart and Winston,
New York: 1982
287 pages, hardcover,
$17.95

Reviewed by
Stan Franklin

I teach BASIC to beginning programming students. As a result, publishing companies send me examination copies of BASIC texts, hoping they'll be adopted for classroom use. (A quick count revealed 15 of them decorating my shelves.)

Recently, *Programming the IBM Personal Computer: BASIC*, by Neill Graham, arrived from Holt, Rinehart and Winston. Because I have one IBM PC as my constant office companion and another for leisure hours, I felt a mild stirring of interest.

Graham covers the usual topics: data types, operations, variables, assignment, input, loops, decisions, functions, and subroutines. One chapter is devoted to program design, debugging, and user errors. Others concentrate on formatting output, arrays, strings, and sequential and random files. There's an eye-catching chapter entitled "Event Trapping and Music." Finally, the author presents an "Introduction to Color and Graphics." That covers a lot of ground, I thought, and wondered if Graham could fulfill his promise.

Two hours and 100 pages later, I was hooked. Over the course of the next several days, I gobbled up the whole book (almost 300 pages), reading with some care and experimenting on both PCs. It was like eating peanuts; I didn't want to stop. When there was nothing left but the glossary and index, I still wanted more. The only thing left to do was to share my good fortune with other PC users.

Since you've already glimpsed the book's contents, let me describe Graham's presentation. As its title implies, the book is aimed directly at users of the IBM PC. Graham asks the reader repeatedly to use the machine in direct mode (i.e., instructions typed without line numbers are executed as soon as they are entered) to illustrate the features he describes. Here's an example of Graham's hands-on approach from the text:

In general, the IF statement takes any value other than zero to represent true:

```
IF 25 THEN PRINT "TRUE"
  ELSE PRINT "FALSE"
TRUE
Ok
```

Chapter 11, "Sequential Files," offers another good example of Graham's approach:

We can easily demonstrate the operation of PRINT # and PRINT # USING by using these statements to write to the screen. Execute the following OPEN statement in the direct mode:

```
OPEN "SCRN:" FOR
  OUTPUT AS #1
Ok
```

The screen has now been opened as file number 1; PRINT #1 and PRINT #1 USING will send their output to the screen. Experimentation quickly reveals that PRINT #1 now behaves like PRINT and that PRINT #1 USING behaves exactly like PRINT USING:

```
PRINT #1, 25, -10, -30
 25     -10     -30
Ok
PRINT #1, USING
 "$$,###.## "; 24.93,
 7039.10
$24.39  $7,039.10
Ok
```

This hands-on presentation leaves an active reader with a feeling of familiarity with BASIC statements on the PC.

From the beginning of the book, I was struck by the nontraditional order in which Graham covers various topics. AUTO, RENUM, and the uses of the Alternate and function keys were explained in the first chapter. As I read further, I realized that Graham's sequence had been carefully thought out. Features are introduced in the order in which a new user will need or wonder about them. This order of presentation appeals to the mathematician in me.

As each new command or statement appears, the reader is already familiar with the concepts he needs to understand it. There's no need to go thumbing back through the book to review a forgotten command.

New commands are introduced first in their more common forms and later in more complex guises, as needed. SAVE first appears on page 17. SAVE ,A (save a program in text format rather than coded) is explained on page 223 as a prelude to the MERGE command that requires it.

Graham presents his ideas in sentences that are short and to the point. Yet he restates ideas often enough to ensure that descriptions are clear and precise. For instance,

A number is printed with a space following the last digit. A positive number is printed with a space preceding the first digit; and for a negative number, the preceding space is replaced by a minus sign:

```
PRINT 100
 100
Ok
PRINT -100
-100
Ok
PRINT "XXXX"; 100;
  "XXXX"; -100; "XXXX"
XXXX 100 XXXX-100
  XXXX
Ok
```

In the output from the first PRINT statement, 100 is preceded by one space. In the output from the second PRINT statement, the preceding space is replaced by a minus sign. In the third PRINT statement, the semicolons, as usual, do not introduce any additional spaces. However, 100 is printed with a space preceding it and a space following it, and -100 is printed with a space following.

Every few pages, the author provides pertinent words of caution. A few examples follow:

Type declaration statements should be used with caution. It is easy to forget what letters of the alphabet correspond to what types, and thus have the computer assume that a variable is of a different type than the one you intended. This can lead to hard-to-find errors, such as a result being computed with insufficient precision.

Incidentally, when data is being stored on cassette tape, the computer has no way of knowing whether the cassette recorder is operating properly and the data is actually being stored. A common error is forgetting to put the recorder in the record mode, so that the recorder is playing data back while the computer is sending it data to be recorded. Because you won't be warned of recording problems, it's a good idea to record each cassette file at least twice.

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we close a file that has been written to. Otherwise, (a) some of the data written to the file might not actually be transferred from main memory to the file, and (b) in the case of a diskette file, the file might not be entered properly in the directory on the diskette.

Don't confuse the null character with the null string. The null character is the character whose ASCII code is zero. The null string contains no characters, null or otherwise.

As you might have guessed by now, I'm sorely tempted to go on quoting these warnings. If only I had had this kind of help when I first began programming in BASIC; I'm sure I made each and every error Graham cautions against.

Between the descriptions and warnings is a wealth of explanations. Topics discussed include control structures, modularity, top-down design, testing, debugging, error trapping, sorting, and garbage collection. An example gives a flavor of Graham's explanations:

INKEY$ is particularly useful for video-game programs, which are constantly busy moving objects around on the screen but which must also check the keyboard periodically to see if the user has entered a command, such as to fire a missile.

Some beginning BASIC texts offer the student relatively trivial program listings as models, but not so with this one. Versions of an information-retrieval program illustrate the use of arrays and sequential files. A text editor exercises BASIC's athletic string-manipulation capabilities. A simple game program affords practice with event trapping. Every module in each of these programs is explained individually. The student is led to a detailed understanding of how modules work independently and together. These programs are worthy of study, both for how-to techniques and as a model of structured-programming style.

Each chapter ends with a short list of suggested exercises. These range from "Modify program such-and-such to do so-and-so," to substantial extensions of example programs, to "Try programming the computer to play some of your favorite songs." (Exercise 4 from the first chapter deserves special notice. You are asked to "Write a program that self destructs.") When you've successfully negotiated each exercise in this text, you can be sure you're off to a fast start as a BASIC programmer on the IBM PC.

Hard as it is to find anything to be negative about, I'll try. The last chapter, entitled "Introduction to Color and Graphics," is the least complete. Additional features available with the Color/Graphics Monitor Adapter are presented in the same lucid manner the reader has, by now, come to expect. But the chapter ends with neither example programs nor exercises. For the monochrome user, this is not a problem, but the user of a color system will want to augment the text at this point.

Perhaps a table of contents for example programs would have been of use. A greater variety of exercise programs, which would give instructors more choice for assignments, would also be welcome for a text being considered for classroom use.

For readers who already know one dialect of BASIC, Graham's book offers an efficient means of learning the idiosyncrasies and features of the IBM PC version. Microsoft has produced a powerful, yet remarkably easy-to-use, implementation of the BASIC language for IBM. The addition of a WHILE statement facilitates a more structured approach. The full screen BASIC editor, together with the function keys and use of the Alternate key, make programming the PC in BASIC a breeze compared to other systems I know. Graham's text allows efficient and pleasant mastery of these tools.

While the experienced BASIC programmer can skim the chapters, pausing only to become familiar with those features peculiar to *this* system, the approach of the novice programmer must, of course, be different. The text starts almost gently, leading the student through the mysteries of BASIC. In later chapters the pace quickens. *Programming the IBM Personal Computer: BASIC* is a must for anyone (whether experienced or a novice) who intends to program the IBM PC in BASIC.■

Stan Franklin is professor of mathematical sciences at Memphis State University (Memphis, TN 38152). A mathematician by training, he has become addicted to personal computing both at home and at work.

Public Computer Course

The Groton, Connecticut, library has a packet of information on a one-hour computer course. Volunteers use this course to teach the public how to operate the library's Apple IIes. The packet has a manual, software list, operating tips, hardware diagram, instructions on using disk drives, a glossary, a user's responsibility agreement, and rules and regulations. It costs $6, postage paid, from the Groton Public Library, Rt. 117, Groton, CT 06340.■

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Experiments in Artificial Intelligence for Small Computers

John Krutch
Howard W. Sams and Co., Indianapolis, IN: 1981
112 pages, softcover, $9.95

Reviewed by
John Figueras

Several years ago, I asked a computerist at Stanford University why artificial-intelligence (AI) programs were written in LISP. He replied that you could do things in LISP that you couldn't do in other languages. I didn't believe him then, and, with the appearance of Krutch's book, I believe him even less now.

Krutch has carried over into BASIC programs the kinds of problems and solutions that are considered the showpieces of AI. Each of the seven chapters in this treatise is devoted to a special province of AI. The first three chapters cover the Kingmove program (elementary chess moves), Checkers, the alpha-beta algorithm, and Problem Solving—TF, a pattern-matching program that tries to predict your behavior during entry of random strings composed of symbols "T" and "F." Chapter 4 covers Fetch, a semantic information-retrieval program that deduces logical consequences from declarative input statements, including a language parser. The fifth chapter explores Haiku, a program that composes verse. Autowriter is a program covered in Chapter 6 that writes computer-generated text such as stories, and the last chapter is devoted to Joseph Weizenbaum's Doctor program of natural-language processing.

Krutch presents programs in Level II BASIC for the Radio Shack TRS-80, but an appendix enables users of other versions of BASIC to adapt the programs to other machines. Apple users should watch out for the random-number function RND (N) in Level II BASIC, which returns a random number between 1 and N and must be replaced in Applesoft by the expression INT (N * RND(1)) + 1. One subtlety that gave me about an hour's worth of trouble is that apparently the STR$ function in Level II BASIC returns a string padded on the left with a leading blank, which the Applesoft STR$ function does not do. The pattern-matching program in Level II BASIC, TF, removes this blank space with the MID$(A$, 2) function. You're in trouble if you use the Applesoft equivalent to remove the nonexistent blank. By paying careful attention to the author's appendix and scrutinizing the program, you should be able to make a relatively painless translation for your computer. I tried the Haiku program, which generates four types of this terse form of Japanese poetry. The results were quite delightful:

Sun under the glade:
A dawn firefly on a lake
Crimson haze

Of course, most of the time, the poetry is exactly what

you might expect from a random-number generator. The program is based on Krutch's own analysis of the forms and vocabulary that actually appear in English versions of haiku. The vocabulary of nouns, verbs, prepositions, and articles is contained in a group of clearly identified DATA statements that you can change to suit your own taste in haiku.

The other program that I played with, TF, asks the user to key in random sequences of the symbols T and F. It detects patterns of entry (some of which you may not even be aware) and predicts every fifth symbol that you enter. It is interesting to watch the program become "trained" as you continue to enter symbols. Its recognition rate is about 70 percent, which is significantly better than guessing.

Krutch must have done quite a bit of digging and incisive reading to penetrate AI methodology and translate it into relatively simple BASIC programs. I am afraid, however, that he has brought home the fact—pointed out by others—that the past successes claimed for AI were based on tricks that produce impressive demonstrations but that rely more on the intelligence of programmers than on the intelligence of programs and computers.

Krutch's book offers insight into early techniques, and any home computerist skilled in BASIC can have lots of fun with his programs. They are models of clarity and good form and are worth the attention of anyone who might like to learn how a pro styles his programs. ■

John Figueras (65 Steele Rd., Victor, NY 14564) has a doctorate in organic chemistry.

[redacted]

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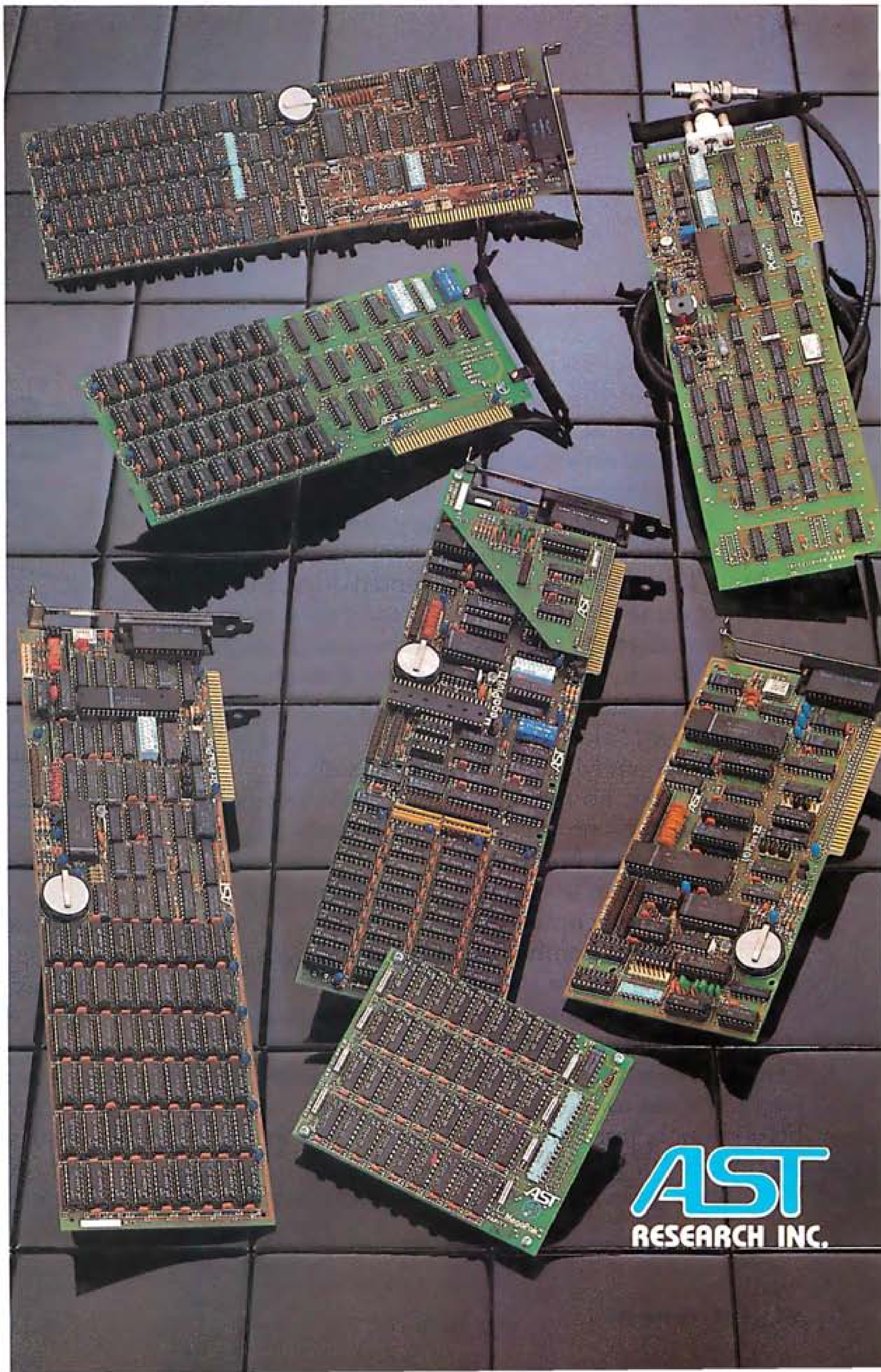

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Book Reviews

The Handbook of Artificial Intelligence, Volume 3

Paul R. Cohen and Edward A. Feigenbaum, eds.
William Kaufman Inc.
Los Altos, CA: 1982
639 pages, $45

Reviewed by
Henry W. Davis and
James E. Brandeberry

The Handbook of Artificial Intelligence is a comprehensive three-volume survey of artificial intelligence (AI) that presents basic concepts so as to be understandable to the novice and useful to the expert. Each of the 15 chapters covers a subspecialty of AI. Because the volumes have a hierarchical structure, readers can cover the chapters in sequence or go directly to a particular area of interest. The survey articles that appear at the beginning of each chapter are substantive 10-page summaries of the history and direction of various AI fields. Copious references point readers to related material both within and outside of the three-volume set.

Volumes 1 and 2 were reviewed in the July and September 1983 issues of BYTE. Volume 3 covers planning, learning, automatic deduction, machine vision, and cognitive science (the overlap area between AI and psychology). The chapters on machine vision and learning are especially comprehensive; each contains almost 200 pages. The *Handbook* has no chapter on robotics; the AI aspects of robotics are covered in the material on planning and vision.

Planning

A plan is a list of operations or actions designed to achieve a goal. Normally the list is at least partially ordered. For example, a plan to paint a ceiling might include these actions: get the paint and brush, get the ladder, set up the ladder, prepare the ceiling, and put on the paint. In automatic planning, a program takes a general goal (such as painting a ceiling) and produces an ordered list of basic operations that will achieve the goal when performed in sequence. The program must know ahead of time those basic operations from which it is to build the plan, as well as their prerequisites, to properly sequence them.

The problem in generating even simple plans is that the computer gets bogged down by possible plan sequences, most of which won't work. That's because many parts of the plan interact with one another. In the previous example, we have to get the ladder before we prepare the ceiling due to the interaction of two basic operations. If our goal is to paint both the ceiling and the ladder, then we must paint the ladder last. In this case, two subgoals of our goal have interacted. Failure of a program to deal adequately with such interaction in generating even a 10-element plan could cause it to consider and reject over 3.6 million (10 factorial) alternatives.

Three approaches to planning that several successful programs have used are nonhierarchical, hierarchical, and skeletal refinement. The difference between hierarchical and nonhierarchical planners is that the former represent the goal through several layers of abstraction. A plan is sketched for each layer and then refined in the layer below. This enables the hierarchical planner to deal with interacting subgoals before it is committed to a lot of processing that must be undone later. It also enables the planner to expand those parts of the potential plan that are crucial to its success before it worries about inessential details. Nonhierarchical planners cannot tell inessential details (such as paint stirring) from crucial ones (such as getting the paint). While clever ways of handling the interaction of subgoals have been devised for nonhierarchical planners, they appear inadequate for complex plans. In the skeletal-refinement approach, the planner maintains a library of rough-plan outlines for dealing with various subgoals. Several outlines are fleshed out and combined to generate a plan. These plan outlines are very similar to *scripts*, data structures used in natural-language processing and discussed in Volume 1 of the *Handbook* (see July 1983 BYTE, page 450).

Five articles describe programs using these techniques for planning in domains that are as varied as toy-block manipulation, engine repair, and molecular-genetics-experiment design. An article on the process of human planning appears in the chapter on cognition and describes a model developed by Barbara and Frederick Hayes-Roth of the Rand Corporation. They propose that humans plan using a process that combines hierarchical and opportunistic approaches. A key role in their model is played by a data structure called the blackboard, which has been used successfully in speech-understanding systems and is described in Volume 1 of the *Handbook*. We do not doubt that the Hayes-Roth model will be explored by future artificial-intelligence programs.

Learning

Learning is the process through which people and computer programs increase their knowledge and improve their skills. AI research in learning is motivated by the need for more capable, flexible programs and the desire to understand the nature of learning itself.

Several different types of learning have been studied in AI. The *Handbook* focuses on *inductive inference*, or learning from examples. That is, the program is given samples of how it should behave and, from them, seeks higher-level rules or concepts to enable it to perform as desired. For example, a poker program might be given several positive and negative samples of a flush and, from this, must build concepts enabling it to recognize a flush in the future. In another example, a program that does symbolic integration, as in a freshman calculus class, begins by blindly applying all the integration techniques it knows to a given problem. By observing what works and what fails, it builds rules about which techniques work best in various situations. The program has thus become skilled through working examples and no longer needs to search blindly.

A type of induction for which well-understood AI techniques exist occurs when a single concept is to be learned from the samples. This is illustrated by the flush poker example. Multiple-concept learning problems, in which many possibly overlapping concepts must be learned from a single-sample set, are considerably harder and not yet well understood. For example, Meta-DENDRAL, a program from Stanford University, learns multi-

ple concepts. From descriptions of molecules in some family, along with their mass spectrums, the program can determine several molecular-decomposition rules that will explain the spectral data.

An even more difficult form of induction is learning to perform multiple-step tasks. The symbolic-integration example illustrates this type of learning because such problems usually involve several steps. One of the difficulties with multistep tasks is the *credit assignment problem*: once a task is completed, whether successful or not, the program must then assign credit or blame appropriately to each intermediate step. Only then can it begin to affect its own performance rules.

The techniques and directions of this fascinating process are very well explained in the *Handbook*. One of seven articles on learning programs is Samuel's checker-playing program that improves its skill with play and, although 20 years old, is still a delight to read about. Another is Lenat's AM, which discovers "interesting" concepts in mathematics. The symbolic-integration learning, discussed above, is performed by Thomas Mitchell's LEX.

Cognition

In AI, intelligent programs can employ mechanisms beyond those used by humans. Nevertheless, psychology and AI have had a mutually helpful relationship: knowledge about human intelligence suggests extensions to the theory of machine intelligence, and vice versa. A historic overview explains how AI relates to cognitive science, the branch of psychology that uses computer programs to simulate theories of human cognition. Eight articles describe many of the foundation programs in cognitive science, some of which were seminal in AI.

A program of great importance to both AI and cognitive science is General Problem Solver (GPS), developed in 1956 by Allen Newell, Herbert Simon, and their colleagues at Carnegie-Mellon University. The program, which worked on problems from a variety of such areas as logic, symbolic integration, and puzzles, is described in Volume 1 of the *Handbook* and reexamined from a cognitive-science perspective in Volume 3. GPS was designed in an effort to model a certain human problem-solving mechanism (now called *means-ends analysis*) in a domain-independent way. Elaborate empirical tests indicate that people do use this technique; it is now a stock tool in AI.

Five articles describe models of human memory. For example, an early 1960's program by Edward Feigenbaum simulates the way humans memorize sequences of paired nonsense syllables. Its behavior is strikingly like that of people's and suggests possible mechanisms in human memory. In 1968 Ross Quillian developed a *semantic net* formalism that enabled his program to recognize word meanings in sophisticated contexts. His basic knowledge-representation scheme, discussed in Volume 1 of the *Handbook*, has since become a standard programming tool in AI. Empirical evidence suggests that parts of his model may be used by humans. Several psychologists have extended Quillian's ideas to obtain programs that simulate aspects of human cognition. For example, John Anderson's ACT system has a long-term memory, a short-term memory, and a programmable production system that effects changes in these memories. Intended to be a general model of human cognition, it makes reasonable predictions about human behavior in experimental situations. By changing the production system, one can test different psychological theories.

Automatic Deduction

The section on deduction contains six articles on the history and major themes of automatic deduction. Readers who find this section difficult to read, as I did, may want to review the material on predicate calculus in Volume 1 of the *Handbook*.

A program is doing *automatic deduction* (also called *mechanical theorem-proving*) when it uses deductive inference to draw conclusions from information in its database. In AI, such programs are being developed to perform commonsense reasoning as well as to prove sophisticated mathematical theorems. It is not always possible with a computer to store all the little facts necessary to answer common questions. Instead, we store general information and let the program draw inferences. For example, "John owns a pet bird" and "All birds fly" leads to the conclusion that "John's pet flies." Instead of storing "fly" separately along with all the things that John's pet can do, we let the program draw inferences from general information.

An early and very important development in automatic programming was a technique called *resolution*, pioneered by J.A. Robinson. Ironically, it looked too promising in the 1960s. Disappointment with the early effectiveness of resolution led to condemnation of any use of deduction in problem solving. But this attitude has passed; today's view is that

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resolution is practical but must be enhanced with problem-specific information and be used with other tools.

Although it is a powerful method, a problem with resolution is that it is not attuned to the way humans think. In response to this, an approach called *natural deduction* has been developed. Natural-deduction systems are more complex but easier for people to interact with. The *Handbook* describes a system, developed by R.S. Boyer and J.S. Moore, that has done such diverse tasks as proving the unique factorization theorem and verifying the equivalence of interpreted and compiled code.

An interesting article on *nonmonotonic logic* describes an effort to formalize for the computer the human experience of getting new information that partially contradicts previous premises. Using the bird example, if we later discover that John's pet is an ostrich, and that ostriches don't fly, then we must change the whole pattern of inferences we have drawn. Efficient and general ways of handling this problem with computers have not yet been worked out.

Vision

Computer vision activities fall into several categories. *Signal processing* is concerned with transforming one image into another with more desirable properties. *Classification* is concerned with techniques for classifying images into predetermined categories. The *Handbook* focuses on the *image-understanding problem*; that is, the problem of building a description not only of the image itself but also of the scene it represents. It is the image-understanding problem that connects computer vision to AI.

Pioneering work was done in 1965 by L.G. Roberts when he noted that describing solid objects in a picture requires a different approach from that of processing two-dimensional forms such as printed characters. His approach involved describing the three-dimensional scene that generated the picture rather than describing the picture. To make the problem more tractable, he restricted his three-dimensional scenes to the *blocks-world*; that is, scenes that contain only cubes, rectangular solids, wedges, and hexagonal prisms. In this limited world, Roberts was able to calculate precise orientation, position, and relative dimensions of objects. Work by Roberts and others during the early 1970s led to techniques for finding lines or edges in pictures where visual noise and lighting make their presence obscure.

Later work expanded on the blocks-world characterization of scenes to provide techniques for representing real-world scenes. The key factor was to learn how orientation of surfaces, distance to camera, reflectance, and amount of illumination can be computed using laws of physics and basic rules of continuity of shape and motion. These properties are then used as clues to aid in describing the scene by means of certain primitives used for shape description.

A number of interesting algorithmic methods have been developed to help understand a scene. *Pyramids* and *quad trees* are hierarchical image representations that enable the computer to work with multiple levels of resolution of the image and to concentrate on areas of high-information content. These characteristics seem to be present in human perception. *Relaxation* methods are a powerful technique for reducing scene ambiguities (such as incomplete or missing edges) by using local constraints in an iterative procedure. Linguistic methods are a promising technique, similar to compilers for computer languages. A compiler recognizes strings of language primitives as belonging to the language or as errors (not belonging to the language) and then associates meaning to the strings of primitives. That is the goal of linguistic methods for computer vision. However, a problem lies in defining an appropriate set of primitives and finding processes or mechanisms for detecting these primitives.

The *Handbook* describes several successful vision systems. These include two in robotics, a transistor wire-bonding system and GM's CONSIGHT-I, a system for transferring parts from conveyor belts. Another system, Stanford's ACRONYM, attempts to identify and classify instances of modeled objects; that is, objects for which the user has provided a stylized prototype description. It extracts three-dimensional information concerning shape, structure, location, and orientation. The principal domains it has been applied to are aerial-photograph interpretations of airport scenes and low-angle views or industrial parts at an automatic workstation.

Conclusion

The *Handbook* is comprehensive, clear, and has an excellent bibliography. There are a few unclear passages and difficult articles, but, given the scope of the work, these are trivial objections. The reader will not be able to implement the *Handbook's* ideas directly. The problems and current approaches are explained on a conceptual level and references tell where the technical details can be found. The three volumes are, in our opinion, the best general text on AI currently in print. ■

Henry W. Davis is a professor of computer science at Wright State University. James E. Brandeberry uses computer vision in robotics research and is an associate professor of computer science at Wright State University (Dayton, OH 45435).

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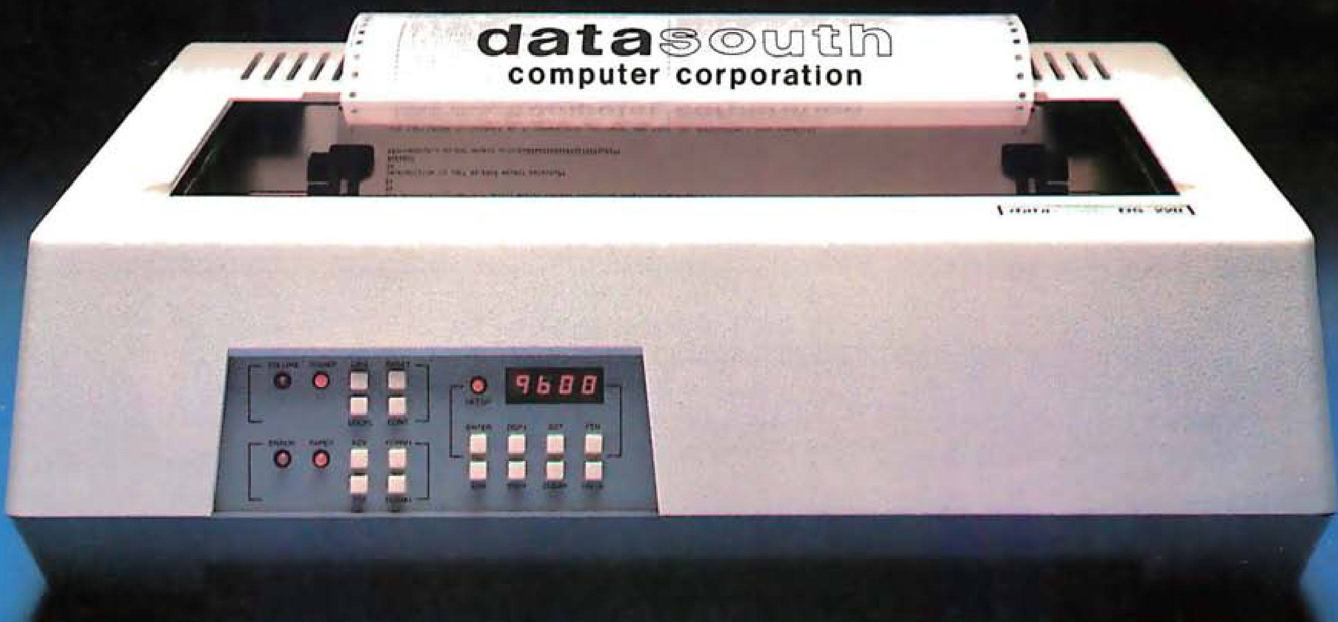

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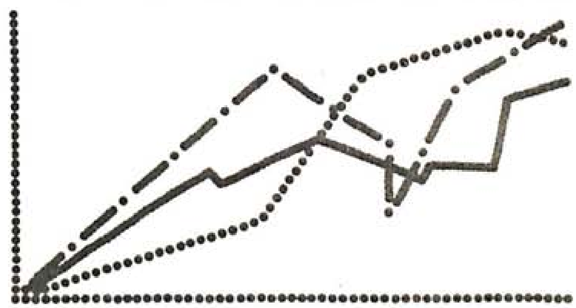

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Array Capabilities for dBASE II

by Charles O. Hartman

Suppose you've used Ashton-Tate's dBASE II program to create a dictionary database. For a text-processing application, you divide an input line whose length is not known ahead of time into individual words that can be looked up in the dictionary. The good substring-handling capabilities of dBASE II make it easy to locate the spaces that define the words. But because dBASE II has no array variables, how can you store each word for separate processing? First, you'll need some dBASE II background.

In advertisements and in the company's manual, Ashton-Tate claims that its database program is a true programming language. For the most part, this claim is justified. The program includes provision for "command" files, whose lines are executed sequentially, and it even includes an adequate line editor to help in debugging these files. Like BASIC, dBASE II operates in either immediate or program mode and, as in BASIC, the immediate mode simplifies the debugging of processes meant to run in program mode. Also offered by dBASE II is a full repertoire of input and output formats (four different classes of input commands, three of output). As a high-level language, dBASE II renders complex file handling more or less transparent.

However, dBASE II is lacking in two important ways. First, it is poor in program control. Though it has IF, THEN, ELSE, and a somewhat awkward form of a CASE instruction, it lacks many control structures on which BASIC or Pascal programmers have learned to depend. Its only looping command is DO WHILE, whereas both BASIC and Pascal allow simple FOR loops and Pascal adds REPEAT. . .UNTIL to delay testing until the end of the loop. Though DO WHILE is logically sufficient, in many situations it multiplies the amount of code required for a given task, wasting both disk space and time—resources already limited by a very high-level language and by the large files a database program naturally entails.

Second, dBASE II lacks structured memory variables. The records that make up database files are structured, of course, but the program variables can take only three simple types: character, numerical, or logical. The absence of array capabilities creates particular difficulties; for example, arrays of two dimensions provide the easiest and most usual solution for the problem of storing each word for separate processing.

Typically, an array wide enough for each word and long enough to hold all entries is established with the DIM statement in BASIC or a type declaration in Pascal. The array can then be accessed by subscripts, each of which can be a variable. For example, here is *one* way the process of establishing such an array could be coded in BASIC:

```
10   J = 1 : K = 0
100  FOR I = 1 TO LEN(LINE$)
110  If MID$(LINE$,I,1) < > "  " GOTO 140
120  J = J + 1    'NEXT ROW OF ARRAY
130  K = 0
140  K = K + 1 'NEW ROW STARTS IN COLUMN 1
150  ARRAY$(J,K) = MID$(LINE$,I,1)
160  NEXT I
```

After this, ARRAY$(n) refers conveniently and concisely to the nth word in the line.

An even simpler solution uses an array of strings, each of which can be accessed as WORD$(X). Yet, conceptually, a BASIC string is an array of characters; therefore an array of strings is actually a two-dimensional array, and this solution is a subset of the one just given.

Without arrays, you can do all necessary processing on each word only within the DO WHILE loop that divides the line into separate words. But if a choice among later processing paths depends on earlier results, or if the processing for each word is very time-consuming or involves disk access, this quickly becomes impractical. A second alternative is to write a separate routine for each word, to associate it with a separate variable name (Word1, Word2, etc.). But the maximum number of words possible must be assumed because the

number of words is not known ahead of time. And the code for each routine is identical, except that Word2 replaces Word1, Word3 replaces Word2, and so on. The waste of time and space can be enormous.

But take heart! There is a way around this difficulty. It depends on an undocumented use of the macro function of dBASE II. The macro sign, "&" (as in some assembler languages), substitutes the current value of the variable for the variable's name. (In linguistic terms, it distinguishes the *use* of a variable from the *mention* of the variable.) The normal purpose of the "&" function, as anticipated in the dBASE II manual, is to substitute an interactively input value in a command:

```
INPUT "Name, in quotes?" TO Name
FIND &Name
```

These macro substitutions are necessary because some commands (such as FIND) use the content of a variable and some (such as INPUT) use its name. This is ultimately a result of the weak variable typing that makes dBASE II so casual and convenient in other ways.

To create a dBASE II pseudoarray, append a macro variable to the name of a base variable. The sequence Word1, Word2, and so on, becomes the single variable name Word&Counter, and the value of Counter can be incremented like that of J in the BASIC example given earlier (when Counter = 1, Word&Counter = Word(1), and so on). Macros also can be nested, so arrays of more than two dimensions are possible.

There *is* a minor complication to this simple solution, however: the macro-function works only on character (i.e., string) variables. For example, this sequence will *not* work:

```
STORE 1 TO Counter
INPUT "Next word?" TO Word&Counter
STORE Counter+1 TO Counter
```

Instead, the first line would have to be

```
STORE '1' TO Counter
```

which defines Counter as a character variable. But this change requires another because you cannot directly increment a character variable, only its *value*. As with BASIC and most implementations of Pascal, dBASE II has a VAL function for this kind of type-conversion. The conversion has to be performed twice: after being incremented, the numeric value must be turned back into a string. A STR function is provided by dBASE II for this purpose. With this in mind, you might change the third line in the preceding fragment to

```
STORE STR(VAL(Counter)+1) TO Counter
```

We're almost finished, but one final quirk requires a change. The STR function demands a second parameter after the name of the character variable, an integer to


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Listing 1: *An example of a dBASE II program (a .CMD file) to get a line from the keyboard, divide it into words, and look them up in an alphabetically-indexed dictionary database, DICT.DBF.*

```
* get a line from the keyboard:
ERASE
STORE "  [blanks to width of screen]  " TO Inputline
@ 8,0 SAY "Type in a line"
@ 10,0 GET Inputline
READ
* strip trailing blanks, add one back as last end-of-word flag
STORE TRIM(Inputline)+' ' to Inputline


*divide the line into words:
STORE 1 TO Wordbegin
STORE 1 TO Pointer
STORE '1' TO Counter
DO WHILE Pointer <= LEN(Inputline)
  IF $(Inputline,Pointer,1) = ' '
    STORE $(Inputline,Wordbegin,Pointer-Wordbegin) TO Word&Counter
    IF VAL(Counter) < 9
      STORE STR(VAL(Counter)+1,1) TO Counter
    ELSE
      STORE STR(VAL(Counter)+1,2) TO Counter
    ENDIF
    STORE Pointer TO Wordbegin
  ENDIF
  STORE Pointer+1 TO Pointer
ENDDO


* look up words in DICT.DBF
USE Dict INDEX Alphix
STORE VAL(Counter) TO Wordtotal
STORE '1' TO Counter
DO WHILE VAL(Counter) <= Wordtotal
  FIND &Word&Counter
ENDDO
USE
RETURN
```

determine the length of the string. If the array is to have fewer than 10 elements, the necessary change is trivial:

```
STORE STR(VAL(Counter)+1,1) TO Counter
```

If this limit cannot be assumed, the length parameter must be increased. But "STORE STR(VAL(Counter)+1,2) TO Counter" cannot be used alone because it would insert an illegal blank space in the variable names for values of 9 or less. Therefore, a branch must be provided:

```
IF VAL(Counter)<9
  STORE STR(VAL(Counter)+1,1) TO Counter
ELSE
  STORE STR(VAL(Counter)+1,2) TO Counter
ENDIF
```

The transformation is now complete.

Listing 1 shows a routine based on this principle, to divide a line into words and look them up. To illustrate the principle, the routine is somewhat stripped down in that it contains no error-trapping for extra blanks between words or for words not found in the dictionary, and no provision to strip punctuation marks from the end of a word before looking it up in the dictionary. None of these additions, however, presents any real difficulty. ■

Charles O. Hartman has published poetry in The New Yorker *and other magazines. He teaches English at the University of Washington in Seattle. On leave (14 Briggs Terrace, Brookline, MA 02146), he is masquerading as a technical writer and working on an article describing a program that scans iambic pentameter.*

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Choose a statistics package that is easy to use, and then test its accuracy with the tools described here

by Peter A. Lachenbruch

Numerical accuracy is crucial to any statistical program. Many statistical packages designed for use on microcomputers, however, haven't yet benefited from the lessons in numerical accuracy learned by programmers of mainframe statistical packages. For example, many of the microcomputer programs cannot accurately compute the standard deviation for all values of input variables that you're likely to encounter in practical situations. This article describes how to test the accuracy of statistical microcomputer software and provides simple test data you can use to determine a program's limits.

Several programs available for the Apple II are used as examples; the problems pointed out are not unique to these programs, however, nor are they peculiar to the Apple II. Keep in mind, too, that the tests outlined check how the programs behave in difficult cases; during normal use, major problems won't occur. For example, you may never have to deal with a regression that has highly correlated x variables.

When comparing statistical software packages, therefore, your main consideration should be ease of use, a major benefit of most microcomputer programs. (Mainframe programs could benefit greatly by incorporating such ease-of-use features as those found in microcomputer packages.) Then use the tests this article describes to determine when a package's limits of numerical accuracy are reached.

Even a perfectly accurate statistical program would not guarantee accurate results.

Remember that even a perfectly accurate statistical program, if such a thing could exist, would not guarantee accurate results. Another important consideration is the statistical accuracy of your input data. James Frane (in "Methods in BMDP for Dealing with Ill-Conditioned Data—Multicollinearity and Multivariate Outliers, a paper presented at the 1974 American Statistical Association meetings) notes that data can be measured in such a way as to preclude more than one or two accurate digits in a regression result. He points out that the numerical accuracy of the programs often far exceeds the data's statistical accuracy. This is especially true when the independent (x) variables are measured with some uncertainty.

Programs Compared

The statistical accuracy of four programs is compared here. First, Daisy version 1.2.2 from Rainbow Computing Inc. (19517 Business Center Dr., Northridge, CA 91324) is a versatile program with a data-entry procedure similar to that of Visicalc, which makes it easy to use. Rank tests, analysis of variance, and regression are available. While in the process of writing this article, I received version 2.0; I'll briefly discuss that version also.

HSD Anova and HSD Regress are part of a three-package system— the third is called HSD Stats—from Human System Dynamics (9249 Reseda Blvd., Suite 107, Northridge, CA 91324). Data entry with these programs is simple, although a separate file is created for each variable or each case (as you choose). These programs offer some error-checking capability; during my work, for example, one program detected a problem with the regression and appropriately would not calculate the coefficients. I've been informed that a new regression program will be issued shortly; it will

Input integers / Program		1 through 9	1001 through 1009	10,001 through 10,009	100,001 through 100,009	1,000,001 through 1,000,009
Daisy 1.2.2	$\bar{x}$ =	5	1005	10,005	100,005	1,000,005
	s =	2.738613	2.738613	2.741147	3.694967	0
Daisy 2.0	$\bar{x}$ =	5	1005	10,005	100,005	1,000,005
	s =	2.73861279	2.73861279	2.73861279	2.73861279	2.73861279
A-Stat List Command 79.6	$\bar{x}$ =	5	1005	10,005	100,005	1,000,005
	s =	2.739	2.739	2.739	3.771	21.333
A-Stat Correlate Command 79.6	$\bar{x}$ =	5	1005	10,005	100,005	1,000,005
	s =	2.7386	2.7386	2.7365	3.5178	0
A-Stat 83.1 * Data Procedure	$\bar{x}$ =	5	1005	10,005	100,005	1,000,005
	s =	2.739	2.739	2.739	2.739	2.739
HSD-Anova II (Old program)	$\bar{x}$ =	5	1005	10,005	100,005	1,000,005
	s =	2.73	2.73	2.68	0	0
HSD-Anova II (New program)	$\bar{x}$ =	5	1005	10,005	100,005	1,000,005
	s =	2.74	2.74	2.69	2.83	0
Aida	$\bar{x}$ =	5	1005	32,005 **		
	s =	2.739	2.739	2.739		

* A-Stat 83.1 results were sent to me by its authors. That program was officially released in September, after this article was written. It provides correct skewness and kurtosis to one decimal place.

** Aida limits you to a maximum of five digits stored as integers, so the maximum number it can store is 32,767 times 10 to some power. It uses the updating algorithm.

Table 1: *The results obtained calculating mean ($\bar{x}$) and standard deviation (s) with various statistical programs, showing that most of the packages have problems dealing with large integers. Some programs provide hints when they're having trouble with a calculation. For example, the HSD-Anova II program (earlier version) could not handle the calculation of standard deviation for the largest input integers and provided a negative sum-of-squares value, an impossible answer signaling an obvious error. (The new version did not provide a correct value for that standard deviation either, but it provided a positive sum-of-squares value.)*

compute the coefficients even though it detects a problem, but it will issue an appropriate warning.

A-Stat 79.6 from Rosen Grandon Associates (7807 Whittier St., Tampa, FL 33617) is based on a subset of P-Stat, a mainframe package. It was created for use on the Apple and is not a translation of the mainframe code. It produces many useful statistics but provides only three or four digits of output. I received output from A-Stat 83.1, a new version, while writing this article. Although the results are generally much better with the new version, the limited number of output digits remains a problem.

Aida, a general-purpose program offered by Action-Research North West (11442 Marine View Dr. SW, Seattle, WA 98146), permits easy data entry (although you'll have to specify decimal places). It stores numbers in integer form and converts them for manipulation, placing a limit of 32,767 as the largest number than can be saved. This limit can be "swindled" by using the E05 scientific-notation suffix to indicate a larger number.

Computing Means and Standard Deviations

The formula for the mean is

$$\bar{x} = \Sigma x_i/n$$

(the mean equals the sum of the xs divided by the number of observations). A potential problem occurs if there are many observations and if each observation yields a large value for x or if the xs for each observation differ only in the seventh or eighth significant digit. Such conditions rarely occur in microcomputer applications, however, and thus won't be covered here.

Where problems can and do occur, however, is in microcomputer calculations of standard deviation:

$$s = \sqrt{\Sigma(x_i - \bar{x})^2/(n - 1)}\ , \qquad (1)$$

which is algebraically equivalent to

$$s = \sqrt{(\Sigma x_i^2 - n\bar{x}^2)/(n - 1)}\ . \qquad (2)$$

The latter formula is easier to use than the former one, and it works well on a mechanical calculator (although accuracy might dictate that you recode the data by subtracting a number near the mean from the x values corresponding to each observation). Once data is entered, a computer can use the formula to grind out an answer, which we would normally accept without question because, after all, a machine produced it.

If we aren't alert, however, machines can fool us. They can lose precision when calculating the standard deviation of a small set of large numbers.

Consider, for example, the standard-deviation calculations shown in table 1. For each program discussed in this article, the table shows the calculated means and standard devia-

i	x_i	x_i^2	m_i	s_i^2
1	100,001	1.00002 × 10^{10}	100,001	0
2	100,002	1.00004 × 10^{10}	100,001.5	.500000
3	100,003	1.00006 × 10^{10}	100,002	1.000000
4	100,004	1.00008 × 10^{10}	100,002.5	1.666667
5	100,005	1.00010 × 10^{10}	100,003	2.500000
6	100,006	1.00012 × 10^{10}	100,003.5	3.500000
7	100,007	1.00014 × 10^{10}	100,004	4.666667
8	100,008	1.00016 × 10^{10}	100,004.5	6.000000
9	100,009	1.00018 × 10^{10}	100,005	7.500000
Total	900,045	9.00090 × 10^{10}		

Table 2: *Calculation of the variance of the integers 100,001 through 100,009, using the updating formula.*

$$nA + (\Sigma x_{1i})B_1 + (\Sigma x_{2i})B_2 + (\Sigma x_{3i})B_3 = \Sigma y_i$$
$$(\Sigma x_{1i})A + (\Sigma x_{1i}^2)B_1 + (\Sigma x_{1i}x_{2i})B_2 + (\Sigma x_{1i}x_{3i})B_3 = \Sigma x_{1i}y_i$$
$$(\Sigma x_{2i})A + (\Sigma x_{1i}x_{2i})B_1 + (\Sigma x_{2i}^2)B_2 + (\Sigma x_{2i}x_{3i})B_3 = \Sigma x_{2i}y_i$$
$$(\Sigma x_{3i})A + (\Sigma x_{1i}x_{3i})B_1 + (\Sigma x_{2i}x_{3i})B_2 + (\Sigma x_{3i}^2)B_3 = \Sigma x_{3i}y_i.$$

Figure 1: *The normal equations for three predictors.*

tions for five groups of nine integers: 1 through 9, 1001 through 1009, 10,001 through 10,009, 100,001 through 100,009 and 1,000,001 through 1,000,009. For all five groups the standard deviation should equal 2.7386127, but, as table 1 shows, the programs lose accuracy when dealing with the larger numbers. What happened? In calculating x^2 when x is large, the computer truncates the least significant digits; thus, for example, although $100{,}001^2$ actually equals 10,000,200,001, a computer might calculate this value to be 1.00002 × 10^{10}, losing the important information stored in the least significant bit of 10,000,200,001.

There are at least two ways of compensating for this problem. The first one involves incorporating an updating algorithm in the programs. This algorithm calculates a new, updated mean m_i as well as an updated variance s_i^2 (the standard deviation squared) after entry of the data value x_i of each observation. For subsequent data-point entries, the updated mean and variance become:

$$m_{i+1} = (im_i + x_{i+1})/(i+1) \quad (3)$$

$$s_{i+1}^2 = [(i-1)s_i^2 + (x_{i+1} - m_i)^2 i/(i+1)]/i. \quad (4)$$

(Note here that the initial conditions are $m_o = 0$ and $s_o^2 = 0$.)

To understand the benefits of the updating formula, consider using a computer that truncates data at six significant digits to calculate the standard deviation of the integers 100,001 through 100,009, first using equation 2 and then using the updating algorithm. Using equation 2, the evaluation proceeds as follows:

$$s^2 = (\Sigma x_i^2 - 9\bar{x}^2)/8$$
$$= (9.00090 \times 10^{10} - 9.00090 \times 10^{10})/8$$
$$= 0.$$

Note that because the least significant digits of the squared terms are lost (maintaining them would require storage of 11 significant digits), the term within parentheses here is incorrectly evaluated as zero, yielding an incorrect variance of zero.

Now, consider what happens when the same six-significant-digit computer uses the updating formula to calculate the variance. Table 2 shows the updated mean and variance values resulting from the calculations (based on equations 3 and 4) that follow each data entry. Taking the square root of the final variance value (calculated after entry of the ninth data point) yields:

$$s_9 = \sqrt{s_9^2} = \sqrt{7.5} = 2.738613,$$

the correct answer.

Unfortunately, using the updating formula is a long-range solution that is feasible only if you are patient enough to wait for a revised package from the program manufacturer or can modify the program yourself. A second solution is to be aware of the limitations of your package and to subtract the mean (or some convenient value close to the mean) from the observations and recalculate the standard deviations. If the standard deviations are the same with both raw data and the data with the mean subtracted, there is no problem. If the standard deviations differ, however, the standard deviation calculated using the raw data is incorrect. Such a check should also be done in computing sums of squares and cross-products for correlation and regression problems. With some poor methods, you can get a correlation greater than 1 or less than −1.

Subtracting the mean works well for data that are all about the same magnitude. If you have some data values that are less than 100 and some that are around 1,000,000, though, there is very little you can do other than use an updating algorithm to correctly calculate the result.

Such problems would be exacerbated for calculations of higher-order moments, which may be done via an updating algorithm or a two-pass procedure in which the mean is calculated in one pass and the higher-order moments are computed in a second pass. For large data sets and mainframe computing, this two-pass procedure is expensive and inefficient; analyzing data in two passes on a microcomputer, however, is much less costly. Similar problems arise for data in which the observation values are not large, but in which all of the variation occurs in the seventh or eighth significant digit.

Regression Analysis

Another type of statistical analysis often performed on computers is multiple linear regression, which attempts to predict a response (y variable or dependent variable) from a set of predictor variables (the x variables). The prediction equation is straightforward:

$$y = A + B_1x_1 + B_2x_2 + \ldots + B_kx_k.$$

All we have to do is estimate the coefficients $A, B_1, \ldots, B_k$, which in many cases is fairly easy. However, if the independent variables are highly correlated, that is, closely related to one another, computing estimates of these coefficients can be very difficult. The estimates are found as a solution to a set of $k + 1$ equations in $k + 1$ unknowns. These equations are called the normal equations. For example, for three predictors the normal equations are those shown in figure 1.

When the x variables are closely related the problem that arises in solving these equations is that a quantity close to zero is used as a divisor. If the computer is not extremely accurate, the entire solution can thus be thrown far off. A second problem arises if the xs have many significant digits. Then you can have difficulty accurately calculating the sums of squares and cross-products (the coefficients of A, B_1, B_2 and B_3 in the example).

I'll give examples with two sets of data for the regression programs I'm using for demonstration. (I also ran these regressions on a mainframe computer to compare accuracy. The point here is not that the microcomputer programs are not accurate, but that an indication of accuracy can tell that you should check your answers on a larger machine.) The first data set, called the Longley data after its originator, has been reproduced in many statistics texts. I have used the scaled version of the data given in Chambers's text (see reference 1). The results were calculated by hand to 15 digits of accuracy; Chambers's version is shown in table 3.

X						Y
GNP Deflator	GNP	Unemployed	Armed Forces	Population	Year	Employed
83.0	234.289	235.6	159.0	107.608	1947	60.323
88.5	259.426	232.5	145.6	108.632	1948	61.122
88.2	258.054	368.2	161.6	109.773	1949	60.171
89.5	284.599	335.1	165.0	110.929	1950	61.187
96.2	328.975	209.9	309.9	112.075	1951	63.221
98.1	346.999	193.2	359.4	113.270	1952	63.639
99.0	365.385	187.0	354.7	115.094	1953	64.989
100.0	363.112	357.8	335.0	116.219	1954	63.761
101.2	397.469	290.4	304.8	117.388	1955	66.019
104.6	419.180	282.2	285.7	118.734	1956	67.857
108.4	442.769	293.6	279.8	120.445	1957	68.169
110.8	444.546	468.1	263.7	121.950	1958	66.513
112.6	482.704	381.3	255.2	123.366	1959	68.655
114.2	502.601	393.1	251.4	125.368	1960	69.564
115.7	518.173	480.6	257.2	127.852	1961	69.331
116.9	554.894	400.7	282.7	130.081	1962	70.551

Table 3: *Multiple linear regression analysis is performed on these data (known as the Longley data, they describe the U.S. population from 1947 to 1962) to come up with a prediction equation of employment. (Source: J. Chambers,* Computational Methods for Data Analysis. *See reference 1.)*

The Longley data values are known to be highly correlated.

These data are known for being highly correlated, and the goal of using them is to form a prediction equation of employment (variable *EMP*) from a set of six independent variables: Gross National Product Deflator (*GNPDEF*), Gross National Product (*GNP*), Unemployment (*UNEMP*), Size of Armed Forces (*ARFC*), Total Population (*POPN*) and Year (*YEAR*). The data are for the United States from 1947 to 1962. The correlations, which are given in table 4, are extremely high. Any one of four variables can be used to predict the employment variable quite accurately. They are also highly interrelated—these variables are really carrying the same information. The regression results calculated by the

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	GNPDEF	GNP	UNEMP	ARFC	POPN	YEAR	EMP
GNPDEF	1.0	.9916	.6206	.4660	.9792	.9912	.9709
GNP		1.0	.6043	.4478	.9911	.9953	.9836
UNEMP			1.0	−.1786	.6866	.6683	.5025
ARFC				1.0	.3655	.4183	.4591
POPN					1.0	.9940	.9604
YEAR						1.0	.9713

Table 4: *The Longley data are highly correlated. Any one of four variables can be used to accurately predict the employment variable.*

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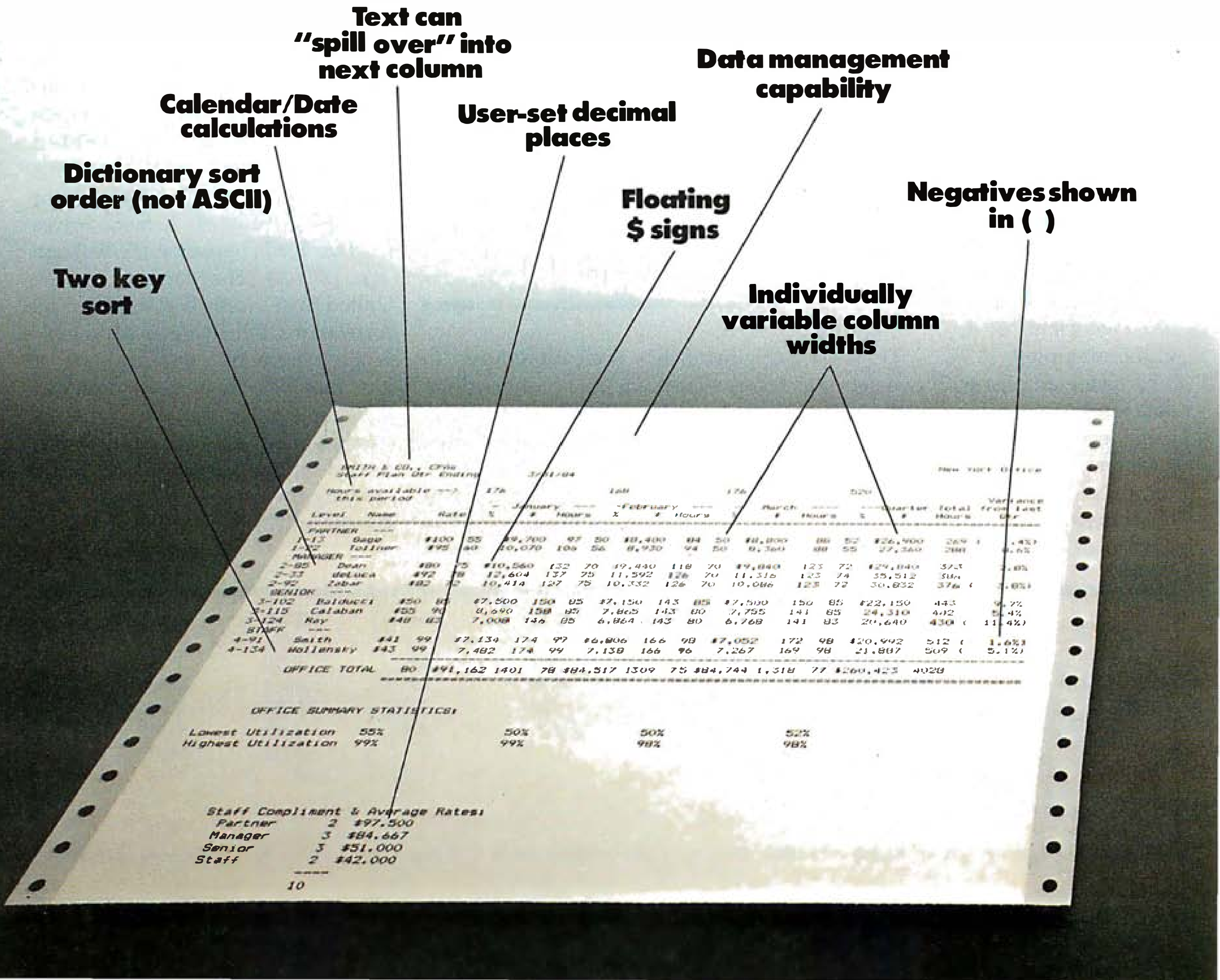

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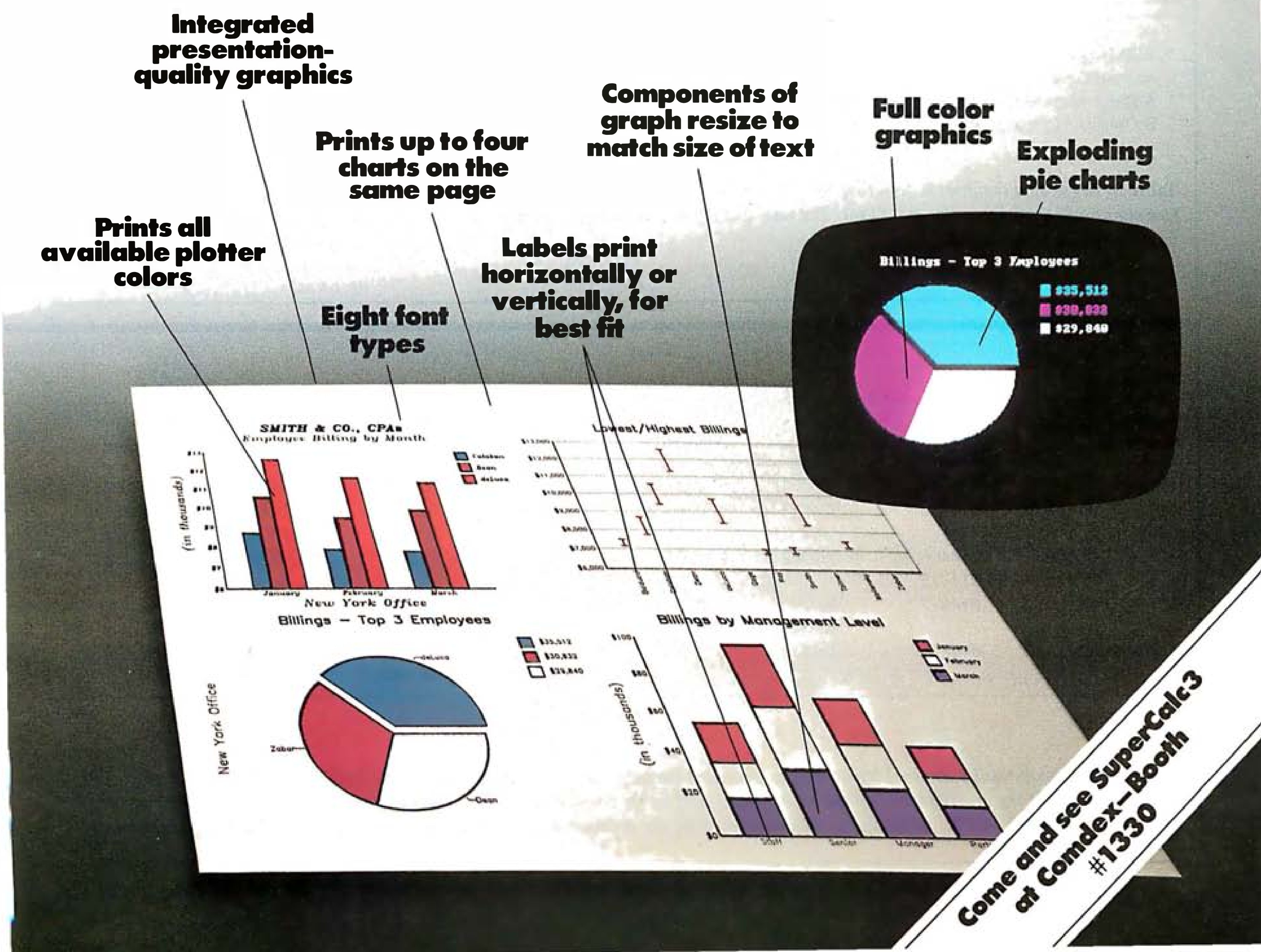

Variable	GNPDEF	GNP	UNEMP	ARFC	POPN	YEAR	Constant
Longley	.0150619	–.035819	–.020202	–.010332	–.051104	1.829151	–3482.259
Sas	.0150602	–.035819	–.020202	–.010332	–.051104	1.829151	–3482.259
digits of accuracy	5	5	5	5	5	7	7
ratio	1.000113	1.000006	1.000015	1.000029	1.000002	1	7
Glim	.015060	–.0358108	–.0202023	–.0103323	–.0511071	1.829150	–3482.256
digits of accuracy	4	5	6	6	4	6	6
ratio	1.000126	1.000011	1	1	.9999413	1.000001	1.000001
Daisy 2.0	.015062	–.035819	–.020202	–.010332	–.051104	1.829152	–3482.259
digits of accuracy	5	5	5	5	5	6	7
ratio	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Daisy 1.2.2	.014765	–.035631	–.020176	–.010325	–.052007	1.826827	–3477.6646
digits of accuracy	2	2	3	4	1	3	3
ratio	1.037964	1.009105	1.002049	1.000804	.9631198	1.001743	1.001832
HSD-Regress*							
A-Stat** 79.6	.015	–.035	–.020	0.010	0.055	1.821	–3465.50
digits of accuracy	2	1	2	2	1	2	2
ratio	1.004127	1.023406	1.01010	1.03320	.9291655	1.004476	1.004837
A-Stat*** 83.1	.0150618	–.035819	–.020202	–.010332	–.051105	1.829	–3482.257
digits of accuracy	5	5	5	5	4	4	6
ratio	1.00001	1.0	1.0	1.0	.99998	1.000083	1.0
Aida	.01294	–.03477	–.02005	–.01028	–.05750	1.81897	3461.856
digits of accuracy	1	1	2	3	1	2	2
ratio	1.00413	.97866	1.01010	1.03320	1.04294	.99087	.99076

* HSD-Regress indicated there were problems in solving the equations and produced no coefficients.
** A-Stat only printed results to three places after the decimal point.
*** By multiplying the dependent variable by 1000, greater accuracy was possible.

Table 5: *Regression coefficients resulting from calculations performed on the Longley data using microcomputer statistical packages and two mainframe programs—Sas and Glim. The ratio and digits-of-accuracy figures shown for each program compare the computer results with Longley's hand-calculated results.*

Daisy 1.2.2

Dependent Variable	GNPDEF	GNP	UNEMP	ARFC	POPN	YEAR	Constant
EMP	.014765	–.035631	–.020176	–.010325	–.052007	1.82688	–3477.66461
EMP + 2 × YEAR	.014060	–.034611	–.020023	–.010281	–.055533	3.81006 (3.826828)	–3444.86125
EMP + GNPDEF	1.014406 (1.014765)	–.035062	–.020091	–.010300	–.053900	1.817287	–3459.01282
EMP + GNP	.014877	.964200 (.964369)	–.020201	–.010333	–.051450	1.829662	–3483.20553
EMP + POPN	.014875	–.035818	–.020204	–.010333	.948622 (.947993)	1.829966	–3483.79906

Table 6: *Regression results obtained by altering a dependent variable. Here, the dependent variable EMP has been modified four ways: first by adding to it the independent variable YEAR multiplied by the constant d = 2 and then by adding to it the independent variables GNPDEF, GNP, and POPN, respectively, each multiplied by the constant d = 1. The resulting regression coefficients should remain*

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programs are given in table 5. The two mainframe packages are Sas (run on an IBM 370/168) from the Sas Institute in Cary, North Carolina, and Glim (run on a Prime 750) from the Numerical Algorithms Group in Oxford, England.

The equations given by Sas and Glim are accurate to five or six digits in each regression coefficient when compared to Longley's results. In Daisy 2.0, the accuracy problems of version 1.2.2 have been corrected, and version 2.0 warns you if the correlation between the dependent variable and a predictor is greater than 0.95. It also warns if the sum of residuals resulting from the regression calculations is "not zero." When using this data, I got the warning, and the sum was -7.6×10^{-6}. Daisy 1.2.2, A-Stat 79.6, and Aida average about two digits of agreement. HSD Regress simply refuses to calculate the regression coefficients and indicates that the data do not permit it to compute the coefficients accurately. A-Stat prints the determinant (a quantity used to solve the equations); for these data it is $1.57031956 \times 10^{-8}$. If the coefficients in the normal equations are not small, then a small determinant such as the one A-Stat calculated for these data indicates serious problems in solving the normal equations. (Readers who have some background in matrix algebra might note that the accuracy of the solution depends on the condition number of the matrix of the normal equations. This condition number is the ratio of the largest to the smallest nonzero eigenvalue.)

Thus, A-Stat 79.6 and HSD Regress indicate when they are in distress. A-Stat only gives regression coefficients to three decimal places, so the results given can have at most three digits of accuracy if the coefficients are less than 1. In fact, when the first digit after the decimal is a 0, at most two digits can be in agreement with the Longley results. The ratio of the Longley coefficients to the coefficients computed by the programs is also given in table 5. For Sas, Glim, and Daisy 2.0, this ratio is never greater than 1.0001 (0.1 percent accuracy). For Daisy 1.2.2, A-Stat, and Aida, the ratio may be as high as 1.04 (4 percent accuracy). For A-Stat one coefficient is almost 8 percent low. The ratios are generally greater than 1, so the resulting prediction will be systematically low, possibly by a substantial amount. This low prediction may not be the case for other problems.

Another check that is helpful is referred to by Kennedy and Gentle on page 329 of *Statistical Computing* (see reference 3). The procedure is as follows:

1. Perform the usual regression.
2. Multiply one of the independent variables by a nonzero constant (d), add it to the dependent variable, and calculate a regression on this new dependent variable.
3. The regression coefficients should be the same except for the one used to change the dependent variable. This one should be d units greater (if $d > 0$). The residuals should be the same.

This procedure (with $d = 2$ multiplying the independent variable *YEAR* and $d = 1$ multiplying the other independent variables) was used with Daisy 1.2.2 and Aida; results are in tables 6 and 7.

The constant term varies about 1 percent in magnitude. The *GNPDEF* coefficient changes by 7 percent in the worst case examined, that of *GNP* by 3 percent, *UNEMP* by less than 1 percent, *ARFC* by less than 1 percent, *POPN* by 7 percent, *YEAR* by about 1 percent. The variables that are most perturbed are those that are highly correlated with *EMP*. Sas, Glim, and Daisy 2.0 all give satisfactory results with this test (data not shown). Sas is accurate to six digits and Glim is accurate to five.

Kennedy and Gentle's procedure, which is available with a little effort on any package, gives a simple

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Aida*

Dependent Variable	GNPDEF	GNP	UNEMP	ARFC	POPN	YEAR	Constant
EMP	1.294	−3.477	−2.005	−1.028	−5.750	181.897	−346185.63
EMP + 2 × YEAR	1.294	−3.477	−2.005	−1.028	−5.750	181.897 (183.897)	−346185.65
EMP + GNPDEF	2.275 (2.294)	−3.491	−2.007	−1.026	−5.701	182.1337	−346646.77
EMP + GNP	1.308	−2.466 (−2.477)	−2.002	−1.025	−5.758	181.529	−345474.675
EMP + POPN	1.269	−3.458	−2.004	−1.025	−4.711 (4.750)	101.477	345375.96

* Dependent variable was multiplied by 100 to get more digits on printout.

the same as the values shown in table 5, except for the coefficient corresponding to the independent variable used to modify the dependent variable (for example, the coefficient corresponding to the independent variable YEAR for the dependent variable EMP + 2 × YEAR). Such coefficients should differ from the corresponding table 5 value by the constant d; their correct values are shown here in parentheses.

Observation	1*	2	3	4	5
1	.26730	.26741	.26736	.26730	.26728
2	−.09372	−.09392	−.09391	−.09367	−.09364
3	.04637	.04678	.04662	.04630	.04629
4	−.41041	−.41042	−.41034	−.41043	−.41044
5	.30784	.30169	.30474	.30993	.31006
6	−.24961	−.25236	−.25118	−.29914	−.24909
7	−.16337	−.15988	−.16144	−.16393	−.16401
8	−.01286	−.01074	−.01164	−.01321	−.01326
9	.01391	.01433	−.01425	−.01382	.01379
10	.45582	.46010	.45829	.45509	.45501
11	−.01654	−.01231	−.01417	−.01726	−.01731
12	−.03881	−.03847	−.03864	−.03888	−.03885
13	−.15597	−.15792	−.15704	−.15566	−.15561
14	−.08551	−.08443	−.08491	−.08570	−.08571
15	.34180	.34002	.34074	.34211	.34213
16	−.20715	−.20986	−.20874	−.20667	−.20666

*Dependent variable for regression

Column	Dependent Variable
1	EMP
2	EMP + 2 × YEAR
3	EMP + GNPDEF
4	EMP + GNP
5	EMP + POPN

Table 7: *Residuals from altered regressions using the Daisy 1.2.2 program. If the calculations are accurate, the columns should all be the same.*

x_1 = Body Weight (grams)	x_2 = Liver Weight (grams)	x_3 = Relative Dose	y
176	6.5	0.88	0.42
176	9.5	0.88	0.25
190	9.0	1.00	0.56
176	8.9	0.88	0.23
200	7.2	1.00	0.23
167	8.9	0.83	0.32
188	8.0	0.94	0.37
195	10.0	0.98	0.41
176	8.0	0.88	0.33
165	7.9	0.84	0.38
158	6.9	0.80	0.27
148	7.3	0.74	0.36
149	5.2	0.75	0.21
163	8.4	0.81	0.28
170	7.2	0.85	0.34
186	6.8	0.94	0.28
146	7.3	0.73	0.30
181	9.0	0.90	0.37
149	6.4	0.75	0.46

Table 8: *Data used in regression analysis to determine the percentage of a drug absorbed by rats as a function of their body weights. (Source: S. Weisberg,* Applied Linear Regression. *See reference 4.)*

	Body Weight	Liver Weight	Relative Dose	Percent Absorbed
Body Weight	1.0	.5000	.9902	.1511
Liver Weight		1.0	.4901	.2033
Relative Dose			1.0	.2275

Table 9: *Correlations between sets of the table 8 data collected in an experiment with rats.*

Rat Data	Body Weight	Liver Weight	Relative Dose	Constant
Glim	−.021246	.014298	4.17811	.265922
Daisy 2.0	−.021246	.014298	4.17811	.265922
digits of accuracy	5	5	6	6
ratio	1.0	1.0	1.0	1.005408
Daisy 1.2.2	−.021246	.014298	4.178109	.2659217
digits of accuracy	5	5	6	6
ratio	1.0	1.0	1.0	1.0
HSD-Regress*				
A-Stat**	−.021	.014	4.178	.266
digits of accuracy	2	2	4	3
ratio	1.01171	1.02129	1.00003	.99971
Aida	−.02138	.01369	4.2099	.26538
digits of accuracy	2	2	2	2
ratio	.99373	1.0286	.99245	1.00204

* HSD-Regress indicated problems in solving the equations.

** A-Stat 79.6 prints only three digits.

Table 10: *Accuracy of the analysis of the rat data shown in table 8.*

Text continued from page 567:

means of checking on the stability of the regression.

The second data set I used to test the statistical programs is a regression analysis of an experiment conducted on rats to determine the percent absorption of a drug as a function of body weight, liver weight, and relative dose. The relative dose was based on body weight, so there was a high correlation between body weight and relative dose. The data are given in table 8 and the correlations are given in table 9.

I did not run the data on Sas, nor are "true" results of 15 digits of accuracy available for this rat data as they are for the Longley data. The comparisons here are with the results of Glim. Again, HSD Regress detected a problem with the data and refused to compute the equation based on three variables. It would give results based on two variables as long as relative dose and body weight were not those two—the high correlation with those variables was too much for it to bear. The number of digits of consistency of A-Stat 79.6 and Aida was again low compared to Glim, being about two digits. Daisy 2.0 and 1.2.2 and Glim agreed to five digits. The ratios of the coefficients were all close to 1. The worst was about 3 percent too high, as shown in table 10.

Moral of the Story

What can be learned from all this? Always check your input data. In the process of doing this study, I discovered two errors. On the rat data I had erred when entering one data point on Glim, which made all programs disagree with Glim on the rat data. Thus, always check your data, then do it again.

Don't completely trust a statistical-analysis program. Check it out with some simple tests such as those suggested in this article. If the program has a facility to give you some diagnostic information, such as the determinant, check it on every problem. The more useful test is the one based on adding an independent variable to the dependent variable. If the data are really important to you and you suspect them in any way, rerun the data on a mainframe using standard software. Suggestive signs are high correlations in the independent variables, a small determinant, instability in the coefficients, or a diagnostic indication from the program.■

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2. Cooke D., A. H. Craven, and G. M. Clarke, *Basic Statistical Computing.* London: Edward Arnold Publishing Co., 1982. A nice elementary text with many BASIC programs, this text examines accuracy and speed considerations. Its programs are concerned with elementary statistical analysis. I highly recommend this one.
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4. Weisberg, S. *Applied Linear Regression.* New York: John Wiley and Sons, 1980. This book is a useful treatment of many regression topics, including diagnostic procedures.

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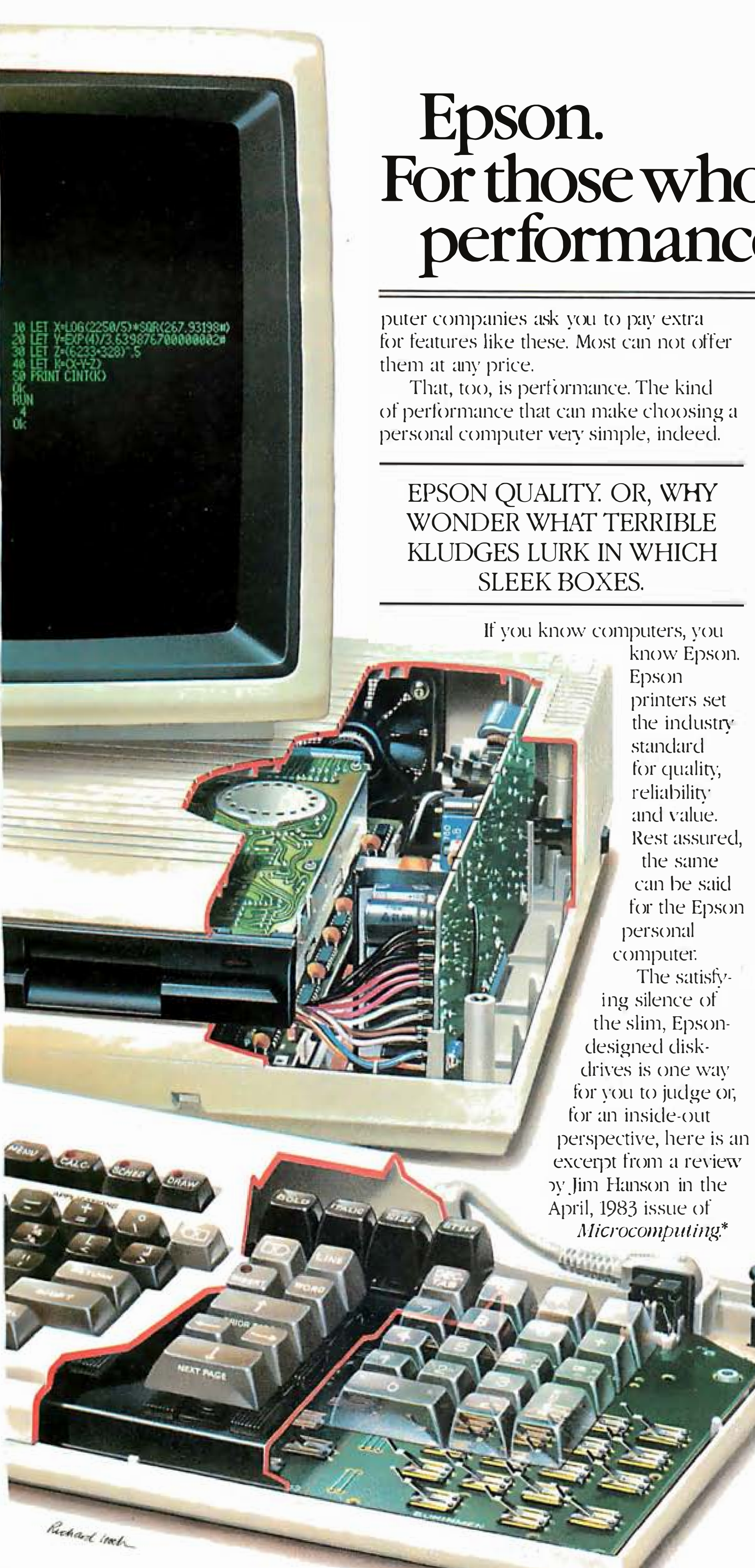

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User to User

Conducted by Jerry Pournelle

Computing in Singapore

Dear Jerry,

Come, come, now, Jerry, I'm sure that you have very good reasons to dislike the "European standard," as you call it ("Terminals, Keyboards, and How Software Piracy Will Bring Profits to Its Victims," November 1982, page 394), but you really needn't act so heavy-handed. If IBM and DEC (and Olivetti, for that matter) want to "wreck" their keyboards, so what? You are not compelled to buy their machines.

(I may as well point out that I have been a touch typist for only about five months, and I have hardly used the Selectric layout you rave about. So if there is something better, I have never experienced it. Although the M20 has incorporated the "European standard," an Olivetti typewriter I also have seems to have the Selectric layout: the shift keys are large, and the single- and double-quote marks are to the right of your right pinky. I say "seems" because I haven't the faintest idea whether this is the Selectric layout.)

Your points in the following paragraphs are good, though. The stupid thing we are talking about is indeed only a keyboard and should accommodate the user, not the other way around. The M20's keyboard is completely reprogrammable under PCOS (Olivetti's custom Professional Computer Operating System), and I can make it do anything I want. It really escapes me why all the other computer companies of note like Apple, Tandy, IBM, etc., opted not to have easily reprogrammable keyboards.

One thing disturbs me: disk formats. CP/M is supposed to provide some kind of standard. But if I go to a computer store, it has disks "for CP/M" in "the Apple/Softcard format," "the Northstar format," "the NEC format," and "the 8-inch single-sided single-density format." A standard? It seems to me that if I want to run CP/M programs on my machine, I need to purchase 8-inch drives (not offered by Olivetti or by any other company for the M20) and transfer programs to 5¼-inch floppies. Seems like a lot of trouble.

I've noticed that most computer aficionados like myself are male. There seems to be some kind of cultural conditioning that we give our females: "No, Nancy, you can't use papa's computer. That is for boys. Go play house." Sigh.

I'm looking for more pen pals my age (I'm 15) in the United States. Since you profess to have a cloud of kids causing chaos in Chaos Manor, perhaps you could recommend one (preferably female, because I already have a male pen pal in California). I'm interested in computers of all kinds, but my greatest interest is in microcomputers (I don't have constant access to minis, let alone mainframes). I have used, for varying periods of time, ZX-81s, TRS-80s, Apples, Sords, and Picos (a learning machine made here in Singapore) as well as the Olivetti M20, which I have had for almost seven months.

My latest computer-related interest is graphically presented perspective, i.e., when a computer creates pictures, using high-resolution graphics on the screen as the eye would see if an object were just behind the screen (see November 1982 BYTE, page 474). The mechanics of drawing such a picture can become somewhat complex: you have to define the pitch, bank, and heading of the observer, you have to define the distance of the object, and you have to create "perspective plane" (usually the screen) in which to picture the projectors (imaginary lines leading from the object to the observer). Unfortunately, my microcomputer does not run fast enough to give it lifelike animation. How I would like to have an HP9000, which has a full 32-bit architecture, that can. It is a bit out of my reach, though, at S $120 000 (US $60,000).

How I thought that a 16-bit computer was enough! After all, it can receive text much faster than I can type it, it can move convoluted blocks of text at blinding speeds, it can, with the appropriate software, relate cells to other cells (like Visicalc and Multiplan), and it can utilize the microprocessor's block-move capabilities to move pictures, albeit in two dimensions, around the screen faster than my eye can follow. But it cannot perform three-dimensional rotation fast enough to take advantage of the eye's visual persistence, even without hidden-line removal. Picture refresh in three dimensions takes an agonizing 2 seconds for a simple wire-frame house.

Sometimes I feel very, very old, even though I am only 15. Due to a very pressure-oriented school system, where one must give more than a casual attention to school work, I cannot spend as much time as I'd like using computer systems. So I fall behind. And whiz kids like Eugene what's-his-name of Hewlett-Packard fly far ahead, unencumbered by having to go to school or any of those mundane things like a mere mortal like myself has to do.

Recently, I went to Computa '83, a somewhat large computer exhibiton here in Singapore (it was supposed to be the largest in Asia). I went there confident in my higher-than-average knowledge of microcomputer systems. Boom.

Mainframes. Minis. And I didn't know the first thing about them. Do you know the Tata Elexi 6400, being a "full" 64-bit machine, can store 193 megabytes of memory? With 4 gigabytes on line?

Oh, of course, there were those small machines like the Apple, the NEC, and the current crop of Japanese computers (strangely, many S-100 systems and the Olivetti M20 were not exhibited). But those were holdovers from the last show. Nothing new.

The most common microcomputers here in Singapore are imitation Apple II's, I am sad to report. Software as well as hardware piracy here is rife. Programs can be bought for only a few dollars above the price of a disk and photocopying the manual. There are shops in Singapore, run by otherwise honest people, that specialize in program copies. I was in one recently (no, not to buy anything, as I have an often troublesome set of scruples), and a man wanted to buy a copy of Sorcim's Supercalc. The vendor offered it to him for about S $20, and he complained that that was too high! They proceeded to haggle over the price, with the happy customer eventually walking out with the program and photocopied manual for S $15, no doubt to go home and try it out on a fake Apple II. People do not think twice before making and distributing copies to friends.

It sometimes makes me sick.

What's it like in America?

Victor Chua
1 Sunset Ave.
Raffles Park
Singapore 1128
Republic of Singapore

Great heavens, if you're typical of 15-year-

old students in Singapore, we should stop worrying about competition from Japan and turn our attention farther west!

I wish I had time to conduct a long correspondence with you, particularly on what it's like in America; I wouldn't mind knowing what it's like in modern Singapore (when I was last there the British hadn't pulled back west of Suez, and there was insurgency in the Malay States).

Regarding disk formats, I have my own complaints about that; fortunately, Lobo and Kaypro have come up with programs that read a number of different formats, and Tony Pietsch has written one we can use with the Compupro. There will undoubtedly be other translator programs. It takes a bit of time, but, after all, the micro industry is still quite young. . . . **Jerry**

In Praise of APL

Dear Jerry,

Let me make a user's comment on APL, a language you recently said you propose to learn in the coming year ("The Debate Goes On. . . ," August, page 312).

I am not a computer buff and not in your class as a language analyst. But I do use a computer at home (in BASIC and FORTRAN on celestial mechanics and correspondence) and at work (in APL on engineering, financial analysis, and reports) for several hours every day of the week and have done so for years. The focus is on the problem and the results.

For complicated one-shot problems of the kind that arise in my work, APL is in a class by itself, in my opinion. The reason is that practically all of the functions and operations on scalars, vectors, and matrixes that arise, in any number of dimensions, are optimized APL functions callable with just 1, 2, or 3 keystrokes. For example, I recently did a modest optical analysis that took around 900 lines of BASIC. For comparison, the same job in APL is 45 lines. The convenience of APL is high for the working engineer who is not just cranking out numbers or text from canned routines but who is constantly addressing new situations and writing new software. This is not to say that APL is weak for other uses, but those lie outside my immediate experience. The language is completely interactive and can be checked out line by line as it is written.

Your remark that APL is interpreted (and hence, by implication, is slow) is somewhat wrong on two counts: first, the multitude of APL functions are precompiled in efficient machine language, and the names are the addresses of these functions. Thus, the execution is quite fast. Second, if the analysis of some piece of a problem takes a week or more (typical) and the programming an afternoon (FORTRAN) or half an hour (APL), a few seconds' difference in run time is irrelevant.

Norm Peterson
Santa Monica, CA

Thank you for the clarification; I was a bit unclear in the article and should have mentioned that one of APL's major advantages is that it's very *fast.*

APL enthusiasts tend to be enthusiastic about their favorite language, and many report that they can solve problems while other programmers are still thinking about an approach. In other words, APL is a hacker's delight, if by hacker we mean someone more concerned with getting the answer faster than with writing elegant programs. (That's one definition; there are others, and I don't care to get into a debate on what the word hacker means. As Humpty Dumpty said of words, the important question is who shall be master.). . . **Jerry**

Don't Knock C

Dear Jerry,

In response to your article "The Debate Goes On. . ." (August, page 312), I agree with much of what you wrote. However, I feel you were unreasonably harsh on C.

You state that C produces overly large object modules because it was originally designed for use with Unix and lots of extra code has to be linked into the programs to let them run on microcomputers. This is misleading. Your sample program,

```
/* simple.c */
/* A very simple program */
main( )
{
    printf ("This is a very simple pro-
    gram. \ n");
}
```

calls a very complicated subroutine, printf. Even on the VAX 11/750 system I use (running Unix), this program compiles to code over 4000 bytes long.

By making two changes, we can dramatically reduce the space needed. First, get rid of printf. On Unix you can replace it by the low-level system call write.

The second change is a little hairier. On Unix, the program simple.c will compile to a loadable object file simple.o, which is then linked by the loader with a "start-up" file, /lib/crt0.o, and the library /lib/libc.a. The code in crt0.o calls the routine exit, which eventually calls all sorts of routines to close files, print error messages, etc. The library libc.a also contains the routine _exit, which does a quick and dirty exit. Putting it all together, we get:

```
/* simple2.c */
/* A (somewhat less) simple program */
main ( )
{
    /*Meaning of arguments:
        1 = standard output file
        descriptor
        ". . ." = string to be output
        31 = number of characters to
        output.
    */
    write (1, "This is a very simple pro-
    gram. \ n", 31);
}
exit( )
{
    _exit( );
}
```

The start-up code will now call the user's exit ( ), so the library exit ( ) is not loaded. The resulting executable code is 164 bytes long. An even shorter alternative would be to rewrite the start-up code to call _exit or to do an exit system call in line.

We can simplify the program by creating a library routine for printing strings:

```
/* Quick and dirty string printing */
prints(s)
char *s;
{
    while (*s != ' \ 0')
        write(1,s++,1);
}
```

or

```
/* A faster version */
prints(s)
char *s;
{
    char *p;
    /* Make p point at the ' \ 0' at the
     end of the string. */
```

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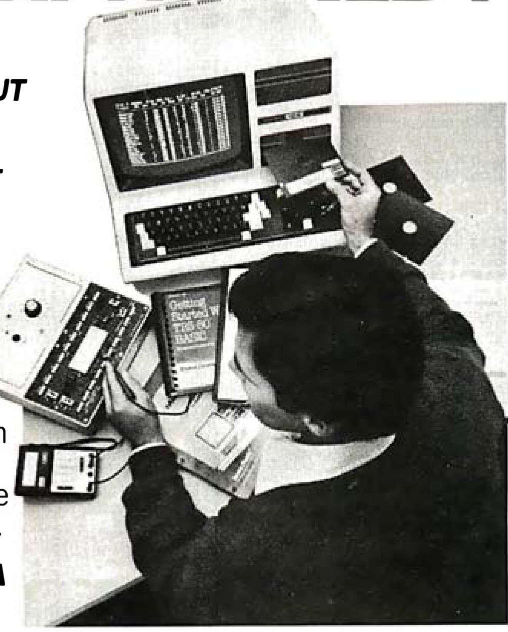

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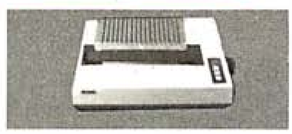

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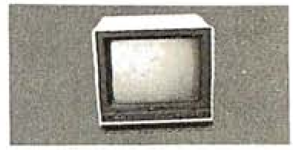

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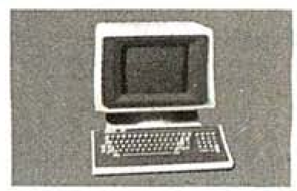

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```
    for (p=s; *p!='\0'; p++);
    /* So, p-s is the length of the
    string*/
    write(1,s,p-s);
}
```

Here are some simple rules for getting compact object code for C:

1. Be very careful with library routines. Calling printf will probably mean loading the entire standard I/O library. If space is critical, load or write a less general special-purpose routine.
2. Use a peephole optimizer. The Unix C compiler has a very useful optional phase that makes local ("peephole") optimizations in the output code. It usually makes for substantial savings in both space and time. In my opinion, all compilers should have such a phase.
3. Use register variables. The code will be more compact and much faster. Compilers without register variables are cripples.
4. Exploit the features of the language. Writing FORTRAN- or Pascal-style code with arrays instead of using C's pointer arithmetic will increase code size and running time. In fact, try not to use arrays at all.

It is not difficult to get compact code from C. Remember that the Unix (versions ≤6) operating system on the PDP-11 was written almost entirely in C and had to fit into a 64K-byte instruction space.

The utility of C depends as much on the compiler as on the language. C is a systems programming language, a high-level universal assembler, if you will. If your C compiler produces voluminous or inefficient code, you might as well use Pascal.

I don't understand your comment about readability. I find well-written C easy to read. It isn't self-documenting, but no language is. Your problems are probably caused by a lack of familiarity with the notation rather than any inherent obscurity in the language.

Paul F. Dietz
Canoga Park, CA

Thank you for the explanation. My point was that the C language requires a bit more work than, say, Pascal or CB-80, a point which I think you've illustrated very well.

Those who use C a lot may not have problems recalling the notation and understanding what they've done, but I know a number of good programmers who don't work with C weekly and who have great difficulty in understanding what they did when it comes time to modify it. . . . **Jerry**

Ada's Shortcomings

Dear Jerry,

I want to voice disagreement with the assumption that Ada will become a major programming language.

It is commonly believed that the Department of Defense (DOD) will require Ada for all its programming. The June 30, 1983, *Electronics* (page 54) gives the actual requirements—it will be used for all "critical systems" entering advanced development after January 1, 1984. A critical system would be something like an ICBM targeting program; payrolls, personnel record keeping, and test-data number crunching are not critical systems. Obviously, the bulk of DOD programming is noncritical and won't be required to use Ada. Another item on the same page said that the first Ada compiler has passed certification (Rolm and Data General, for the Eclipse MV and a Rolm supermini). I hear, unofficially, that this compiler is the slowest measured entity since I tried out for my high school track team. The July 14 issue of the same publication (page 49) announces another compiler due for certification in 1984. It compiles for several 16- and 32-bit CPUs and is claimed to be acceptably fast.

In short, we're dealing with a major language for which only one compiler exists, with few on the horizon. Since DOD won't allow subsets or extensions, we can expect this situation to continue for a while. Of course, there are some "Ada" compilers that aren't mil-spec, to allow practice for real Ada, but these give up one of the language's few endearing qualities (portability), and you're practicing to use a language that barely exists in the real world. I'm not even sure what portability means when an update to an operating system may render your standard Ada compiler nonstandard, but let that go.

The big advantage to Ada, by most writers, is DOD support. As previously mentioned, this support is not as great as is typically claimed. I won't embarrass anyone by naming the Air Force Base in whose computer labs I worked this summer, but they don't plan to do any Ada programming. Ever. Part of it is laziness. COBOL and FORTRAN work, and they know those already. Another part of it is the fact that Ada is so powerful, so big, with so many bells and whistles, that they're afraid that they'll shoot themselves in the foot with it. The language offers plenty of opportunities for odd data combinations (one example) to send the program into unpredictable activity and very little to stop you from writing that sort of program. C.A.R. Hoare's comments in the February 1981 *Communications of the ACM* on this difficulty are more than I can improve upon.

It would help if Ada had a semiofficial subset that would be small enough to allow it to be thoroughly learned and still big enough to be useful. This would require a DOD policy reversal (unlikely) or action by IBM or Japan's MITI (Ministry of International Trade and Industry). No one else is big enough to set a standard. It's probably too late to get that done before word gets around that Ada is an overgrown specialty language or before Congress finds out that the Pentagon has been throwing money at this project for years without a line of usable code to show for it. To put it in one sentence, I can't see anybody using Ada unless he's being forced to use it, and there won't be many people in that situation.

Philip R. McLean
University, AL

Today's mail brings both your letter and a brochure from Telesoft, which claims to have Ada compilers for the IBM PC and the 68000 chip. Many other Ada compilers are appearing, according to my friends on the computer networks.

Certainly it has taken longer than anyone expected to get good Ada compilers, and I gather the first ones—even for very large

machines—were very slow indeed, but that situation is rapidly changing. Whether that will cause military programmers to rewrite "nonurgent" programs into Ada is another matter, of course.

It's the urgent ones that concern me. I had in mind the Hoare comment when I mentioned the difficulties of verifying Ada.

You certainly raise some interesting points, and I'd be pleased to hear from other readers who have ideas on the subject. . . . **Jerry**

Pro Power

Dear Jerry,

With respect to the quality of software documentation, I recommend Power to your attention: I find it very easy to use by (1) skimming through the manual once to find out what kind of things it will do for me, (2) referring to the index or the enclosed reference card for a specific application, and (3) checking the detailed explanation of the particular command for how to use it.

The main reason I got Power was to try to rescue the information on a couple of disks (I bought a couple boxes of cheap disks before I learned better) with damaged directories. I was delighted with the results: it turned out that the glitches in both disks were in an unused part of the directory track, and with Power it is possible to read and transfer anything on the disk except the 128-byte sector where the damage is. It is also possible to alter, byte by byte, anything anywhere on a disk, again excepting any damaged sectors. I have used this feature to get rid of a pestiferous and unnecessary warning message in Wordstar. There are a number of other very convenient utility programs.

On to another subject. I much dislike the amber-trace CRTs that are being pushed on computer users now and much prefer the traditional green. It is true that yellow is the most easily identified color (hue), but it also remains true that the spectral sensitivity of the human eye is highest in the green, and I maintain that, for a monochrome display, sensitivity is more important than color discrimination. I have a friend who uses an IBM PC at his work, and he recently replaced a green monitor with an amber one because it was easier for him to read. It turns out that his problem is that he is at the age where he is still trying to fight off the effects of presbyopia, and he won't get glasses yet. I use trifocals myself and have found it very desirable to get a pair of glasses with single lenses, focused for the distance at which my keyboard, monitor, and printed information all lie.

H. Orlo Hoadley
18 Kingsberry Dr.
Rochester, NY 14626

I reviewed an early version of Power over a year ago. Perhaps it's time to look at an updated version. Thanks.

As to amber screens, de gustibus non est disputandem—*it's a matter of taste. Some love them. . . .* **Jerry**

Duplicating the Original

Dear Jerry,

I have been trying to find out about the differences between machines built around a chip and machines built to take

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any chips. For instance, if I bought a Compupro and put an 8088 card in it, would I then be able to run anything written for a PC? Besides just running, would it run as fast or as efficiently? It seems clear that any sort of simulation can never perfectly duplicate the original, so software written for that original can never be entirely functional. And if I plug a 68000 card in there, can I go and buy anybody's Unix, or do I have to wait for Compupro to set it up? I am a fairly clever lad with a ham radio license (expired), a smattering of physics, and a lot of curiosity. I would love to get a machine that would let me play with all of the newest chips, but more important is to be able to play with all of the new software, which nowadays seems to come out on Apple and PC before anything else.

After-market hardware seems to follow the same trend: I can get voice-recognition equipment for under $1000, but only if I have an Apple or a PC. I guess what it works down to is whether to just get a PC for the software support and competitive pricing. What is the difference, really, between a PC and a Compupro from the inside out? You were the first person I came across who actually seemed to have owned and used a lot of this stuff.

Charles L. Convis Jr.
Mcloud Biosystems
314 Rigg St.
Santa Cruz, CA 95060

S-100 systems can in theory emulate other systems, but there are problems. The graphics are different, and the ROM software in the PC is different. The answer to your question is, alas, sometimes, and it depends on the software. I wish I didn't have to be so ambiguous. . . . **Jerry**

Pro p-System

Dear Jerry,

While I admire your science fiction and your amazing capacity for work, your recent user's column about the Sage Computer and the p-System ("Sage in Bloom, Zeke II, CBIOS Traps, Language Debate Continues," March 1982, page 218) calls for some criticism. Your view of the p-System as a bug was completely negated a few lines down by stating that it was the fastest system you had benchmarked. You later mention that the p-System points one back to the editor during a syntax error, one of many good features that have been in the system for several *years*. Otherwise, you have nothing good to say about the system. In comparison to your favorite CP/M, one should fairly point out that the integrated system of languages, operating environment, editor, and utilities is quite powerful and allows one to keep automatic libraries of compiled program segments, automatically date files, and maintain volume names for disks that ensure that the proper disks are being used. Many other features, such as I/O redirection, the monitor function, chaining, and concurrent processes make the system a joy to use. You might have pointed out that the p-System was first developed as a student operating system and is thus a lot "friendlier" than CP/M or Unix in the humble opinion of this user. If you don't like Pascal, you might have pointed out that one can use the p-System with BASIC, FORTRAN, Lisp, or

Modula-2, the latter being mentioned in your flash as being available without mentioning that it is the p-System that supports the version you acquired.

Finally, the reason the p-System on the Sage is not a bug for me is that if I bought one, having chosen the p-System two years ago for its excellent features, I could take my entire environment of programs, printer controllers, my nifty banking program, and the procedure that signs my name, and install them painlessly on the new system. No new versions of BASIC to learn, no new software to buy, just a continuation of the growth and power of my computing environment. That is worth a lot.

Joseph A. Gear
Vernon, Ontario
Canada

I confess some unfamiliarity with the p-System, and thus have little right to strong opinions; certainly there are a number of Sage users who consider the p-System a definite plus. However, do recall that my son Alex and his young lady friend are both students at the University where UCSD Pascal was developed, so I have the benefit of advice from people pretty thoroughly familiar with it.

I don't myself care for the general philosophy of the UCSD operating system; but again, that may be prejudice due to unfamiliarity. There certainly are a number of satisfied p-System users: after all, Carl Helmers, former editorial director of BYTE, is so enamoured that his license plates read P-CODE! . . . . **Jerry**

Naming Names

Dear Jerry,

For "pseudo disk," how about "virtual disk," and for the "box that contains. . . bus and power supply," "crux."

M. Gary Cohen
Searsport, ME

I like "virtual disk." "Crux," though, eludes my affection. Thanks. . . . **Jerry**

Logo: No Go

Dear Jerry,

While reading my kids a story, it occurred to me that somebody should vocalize the analogy of "The Emperor Has No Clothes" to "Logo Is a Fraud." The entire Logo mystique (even the normally sensible BYTE devoted an entire issue to its perpetuation) is supported only by a bunch of "educators" and several thousand defrauded kids. I say defrauded kids because they could have learned all that Logo has to teach by playing any of several games (e.g., Face Maker, Deedle Drawing, and Kids' Programming Language). Had they been taught BASIC, they could have had the rudiments of a useful language. My own experience with my kids and others says that any kid who can understand Logo can do similar tricks with print statements on any computer with graphics. (Yes, I am saying a ZX-81 could replace all of Logo.)

I just hate to see the entire computer community acting as if Logo were something useful when common sense says it is baloney. Try to purchase a useful program in Logo!

Pat O'Neil
Tempe, AZ

I have no real experience with Logo. What I've heard is good, but it does seem strange that we don't have it running on more machines.

I must say I've not heard others express your particular view, but, then, I've not heard many views at all. . . . **Jerry**

On Heath Kits

Dear Jerry,

I recently purchased the Z-100 and find it to be versatile, powerful, and feature-packed. Heath/Zenith has done a good job (I built mine). I have an additional complaint about the system that you didn't mention in the review—the fan noise. I have the Z-100 in my office at home and find the fan noise quite objectionable. I also quite agree with your criticism about the keyboard. It was a design error not to have built the Z with a removable keyboard. I hope to have mine removed in the near future.

Wayne Hatter
709 Wakefield Rd.
Neptune, NJ 07753

We are still pleased with the Z-100, despite the noise. If you manage to detach the Z-100 keyboard, let me know how! . . . **Jerry**

Dear Jerry,

Although I have been involved with programming since junior high school on everything from HP and IBM mainframes to calculators, I have recently been bitten by the personal computer bug. I am considering starting with a Heath kit such as the H-100 but have never seen one (or any Heath product, for that matter). What is your opinion of the products from Heath/Zenith? Also, I have not noticed a vast amount of compatible software. Do you know if it is available but just not listed in favor of the more popular computers?

I am also a little confused when it comes to CP/M. What's the difference between CP/M-86 and CP/M 2.2, etc., and will any CP/M software run on any CP/M-compatible computer?

1Lt. James Blue
583rd Ordnance Co.
APO NY 09078

I like the Z-100 but cannot comment on the kit version because I have never built one.

CP/M-86 is 16-bit for an 8086 or 8088 CPU; CP/M 2.2 is for an 8080, 8085, or Z80. . . . **Jerry**

Using RAM Disks

Dear Jerry,

When a "RAM disk" is used as a substitute for one of the disk drives in such a system, does one load the program or the data disk in the RAM disk for best efficiency?

James M. Baehr
Lake Bluff, IL

The RAM disk allows very quick disk access. Since most programs only load once and have done with it, it's usually better to put the data, particularly files, on the RAM disk if you're short of space.

Try it, you'll like it! . . . **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.

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IBM UPDATE

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Clubs and Newsletters

Take a Survey

Survey, an engineering newsletter for engineers and programmers who work with microprocessors and personal computers, contains abstracts of timely magazine articles categorized for easy access and reference. Headings include personal computers, engineering, hardware, and programming. Article inquiries require a $1 response fee. *Survey* is produced six times a year by KVA Associates for $37 a year, $43 in Canada and Mexico, and $50 a For details, contact KVA Associates, 2821 Camino del Mar, Del Mar, CA 92014.

CCC Middletown

The Connecticut Computer Club meets at the Kent Memorial Library in Suffield, Connecticut at 7:30 p.m. on the first Thursday of each month. Anyone interested in hardware or software for any make of computer can join for a $6 annual fee. For details write to Bill Curlew, Connecticut Computer Club, 92 Plaza Dr., Middletown, CT 06457.

Every Which Way

PC Report is the monthly newsletter of the IBM PC Users Group, an affiliate of the Boston Computer Society (BCS), that contains notes from meetings, ads, special-interest-group news, software-exchange news, abstracts of software reviews, tutorials, special reprints, and announcements of new products, publications, and services. Back issues are available while they last ($1.50). Address all correspondence to BCS/IBM PC Users Group, POB 307, Wellesley Hills, MA 02181.

The HX-20 Users Group of London, England, welcomes information from all users about their occupations and applications of the Epson HX-20. A newsletter is produced that contains documentation, how-to articles, programs, and coming events. Contributions to the newsletter are welcome. Contact the HX-20 Users Group at 25 Sawyers Lawn, Drayton Bridge Rd., Ealing, London W13, England.

Users in Ohio, North and Central

The Akron/Canton PC Users Group is for users of the IBM PC as well as anyone else interested in small computers. Meetings are held on the first Monday of each month from 7 to 9 p.m. in Akron and Canton, Ohio, alternately. Dues are $10 per year and a newsletter is produced. For further details, contact James Finucane, 10690 Clapsaddle Ave., Alliance, OH 44601, or call (216) 935-0252.

Free Ads For Members

The Greater South Bay IBM PC Users Group meets every month and produces a newsletter, *GSBUG*, that contains news, announcements, and minutes of meetings. The group contains special-interest groups for communications, beginners, and investors. Membership dues are $25 annually, family dues are $30, youths are $10, and the newsletter is available without membership for $10. Members receive free advertising for up to three lines. For further information, contact the Greater South Bay IBM PC Users Group, POB 665, Lomita, CA 90717.

Try Tristate OSI

The Tristate OSI Users Group provides a forum for reference to OSI users in Ohio, Kentucky, Indiana, and other areas. This is an informal association of people who share advice about systems, interests, and problems. Inquiries can be sent to Ted Morris, Tristate OSI Users Group, 6306 Kincaid Rd., Cincinnati, OH 45213.

International ZX Users Group

The ZX Users Group of New York is for users of Timex/Sinclair computers. A newsletter, the *ZX World News Bulletin*, is produced every other month and contains news for special-interest divisions such as telecommunications, small business, medical and research, corporate and business, hardware and software, home computing, education, graphics, word processing, and more. For details, write to the ZX Users Group of New York, Box 560, Wall St., New York, NY 10005.

South Florida Enjoys Apples

The Apple Computer Enjoyment Society meets regularly at the North East High School in Fort Lauderdale, Florida. Separate meetings are held for beginners and advanced users. Additional information is available from the Apple Computer Enjoyment Society, POB 9222, Coral Springs, FL 33065.

Morrow Users Form Group

A national users group of owners of the Morrow Micro Decision and Decision I computers has plans to publish a newsletter and provide purchasing discounts and other benefits for members. A title for the group has not yet been chosen. Anyone interested in participating should contact Users Group, POB 14241, Arlington, TX 76094.

60-Minute Atari Newsletter

Bits, Bytes, and Pieces is a club for users of Atari computers. Meetings are held on the first Saturday of each month at 1:30 p.m. in A Building/Recreation room at Orchard Estates in Williamson, New York. A 60-minute newsletter is produced on cassette that records discussions about hardware and software, music, programs, science fact and fiction, and a general exchange of ideas between members. Annual membership is $36, which includes the cassette and access to a disk library maintained by the club. Interested parties can obtain a sample cassette for $3, which will be credited toward the membership fee. For information, write to Bill Wheat, 1103 Arrowbend Dr., Williamson, NY 14589.

Members' Disk Needs Met

The Morrow Users Group (MUG.1) meets regularly and produces a newsletter that contains minutes of the meeting, answers to questions submitted to the newsletter, reports, and reviews. A software library is maintained and aims to accommodate members' needs. Membership is $15 a year. For details, write the Morrow Users Group, c/o S. S. White, Suite 126, 9001 East Bloomington Freeway, Bloomington, MN 55420, or call Will Thorp at (612) 571-4318.

Oregonians Meet

The Jackson Amateur Computer Society meets about four times a year in southwestern Oregon. Meetings include speakers and presentations, and a newsletter is produced. Membership dues are $5 a year. An electronic bulletin board called the Medford FORUM-80, (503) 535-6883 is open 24 hours a day. For further details, contact the Jackson Amateur Computer Society, c/o C. B. C. Inc., 2355 Camp Baker Rd., Medford, OR 97501.

Join a Society

Triangle Sinclair Users Group (TSUG) meets every month in North Carolina to discuss new products and bugs. Meetings include presentations, a software exchange, and programs for sale. A $10 annual membership includes the newsletter that announces software discounts, club news, and reviews. For details, contact TSUG, 206 James St., Carrboro, NC 27510.

Houston Club Forming

The Savid Computer Club has formed. To receive a membership application send a self-addressed stamped envelope to Savid Computer Club, 312 West Alabama #2, Houston, TX 77006.

Changes and Updates

The IBM Personal Computer users group that is active in Cincinnati, Ohio, is now called ACORN. The nonprofit club maintains a public-domain disk library, for which there is a minimal charge to copy disks. Contact the group by writing ACORN: Greater Cincinnati Users Group, POB 3097, Cincinnati, OH 45201.

The Personal Computer Club of Toronto, formerly the IBM PC Users Group of Toronto (November 1982 BYTE, page 539), welcomes even those interested in the IBM PC who are outside of the Toronto, Canada, area. Meetings are planned for the third Tuesday of each month, a software library has formed, and an electronic bulletin board is in the works. The club contains about 10 special interest groups in communications, education, C and assembly languages, spreadsheets, speakers, color graphics, and more. The monthly newsletter is free to all members and includes ads, updates, and features. Membership is $30 a year. To contact the club write to the Personal Computer Club of Toronto, POB 266, Station A, Toronto, Ontario M5W 1B2, Canada.

The Boston Computer Society, representing at least 19 user/interest groups, produces and mails a Calendar each month as a monthly guide to meetings and events. It is suitable for posting. For information, write to the Boston Computer Society, Three Center Plaza, Boston, MA 02108, or call (617) 367-8080 (April 1983 BYTE, page 461).

A Commodore VIC-20 users group has formed under the auspices of the New York Amateur Computer Club Inc. (NYACC). Meetings will be held in New York City, but members from around the country are welcome to join on a correspondence basis. Interested VICtims should write to Mike Brown, New York Amateur Computer Club, POB 106, Church St. Station, New York, NY 10008 (November 1982 BYTE, page 539).

No Need to Shuffle

The Buffalo IBM Users Group (BIBMUG) serves users in the western part of New York state. It provides a forum for the exchange of information and experiences, a software exchange, a monthly newsletter, and other members' services such as volunteers who help newcomers get acquainted with their computers and an electronic bulletin board. Membership is $20 a year, $10 for students and senior citizens. For details, write to BIBMUG, POB 1487, Buffalo, NY 14221. ■

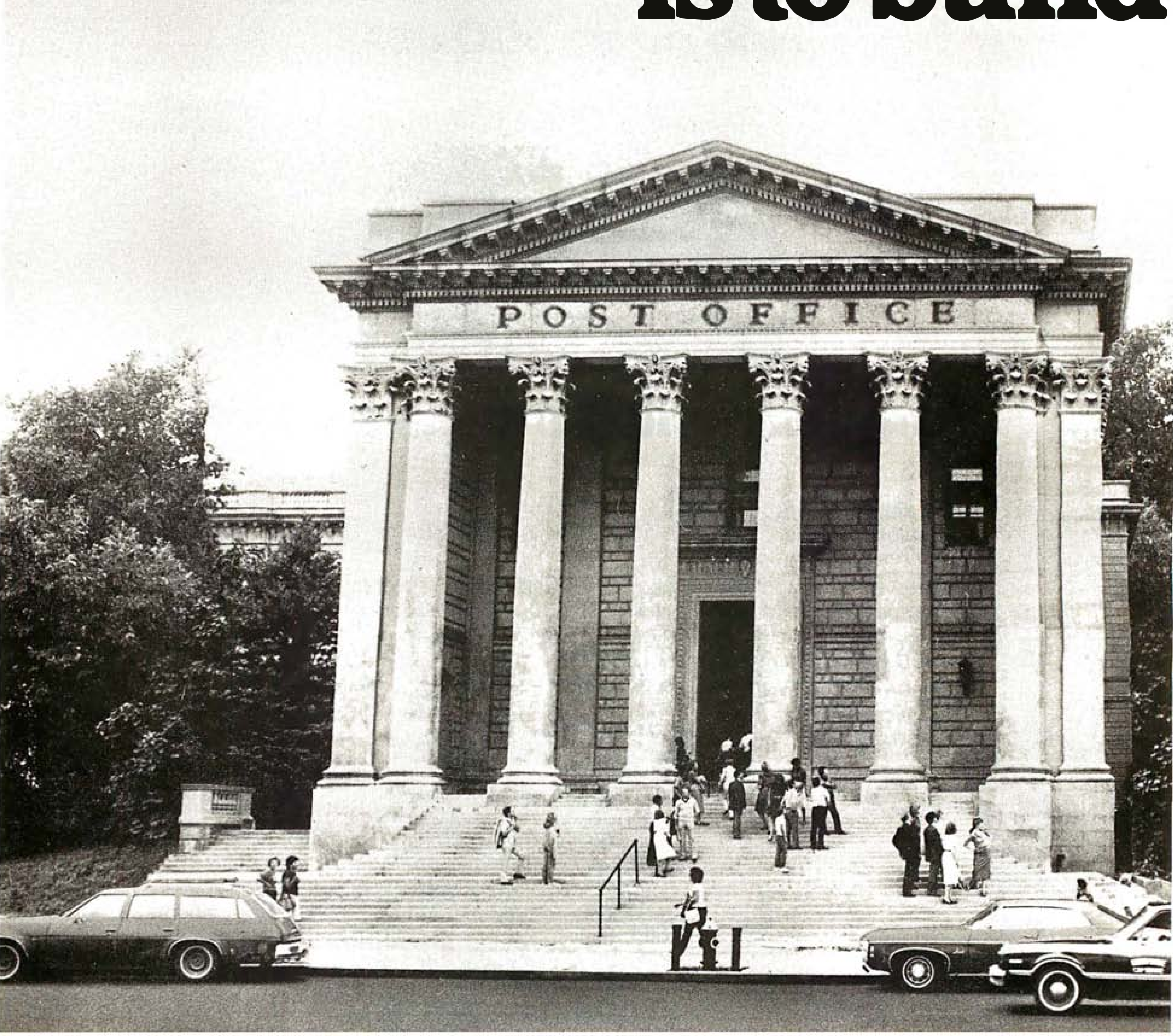
BYTE's Bits

Quick Switch

Two photos were inadvertently transposed in the "What's New?" section in the August 1983 BYTE. On page 511, the top photo depicts a 40-column thermal printer with added interface modules from Alphacom of Campbell, California. The bottom photo shows the letter-quality daisy-wheel printers from Morrow of San Leandro, California.

We apologize to the manufacturers, Alphacom and Morrow, and to our readers for this error. ■

The best way to im
is to build



An idea whose time has come. And gone.

It should come as no shock that your mail is being handled by a postal system that's 208 years old.

Of course, they've made improvements along the way. Like adhesive stamps, mailboxes and zip codes. But the basic idea of carrying mail hasn't changed since the days of Benjamin Franklin.

When you think of how much the world has changed since then, you start to realize that the post office hasn't exactly kept up with the times.

The nation's new postal system.

The nation needs a whole new way to deliver mail. One that's faster, cheaper and more convenient. It's called MCI Mail.

MCI Mail is an *electronic* way to send mail from your office or home to *anyone, anywhere.* Regardless of the kind of equipment they have. Or whether they have any equipment at all. Just type in a name and street address and we'll get it there.

Instead of using a mailbox and a stamp, you use practically any electronic typewriter, home computer, word processor, data terminal or telex.

We've broken the language barrier.

Until now, different communicating machines spoke different languages. For instance, a Wang couldn't get along with an Apple.® They were incompatible.

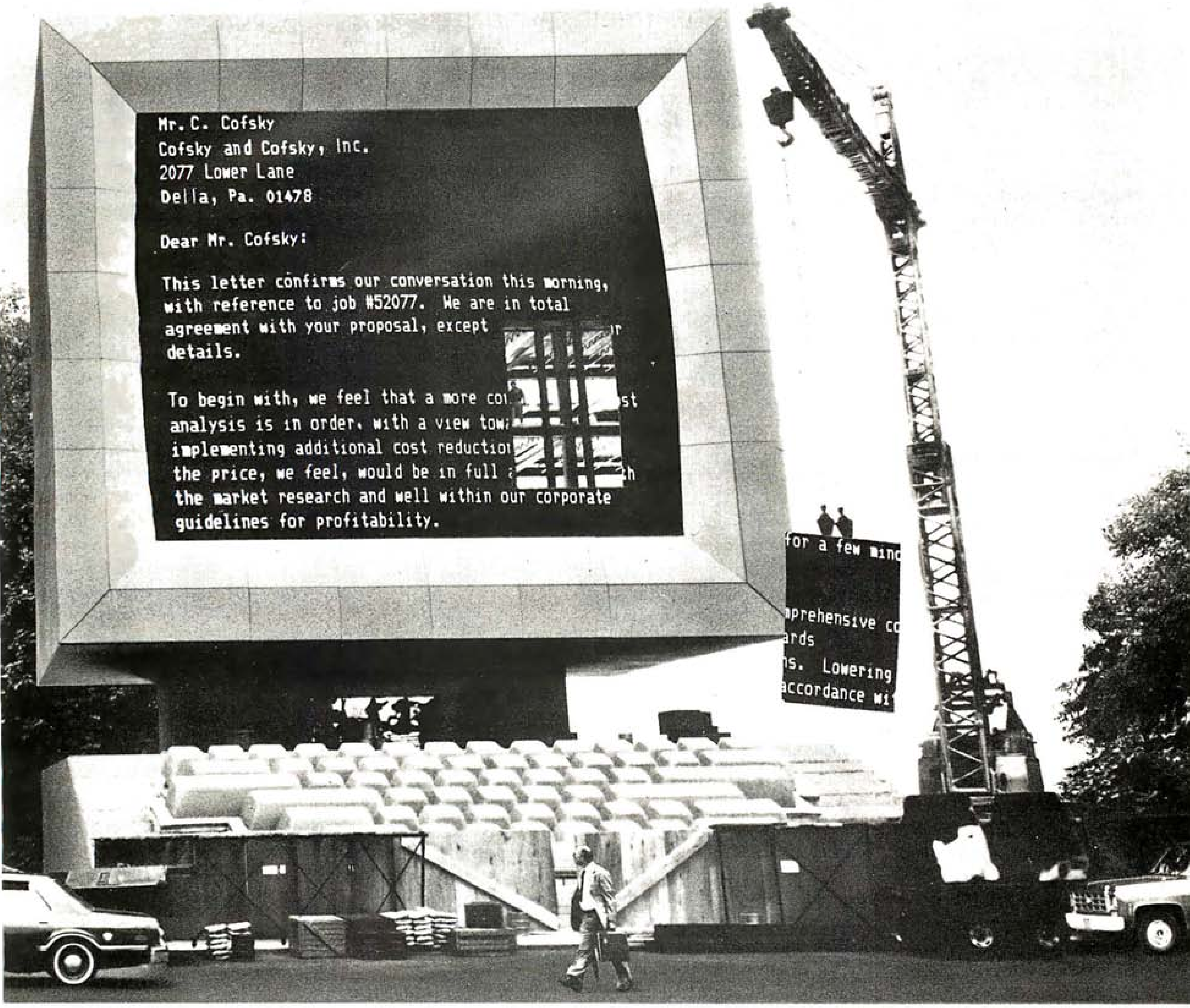
But with MCI Mail, most kinds of communicating machines can communicate with each other. *Instantly.*

My grandma doesn't have a Wang.

Not every person in the world has a sophisticated piece of equipment around the place. But that doesn't stop MCI Mail.

You can reach these people in a matter of hours. Or overnight. What they get is a

prove the post office a new one.



high-quality copy, which can be sent on your letterhead, with your signature.

All right, already. What's the price?

You'd expect to pay more for all this speed and convenience. But what's really amazing is that it costs less than any other fast delivery. In fact, it can cost up to 90% *less* than overnight mail. Speaking about cost, this is one of the few times you can save money without spending money. If your equipment is hooked up to a phone, you don't have to buy a thing. All you're doing is making better use of the equipment you already have.

Besides that, there are no monthly service charges, no subscription fees, and no connect charges to pay. The only time you do pay is when you send out mail.

We've even made it absolutely painless to sign up. Just call 800-MCI-4244 today and you can use MCI Mail in a few days.

The post office is an idea that worked for 208 years. But MCI Mail is the way mail should work today.

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Ask BYTE

Conducted by Steve Ciarcia

Number Crunchers Take Note

Dear Steve,

My interests fall in the area of what might be termed "high-capacity" microcomputers. I would appreciate your advice on a couple of matters. First, which systems do you feel are the most powerful for number-crunching applications? Perhaps one of the 8086/8087/80286- or 68000-based systems? Second, do you know of any products that interface 9-track tape drives to the S-100 or other buses? Thank you for your assistance.

David Lavers
Calgary, Alberta, Canada

Electrovalue Industrial Inc. advertises 9-track tape drives and controllers for the Apple II computer. They may have controllers for others. Write or call them at Electrovalue Industrial Inc., POB 376-T, Morris Plains, NJ 07950, (201) 267-1117.

I am going to pass on the question as to which 16-bit system is the most powerful for number-crunching applications and, instead, reference an article that compares many of them. "An Architectural Comparison of Contemporary 16-Bit Microprocessors" by Hoo-min D. Toong and Amar Gupta, published in the May 1981 issue of IEEE Micro, *does an excellent job of comparing the various 16-bit processors and should answer your questions. . . .***Steve**

Good-bye Howard Cosell

Dear Steve,

For some time I have wondered how much is involved in the process of overlaying video images, i.e., having a game or text generated by a personal computer displayed over either a broadcast video signal or one produced by a videotape or videodisc system.

Think of the fun you could have if a system like this existed—you could blast the bad guys on network television shows from your easy chair with a joystick! Or perhaps computer-generated messages could be displayed on-screen over the show you are watching, telling you that your dinner is ready, someone is at the door, or the dog wants in. You could even program while watching the news.

I know that television stations have the complex video equipment that does this because we see it all the time. Why can't some simplified system be devised that will allow a person to modulate a signal on the same frequency or channel as that being used by local stations and give the computer-generated image priority so that the broadcast image will in effect become the background or playfield area?

I realize that things that sound simple are often the hardest of all to implement; there may even be legal barriers involved in producing signals of the same frequency as those assigned to licensed broadcast stations. I just wanted to see what your feedback on the subject might be.

Doug Arnold
Cullman, AL

An article in the September 1982 issue of Micro, *"Superimposing TV Pictures on PET Video" by Peter D. Hiscocks, describes a method of overlaying a TV camera signal on a microcomputer. The combined output can be fed to a separate monitor or VCR. While a TV camera is shown, the concept can be applied to a TV receiver. The key requirement is to synchronize the microcomputer display to that of the TV receiver. There should be no legal problems because you can work with video signals and not worry about transmitting radio-frequency signals on TV-channel frequencies.*

*As you mentioned, while the concept is straightforward, this is not a beginner's project. A means to isolate the TV from the computer should be employed to prevent unwanted ground loops; synchronizing the sweep rates also requires a knowledge of TV operation. . . .***Steve**

VCR Storage and Retrieval

Dear Steve,

I really enjoy your articles. The laser-optical videodisc interface was especially good.

Is it possible to address VCRs for video and/or data storage and retrieval?

Michael Daugherty
Kapaa, HI

*It is not only possible to interface a VCR for video and data storage and retrieval, it has been done! An article in the July 1980 issue of BYTE, "Interactive Control of a Videocassette Recorder with a Personal Computer" by Dr. Richard C. Hallgren (page 116), describes the interfacing of a Sony Betamax VCR to a Radio Shack TRS-80 and an Apple II. . . .***Steve**

Sound-Generator Interface

Dear Steve,

I like the sound-generating circuit in figure 2 of your article, "Add Programmable Sound Effects to Your Computer," in the July 1982 BYTE (page 60). Can you show me how to interface this to an Apple IIe and an IBM PC? Thank you.

Wayne Straub
Santa Cruz, CA

The programmable sound generator can easily be interfaced to a Centronics parallel port (or any parallel port, for that matter). If you have a parallel printer port on your computer, this is all that is required: connect the eight DATA lines to the eight DATA lines on the port. Connect the STROBE line to the strobe output (the jumper on the sound generator will have to be set, depending on the polarity of the strobe). Finally, connect the READY line to the ready or busy input of the port.

*Sending data to the card is the same as sending data to a printer. In BASIC, just use a POKE command to send the data to the address of the port. . . .***Steve**

Apples and Cats

Dear Steve,

I have an Apple II and a Novation Cat direct-connect modem. I'd like to find a commercially available RS-232C interface card for the Apple II with appropriate software and documentation so that I can use the modem to communicate with family and friends in the U.S. Can you recommend such an in-

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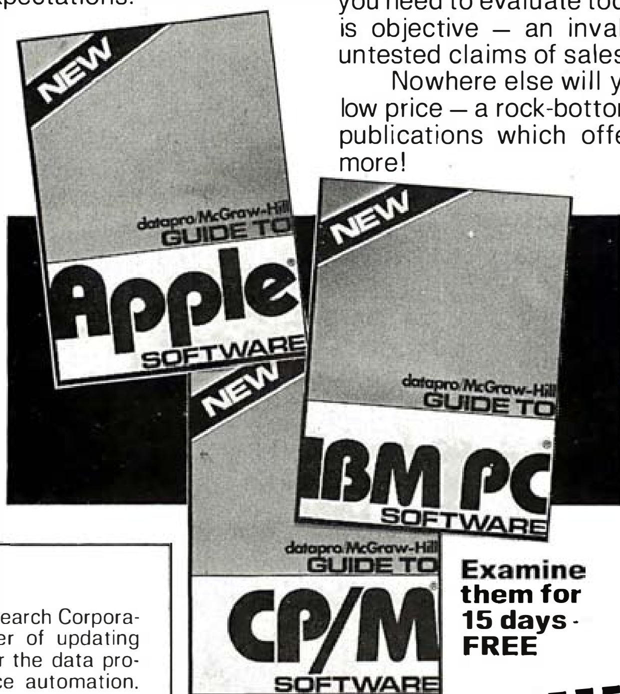

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terface card? Thank you.
Frank Bason
Silkeborg, Denmark

One of the more popular serial interface cards for the Apple II is the California Computer Systems (CCS) Model 7710. It features full handshaking and data rates up to 19,200 bps. Most software packages provide support for this board, and I've seen prices in BYTE as low as $126.

Many software packages are available for use with your modem. Transend by SSM Microcomputer Products is a very versatile package that comes in three versions, the least expensive of which is $89. . . .Steve

Terminology

Dear Steve,

Would you please answer a couple of questions for me. They involve terminology and, although I see these terms often, I do not feel that I know exactly what they mean.

First, what are static RAM and dynamic RAM? What is the difference?

Similarly, what are memory-mapped and bit-mapped, and what, if anything, is the difference? Whenever I see these terms, they always seem to be used with reference to a CRT or video display. Are they used in any other sense?
Donald W. Kearney
Martinsburg, WV

Static and dynamic RAM are two methods of obtaining random-access memory (also known as read/write memory). A static RAM chip can be thought of as a flip-flop device. When a data bit is written into an addressed cell, it flips the state of the cell to a 1 or 0 and remains in that state (hence, static) until changed. A dynamic RAM chip can be likened to a capacitor. When a data bit is written into an addressed cell, it charges up a capacitor and uses the charge, or lack of charge, to indicate the state. The problem is that this charge gradually leaks away due to internal resistance and must be recharged (refreshed) periodically in order to retain the memory bit. These chips are known as dynamic RAMs.

A memory-mapped video display is one that displays the contents of an area of memory. The display can be bit-mapped or byte-mapped. In a bit-mapped display, each video memory location written into will display up to eight dots on the screen. As an example, the hexadecimal word FF will display eight dots (one dot for each 1), and the hexadecimal word 00 will display no dots. This effect can be used to create a high-resolution display on the screen. Although all computers do not handle bit-mapping in the same way, the idea is similar.

Byte-mapping is a more coarse version of bit-mapping. Instead of single-dot resolution, only block resolution is available. As an example, the Radio Shack Models I and III utilize a block graphics approach, creating shapes by combining various block combinations. . . .Steve

Color Computer Items

Dear Steve,

In response to Mr. Duff Kennedy (Ask BYTE, May 1983, page 516), there is a BASIC compiler currently available for the Color Computer from Aardvark Technical Services, 2352 South Commerce, Walled Lake, MI 48088. Written in BASIC, it can handle only a small

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Circle 17 on inquiry card.

Ask BYTE

subset of the BASIC language, but it is easy to use and is great for short machine-language subroutines within a BASIC program. The price is a modest $24.95. I wholeheartedly recommend it to anyone who wants to speed up slow BASIC programs. Aardvark also sells versions for the VIC-20 and Ohio Scientific computers.

I also have a question regarding the Color Computer. I am interested in building many peripheral devices interfaced through the joystick port of the computer but have not been able to find the 240-degree, 5-pin DIN (Deutsche Industrie Norm) plug to fit the port. Radio Shack doesn't sell it, and I have combed the ads in BYTE and many other magazines fruitlessly. Could you please tell me where I can find such a plug? Thank you very much.

Greg Robinson
Cleveland Heights, OH

Thanks for the information regarding the BASIC compiler for the Radio Shack Color Computer.

In regard to your question, Switchcraft Inc. carries a complete line of 5-pin DIN plugs with a 240-degree contact spread. The straight-handle male plug is part number ST-304 and should be available at your local electronics supply company. (A right-angle male connector is also available, part number RA-354.) If not, write or call Switchcraft for the name of your nearest distributor. Its address is Switchcraft Inc., 5555 North Elston Ave., Chicago, IL 60630, (312) 792-2700. . . .**Steve**

EPROM Programmers

Dear Steve,

I'm working on an IMSAI system and need a homebrew kit for stand-alone EPROM programming. Because I want to use the chips for bootstrap start-up and data input, I need (1) a programmer for 2708 and 2716 chips, something that can be fabricated from scratch with little cost, and (2) an S-100 board with the appropriate architecture for the chips. Can you direct me to books, schematics, kits, or other resources? Thanks for your help.

Romolo Toigo
Chatham, NY

Many articles have been published in recent years on the subject of EPROM programmers. One article, "Program Those 2708s!" by Robert Glaser, which appeared in the April 1980 BYTE (page 198), describes the hardware and machine-language software for an S-100 system that is capable of programming either 2708 or 2716 EPROMs. Hope that will get you started. . . .**Steve**

Calculating Bandwidths Revisited

Dear Steve,

I have read several letters in Ask BYTE addressing the confusion of pixels, resolution, and bandwidth when referring to video monitors. The letter from J. T. Miller (Ask BYTE, January 1983, page 484) asked how to calculate bandwidths needed for 80-column lines. Although your response uses good logic, one important consideration has been neglected from your calculations. You said bandwidths "can be calculated by dividing the active trace time by the number of horizontal dots." But this results in bandwidths exactly twice that of what is needed.

Ask BYTE

Regardless of how many dots may occur during the active trace time, the maximum frequency that can be produced is when every other dot is on, giving an on-off-on-off pattern. Any other combination results in a lower frequency. Because the cycle time of the frequency created by this pattern is the time of two dots, you must divide the total number of dots by two. Using 640 dots (as in your example), the formula becomes

42/320 = 131 nanoseconds (ns) per cycle, or 7.62 MHz

It should be noted that these formulas can be used to determine the bandwidth requirements of any computer character or graphics generator display. You must be able to determine the total number of displayable pixels in addition to the active horizontal trace time (the sweep time that may contain pixels).

Further confusion is often introduced when the relationships between horizontal resolution and bandwidths are explained. Horizontal resolution is the method most video monitor manufacturers use to rate their ability to reproduce fine detail. When using the conventions of a 4:3 aspect ratio, with approximately 60-Hz vertical and 15,750-Hz horizontal sweep frequencies (as is necessary for any graphics system compatible with standard televisions or monitors), the complex relationship can be reduced to a constant formula: Lines of Resolution × 12,727.27 = Bandwidth. In order to fully explain this relationship, we must first know exactly what horizontal resolution is.

The methods for determining the number of lines of resolution are carry-overs from optical-resolution methods. It is actually the number of individual lines that can be resolved per unit area in the medium concerned. To measure vertical resolution, horizontal lines are used. Horizontal resolution uses fine vertical lines. The limit is said to be when the lines are at the spacing that just reaches the point where you can no longer distinguish the individual lines. (Reducing the spacing further would make the lines appear as a uniform gray area.)

Once this cutoff point has been determined, the next step is to determine how many lines of resolution this is. Usually, this is done by reading the number corresponding to this point from the scale on the resolution chart. But this number does *not* represent how many lines would be made if this spacing were extended to the full width of the screen. The scale represents the number of individual black and white lines that would cover a width equal to the picture's height. This is to ensure that equal spacing can be applied to horizontal or vertical resolution scales, despite nonsquare aspect ratios.

To determine the time required for the sweep width that is equal to the picture's height, you must multiply the active horizontal picture area by 0.75 (because of the 3:4 aspect ratio). The active picture area can be found by subtracting the total horizontal blanking time from the total time for one horizontal line. The times used in the National Television System Committee (NTSC) standard, as is the standard broadcast practice in the United States, are approximately 11.1 microseconds (μs) for blanking and 63.5 μs total horizontal time. This gives

$$63.5 - 11.1 = 52.4\ \mu s$$
(active picture area)

To get the time of the sweep equal to picture height, we have

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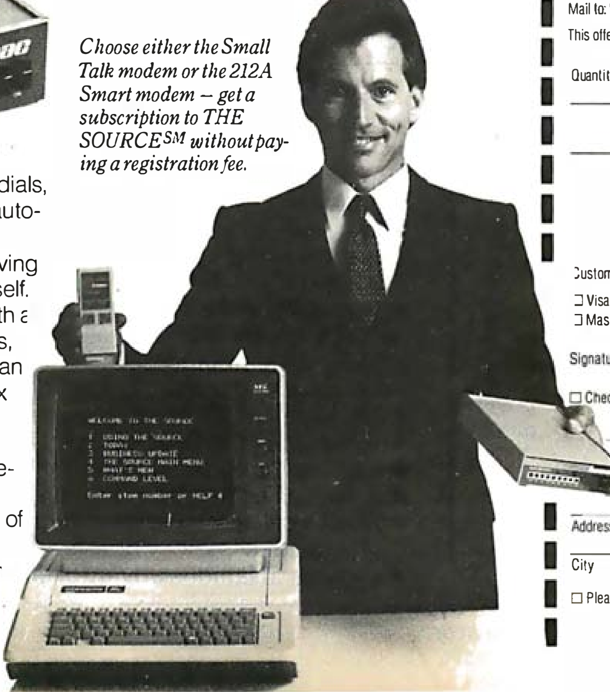

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Circle 226 on inquiry card.

52.4 × 0.75 = 39.3 μs
(measured picture area)

To get the frequency equal to the resolution limit, we must divide the lines of resolution by two. This is required because it is the total of black *and* white lines, each of which individually represents one-half cycle of the frequency. It takes one black and one white line to equal one complete cycle of the cutoff frequency. When the measured picture area is divided by this number, you get the time of one cycle of the cutoff frequency. The frequency is simply the inverse of this time, or 1/time.

If we use the typical broadcasting limit of 330 lines of resolution, we get

330 lines of resolution/2 = 165 cycles
39.3 μs measured picture area /165 cycles = 238 ns
1/238 ns = 4.2 MHz (which is the specified upper bandwidth limit for NTSC)

Applying the previously mentioned constant in place of the complex calculations, we have

330 × 12,727 = 4,200,000 (4.2 MHz)

These formulas can be helpful when translating from "computerese" to "videoese" because of the different methods and terms used to describe the detail characteristics of the picture. Some caution is advised, however, because even though the calculations from lines of horizontal resolution to bandwidth are quite standardized, the calculations from pixels to bandwidth vary because of different active picture times from system to system.

David K. Broberg
Indianapolis, IN

Thank you very much for your letter. You are indeed correct in dividing the total number of dots by two. The maximum frequency does occur with alternating black and white dots and was overlooked in my example.

*There is much confusion on the subject of resolution, especially when manufacturers of monitors do not always publish consistent sets of specifications. Ratings are in terms of bandwidth, lines of resolution, pixels, etc. It becomes difficult to compare unless the relationships and definitions are known. Your letter will do much to clarify this issue. . . .***Steve** ■

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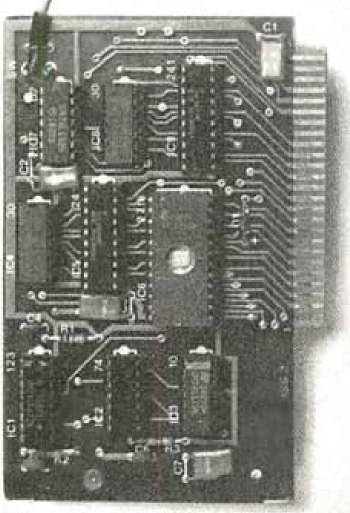

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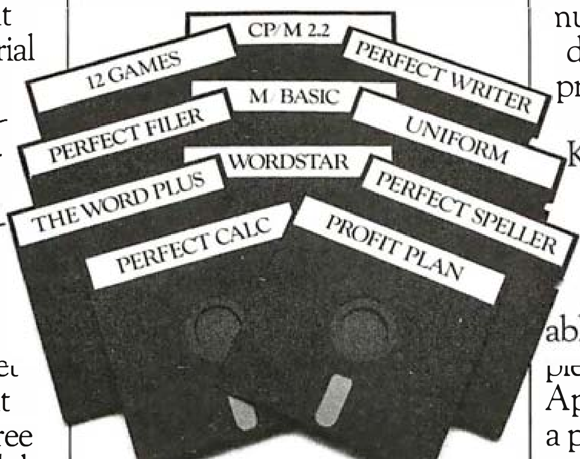

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Apple

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Practical Accountant, a user-friendly, single-entry, small-business accounting program that can balance your checkbook as well as provide cash-flow, profitability, and forecasting information. Key features include easy data entry, automated reports, flexible charts, easy access, and check-printing capabilities. For the II, II Plus, and IIe; floppy disk, $149.95. Softlink Corp., 3255-2 Scott Blvd., Santa Clara, CA 95051.

Sign-up, a sign-generating program. Produce signs and banners to display in grocery, hardware, or stereo stores. You can print up to eight justified or centered lines with up to 8-inch letters. Good for nonprogrammers due to menu-driven commands and arrow keys. Requires Epson printer. For II and IIe; floppy disk, $69. Frost Byte, POB 616, Walker, MN 56484.

Statpro, an integrated software program to handle complex data storage and management, statistical and graphical analyses, and report generation formerly limited to larger computers. Database allows quick access to extensive numerical data capabilities. Statistics contains a comprehensive collection of statistical procedures such as descriptive, regression, analysis of variance, time series, and multivariate. Graphics plots the results of all Statpro statistical analyses. For II, II Plus, and IIe; floppy disk, $1995. Wadsworth Electronic Publishing Co., Statler Office Building, 20 Park Plaza, Boston, MA 02116.

CP/M

Josef, a programming language that lets you develop programs from a vocabulary of commands. Newly created programs can be entered into the vocabulary to create more complicated programs. Includes a tutorial and built-in vocabulary of commands. Floppy disk, $35. Modular Systems 82, POB 1456, Wolfville, Nova Scotia B0P 1X0, Canada.

Mini-Ledger, a single-entry accounting program developed for small businesses with less than 25 employees. It is designed to ease business decision making by keeping track of monthly expenses and income. Floppy disk, $150. Paradigm Consultants, Suite 203, 39812 Mission Blvd., Fremont, CA 94539.

Commodore

Busicalc, an electronic-spreadsheet program that can balance household budgets, prepare cash-flow forecasts for businesses, and redo year-end accounts. This program lets you set up rows, columns, and headings. For the 64; cassette, $69. Skyles Electric Works, 231E South Whisman Rd., Mountain View, CA 94041.

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Fundamentals of Mathematics, an educational system for grades 3 to 12 that contains almost 90 lessons, programs, tutorials, and drills. The teacher is given an assortment of sample-problem, pretest, and posttest worksheets. For the 64; floppy-disk preview, $9.95. Sterling Swift Publishing Co., 7901 South IH-35, Austin, TX 78744.

IBM Personal Computer

Big Top, an arcade-type game in which you maneuver an acrobat through a multiring circus. Climb ladders, jump over beach balls, duck cannon balls and knives, and avoid obstacles while trying to collect all the ringmaster's hats. Floppy disk, $39.95. Funtastic Inc., 5-12 Wilde Ave., Drexel Hill, PA 19026.

Buy or Lease, a financial decision-making tool. This program provides up-to-date coverage that reflects current economic trends. Includes first-year expensing, investment and energy credit, accelerated cost recovery, current interest rates, and all tax rates. No prior programming experience needed. Floppy disk, $125. John Wiley & Sons, 605 Third Ave., New York, NY 10158.

Compac, a file-reduction system. Any file—ASCII text or binary—can be reduced by 10 to 40 percent. Two independent programs, Compac and Decompac, compress and restore your files, respectively. Floppy disk, $49. Sextant Systems, POB 251, Holmdel, NJ 07733.

Creative Graphics, a general-purpose drawing program that enables the nonprogrammer to create, modify, and store color graphics designs. It also provides a slide-show generator and hardcopy output to present black-and-white and color designs. Floppy disk, $139.95. Accupipe Corp., 222 West Lancaster Ave., Paoli, PA 19301.

Decision, a program that compares up to 21 multiple complex alternatives to improve decision making. This program will organize, quantify and sum evaluations, and develop values. Features include easy data entry and revision, automatic file management, and error handling. Floppy disk, $20. Once Begun Computations, Searsport, ME 04974.

The Draftsman, a business-presentation package for producing charts, graphs, and simple illustrations. Generate two-dimensional graphs with minimal input or combine multiple graphs on one screen. Requires a color card. Floppy disk, $200. Starware, Suite 450, 2000 K St. NW, Washington, DC 20006.

File Command, a utility program that combines a file directory with a multiline command area to provide a fast, easy way to issue DOS commands and manage files. The directory can be stored by file size, by the dates that files were created or last saved, alphabetically by filename or extension, or by drive and directory path. Floppy disk, $35. IBM Corp., Personal Computer, POB 1328-C, Boca Raton, FL 33432.

Gradebook 3.0, a utility package that lets teachers store, retrieve, print, calculate, and correct up to 200 students' scores and grades. As many as 60 scores may be recorded per pupil in such categories as daily, quiz, test, exam, and project. Floppy disk, $36.95. DEC Computing, 609 Oakleaf Dr., Garrett, IN 46738.

Learning DOS 2.00, a utility package that teaches you how to use the disk operating system. This package includes on-screen practice and instructions, graphics for computer terms, and explanations of batch files and fixed disks. Floppy disk, $30. IBM Corp. (see address above).

Learning to Program in BASIC, a technical private-tutor course that teaches programming systematically so as to reduce the programming required to accomplish a specific task. Floppy disk, $35. IBM Corp. (see address above).

PFS:File, an information-management package that works like a conventional paper-filing system except that you can record, retrieve, and review information in a fraction of the time. It lets you design your own basic form, fill in the blanks, and change the data. Floppy disk, $140. Software Publishing Corp., 1901 Landings Dr., Mountain View, CA 94043.

PFS:Graph, a graphics program that produces bar, line, or pie charts of presentation quality in minutes. It also produces picture or dot-image files that can be used with PFS:Write documents. Floppy disk, $140. Software Publishing Corp. (see address above).

PFS:Report, a utility package that enables you to produce tabular reports from files created by PFS:File. Each of the multiple columns corresponds to an item from the form of your data file. Data can be sorted alphabetically or numerically, and numeric calculations can be performed. Floppy disk, $125. Software Publishing Corp. (see address above).

The Mail Manager, a mailing-list system that helps you prepare, maintain, and print your mailing lists. Print on standard-sized labels and prepare up to 1000 label-file listings. The program features user-definable sorting and selection of records based on field value or record number. Floppy disk, $39. Starware (see address above).

Master Miner, an arcade-type game. Mine the riches of an asteroid belt in the year 2184. Don't let claim jumpers steal your gems before you can deposit them into your starbase. Requires color-graphics adapter. Floppy disk, $39.95. Funtastic Inc. (see address above).

Medicomp Personal Medical Records Program, a personal medical history. Each individual can maintain a personal medical history as well as keep track of such peripheral information as appointment dates, names of doctors, insurance policies, and more. Transferable to a doctor's compatible program. Floppy disk, $89. Medicomp of Va. Inc., 9526-A Lee Highway, Fairfax, VA 22031.

Microsoft Flight Simulator, a flight-simulation of a single-engine aircraft. Its working instruments, panoramic graphic views, and real-time flight conditions provide full use of flight controls accurate enough to meet FAA regulations for day or night and visual- or instrument-flight conditions. Floppy disk, $49.95. Microsoft Corp., 10700 Northup Way, Bellevue, WA 98004.

Money Matters, a personal-finance program to help maintain your checkbook, reconcile your bank statement, plan and review a budget, and keep records of money-saving tax deductions for personal, family, or small-business use. This menu-driven program features extensive help screens and error checking. Floppy disk, $99. Starware (see address above).

Multi-job, a PC-DOS-enhancement program that can run existing programs written in BASIC, Pascal, assembly language, or any other language for the PC. You can shift from one job to another using a single-function key. You can use the printer, sort, capture data, download, and plot simultaneously. Floppy disk, $159. Starware (see address above).

One Hundred and One Monochrome Mazes, an arcade-type game for the whole family. Complete 101 mazes by going through trap doors, invisible walls, and deep black pools. Some are easy and others are not. If you can solve the last maze (#101), you become a master. Floppy disk, $35. IBM Corp., POB 1328-C, Boca Raton, FL 33432.

PC Parrot, a speech-synthesis program. Without interfacing extra hardware you can add audible speech and other sound effects to any BASIC program. Floppy disk, $39.95. Dragon Data Systems, Suite 110, 1068 Homer St., Vancouver, British Columbia V6B 4W9, Canada.

Private Tutor, an interactive learning program. This self-study system is easy to use in the home, school, or office. It provides lessons and drills for home users; can design special-education requirements; and handles business, finance, manufacturing, or personnel services. Floppy disk, $50. IBM Corp. (see address above).

Report Manager, a three-dimensional application generator and spreadsheet that gives computer users in business the power of a programmable, multidimensional system for financial planning, forecasting, and statistical analyses. Floppy disk, $399. Datamension Corp., 615 Academy Dr., Northbrook, IL 60062.

Trickers, a strategy game for up to three players. Similar to chess and checkers, you move your colored circles to their crown edge by jumping and removing opponents whenever possible. Crowns are indicated by triangles. Floppy disk, $12.95. Trickers, POB 239, Barrington, IL 60010.

Versaform, a business-form processing package. Using the familiarity and structure of existing paper forms, this program accelerates both the speed and accuracy of processing information. It merges customer information, financial data and costed line items, and simplifies the error-free processing of most business forms. Floppy disk, $389. Applied Software Technology, 170 Knowles Dr., Los Gatos, CA

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Word Proof, a word-working program. Improve your writing with this program that checks your spelling and finds synonyms and anagrams. It also has a full-screen editor to write, format, modify, and print what you write. Up to 22 lines of text can be displayed at one time. Floppy disk, $60. IBM Corp. (see address above).

Mattel Intellivision

Dracula, an arcade-type game for one or two players. As Count Dracula in a human form, you must run from constables who patrol the streets, fly away from vultures attacking you as a vampire, and return to your coffin before sunrise. Cartridge, $39.95. Imagic, 981 University Ave., Los Gatos, CA 95030.

Ice Trek, an adventure game for one player. To prevent the advance of a devastating Ice Age, you must guide Vali through herds of caribou and over an arctic river to unlock the Aurora Borealis. Cartridge, $39.95. Imagic (see address above).

Nova Blast, an arcade-type game. To protect the underwater city from flying fighters and water walkers, you pilot a skysweeper equipped with radar. Avoid collisions and shots from the enemy. Cartridge, $39.95. Imagic (see address above).

Safecracker, an adventure game. Your job as a super spy is to steal top-secret documents from various embassies. If you can't crack the safe, you can blow it open with dynamite. Avoid police and traffic accidents as you careen through the town. Cartridge, $39.95. Imagic (see address above).

Tropical Trouble, an arcade-type game. A pleasant shipwreck on a South Sea island turns to danger when Doris is captured. Help Clarence rescue her while fighting off boulders, coconuts, clams, and ferns. Cartridge, $39.95. Imagic (see address above).

Truckin, a highway-trucking simulation game. As a trucker, you race against time to any city in North America. Watch out for Smokies, sharp turns, and other trucks. Earn as much as you can hauling loads, watch your gas gauge, and radio ahead to synchronize pick-up and delivery. Cartridge, $39.95. Imagic (see address above).■

This is a list of software packages that have been received by BYTE Publications during the past month. The list is correct to the best of our knowledge, but it is not meant to be a full description of the product or the forms in which the product is available. In particular, some packages may be sold for several machines or in both cassette and floppy-disk format; the product listed here is the version received by BYTE Publications.

This is an all-inclusive list that makes no comment on the quality or usefulness of the software listed. We regret that we cannot review every software package we receive. Instead, this list is meant to be a monthly acknowledgment of these packages and the companies that sent them. All software received is considered to be on loan to BYTE and is returned to the manufacturer after a set period of time. Companies sending software packages should be sure to include the list price of the packages and (where appropriate) the alternate forms in which they are available.

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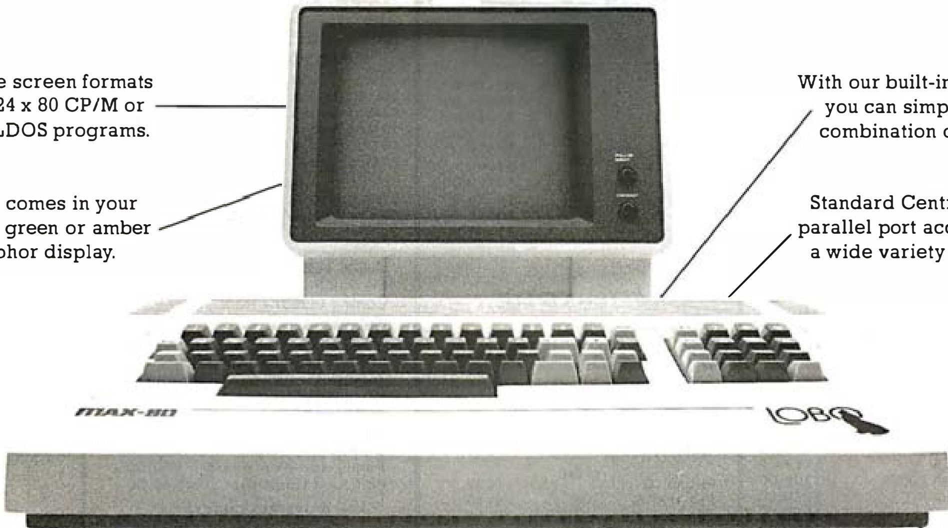

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November 1983

November
Computer Showcase Expos, various sites throughout the U.S. This popular show will bring together hardware and software manufacturers, dealers, and consumers of small computer systems. For further details, contact the Interface Group, 160 Speen St., POB 927, Framingham, MA 01701, (800) 225-4620; in Massachusetts, (617) 879-4502.

November-December
Courses from the Continuing Education Institute, various sites throughout the U.S. Among the courses offered are "Man-Machine Interface," "Applied Interactive Computer Graphics," and "High-Performance Computer Architecture." For more information, contact the Continuing Education Institute, Oliver's Carriage House, 5410 Leaf Treader Way, Columbia, MD 21044, (301) 596-0111; in California, (213) 824-9545.

November-December
The IBM System/36 Seminar, various sites throughout the U.S. This seminar provides a discussion on the capabilities and performance of the IBM System/36. For registration and details, contact DGC Inc., 1450 Preston Forest Square, Dallas, TX 75230, (214) 991-4044.

November-December
Intensive Seminars for Professionals, various sites throughout the U.S. *Electronics* magazine, a McGraw-Hill publication, offers seminars in management and such technical areas as speech recognition and synthesis, controlling electromagnetic interference, fundamentals of computer graphics, and microprocessor interfacing. In-house presentations can be arranged. For a catalog outlining seminars, locations, and fees, contact Irene Parker, McGraw-Hill Seminar Center, Suite 603, 331 Madison Ave., New York, NY 10017, (212) 687-0243.

November-December
James Martin Seminars and **Seminars of Excellence,** various sites throughout the U.S. and Canada. For a brochure describing these data-processing and computer-related seminars, contact Technology Transfer Institute, 741 10th St., Santa Monica, CA 90402, (213) 394-8305.

November-December
Seminars for Professional Development, various sites throughout the U.S. Datapro Research Corporation offers more than 35 professional development seminars in such areas as personal computers, data communications, systems and software, and office automation. Complete outlines and schedules are available from Datapro Research Corp., 1805 Underwood Blvd., Delran, NJ 08075, (800) 257-9406; in New Jersey, (609) 764-0100.

November-December
Software Workshops in MMSFORTH, Boston metropolitan area. These workshops are public versions of the profe ional training Miller Microcomputer Services (MMS) offers to client ›mpanies in support of the MMSFORTH product line. A variety of topics and skill levels are covered. Full details are available from Miller Microcomputer Services, 61 Lake Shore Rd., Natick, MA 01760, (617) 653-6136.

November-January 1984
Courses from Integrated

s throughout the U.S. A

few of the course titles include "Digital Image Processing," "Digital Signal Processing," "Computer Graphics," and "State-of-the-art Robot Systems." The fees for these courses range from $695 to $895. For information, contact Ruth Dordick, Integrated Computer Systems, 6305 Arizona Place, Los Angeles, CA 90045, (213) 450-2060.

November-January 1984
Courses from Q. E. D. Information Sciences, various sites throughout the U.S. Scheduled courses include "Systems Analysis Workshop," Database Design," and "Project Management and Control." Address inquiries to Q. E. D. Information Sciences Inc., Q. E. D. Plaza, POB 181, Wellesley, MA 02181, (800) 343-4848; in Massachusetts, (617) 237-5656.

November-January 1984
Technology Opportunity Conference, various sites throughout the U.S. This conference series focuses on the convergence of optical-storage, videodisc, and computer technologies. For full details, contact Technology Opportunity Conference, POB 14817, San Francisco, CA 94114, (415) 626-1133.

November-August 1984
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.

November 8-11
Wescon/83 and Mini/Micro West-83, San Francisco, CA. A conference and exposition, Wescon covers a broad range of topics, including artificial intelligence, computer peripherals and simulation, and robotics. Mini/Micro serves the original equipment manufacturer community by exploring peripherals, processors, data communications, and software. Contact Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

November 9-10
Business-Expo, Philadelphia, PA. This exposition serves as a showcase for office equipment ranging from computers to coffee machines. More than 20 seminars are planned. Address inquiries to Business-Expo, 702 East Northland Towers, 15565 Northland Dr., Southfield, MI 48075, (313) 569-8280.

November 9-11
Cryptography and Data Security, Washington, DC. For details, contact Hellman Associates Inc., Suite 300, 299 California Ave., Palo Alto, CA 94306, (415) 328-4091.

November 9-15
Interkama 83, Düsseldorf, West Germany. This exhibition is designed for the instrumentation and automation industries. It's expected to attract more than 1000 exhibitors from over 25 countries. For complete details, contact Düsseldorf Trade Shows, 500 Fifth Ave., New York, NY 10110, (212) 840-7744.

November 11-13
The Austin Computer Fair Xmas Show, Palmer Municipal Auditorium, Austin, TX. More than 100 exhibits and seminars will serve to acquaint the public and business community with the computer industry. Contact David Orshalick, Austin Seminars Inc., POB 4531, Austin, TX 78765, (512) 835-8796.

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Event Queue

November 11-13
Hometech '83, Exhibition Centre, Bristol, England. Personal computers and related equipment will be displayed. Contact Tomorrow's World Exhibitions Ltd., 9 Park Place, Clifton, Bristol BS8 1JP, England; tel: (0272) 292156.

November 13-16
IIE Fall Conference, Sheraton Centre Hotel, Toronto, Canada. Sponsored by the Institute of Industrial Engineers (IIE), this event will include speakers, educational sessions, plant tours, workshops, preconference seminars, and leisure activities. For registration and details, contact IIE Conference Department, 25 Technology Park/Atlanta, Norcross, GA 30092, (404) 449-0460.

November 14-16
VLSI Design, Los Angeles, CA. For details, contact Hellman Associates Inc., Suite 300, 299 California Ave., Palo Alto, CA 94306, (415) 328-4091.

November 14-17
AUTOFACT 5 Conference and Exposition, Cobo Hall, Detroit, MI. The focus of this event will be on CAD/CAM (computer-aided design/manufacturing) and the expanding technologies of computer-integrated manufacturing and the automated factory. More than 90 companies will exhibit CAD/CAM systems, computer graphics, software, industrial robots, and computer-based test and measurement systems. Concurrent technical sessions and tutorials will be held. Contact Gregg Balko, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1080.

November 14-17
Canadian Computer Show & Conference, International Centre, Toronto, Ontario, Canada. Further information is available from Industrial Trade Shows of Canada, 20 Butterick Rd., Toronto, Ontario M8W 3Z8, Canada, (416) 252-7791.

November 15-17
SNA Architecture and Implementation, Sheraton Rolling Green Inn and Conference Center, Boston, MA. This seminar provides the working knowledge needed to design SNA (system-network architecture) networks and evaluate SNA-compatible products. Examples of how various protocols are used to control communications will be provided. Other topics include SNA functional layering and network elements. The fee is $650. Full details are available from Communications Solutions Inc., 992 Saratoga-Sunnyvale Rd., San Jose, CA 95129, (408) 725-1568.

November 15-17
The Technical Manager in an Engineering Environment, University of California, Berkeley. This course will deal with practical techniques for efficient management. It will include workshop sessions and clinics focusing on specific problems. The fee is $645. Further details are available from Continuing Education in Engineering, Department 670N, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

November 15-18
Understanding Microprocessor-based Equipment and Troubleshooting, Ramada Airport Inn, Rochester, NY. This course is designed to provide technicians and engineers with a background in microprocessor fundamentals and troubleshooting tech-

Event Queue

niques. Equipment familiarization and hands-on experimentation are emphasized. The registration fee is $595; multiple discounts are offered. Contact Micro Systems Institute, Garnett, KS 66032, (913) 898-6152.

November 17-18
Voice-Data Integration and the Digital PBX, Washington, DC. This symposium features presentations on major voice-data PBX systems and on such related equipment as integrated workstations, voice-store-and-forward equipment, and more. For information, contact Diane Pontisso, Phillips Publishing Inc., Suite 1200N, 7315 Wisconsin Ave., Bethesda, MD 20814, (301) 986-0666.

November 17-19
Ed-Com/Fall '83, Los Angeles, CA. This conference and exposition offers demonstrations, seminars, hands-on sessions, panels, and micro courses that address, evaluate, and analyze the development of computers in education. Hardware, software, and publishing companies will display items of interest. Contact Carol Houts, Judco Computer Expos Inc., Suite 201, 2629 North Scottsdale Rd., Scottsdale, AZ 85257, (800) 528-2355; in Arizona, (602) 990-1715.

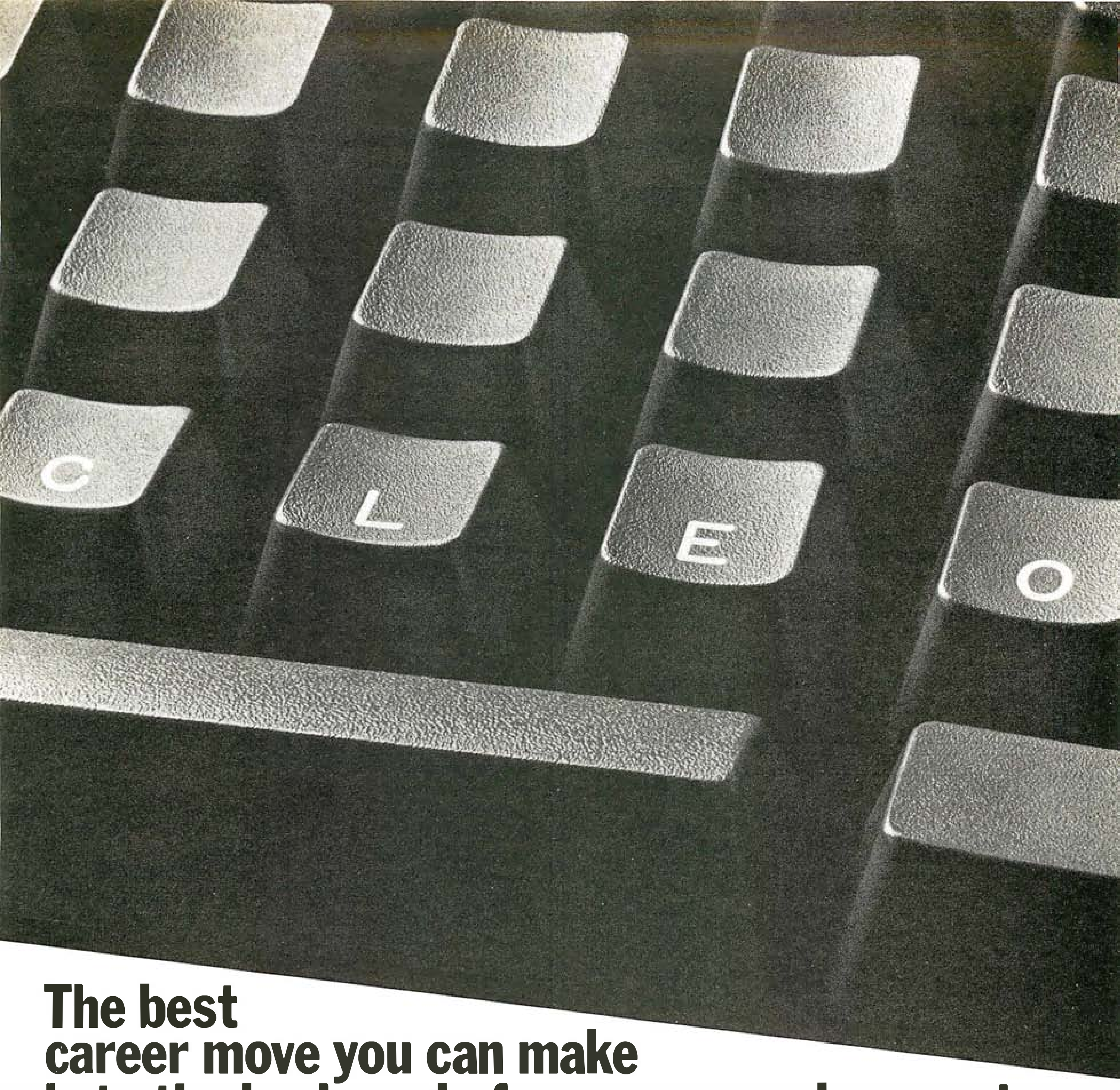
November 17-19
The Fifth Annual Northeast Computer Show and Software Exposition, Hynes Auditorium, Boston, MA. This end-user computer show offers nearly 500 displays of computers, peripherals, accessories, and software. More information is available from Northeast Expositions, 822 Boylston St., Chestnut Hill, MA 02167, (800) 841-7000; in Massachusetts, (617) 739-2000.

November 19
TC/TC: A Teachers College Conference on Teaching with Computers, Teachers College, Columbia University, New York, NY. As many as 60 teachers will present computer-based lessons that they have developed. Lessons include reading, music, art, mathematics, French, composition, and poetry for kindergarten through 12th grade. Workshops will also be featured. Contact the Office of Continuing Education, Box 132, Teachers College, Columbia University, New York, NY 10027, (212) 678-3065.

November 20-22
The Third Annual Purdue On-Farm Computer Use Conference and Trade Show, Purdue University Armory, West Lafayette, IN. Exhibits and demonstrations will be featured. Contact Stephen J. Resch, Continuing Education Administration, Stewart Center, Purdue University, West Lafayette, IN 47907, (317) 494-2755.

November 20-24
The Third Gulf Computer Exhibition and the **Gulf Office Exhibition**, International Center, Dubai, United Arab Emirates. These concurrent exhibitions are designed to promote all aspects of computer technology and computer-related office equipment. Information is available from Mid-Asia/Africa Business Co. Inc., Suite 308, 739 Boylston St., Boston, MA 02116, (617) 536-3442.

November 28-December 2
Welcome to the World of Personal Computing, Fort Lauderdale, FL. This is a comprehensive introduction on how to use microcomputer technology in business, industry, and government. The workshop agenda offers six modules ranging from user productivity to software



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reliability. For details, contact Keston Associates, 11317 Old Club Rd., Rockville, MD 20852, (301) 881-7666.

November 29-December 2
Understanding Microprocessor-based Equipment and Troubleshooting, Sheraton Greenway Inn, Phoenix, AZ. For details, see November 15-18.

December 1983

December
Courses in Continuing Engineering Education, Washington, DC, and San Diego, CA. Two titles of the five available courses are "Intelligent Robots: The Integration of Microcomputer and Robotic Technology" and "Programming in the C and Unix Environment." Course fees range from $695 to $875. For information on dates, locations, and fees, contact George Harrison, George Washington University, Continuing Engineering Education, Washington, DC 20052, (800) 424-9773; in the District of Columbia, (202) 676-6106.

December 6-8
Personal Computers and Information Networks in a Wired Society, San Francisco, CA. The topics for this executive seminar include personal computers and telecommunications for computerized commerce, inter-enterprise-communication links, fifth-generation and Japanese technologies, bypass and integrated links, and field trips. The registration fee is $795. For details, contact Stanford Business Research Foundation, 825 San Antonio Rd., Palo Alto, CA 94303, (415) 856-0711.

December 6-8
The Seventh International Online Information Meeting, Cunard Hotel, London, England. This conference offers presentations that address current problems and opportunities facing those who provide information in business, industry, government, and education. Topics on the agenda include networks, costs of online and videotex systems, software, and user information. Products, services, systems, and publications will all be on display. Further details are available from the Organizing Secretary, International Online Information Meeting, Learned Information Ltd., Besselsleigh Rd., Abingdon, Oxford OX13 6LG, England; tel: (0865) 730275; Telex: 837704 INFORM G.

December 6-8
Business-Expo, Dallas, TX. For details, see November 9-10.

December 6-8
The Software Maintenance Workshop, Naval Postgraduate School, Monterey, CA. Topics of interest include definitions of software maintenance, tools for software and database maintenance, and program evolution. Contact the IEEE Computer Society, Suite 300, 1109 Spring St., Silver Spring, MD 20910, (301) 589-8142.

December 6-9
Understanding Microprocessor-based Equipment and Troubleshooting, Capitol Plaza Holiday Inn, Sacramento, CA. For details, see November 15-18.

December 7-9
The 1983 ACM Conference on Personal and Small Computers, San Diego, CA. This event, sponsored by the Association for Computing

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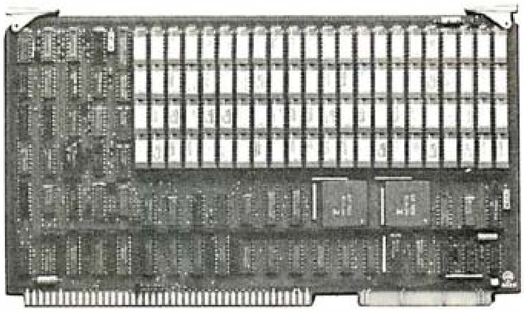

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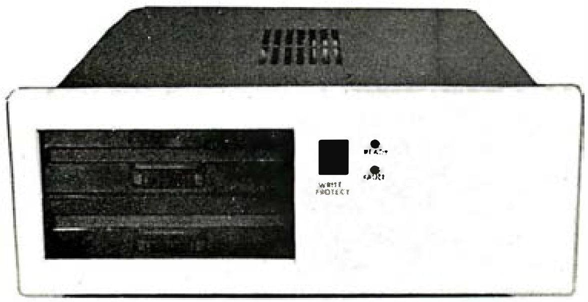

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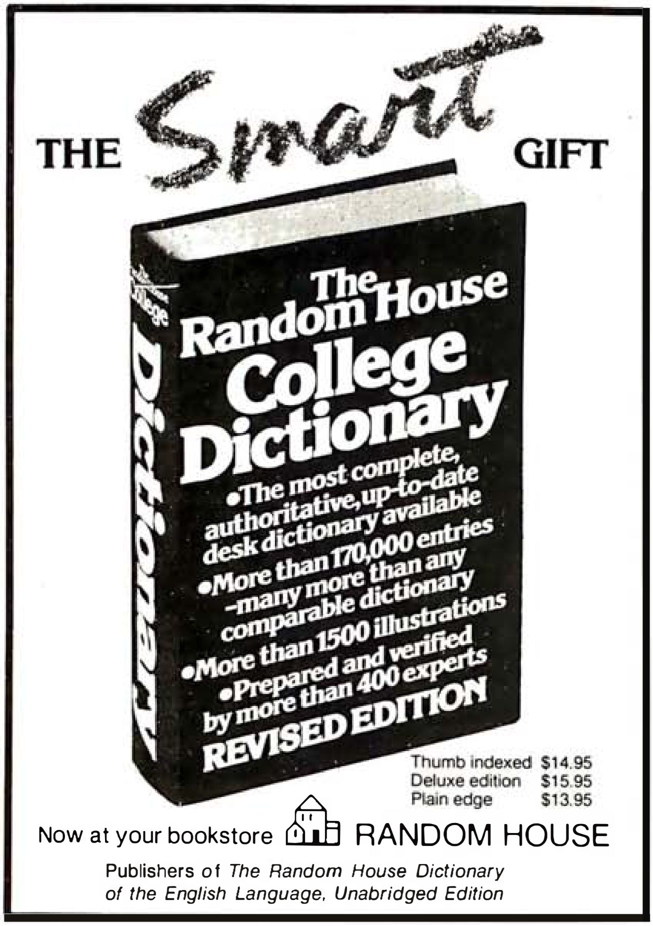

Machinery (ACM), includes sessions on distributed systems, graphics, languages, distributed operating systems, algorithms, operating systems, human interfaces, local-area networks, and database systems. Contact Anne-Marie Claybrook, The Mitre Corp., POB 208, Bedford, MA 01730.

December 7-9

Teaching Math with Microcomputers, Dunfey Atlanta Hotel, Atlanta, GA. This seminar, sponsored by the National Council of Teachers of Mathematics (NCTM), is designed to inform educators in elementary, intermediate, and secondary schools about using microcomputers effectively in mathematics education. For details, contact NCTM Seminar Series, 1906 Association Dr., Reston, VA 22091, (703) 620-9840.

December 8-11

Southeast Computer Show and Office Equipment Exposition, Atlanta, GA. Contact Dee Harris, Computer Expositions Inc., POB 3315, Annapolis, MD 21403, (800) 368-2066; in Maryland, (800) 492-0192.

December 9-15

Educatec 83, Porte de Versailles, Paris, France. This is the first French exhibition of computerized teaching and training equipment, materials, and techniques. Meetings, symposiums, and debates on educational technologies and professional training will be held. For details, contact Edit Expo International, 4 rue de Chéroy, 75017 Paris, France; tel: (1) 294 05 60; Telex: 641284 F EDIXPO.

December 12-14

An Introduction to Small Computers for Business Applications, Hamilton Hotel, Schaumberg, IL. This conference and hardware demonstration will provide a current introduction and review of small computers and microprocessors with an emphasis on what they are, what their terminology is, and what is available. Program materials are included in the $350 fee. For details, contact Bob Mattis, Information Systems Division, EECI Inc., POB 241, Glen Ellyn, IL 60137, (312) 790-0010; in California, (415) 763-2371.

December 12-15

Conference on Human Factors in Computing Systems—CHI '83, Boston, MA. Papers, sessions, and tutorials will focus on system usability. Additional information is available from Raoul N. Smith, GTE Laboratories, 40 Sylvan Rd., Waltham, MA 02254, (617) 466-4044.

December 13-15

Automatic Testing and Test Instrumentation '83, Metropole Hotel, Brighton, England. This is an exhibition and conference covering all aspects of test systems. For details, contact Network Events Limited, Printers Mews, Market Hill, Buckingham, MK18 1JX, England; tel: (028 0) 815226; Telex: 83111.

December 14-15

Hi Tech Update '83, Delta Ottawa Hotel, Ottawa, Ontario, Canada. An annual update on state-of-the-art high technologies. Contact Marg Coll, 1138 Sherman Dr., Ottawa, Ontario K2C 2M4, Canada, (613) 225-4229.

December 15-16

Personal Computer Local Networks, San Francisco, CA. This is the final program in the four-part Architecture Technology Corporation 1983 Forum Series. This program will bring together manufacturers and users of local network schemes to ex-

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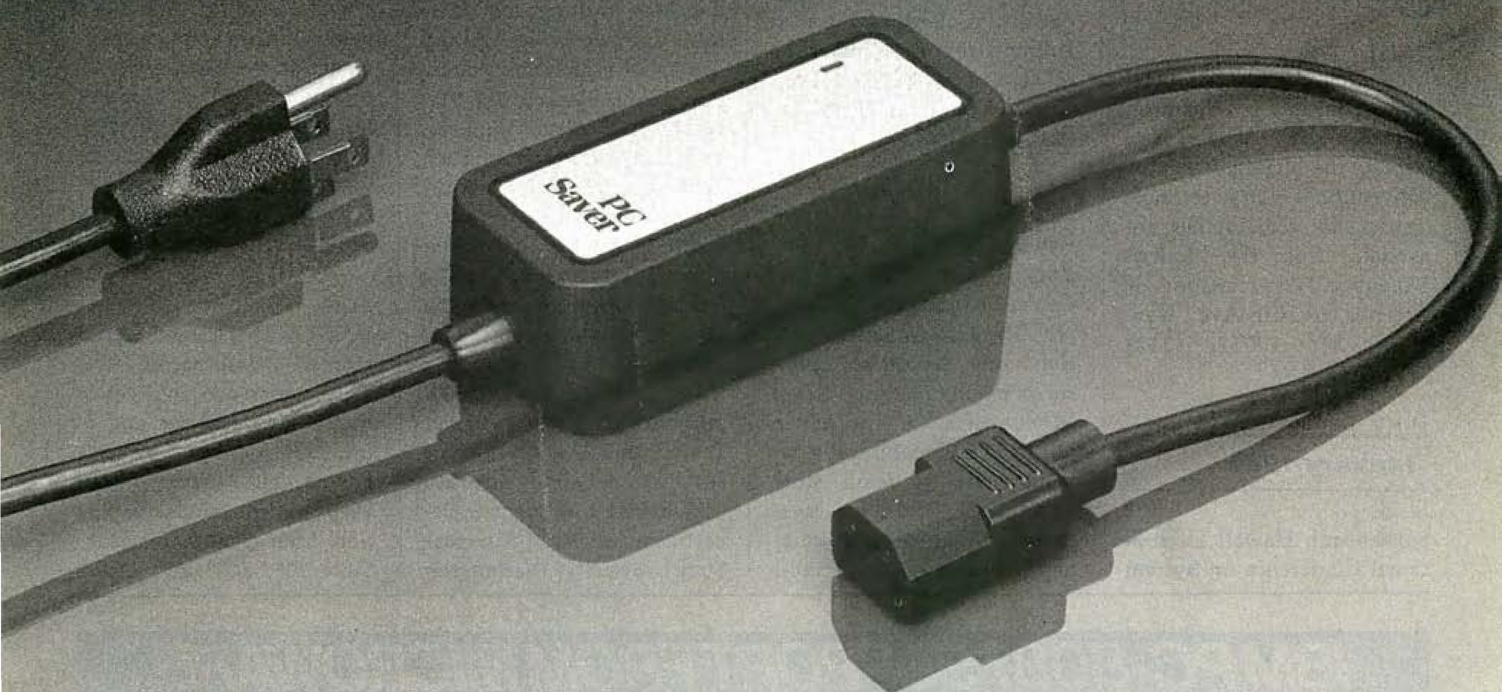

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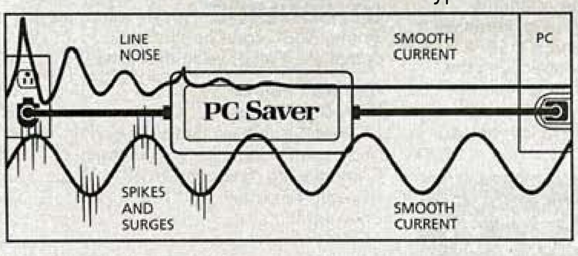

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change information in an informal setting. The format includes presentations, panel discussions, and a technological summary. The fee is $395. For further information, contact the Architecture Technology Corp., POB 24344, Minneapolis, MN 55424, (612) 935-2035.

December 27-30
Modern Language Association Convention, Sheraton Centre, New York, NY. Among the highlights of this convention is a large technology exhibit. Full details are available from the Modern Language Association of America, 62 Fifth Ave., New York, NY 10011, (212) 741-5587.

January 1984

January 4-6
Seventeenth Hawaii International Conference on System Sciences, Honolulu, HI. This conference is devoted to advances in information and system sciences with emphasis on medical-information processing, decision-support systems, and office automation. For information, contact Emily Yano Jorgensen, Center for Executive Development, College of Business Administration, University of Hawaii, 2404 Maile Way C-202, Honolulu, HI 96822, (808) 948-7396.

January 8-11
Retail Directions '84, New York Hilton and Sheraton Centre Hotels, New York, NY. The 73rd annual convention and exposition sponsored by the National Retail Merchants Association (NRMA) will feature new developments in retail store technology, business systems, marketing techniques, and sales-promotion tools. Admission is free to bona fide members of the retail industry. For details, contact Dan Soskin, NRMA Enterprises, 100 West 31st St., New York, NY 10001.

January 8-14
CADRE '84 Conference and Teachers Institute, San Jose, CA. Computers in Art and Design, Research and Education (CADRE) is a forum that comprises leaders, thinkers, and computerists from such fields as art, research, industry, education, and the public sector to explore the impact of computers on the arts. The teachers institute begins on January 11, 1984, and the fee is $100. Early registration for the conference is $150; $200 if postmarked after November 1, 1983; and $250 on site. For further details, contact CADRE '84 Conference, Department of Art, San Jose State University, Washington Square, San Jose, CA 95192, (408) 277-2555.

January 16-17
Interface Circuit Design, San Francisco Airport Hilton Hotel, San Francisco, CA. This short course will cover MOS analog/digital interface circuit design for VLSI digital systems. Course notes are included in the $450 fee. For a brochure, contact Continuing Education in Engineering, University of California Extension, 2223 Fulton St., Berkeley, CA 94720, (415) 642-4151.

January 16-20
UNIFORUM, Washington-Hilton, Washington, DC. This conference and exposition is designed for and by users of Unix-based systems. For details, contact Mark Weber, Professional Exposition Management Co. Inc., Suite 205, 2400 East Devon

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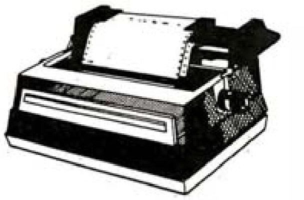

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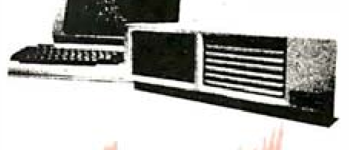

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January 17-19
Mini/Micro-Southeast and **Southcon/84 High Technology Electronics Exhibition and Convention,** Orange County Convention/Civic Center, Orlando, FL. Mini/Micro is designed for the original equipment manufacturing community to explore peripherals, processors, data communications, and software. A few of the topics Southcon/84 will address are artificial intelligence, computer-aided design, and factory automation. For details on these concurrent events, contact Electronic Conventions Inc., 8110 Airport Blvd., Los Angeles, CA 90045, (213) 772-2965.

January 23-25
Teaching Math with Microcomputers, Hacienda Resort Hotel, Las Vegas, NV. For details, see December 7-9.

January 24-26
Advanced Semiconductor Equipment Exposition (ASEE) and **Technical Conference,** San Jose Convention Center, San Jose, CA. Five sessions designed as a broad-based program focus on the manufacturing aspect of the semiconductor industry. For details, contact Joyce Estill, Cartlidge & Associates Inc., Suite 205, 4030 Moorpark Ave., San Jose, CA 95117, (408) 554-6644.

January 24-26
Specialized Tubing in the Aircraft Industry, Disneyland Hotel/Convention Center, Anaheim, CA. This clinic, sponsored by the Society of Manufacturing Engineers (SME), will focus on state-of-the-art technological advances in specialized aircraft tubing. Topics include automated computerized bending, computerized support systems, production tube bending, tube cut-off, tool design, and end finishing. The fee is $420 for SME and affiliate members; $480 for nonmembers. To register, contact Leonard B. Antosiak, Special Programs Department, Society of Manufacturing Engineers, One SME Dr., POB 930, Dearborn, MI 48121, (313) 271-1500 ext. 384.

January 25-27
The Business Telecommunications Exposition, Giants Stadium, Stadium Club, East Rutherford, NJ. This exposition is for managers of telecommunications in such fields as facsimile, communications (voice, video, and data), office automation, word processing, and purchasing. Registration is required for admittance to the exposition. Contact Michael Houston, The Exposition Group Inc., 9128 Columbia Ave., North Bergen, NJ 07047, (201) 662-1318.

January 27-29
Computer/Electronics High Tech Show, Cincinnati Gardens Exhibition Center, Cincinnati, OH. Wholesalers, retailers, manufacturers, and individuals will display hardware and software. For information, call the High Tech Show, (513) 351-9112. ■

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Books Received

The Art of Computer Programming, Donald William Drury. Blue Ridge Summit, PA: Tab Books, 1983; 311 pages, 13 by 21 cm, softcover, ISBN 0-8306-1455-9, $10.95.

Automation of Reasoning 1, Classical Papers on Computational Logic, 1957-1966, Jörg Siekmann and Graham Wrightson, eds. New York: Springer-Verlag, 1983; 544 pages, 17 by 25 cm, hardcover, ISBN 0-387-12043-2, $35.

Automation of Reasoning 2, Classical Papers on Computational Logic, 1967-1970, Jörg Siekmann and Graham Wrightson, eds. New York: Springer-Verlag, 1983; 656 pages, 17 by 25 cm, hardcover, ISBN 0-387-12044-0, $39.

BASIC for Microcomputers: Apple, TRS-80, PET, Roger W. Haigh and Loren E. Radford. New York: Van Nostrand Reinhold, 1983; 352 pages, 20 by 24 cm, hardcover, ISBN 0-442-27843-8, $22.45.

Beginner's Guide to Reading Schematics, Robert J. Traister. Blue Ridge Summit, PA: Tab Books, 1983; 140 pages, 13 by 21 cm, softcover, ISBN 0-8306-1536-9, $8.95.

Beginning Programming with Ada, James A. Saxon and Robert E. Fritz. Englewood Cliffs, NJ: Prentice-Hall, 1983; 240 pages, 27.8 by 21.5 cm, softcover, ISBN 0-13-071688-X, $16.95.

CP/M Simplified, 1st ed., Jeffrey R. Weber. Cleveland, OH: Weber Systems Inc., 1982; 318 pages, 21.5 by 13.8 cm, softcover, ISBN 0-938862-05-9, $13.95.

Clean Slate Word Processing for the TRS-80, Henry Melton. Indianapolis, IN: Howard W. Sams & Co., 1983; 384 pages, 15 by 23 cm, spiral-bound, ISBN 0-672-22005-9, $17.95.

The Complete Guide to Video, Martin Clifford. Indianapolis, IN: Howard W. Sams & Co., 1983; 344 pages, 13.5 by 21.5 cm, softcover, ISBN 0-672-21912-3, $15.95.

Computer-Based Training, A Guide to Selection and Implementation, Greg Kearsley. Reading, MA: Addison-Wesley, 1983; 216 pages, 17 by 24.5 cm, hardcover, ISBN 0-201-10333-8, $29.95.

Computer Basics, Hal Hellman. Englewood Cliffs, NJ: Prentice-Hall, 1983; 48 pages, 18.5 by 24 cm, hardcover, ISBN 0-13-164574-9, $8.95.

Computer Communication Techniques, E. G. Brooner and Phil Wells. Indianapolis, IN: Howard W. Sams & Co., 1983; 144 pages, 15 by 23 cm, softcover, ISBN 0-672-21998-0, $15.95

The Computer Primer, A Complete Guide for Gifted Beginners, Ann Cavanaugh. New York: Trillium Press, 1983; 496 pages, 20 by 27 cm, softcover, ISBN 0-89824-046-8, $12.95.

From Baker Street to Binary, Henry Ledgard, E. Patrick McQuaid, and Andrew Singer. New York: McGraw-Hill, 1983; 288 pages, 15 by 22.5 cm, softcover, ISBN 0-07-036983-6, $10.95.

A Guide to Programming in Level II BASIC, Bruce Presley. New York: Van Nostrand Reinhold, 1982; 266 pages, 22 by 28 cm, softcover, ISBN 0-442-25892-5, $12.95.

The Handbook of Microcomputer Interfacing, Steve Leibson. Blue Ridge Summit, PA: Tab Books, 1983; 261 pages, 19.5 by 23.5 cm, softcover, ISBN 0-8306-1501-6, $14.95.

The Home Video Handbook, 3rd ed., Charles Bensinger. Indianapolis, IN: Howard W. Sams & Co., 1982; 394 pages, 13 by 20.5 cm, softcover, ISBN 0-672-22052-0, $13.95.

How to Make Your Small Computer Pay Off, Gary Gagliardi. Belmont, CA: Lifetime Learning Publications, 1983; 304 pages, 16.5 by 23.5 cm, softcover, ISBN 0-534-97926-2, $15.95.

Integrated Circuits Applications Handbook, Arthur H. Seidman. New York: John Wiley & Sons, 1983; 704 pages, 17 by 24 cm, hardcover, ISBN 0-471-07765-8, $39.95.

Introducing the Unix System, Henry McGilton and Rachel Morgan. New York: BYTE Books/McGraw-Hill, 1983; 576 pages, 15 by 23 cm, softcover, ISBN 0-07-045001-3, $18.95.

Introduction to Satellite TV, Chris Bowick and Tim Kearney. Indianapolis, IN: Howard W. Sams & Co., 1983; 144 pages, 13.5 by 21.5 cm, softcover, ISBN 0-672-21978-6, $9.95.

Learning with Logo, Daniel Watt. New York: BYTE Books/McGraw-Hill, 1983; 384 pages, 21 by 28 cm, spiral-bound, ISBN 0-07-068570-3, $19.95.

Measurement and Tuning of Computer Systems, Domenico Ferrari, Giuseppe Serazzi, and Alessandro Zeigner. Englewood Cliffs, NJ: Prentice-Hall, 1983; 544 pages, 18.5 by 24.5 cm, hardcover, ISBN 0-13-568519-2, $35.

Microcomputer Programs in Print, Owen C. Schultz, ed. Roanoke, VA: Postroad Press, 1983; 208 pages, 21.5 by 28 cm, softcover, ISBN 0-912691-01-8, $19.95.

Microcomputers Can Be Kidstuff, Anna Mae Walsh Burke. Rochelle Park, NJ: Hayden Book Co., 1983; 192 pages, 17 by 24.5 cm, softcover, ISBN 0-8104-5202-2, $8.95.

Numerical Methods for the Personal Computer, Terry E. Shoup. Englewood Cliffs, NJ: Prentice-Hall, 1983; 254 pages, 15 by 22.5 cm, softcover, ISBN 0-13-627208-8, $18.95.

Programming in Ada, Richard Wiener and Richard Sincovec. New York: John Wiley & Sons, 1983; 368 pages, 16.5 by 24.5 cm, hardcover, ISBN 0-471-87089-7, $22.95.

Secrets of Better BASIC, Ernest E. Mau. Rochelle Park, NJ: Hayden Book Co., 1983; 320 pages, 17.5 by 24.5 cm, softcover, ISBN 0-8104-6254-0, $14.95.

TRS-80 for Kids from 8 to 80, vol. 1, Michael P. Zabinski. Indianapolis, IN: Howard W. Sams & Co., 1982; 144 pages, 21 by 28 cm, softcover, ISBN 0-672-22046-6, $9.95.

Third Caltech Conference on Very Large Scale Integration, Randal Bryant, ed. Rockville, MD: Computer Science Press, 1983; 444 pages, 16 by 23.5 cm, hardcover, ISBN 0-914894-86-2, $36.95.

The UNIX Operating System*, Kaare Christian. New York: John Wiley & Sons, 1983; 336 pages, 17 by 24.5 cm, hardcover, ISBN 0471-87542-2, $24.95.

Using Micro-Computers in Business, 2nd ed., Stanley S. Veit. Rochelle Park, NJ: Hayden Book Co., 1983; 192 pages, 15 by 23 cm, softcover, ISBN 0-8104-6257-8, $12.95.

The Video Production Guide, Lon McQuillin. Indianapolis, IN: Howard W. Sams & Co., 1983; 384 pages, 21.5 by 28 cm, softcover, ISBN 0-672-22053-9, $28.95.

Video War, Stephen Manes. New York: Avon Books, 1983; 256 pages, 17.5 by 10.5 cm, softcover, ISBN 0-380-83303-4, $2.25.

The VisiCalc Program Made Easy, David M. Castlewitz. Berkeley, CA: Osborne/McGraw-Hill, 1983; 224 pages, 18.5 by 23 cm, soft-

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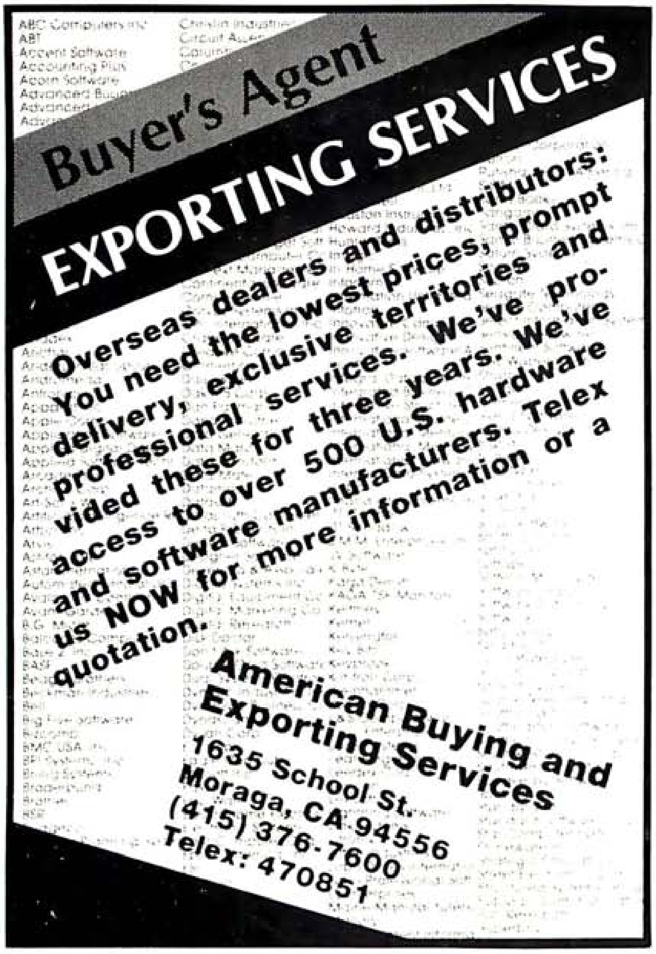

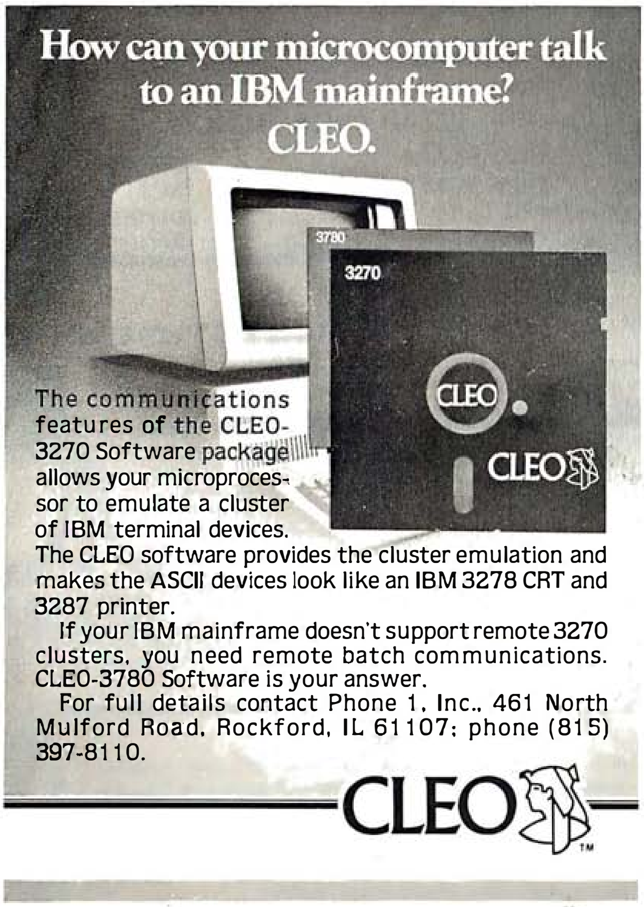

Books Received

cover, ISBN 0-931988-89-6, $12.95.

The Word Processing Book, Peter A. McWilliams. Los Angeles, CA: Prelude Press, 1983; 320 pages, 14.5 by 23 cm, softcover, ISBN 345-31105-1, $9.95.

Writing BASIC Adventure Programs for the TRS-80, Frank Dacosta. Blue Ridge Summit, PA: Tab Books, 1982; 228 pages, 13 by 21 cm, softcover, ISBN 0-8306-1422-2, $9.95.

Your First Business Computer, Peter Luedtke and Rainer Luedtke. Bedford, MA: Digital Press, 1983; 224 pages, 20.5 by 22.5 cm, softcover, ISBN 932376-27-4, $15.

Your IBM PC, Lyle J. Graham. Berkeley, CA: Osborne/McGraw-Hill, 1983; 592 pages, 16 by 23.5 cm, softcover, ISBN 0-931988-85-3, $16.95. ■

In the August 1983 issue under Books Received, the correct page count for *Introductory Reading in Expert Systems* by Donald Michie should be 251 pages. We regret any misunderstanding this error may have caused.

This is a list of books received at BYTE Publications during this past month. Although the list is not meant to be exhaustive, its purpose is to acquaint BYTE readers with recently published titles in computer science and related fields. We regret that we cannot review or comment on all the books we receive; instead, this list is meant to be a monthly acknowledgment of these books and the publishers who sent them.

BYTE's Bugs

Bugs and Pointers

Two sharp-eyed readers spied a pair of bugs snugly hidden in Rinaldo F. Prisco's article "The Bazeries Cylinder: A Cryptographic Challenge" (June 1983 BYTE, page 352). Both Bradley R. Mortensen and Bruno Tilgner noticed that there are two Vs and no Bs in DATA statements 1830 and 1870 (listing 1). The second V in each statement should be changed to a B.

Tilgner, who translated the program into Hewlett-Packard BASIC, also offered a few pointers for using the program with those BASICs where the loop variable is tested on entry into the loop. Currently, the first cylinder will always be in the first position. To change this, line 1210 should read

```
FOR J=LEN(K$)-1 TO
  1 STEP -1
```

If the keyboard contains more than one blank space, line 1750 will most likely result in an error. Tilgner suggests adding GOTO 1730. LEN (S$) will then be set to its new value. Finally, K$, S$, and T$ must be allocated sufficient space at the beginning of the program when used with those BASICs in which a string variable beyond a set limit needs explicit dimensioning.

Dedicated to Righting Wrongs

Jerry Pournelle accidentally misinformed his readers as to where to obtain the DEDICATE/32 encryption program. (See "Interstellar Drives, Osborne Accessories, DEDICATE/32, and Death Valley," July 1983 BYTE, page 323.) The program publisher and exclusive supplier is Merritt Software Inc., POB 1504, Fayetteville, AR 72702, (501) 442-0914. ■

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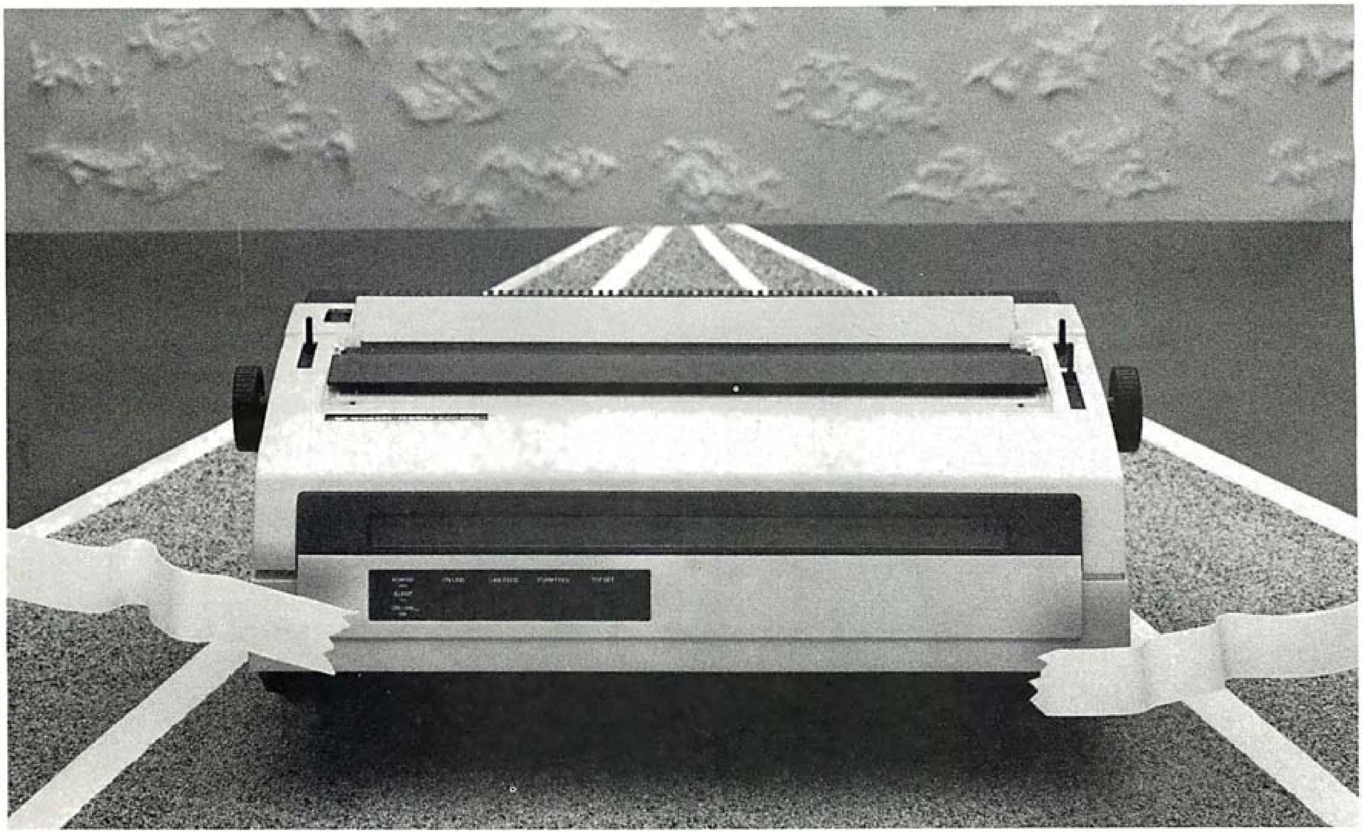

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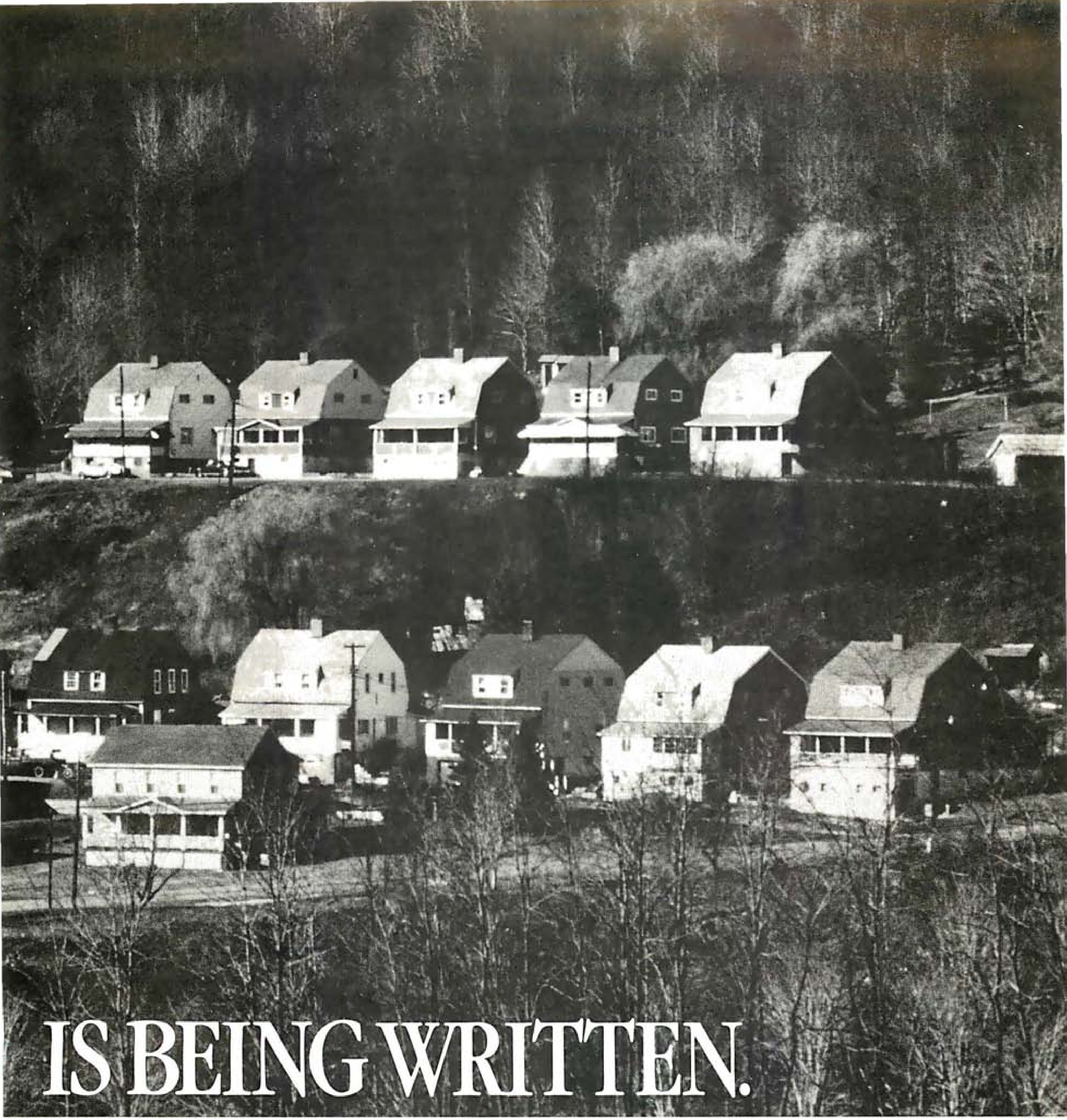
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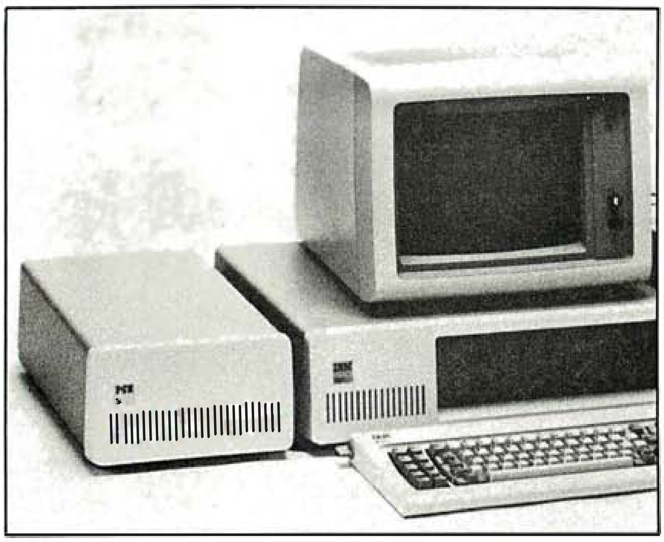

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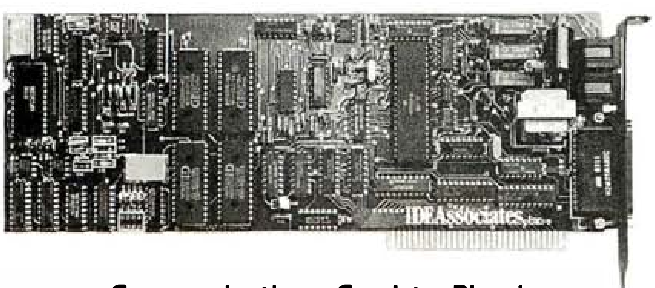

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The Ideacomm 1200, a plug-in card offering fast, reliable communications for the IBM PC, is offered by IDE Associates. A 300/1200 bits-per-second integral modem, it has an RS-232C interface that can be used as a serial port. The speed is automatically selected by the card, which costs $545. Contact IDE Associates Inc., 7 Oak Park Dr., Bedford, MA 01730, (617) 275-4430.

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Plan Trac is a time-, resource-, and cost-analysis software system for strategy planning that provides critical path method (CPM) scheduling. It is user controlled, menu driven, and can handle systems of up to 12,500 nodes. It provides the project manager with CPM-network planning, analysis (time, resource, and cost), progress reporting. network drawing, and interfacing.

Plan Trac is not sold; it is offered on an annual renewable-license basis. It runs on IBM PC-DOS, Radio Shack TRSDOS, and CP/M-based systems. For details, contact Computerline Ltd., 95 Merrymount Rd., Quincy, MA 02169, (617) 773-0001.

Circle 651 on inquiry card.

Manage Projected Costs

The PC/MIS (Project Cost/Management Information System) provides the project manager with project-planning, scheduling, budgeting, and performance-monitoring capabilities. It runs on the IBM PC and other computers using PC-DOS, MS-DOS operating systems, and CP/M-based systems. The user can test and evaluate cost implications of alternative labor combinations and can track cost-plus-fixed fee, unit-rate, and lump-sum contracts. It also features built-in audit routines that check time-sheet and direct-expense data entries for consistency regarding project budgets. A demonstration package is available for $95, which can be applied to a total cost of $895. Contact Davis and Associates Inc., 1655 Peachtree Rd. NE, Atlanta, GA 30309, (404) 875-0793.

Circle 660 on inquiry card.

Colorful Printing

Color-printing software tools from Application Techniques' Rainbow Writer family make it easy for IBM PC owners who have a color printer to produce color output using their existing application software.

The Rainbow Writer Color Screen Grabber ($99) lets you capture,

edit, save, recall, rotate, and print color-graphic images produced on the IBM PC adapter. It supports the Integral Data Systems' Prism Printer, the Transtar 315 color printer, the IBM Graphics Printer, Epson Graftrax printers, and Okidata printers.

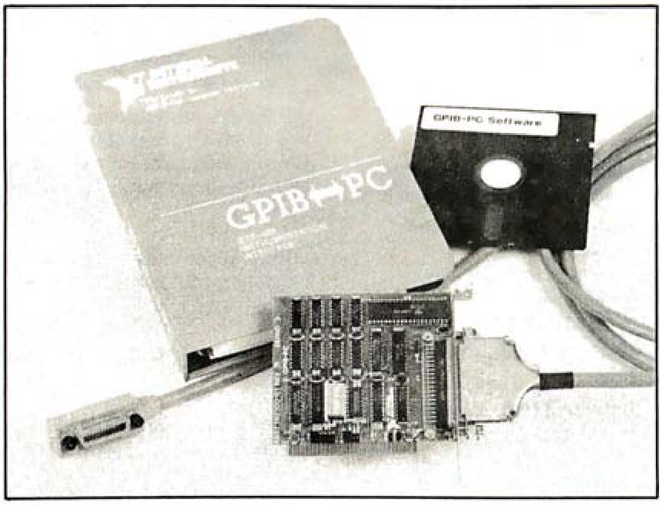
The Rainbow Writer Color Text Formatter ($149) enhances existing word processors to support color text, intercharacter proportional spacing, and merged color graphics for Prism printers. For details,contact Application Techniques Inc., 80 Townsend St., Pepperell, MA 01463, (617) 433-5201.

Circle 664 on inquiry card.

The Color Biz PC Saver

Protect your IBM PC disk drives from environmental contaminants such as smoke, dust, and liquids with this rectangular card that covers the floppy-disk openings. A full-color command summary is printed on the PC Saver. It retails for $9.95 and is available from the Color Corp., 208 North Berkshire, Bloomfield Hills, MI 48013, (800) 521-0793.

Circle 659 on inquiry card.



Interactive-Control Workstation

A general-purpose interface bus (GPIB) for the IBM PC, the GPIB-PC is unique due to its small size (a half-size slot in the IBM PC-XT), its high speed (300K bits per second), an NEC 7210 controller chip, and software.

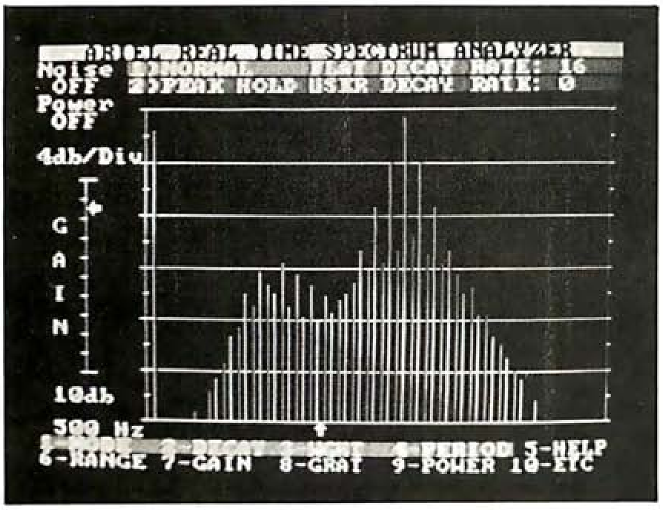
The new IEEE-488 interface converts the IBM PC into an instrumentation workstation complete with software. The interactive-control program is used to program GPIB devices to measure system performance, debug application programs, and locate malfunctioning devices on the GPIB. The transfer of large data files is possible with an IBM PC DMA controller. The circuit card can perform high-speed transfers of 300K bits per second between the GPIB and the IBM PC memory. Complete with documentation, the unit costs $385. Contact National Instruments, 12109 Technology Blvd., Austin, TX 78759.

Circle 652 on inquiry card.

A Data-Acquisition Family for the PC

The DT2801 Series from Data Translation provides a full line of plug-in data-acquisition and control boards for the IBM PC, including upgraded high-speed, high-resolution, 16-bit, and analog-to-digital versions. A high-speed version of the DT2801, the DT2801A, offers 12-bit throughput rates of up to 27,500 samples per second. The DT2805/5716 (low-level input) and the DT2801/5716 (high-level input) provide full 16-bit analog-input resolution based on eight differential input channels with software-programmable gain. The DT2801 is $1345. The 16-bit boards are $2170 for the DT2801/5716, and $2270 is the price for the DT2805/5716. For information, contact Data Translation, 100 Locke Dr., Marlboro, MA 01752, (617) 481-3700.

Circle 655 on inquiry card.



Ariel Real-Time Spectrum Analyzer

The RTA 331 is a ⅓-octave real-time audio-frequency spectrum analyzer for the IBM PC that plugs into a single expansion slot. By dividing the audio spectrum into 31 third-octave bands for 20 Hz to 20 kHz, it interactively displays the relative amplitudes of each frequency band. More than 20 seconds of audio can be stored in 512K bytes of memory. Assembly-language subroutines handle high-speed operations and are accessed from BASIC. Other features include an on-board pink-noise generator, digitally controlled gain, user-defined weighting, and more. The RTA 331 sells for $649.95 from the Ariel Corp., Suite 84, 600 West 116th St., New York, NY 10027, (212) 662-7324.

Circle 657 on inquiry card.

Display Waveforms on Your Monitor

Wave Display is a software package for the IBM PC that can display multiple waveforms captured by a data-acquisition system. The acquired data can be hexadecimal, octal, or decimal and is immediately stored on the disk drive. The data stream displayed on the screen can be 512 through 4K bits in the horizontal resolution with a maximum of 12 bits vertically. It provides automatic readouts of frequency and voltage levels, signal averaging, and supports hard copy to dot-matrix printers. Wave shapes can also be created by using any text editor or word-processing software or by programming BASIC. The package costs $99.95 and is available from Epic Instruments Inc., 551-G Foster City Blvd., Foster City, CA 94404, (415) 574-9081.

Circle 658 on inquiry card.

PC-Path, CPM for the PC

PC-Path is a critical path method (CPM) scheduling program for the IBM PC that can handle up to 500 activities per network. Node numbering is fully random. The reports that are available include data edit, calendar, summary, schedule, and bar chart. PC-Path is designed to work with any project manager who needs to control small to medium projects using CPM scheduling capabilities. It costs $500 and is available from Viplan, 823 Bradwell, Houston, TX 77062, (713) 486-4718.

Circle 665 on inquiry card.

Three in One For the IBM PC

CP+ combines three products in one software package. Features include a computer-aided instruction tutorial on the basic operations of a personal computer, an English-language front-end interface suitable for new users, and a package of file-management utilities. It includes a menu-building facility called START+.

It is available for the IBM PC and other selected MS-DOS-based systems including the Victor 9000 and the TI Professional. The retail price of the 16-bit version is $200. Contact Taurus Software Corp., 3685 Mt. Diablo Blvd., Lafayette, CA 94549, (415) 283-7222.

Circle 663 on inquiry card.

IBM Mass Storage

Three formatted configurations of 5-, 10-, and 20-megabyte hard-disk subsystems are available for the IBM PC and the DEC Rainbow 100.

Mass storage is over 5 times the speed and up to 135 times the capacity of a floppy disk. A hard disk, controller card, host-interface card, power supply, external enclosure, and cabling comprise the hardware included with the system. Each system is equipped with software support for PC-DOS 2.0 or CP/M 80-86 and a utilities package that includes MEMDISK 2.0.

The 5-megabyte hard-disk subsystem is $1595, the 10-megabyte is $1795, and the 20-megabyte is $1995. Contact Chrislin Industries Inc., Computer Products Division, 31352 Via Colinas #102, Westlake Village, CA 91361, (213) 991-2254.

Circle 654 on inquiry card.

Fast Backup for the IBM PC-XT

The backup subsystem for the hard-disk version of the IBM PC, Sysgen Image includes a controller, drive electronics, and a cassette-tape drive. It is software-compatible with either PC-DOS or

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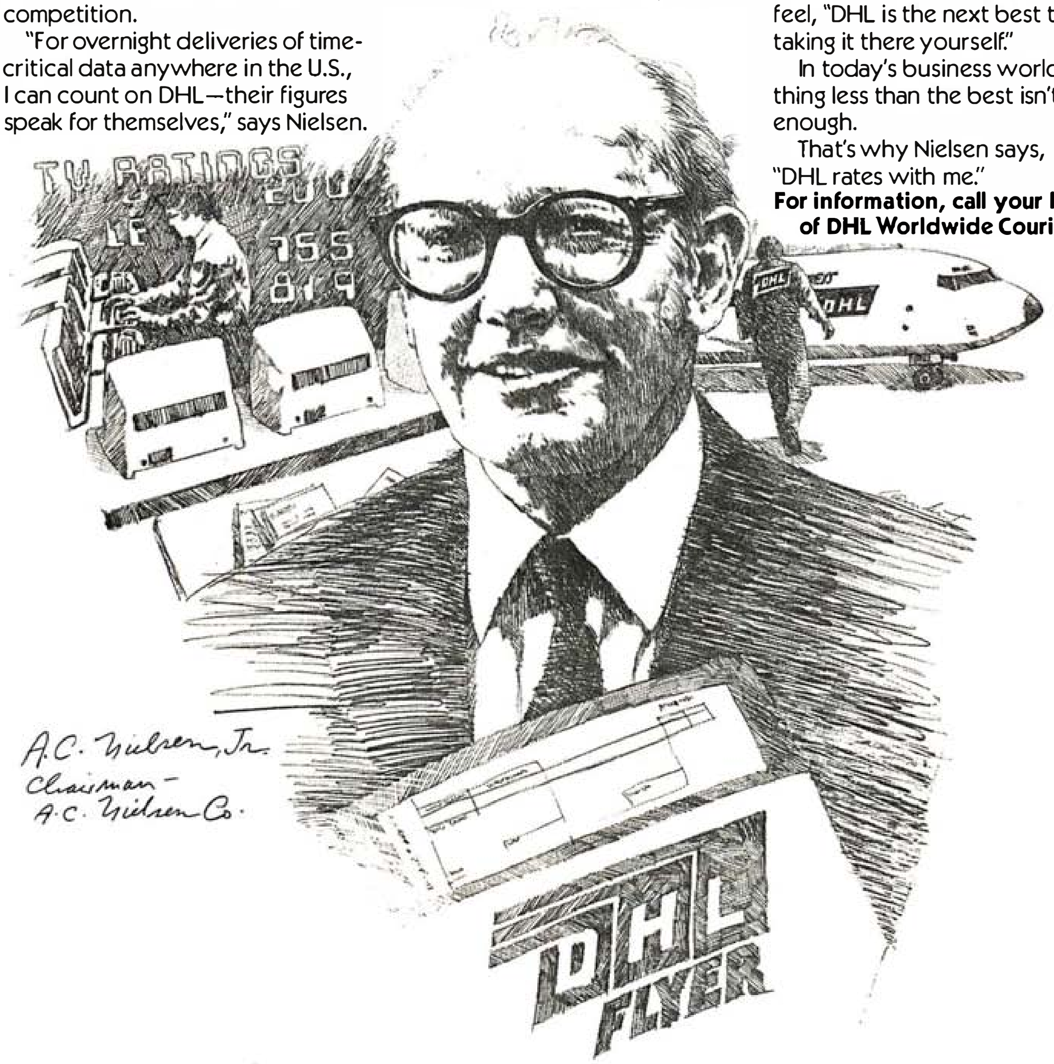

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CP/M-86. It performs complete archival backup of information on the PC-XT's hard disk at the rate of 2.5 megabytes per minute. Storage capacity is 20 megabytes. Two backup modes are Preserve, which backs up data from an individual disk volume and restores the data on an individual disk volume in an image fashion, and File-save, which allows individual files or groups of files to be saved from the hard disk to the streaming tape and vice versa. The price is $995. Contact Sysgen Inc., 47853 Warm Springs Blvd., Fremont, CA 94539, (415) 490-6770.
Circle 656 on inquiry card.

Electronic Catalog Full of PC Supplies

One 5¼-inch, single-sided disk provides instant access to menu-driven information about a wide range of IBM PC-compatible products such as peripherals, software (home, business, education, and entertainment), books, supplies, and accessories. IBM guarantees quality and satisfaction.

The Electronic Catalog for IBM Personal Computer Owners is $3 and is available from International Business Machines Corp., POB 3148, Wallingford, CT 06494, (800) IBM-2468; in Alaska and Hawaii, (800) 526-2484.
Circle 653 on inquiry card.

Relay Can Send, Receive, and Print

Relay is a communications-software package that can simultaneously send and receive messages or files between IBM PCs while printing locally. It can also communicate with mainframe hosts and operate as an APL terminal. In addition to inter-PC communications, Relay enables access to computer-service bureaus such as Dow Jones, CompuServe, and the Source, other mainframes, and other PCs. It retails for $149 and is available from VM Personal Computing Inc., 60 East 42nd St., New York, NY 10165, (212) 697-4747.
Circle 662 on inquiry card.

PRINTERS

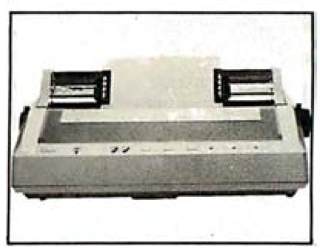
Extended Character Set Printer

The Compucorp 32/40 ECS (Extended Character Set) is a daisy-wheel printer that can accommodate scientific- and technical-typing applications as well as word processing without changing printwheels. Other printwheels offered by Compucorp contain up to 192 characters and will accept additional user-constructed characters. The 32/40 ECS sells for $3295 and is available from Compucorp, 2211 Michigan Ave., Santa Monica, CA 90404, (213) 829-7453.
Circle 678 on inquiry card.

Matrix Printers Built for Heavy Duty

The PLP-8 series of 80- and 132-column matrix printers is designed for listing, invoicing, labeling, and letter printing. Both printers incorporate a heavy-duty 9-needle head to print 1- to 6-part forms at speeds as high as 270 cps. Head travel is 27 inches per second, and the tractor-feed line advance requires 35 milliseconds. Standard equipment includes a parallel interface and adjustable tractor feeds. Sixteen form lengths are front-panel selectable with 32 positions of vertical and horizontal tabs. Perforation-skip is switch-selectable. Print features include 9 by 7 characters with true ascenders and descenders as well as underlining. Character generation is EPROM-based.

A serial interface that accepts data rates ranging from 110 to 9600 bps, current loop, Xon/Xoff, and DTR data restraint is available. The 80-column PLP-8 costs $675, and the 132-column version is $895. Quantity and OEM discounts are offered. Contact Practical Automation Inc., Trap Falls Rd., Shelton, CT 06484, (203) 929-5381.
Circle 677 on inquiry card.



Letter-Quality Printer for the PC

The Model 2050 is a new member of the Spinwriter family that is fully compatible with the IBM PC and its application soft-

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MODEL IV, 16K Cassette	$825
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With standard 40 track double density drives
Over 340,000 bytes.
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Fully assembled and tested systems that are software compatible and functionally identical to Radio Shack units sold at computer stores for $hundreds more.

CONTROLLER BOARDS are high quality double sided epoxy boards with gold plated contacts.
POWER SUPPLY is the finest switching type available.
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40 track, double density, with a 5 millisecond stepping rate.

TCS MODEL III DISK EXPANSION KITS

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2	Controller, Power Supply, Hardware & one 40 track Tandon Drive	$429
3	Controller Power Supply, Hardware, two 40 track Tandon Drives	$598
3a	Kit 3 but with two 80 track drives (dual sided 40s)	$791
3b	Kit three but with two 160 track drives (dual sided 80s)	$989

TCS MODEL IV DISK EXPANSION KITS

11	Controller, Power Supply, Mounting Hardware, one 40 Track Tandon Drive	$479
12	Controller, Power Supply, Mounting Hardware, two 40 Track Tandon Drives	$649
12A	Kit 12 but with two 80 Track Tandon Drives	$629
12B	Kit 12 but with two 160 Track Tandon Drives	$849

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Toll Free 1-800-433-5184 Texas 1-817-274-5625 ware. It attaches to the IBM parallel printer port and prints normal text at a speed of 20 characters per second. Forms up to 16 inches wide can be accommodated. Print thimbles can hold up to 128 characters and can print two typefaces or a full-character alphabet plus numbers, sub- and superscripting, and special symbols that include international and graphics character sets. The unit sells for $1250 and is available from NEC Information Systems Inc., 5 Militia Dr., Lexington, MA 02173, (617) 862-3120.

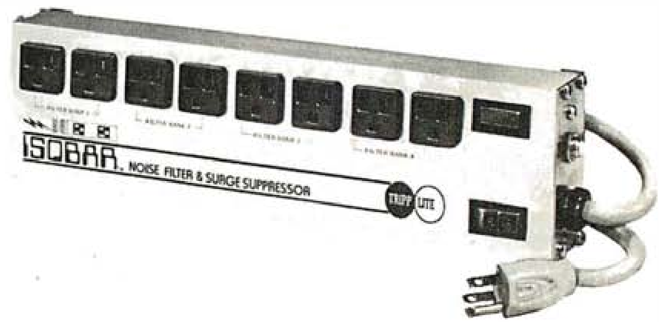
Circle 676 on inquiry card.

PERIPHERALS

Protect Circuitry

The Wire Tree from Networx is a four-outlet filtered power source to protect personal-computer circuitry and memory from voltage spikes, surges, and radio-frequency interference. It also permits control of total-system power from a single, illuminated on/off switch. The price of the Wire Tree is $69.95, and it is available from Networx, 203 Harrison Place, Brooklyn, NY 11237, (212) 821-7555.

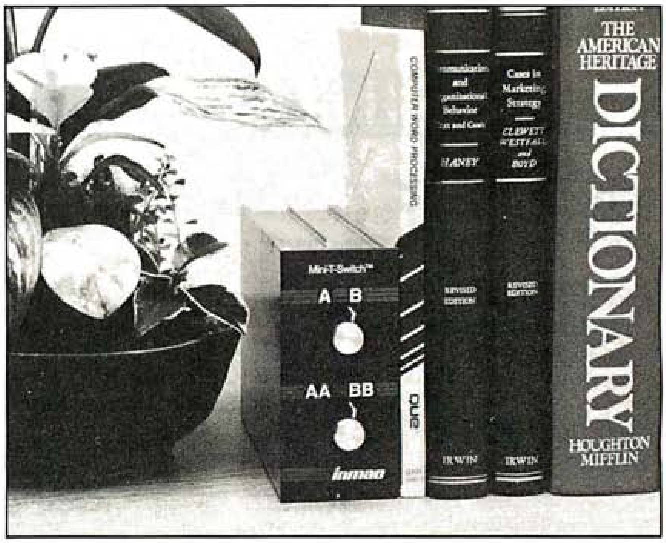
Circle 669 on inquiry card.



Cut Interference

A surge suppressor/noise filter protects sensitive computer equipment by isolating it from equipment interaction and from damaging high-voltage spikes and AC-line noise and hash. It can handle up to 2000-amp spikes and a maximum load of 1875 watts. It comes with three, four, or eight outlets and can plug into any 125-V AC, 15-amp outlet. Contact Indus-Tool, 325 West Huron St., Chicago, IL 60610.

Circle 675 on inquiry card.



T-Switches, Two in One

A Mini-T-Switch from Inmac enables users to configure computer systems in a limitless number of ways while reducing by half the number of modems and printers required. For example, one switch allows two microcomputers alternate access to a common printer. The rack-mountable module combines two T-switches that enable two peripherals to share a common I/O (input/output) port. The Mini-T-Switch is guaranteed for one year. Price is $125 to $230 depending on configuration. Contact Inmac, Department 127, 2465 Augustine Dr., Santa Clara, CA 95051, (800) 547-5444; in California, (800) 547-5447.

Circle 671 on inquiry card.

What's New?

Dual Video, Dual Display

ID Systems Corporation has introduced the ID-200, a family of very high-resolution graphics terminals that offer dual-display architecture, infinite color-graphics patterns, NTSC compatibility, zoom, pan, and other features. The ID-200 Series has a 1280 by 480 pixel resolution with a display-writing rate of up to 1.25 million pixels per second. Eight windows can be displayed at once. The terminal's dual-video generator permits split images to be displayed on separate monitors. The ID-200 has 128 downloadable fonts that allow user-created characters and 16 levels of zoom. It also has a palette of 8 or 16 fundamental colors with 10^{77} user-selectable graphics-pattern elements. The price is $4000. Contact ID Systems Corp., 4089 Leap Rd., Hilliard, OH 43026, (614) 876-1595.

Circle 668 on inquiry card.

Master Your PC

PC Master, a multifunction I/O (input/output) card from the Vista Computer Company, provides a host of features for the IBM PC, PC XT, and compatibles. Included are one parallel printer port, two asynchronous serial ports, real-time clock/calendar with nickel-cadmium battery, joystick A/D (analog to digital) input port, and Votrax speech synthesizer with amplifier and pitch and volume controls, all on a single card. Software support includes a RAM disk emulator, print spooler, Votrax subroutines, and real-time clock utilities. Contact Vista Computer Co. Inc., 1317 East Edinger Ave., Santa Ana, CA 92705, (714) 953-0523.

Circle 745 on inquiry card.

Reduce Costs of Development

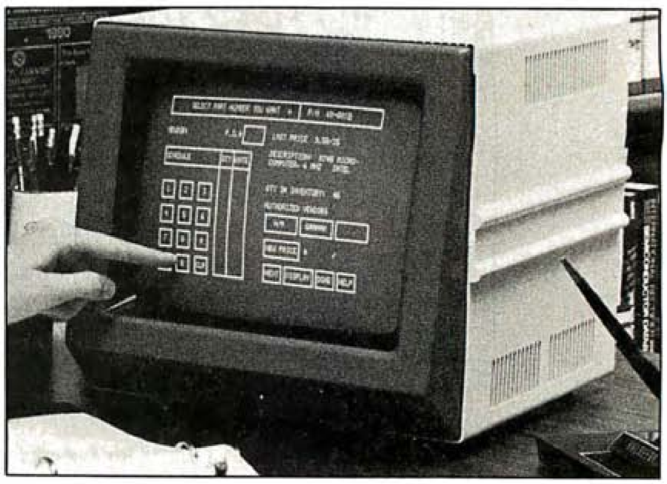
Solarcom Technology has introduced an 8085A microcomputer board that is STD bus-compatible and designed to reduce product- and system-development costs. The SCMT-85 includes an 8155-type 2048-bit static MOS RAM with I/O (input/output) ports and a timer. This single chip contains a 256-word by 8-bit RAM, two programmable 8-bit ports, a programmable 6-bit I/O port, and a 14-bit binary-programmable counter/timer. The SCMT-85 also includes an ADC0809 analog-to-digital converter (ADC). The SCMT-85 sells for $194. Contact Solarcom Technology Inc., POB 4715, Hayward, CA 94544, (415) 489-3141.

Circle 673 on inquiry card.

Color the Commodore 64

Bytes & Pieces has developed a Color Sharpener that solves the color-resolution and intensity problems of the Commodore 64. The electronic unit does not require soldering, wiring, or opening of the computer because it plugs into the 64. The price is $18.95 and it is available from Bytes & Pieces, 550 North 68th St., Wauwatosa, WI 53213.

Circle 674 on inquiry card.



Infrared Touch Terminal

For its touch capability, the Touch Information Display (TID) uses arrays of infrared light-emitting diodes (LED) and phototransistor detectors around the periphery of the screen. Outputs result when criss-crossing beams of infrared light are interrupted. Because no screen overlay or mechanical switches are involved, the optical approach is said to

be more reliable than techniques that rely on capacitive or membrane screens.

The TID's 12-inch diagonal amber-phosphor screen displays 24 lines of 80 characters each. Up to 648 active touch areas can be of any size or shape and are set up using a menu-driven routine stored in ROM.

An Intel 8085 microprocessor and associated memory handle both terminal and touch-panel functions in the TID. It functions as a standard ASCII (American Standard Code for Information Interchange) terminal that emulates the cursor-addressing functions of the ADM-3A from Lear-Siegler. The TID is $1400 and is available from Electro Mechanical Systems Inc., 801 West Bradley Ave., Champaign, IL 61820, (217) 359-7125.

Circle 670 on inquiry card.

Ready to Run

A robotics-development subsystem for the Apple II and IIe consists of a plug-in interface board, a dual-axis driver board, and two size 23 (50 oz.-in.) stepper motors. The A6 T/D interface board plugs into the Apple II/IIe expansion slot and generates software-controlled pulses that drive stepper-motor translators. The board can receive input pulses from rotary encoders or similar position-measuring devices. Positioning software enables users to run and develop a two-axis motion-control system. The price is $365. Contact Rogers Labs, 2710 South Croddy Way, Santa Ana, CA 92704, (714) 751-0442.

Circle 672 on inquiry card.

SOFTWARE

Larger Documents Can Join the Race

A text processor, Sprinter-2, is designed to meet the demands of producing books, reports, manuals, and other large documents.

Built-in text-formatting commands include automatic footnote placement and numbering, multicolumn formats, and header- and footer-line capabilities. The processor also includes automatic numbering of chapters, sections, and pages. You can define one-word instructions and carry out any sequence of the commands. A text file can be printed without modification on any of the supported printers in any type style; the optional spelling checker ($125) is an expandable 40,000-word dictionary, and all popular daisy wheels are supported (Diablo 630 and 1600, NEC, Qume, and more). Sprinter-2 is written in Pascal and is available for any computer using the Softech Micro-system p-System. Sprinter-2 costs $350 and includes a users manual. Contact Scenic Computer Systems Inc., 14852 Northeast 31st Circle, Redmond, WA 98052, (206) 885-5550.

Circle 688 on inquiry card.

Access to Dow Jones

Teleminder is said to provide complete, automatic, and efficient access to the Dow Jones News/Retrieval database. With Teleminder, database users can retrieve news and quotes on up to 360 companies with a single keystroke.

Teleminder is available for 64K-byte Apple II and IIe, 128K-byte Apple IIIs, and IBM PCs. Teleminder connects to Dow Jones, recalls when you last got news, scans and retrieves news updates since that session, loads the information onto a disk, and disconnects. News and stock quotes can be printed for review. For the Apple III and IBM PC, it's $325. Contact Teleware Inc., POB 729, Pine Brook, NJ 07058, (800) 225-0076; in New Jersey, (201) 882-0466.

Circle 776 on inquiry card.

Collector Picks Up Loose Strings

The Collector removes unused strings from Radio Shack TRS-80 Model I/III BASIC programs. Produced by Modular Software Associates, the Collector takes the place of the TRS-80's ROM garbage-collection routine, which sometimes causes the keyboard to lock. The Collector is said to reduce these delays by as much as 95 percent.

The Collector requires 500 bytes of memory and 2 bytes for each active string. It is supplied on a 35-track single-density Model I formatted disk. It costs $24.95, plus $2.50 shipping, and comes with a manual and demonstration program. Order it directly from Modular Software Associates, 209 18th St., Huntington Beach, CA 92648, (714) 960-6668.

Circle 777 on inquiry card.

A Big Splash

Frogger, the popular arcade game, can now be played by one or two players on Atari 400/800 and 1200XL computers. In this fast-action game frogs must hop across a busy highway and over a raging river before they are safely home. Details are available from Parker Brothers, 50 Dunham Rd., Beverly, MA 01915.

Circle 701 on inquiry card.

IBM PC Matrix Manipulation

Matrixpak is a set of matrix-manipulation routines for use on an IBM PC equipped with the Intel 8087 math coprocessor. Supporting seven data types (word, short, long, and binary-coded decimal integers; short, long, and temporary real numbers), the package can use all available memory to operate on large matrices.

Written in assembly language, the package modules are designed to

be called as subroutines from a user program; the routines can be linked into code generated by call-by-reference BASIC, Pascal, and FORTRAN compilers, such as Micro Ware's RTOS-based compilers, as well as other assembly-language programs. Contact Micro Ware, POB 79, Kingston, MA 02364, (617) 746-7341.

Circle 679 on inquiry card.

Highly Integratable Software

A Total Management Planning (TMP) package includes five integrated programs with an unstructured database capability, a menu-driven fully structured database manager, and single-command transfer.

The TMP Freeform ($225) stores and retrieves information using up to 9 electronic index cards, a built-in screen editor, and search keys.

The TMP Manager ($595) is a structured database manager using random file structures with multiple index files for fast information access. You can define, maintain, and manipulate databases using select, sort, and merge on fields and subfields, and print horizontal- and vertical-oriented reports and mailing and price lists.

The TMP Calc ($295) has an update mode that provides the correct results regardless of the data's location on the spreadsheet. Printer output is formatted to avoid wraparound, and 13-digit precision is supported.

The TMP Writer (price not set) is a full-featured word processor supporting fixed, proportional, and smart word-processing printers. It provides full control of headers, footers, pagination, and viewing for easy proofing. It also has a document file/retrieve system with cross-indexing usually found in dedicated word processors.

The TMP Front End (price not set) provides you with the power to integrate any or all of the TMP packages into a common operating environment. For details, contact the United Software Co., Suite 232, 9726 East 42nd St., Tulsa, OK 74145, (918) 622-4800.

Circle 681 on inquiry card.

Streamline Medical Office Procedures

The McGraw-Hill Medical Accounting System (MMAS) is a full-function accounting, billing, and information-management package for any health-care facility.

Functions include accounts payable and receivable, payroll, and general ledger. All modules are fully integrated, menu-driven, and feature error trapping. Changes are easy to make as the database is updated in real time. Users can redefine their own data screens, adapt to changing reporting and billing-form requirements without reprogramming, and set up routines to reconfigure the system to fit new provider environments.

MMAS is implemented in Pascal so it is transferable and timely. It also supports remote data-entry stations that can operate autonomously or online. For information, contact Systemetrics Inc., 104 West Anapamu, Santa Barbara, CA 93101, (805) 963-1268.

Circle 680 on inquiry card.

Handle 1500 Projects

Pertmaster lets users manage up to 1500 activities with 29 resources per activity using the Project Evaluation and Review Technique (PERT) or the critical path analysis (CPA) method. You can produce bar charts and histograms on standard character printers with a line capacity of at least 132 characters. Pertmaster is compatible with most CP/M, MP/M, PC-DOS, or MS-DOS 64K-byte operating systems with hard or floppy dual-disk drives. Analysis is high speed; a full network can be updated in less than 10 seconds. The menu-driven package with 9 selection operations costs $695 and is available from Westminster Software Inc., Building 4, Suite 245, 3000 Sand Hill Rd., Menlo Park, CA 94025, (415) 854-1400.

Circle 683 on inquiry card.

Learn BASIC Alone

The New Step by Step package for Apple II computers provides 20 hours of instruction using voice, animation, and graphics. Teach yourself BASIC instructions, library functions, subroutines, screen formatting, program logic, floating-point notation, and one-dimensional arrays. Each lesson is followed by a summary, exercises, quizzes, and final tests. Two disks, two backup disks, four cassettes, and a workbook are included for $89.95. Contact Program Design Inc., 95 East Putnam Ave., Greenwich, CT 06830, (203) 661-8799.

Circle 684 on inquiry card.

Game from Chris Crawford et al

Excalibur is a complex, multiple-screen simulation game of the kingdom of Camelot. In this one-player game, you must learn to rule wisely using economics, diplomacy, magic, military strategy, and the loyalty of friends and enemies to reach your goals. Use a joystick to

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move around the Round Table room, the treasury, and to Merlin's lair. With Merlin's help you can see into locked treasuries as well as the minds of foes. A floppy-disk version for the Atari 400/800 and 1200 costs $29.95. Contact Atari Program Exchange, 1265 Borregas Ave., POB 427, Sunnyvale, CA 94086.

Circle 682 on inquiry card.

Encyclopaedia Britannica Software

Parents can provide their children with basic vocabulary, reading, and word-processing skills with 12 programs designed for Apple computers from the Encyclopaedia Britannica Educational Corporation. The learning spectrum ranges from first words to mastering words. SAT-preparation exercises are included. A manual accompanies the set, which costs $24.95 to $49.95 when purchased individually and ranges from $43 to $115 when purchased in combinations. Contact Encyclopaedia Britannica Educational Corp., 425 North Michigan Ave., Chicago, IL 60611.

Circle 699 on inquiry card.

More Graphics for the TRS-80

A high-resolution graphics package for Pascal 80 lets you use Pascal with high-resolution graphics in TRS-80 Model III and Model 4.

Simple graphics routines, Pascal turtle graphics, a character-generator printer, and demonstration programs are included. Features include set, reset, and point commands for 640 by 240 pixels (picture elements), line draw and erase commands, and graphic and test commands to switch between high- and low-resolution screens.

The package requires Pascal 80 and the Radio Shack high-resolution graphics board. It sells for $39.95 and is available from New Classics Software, 239 Fox Hill Rd., Denville, NJ 07834, (201) 625-8838.

Circle 685 on inquiry card.

A More Compatible Kaypro II

Uniform is a set of two programs produced by Micro Solutions that allows the user to read, write, and format disks for other CP/M-based computers, thus increasing the Kaypro II's compatibility to include 15 other machines.

The first program, INITDISK, allows formatting and the second, SETDISK, selects the desired format for drive B on the Kaypro II. One copy is $49.95 and is available from Micro Solutions Inc., Software Products Division, 125 South Fourth St., DeKalb, IL 60115, (815) 756-3421.

Circle 689 on inquiry card.

Connect TI To Smart CRT

Octacomm/PC is a smart teletype-emulator program that permits the Texas Instruments Professional Computer to connect to a smart CRT terminal and interactively execute programs on another computer. It uses the standard asynchronous interface board and an RS-232C serial interface. Octacomm/PC allows the remote computer to clear the screen, position the cursor, and use line-drawing graphics. The $125 unit requires 128K bytes of memory and a TI synchronous/asynchronous board. For information, contact Houston Computer Services Inc., Suite 512, 6001 Savoy, Houston, TX 77036, (713) 972-1006.

Circle 700 on inquiry card.

Learn Morse Code

Owners of the TRS-80 Color Computer and TDP-100 can learn the international Morse Code with a package called the Morse Code Teacher. The first in a series, it is designed for the beginner and features three practice routines to familiarize and increase copying or auditory-recognition speed up to five words per minute. It requires 16K bytes of RAM and Extended Color BASIC. It is available on cassette from Cynwyn, Suite 2F, 4791 Broadway, New York, NY 10034, (212) 567-8493.

Circle 690 on inquiry card.

More for Less

A new line of affordable programs (at less than $20) for CP/M operating systems is available for entertainment, educational, statistical, communication, computer language, and utility purposes. Many disk formats are supported. For a catalog, contact Quest Software, Suite 100, 9 North Main, Lombard, IL 60148, (312) 953-2099.

Circle 702 on inquiry card.

Accounts Payable for the TI PC

An accounting package for the small-business or professional person, BPI Accounts Payable, lets you choose between two accounting methods, cash or accrual.

Two open fiscal periods can be maintained for the accrual method and three options are available for paying checks you can also print. Double-entry accounting automatically reports debits and credits to the proper accounts without reentering; general-ledger-account prompts appear on the screen as you enter data.

Accounts Payable from BPI can stand alone or can interface with BPI General Accounting, Job Cost, and Inventory Control systems. It requires a TI Professional Computer and two floppy-disk drives or one floppy-disk drive and a Winchester hard-disk drive. Versions are available for the Apple II, Commodore 8032, and Digital Equipment DECmate II

computers. The price is $395. Contact BPI Systems, 3423 Guadalupe, Austin, TX 78705, (512) 454-2801.
Circle 686 on inquiry card.

Construction Aided by Software

Running on any Unix-based operating system, the Micos I Software Series for Construction Cost Management assists the manager in controlling and managing all construction costs. It features a composite database of over 15,000 construction items that shows both current and historical costs for labor, material, and equipment. The databases can be automatically updated to reflect the local economy through trade/commodity factors. Micos I information is available from Constech Inc., 8615 Freeport Parkway, POB 610663, DFW Airport, TX 75261, (214) 257-1186.
Circle 687 on inquiry card.

Under the Bubble

The PC-DOS Bubble is a product that integrates microcomputers and host computers into a data-processing network. The Bubble from Datalex enables applications software written in the p-System to run in a PC-DOS operating system as if it were native to that environment. One can initiate from and terminate to, PC-DOS without requiring a separate bootstrap operation, enabling access and read or write in both p-system and PC-DOS files from within the p-System. The Datalex Bubble is available from the Datalex Company, Suite 406, 650 Fifth St., San Francisco, CA 94107, (415) 541-0780.
Circle 697 on inquiry card.

Micromentor Helps

The Micromentor Learning System adapts to any student's individual learning rate while it teaches a variety of subject databases such as language arts for the middle grades and SATplus, French, Spanish, Hebrew, and biology for older students. The system uses adaptive-reinforcement techniques to enhance and evaluate students' progress. It requires the Apple II and one or two disk drives. The program is $125, and the subject databases range from $30 to $50. For details, contact Cardinal Software Inc., 96 Blueberry Lane, South Hamilton, MA 01982, (617) 468-4702.
Circle 695 on inquiry card.

Recover Erasures

Unera recovers erased files in CP/M-based computers and is available in disk formats that include Osborne, North Star, Heath/Zenith, Kaypro, Televideo, and more.

File recovery is guaranteed if Unera is used promptly after erasure; yet even if other data has been written to the disks, Unera will recover what it can by recognizing wildcard characters. It supports recovery of multiple files in a single operation, allows disk changing, and can be used in both single- and multidrive systems. The technical accuracy of this program is enhanced because it recovers only the required directory contents, thus maintaining the integrity of the disk.

The package sells for $29 and includes documentation. Contact Compu-draw Software House, 1227 Goler House, Rochester, NY 14620, (716) 454-3188.
Circle 691 on inquiry card.

Read Like the Wind

Super Speed Reading is a program for the Apple II, II Plus, and IIe that teaches you to read as many as 3000 words per minute or more, increasing your reading rate up to 10 times.

This program contains graphics and uppercase and lowercase in regular, medium, and boldface. It keeps user records automatically, displays individual progress reports, and provides comprehension exercises. The $149 price includes two disks and a 130-page manual. For details, contact Magnum Software, 21115 Devonshire St., Suite 337, Chatsworth, CA 91311, (213) 700-0510.
Circle 693 on inquiry card.

Enhance CP/M-based Word Processors

Magicbind can do more than boldface, underline, accent, and super- or subscript. It provides over 60 print-formatting functions, text-editing, and file-processing capabilities. It spaces proportionately, automatically footnotes and numbers chapters, paragraphs, and articles, automatically handles short lines, prints multicolumns, and formats flexible page headings and footings. You can preview text on a video screen to check page breaks and format errors before printing. Magicbind can produce clean copy for mailings, customized wills, contracts, and other legal documents. With documentation, the price is $250. Contact Computer Editype Systems, 509 Cathedral Parkway 10A, New York, NY 10025 (212) 222-8148.
Circle 703 on inquiry card.

Print Color From the Apple

The Color Printer provides an easy, low-cost method of producing full-color printouts using an Epson MX-80 printer with Graftrax and an Apple-compatible computer. Color Printer allows the user to print any image from Apple's high-resolution screen. The package includes an unprotected DOS 3.3 disk, four colored Epson ribbon cartridges, and full documentation. It costs $69.95 and is avail-

able from Enhanced Software Products Inc., POB 178, Wantagh, NY 11793, (516) 799-2679.
Circle 696 on inquiry card.

Manage Inventory with Any Report

An inventory-management system, Infotory, from SSR Corporation is available for the Victor 9000 on both floppy- and hard-disk drive systems. Its capacity is up to 50,000 inventory items with 36 fields of information each. It features a built-in data management/report writer called Anyreport, giving the user unlimited flexibility in designing and saving custom reports to fit specific requirements. Infotory costs $425 for a floppy-disk format and $575 for a hard-disk format. For details, contact SSR Corp., 1600 Lyell Ave., Rochester, NY 14606, (716) 254-3200.
Circle 692 on inquiry card.

Financial Modeling On the Move

A financial-modeling program for professionals and managers called Supercomp-Twenty is transportable across the Digital family from PDP-11s to VAXes.

Available for the Digital Professional 300 Series, Supercomp-Twenty features a Help key, a tutorial, and formatting flexibility with column width, labeling, and a user-defined display. Program functions include financial, mathematical, conditional, and statistical abilities. Two data-access modes link Supercomp-Twenty to many database and graphics programs.

It requires a Professional 300 Series with P/OS-disk or hard-disk operating systems and sells for $395. Contact Access Technology Inc., 6 Pleasant St., South Natick, MA 01760, (617) 655-9191.
Circle 694 on inquiry card.

TC 1000 Drivette

A double-sided microfloppy-disk drive provides one megabyte of storage capacity on a 3¼-inch microfloppy disk. Although it is one-fourth the size of 5¼-inch disk drives and one-half the weight, it offers 60 percent of the power consumption. The TC 1000 gives users twice the capacity of a 500-kilobyte drive at about a 30 percent increase in cost. The TC 1000 is plug- and data-compatible with standard double-sided (80 tracks per side), double-density, 96-track-per-inch, 5¼-inch drives. Plug and data compatibility allows users to download double-sided, 5¼-inch software packages to the unit's 3¼-inch disks without modification. The TC 1000 is available for $295 in evaluation quantities. For details, contact Tabor Corp., Lyberty Way, Westford, MA 01886, (617) 692-2535.
Circle 706 on inquiry card.

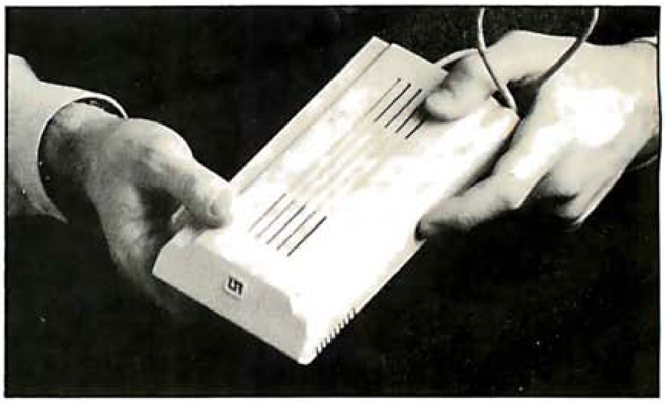
Color-Coded Disks

The jackets of double-density floppy disks in both 5¼- and 8-inch formats are available from Professional Publications in five prime and five pastel colors. Use the colors to identify different jobs, days of the week, typists, or any relevant category. Disks carry a 15-day trial money-back guarantee as well as a lifetime-replacement policy. Contact Professional Publications, POB 199, San Carlos, CA 94070, (415) 593-9119.
Circle 705 on inquiry card.

Seagate's ST425

A 3-platter, 25.52-megabyte, 5¼-inch Winchester hard-disk drive uses a temperature-compensation servo for increased track densities along with a conventional stepper motor for read/write head positioning. The drive operates at an average access time of 60 milliseconds (msec) and track-to-track access time of 16.5 msec. Track density is increased from 345 to 480 tracks per inch, yielding a capacity of 4.25 megabytes on each of the six data surfaces. It is compatible with industry-standard ST506 controllers. The ST425 media is oxide-coated, and the transfer rate is 5 megabits per second. In quantities of 500, the ST425 is $1090. Contact Seagate Technology, 920 Disc Dr., Scotts Valley, CA 95066, (408) 438-6550.
Circle 707 on inquiry card.

COMMUNICATIONS



And the Password Is:

The Password is a lightweight, 300-/1200-bps modem with auto dial and answer. It is compact enough to be mounted on the back of a computer using Velcro. The circuitry uses only 12 integrated circuits. At 1200 bps, three or four typewritten pages per minute can be processed. The Password sells for $449. For information, contact U.S. Robotics Inc., 1123 West Washington Blvd., Chicago, IL 60607, (312) 733-0497.
Circle 726 on inquiry card.

What's New?

Interface with Apple

The Interfacer by Data-Cue provides Apple II owners with a serial-communications port. The port supports synchronous/asynchronous communications and the RS-232C and RS-422 electrical standards. The Interfacer also has two complete parallel-printer ports. It comes with software drivers for printers as well as a terminal emulator for communications with remote computers. It costs $95. For details, contact Data-Cue, 5696 Hwy 431 S, Brownsboro, AL 35741, (205) 883-2933.

Circle 724 on inquiry card.

Pronet Networks Three Units

A multitasking network system for the Apple II called Pronet has been introduced by SWI International Systems. Many people can use the network that runs under the AROS operating system (compatible with Apple DOS 3.3) and the p-System UCSD version 4.1. TurboDOS should be available soon for either the PCPI or Microsoft Z80 cards. A starter system for networking three computers costs $656. SWI plans to offer an IBM PC network with the p-System followed by MS-DOS and TurboDOS. For details, contact SWI International Systems, 7741 East Gray Rd., Suite 2, Scottsdale, AZ 85260, (602) 998-3986.

Circle 728 on inquiry card.

Infonet for All

The Infonet network, which works in more than 150 national metropolitan areas and almost 50 cities around the world, has entered the communications market. Formerly confined to customers of Computer Sciences Corporation's remote-computing service, now anyone can transmit information between desktop computers and remote terminals in branch facilities. More than 150 nodes are interconnected over 130,000 miles of leased terrestrial circuits as well as satellite links. Connect-time fees are $4 per hour for speeds up to 1200 bps; data-volume charges are 4 cents per 1000 characters for up to 1200 bps. Contact Computer Sciences Corp., 650 North Sepulveda Blvd., El Segundo, CA 90245, (213) 615-0311.

Circle 729 on inquiry card.

Small Modem Can Transmit

The Small Wonder is an SR 120 Async Line Driver modem from Data-Control Systems. The SR 120 measures 85 by 133 by 45 millimeters and can transmit one mile over unloaded metallic circuits at 19.2 kbps. Longer distances are possible at lower data rates. The SR 120 conforms to Bell Publications #43401 and #41028. The price is $165. Contact Data-Control Systems, 1455 Research Blvd., Rockville, MD 20850, (301) 279-8700.

Circle 727 on inquiry card.

Modem Adapts, Stores, and Dials

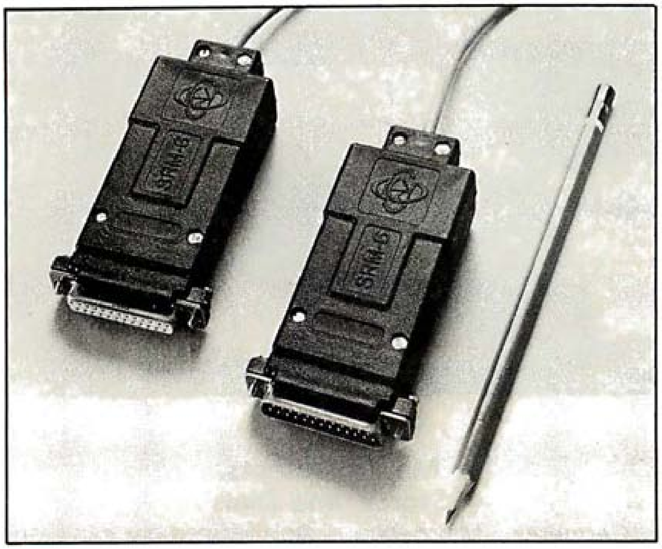
Cermetek Microelectronics has introduced Infomate 212A, a microprocessor-based Bell 212A-type modem that fits on a standard telephone. It automatically adapts to the host's communication parameters and minimizes system-integration problems. Features include automatic dial, answer, speed select, and parity select, and automatic or manual selection of pulse or tone dialing. Its nonvolatile memory can store up to fifty-two 32-digit telephone numbers or log-on messages for database access. Advanced dialing commands such as dial last number and dial until answered are provided. The Infomate 212A costs $595. For details, contact Cermetek Microelectronics Inc., 1308 Borregas Ave., POB 3565, Sunnyvale, CA 94089, (408) 734-8150.

Circle 723 on inquiry card.

Compress Data Twice as Fast

The Scotsman III compresses data at a two-to-one ratio, doubling the capacity of existing phone lines and allowing communication links to operate at twice the normal speed. Because it doubles the throughput of a high-speed data link, it allows a 19.2 kbps (thousand bits per second) data stream to be transmitted using a conventional 9600-bps modem. It contains a built-in four-channel multiplexer and is compatible with most asynchronous, bisynchronous, X.25, SDLC, and HDLC protocols. The units are fully compatible with the standard RS-232C serial and V. 24 interfaces. A cyclic redundancy check (CRC) is used to detect errors between data-compression units. Extensive diagnostics are built in, and statistical data can be used for network optimization. The price of the unit is $5000. Contact Racal-Vadic, 1525 McCarthy Blvd., Milpitas, CA 95035, (408) 946-2227.

Circle 719 on inquiry card.



The Short-Range Modem Family

RAD Computers has introduced a new family of short-range modems that are packaged in a plastic connector cover and do not need an AC power supply. The three models available are the SRM 6D, a 19.2-kbps asynchronous modem with a range of up to 35 km (9 km at 9600 bps with 24-gauge wire); the SRM 6A, which is transformer-isolated from the line and 19.2-kbps asynchronous with a range of up to 20 km (6 km at 9600 bps); and the SRM 6S, which has line-transformer isolation, data rates from 1.2- to 19.2-kbps synchronous with a range of up to 28 km (8 km at 9600 bps). To install, plug the modem into the computer or terminal connector. The unit prices are $60 for the SRM 6D, $95 for the SRM 6A, and $130 for the SRM 6S. For details, contact RAD Computers Ltd., POB 13161, Tel Aviv 61131, Israel; Tel: (03) 494511; Telex: 35517.

Circle 721 on inquiry card.

Reach Out and Transfer

The Reach 2.0 Modem and File Transfer program from the Software Toolworks is capable of automatic programmed interactions with remote host systems. Reach 2.0 lets you dial a remote system using an auto-dial modem such as the Hayes Smartmodem, log in automatically, read mail, send messages, and log off, all without operator intervention. It runs on the Heath/Zenith H-89/Z-89/Z-90 computers and sells for $19.95. Contact The Software Toolworks, Suite 1118, 15233 Ventura Blvd., Sherman Oaks, CA 91403, (213) 986-4885.

Circle 716 on inquiry card.

Link Ranges 20 Miles

An RS-232C link, the Radiomodem is a low-cost, wireless, hand-held transceiver that operates on professional FM-radio communications channels. It can exchange data at up to 600 bps full- or half-duplex to provide medium-distance data links. It comes with a standard DB-25 connector and operates from either 110 V AC or 12 V DC. Typical link ranges of 15 to 20 miles can be extended to 25 miles over level terrain. Voice communications can also be conducted over the same link. Contact Ritron Inc., 148 West Carmel Dr., POB 1998, Carmel, IN 46032, (317) 846-1201.

Circle 720 on inquiry card.

NEC Offers Two Modules

NEC Information Systems has introduced two modules for the NEC Advanced Personal Computer (APC). Coaxxsys-86/3270 and the SNA/SDLC-86/3270 (Systems Network Architecture/Synchronous Data Link Control) allow the APC to connect to an IBM mainframe. Both run on the CP/M-86 operating system and use a standard serial port.

The Coaxxsys-86/3270 combines a printed-circuit board that plugs in to the APC bus with a software program running on CP/M-86. The hardware connects to the same coaxial cable that connects an IBM 3278 terminal to either an IBM 3274 or 3276 controller.

The SNA/SDLC board and 3270 SNA software allow the APC to emulate an IBM 3276 Remote Control/Unit Display Station where, using a synchronous modem, the user can connect the APC via telephone lines to the IBM host computer. Both will be available soon: the SNA/SDLC-86/3270 for less than $500 and the Coaxxsys-86/3270 for less than $1000. For further details, contact NEC Information Systems Inc., 5 Militia Dr., Lexington, MA 02173, (617) 862-3120.

Circle 717 on inquiry card.

Link Up the Easy Way

Advanced Micro Techniques has made CP/M-based computer link-up more accessible with Telex, TWX, telegram, cablegram, mailgram, Infocom, and Easy Link, Western Union's store-and-forward message service with a communications-software package called Micro ez LNK. Because it automatically formats and addresses Telex messages, you won't need to type complex sign-on messages or addresses on-line. Micro ez LNK can empty your electronic mailbox by receiving and storing messages on disk without attention from office personnel. It supports many terminals, 8-bit CP/M-based compu-

ters, and common modems. Soon it will support the IBM PC, the DEC Rainbow, and other 16-bit machines. The price is $150. Contact Advanced Micro Techniques, 1291 East Hillsdale Blvd., Suite 209, Foster City, CA 94404, (415) 349-9336.
Circle 725 on inquiry card.

Modem for Radio-downloading

A receive-only modem, the AM FM Loader, designed for reception of computer data from commercial radio stations, is compatible with Bell 103 (300-bps) signals and will also operate at speeds of up to 4800 bps. Computer programs are downloaded only when the listenership is low, to comply with licensing requirements of radio stations and cable operations around the country. To install, plug in one cable to the radio's audio-output jack; another cable, terminated in a DB-25 connector, plugs into the serial port. For further details, contact the Microperipheral Corp., 2565 152nd Ave. NE, Redmond, WA 98052, (206) 881-7544.
Circle 718 on inquiry card.

Osborne First, Then the Others

Two advanced communications-software packages, Cycom 1 and 2, are available from Cypher Communications Technology. Versions are available now for the Osborne 1 and will soon be available for the TRS-80, Apple II, IBM, and DEC personal computers.

Both packages feature automatic access and file transfer. The Cycom 1 manages electronic mail, file transfer, conversation, and dumb-terminal emulation. The Cycom 2 converts an Osborne 1 into a secure, encrypted communications terminal when used in conjunction with the Cypher Communications National Bureau of Standards Data Encryption Standard encryption chip. Cycom 1 costs $120; Cycom 2 costs $450. Contact Cypher Communications Technology Inc., 1600 Research Blvd., Suite 105, Rockville, MD 20850.
Circle 730 on inquiry card.

Microprocessor-based Videotex

The Sceptre Videotex Terminal from American Bell combines with a color-TV set and a telephone with modular wiring to form a system for accessing and interacting with a videotex database. Advanced videotex features and a self-contained, high-speed communications link join the separate control unit with a wireless keypad to create a complete system. The encryption/security feature is useful for banking at home or private transactions. The QWERTY layout contains 42 alphanumeric keys, 10 control keys, 8 programmable-function keys, and a wireless infrared beam that links it to the control unit. For communications, a 212A-type originate-only synchronous/asynchronous modem is used at a data rate of 1200 bps. The NAPLPS (North American Presentation-Level Protocol Standard) protocol is supported in 7- and 8-bit versions. The unit sells for $900. Contact American Bell Consumer Products, 3 Park Ave., 31st Floor, New York, NY 10016, (212) 689-2612.
Circle 715 on inquiry card.

User-oriented Test Set on Site or Away

The Phoenix Model 1500 Comit is a lightweight, portable communications-interface test set.

The Comit tests modems, multiplexers, printers, and terminals, and it incorporates a 28-key keyboard and an 80-character liquid crystal display with all functions selected via single keystrokes or a menu of options. Synchronous and asynchronous modes operate for all standard bit rates through 19.2 kbps (thousand bits per second) with synchronous rates extended to 72 kbps. The format of an asynchronous data stream can be evaluated for bit rate, character size, parity, and number of stop bits. The Model 1500 can be driven by a modem that allows for distance gauging and unattended real-time remote testing and control of all functions. The Comit lists for $2145. Contact Phoenix Microsystems Inc., POB 4206, Huntsville, AL 35802, (205) 881-2173.

Circle 722 on inquiry card.

SYSTEMS

Two in One and a Language

A 64K-byte personal computer, the Orange + Two uses dual Z80A and 6502 microprocessors and the company's EuroROM feature to read, write, and work with Apple software as well as CP/M-based programs. CP/M 3.0 and Orangeforth-83, a derivative of the FigFORTH language, are both resident in the ROM and available on disk. The built-in disk-drive controller directs two Apple-type drives. Also included are a cassette interface, joystick port, color graphics, and ASCII keyboard with a numeric keypad. The Orange + Two retails for $1095. Contact Orange Plus Computer Systems, 23801 Calabasas Rd., Suite 2050, Calabasas, CA 91302, (213) 999-5210.

Circle 738 on inquiry card.

Serif Type from Wordtronix

The Serif Word Processing Machines are intended to appeal to first-time users because typing functions are the same as typewriter operations. The Serif line uses a Z80A-based processor operating at 4 MHz with 64K bytes of RAM. An additional 16K bytes of RAM are used for screen refresh, and 4K bytes of ROM are used as a bootstrap loader. The adjustable, high-resolution 15-inch screen provides a 57-line by 85-column display. Operator text uses 45 of the 57 lines; 3 lines are for system/operator dialogue; and 9 lines are for menu and help messages. Up to 100 pages of on-line text can be stored with 5¼-inch floppy disks. The slim keyboard is detachable. The Serif 1 comes with one disk drive; two drives are available with the Serif 2. The Typerighter 20 is a typewriter-quality daisy-wheel printer that operates at 200 words per minute or 20 characters per second (cps); the Typerighter 35 operates at 35 cps. Typeright I is accompanying software that provides standard letter-oriented typing features, and Typeright II offers enhanced features for document-oriented word processing. For details, contact Wordtronix, 9950 West 74th St., Minneapolis, MN 55344, (612) 941-0400.

Circle 736 on inquiry card.

Toshiba's 16-bit High-Res Computer

Toshiba America Inc. has introduced a 16-bit IBM-compatible computer called the T300 Personal/Business Computer. The 12-inch green monitor and the 14-inch 8-color monitor both display 80 characters by 25 lines with a resolution of 650 by 500 addressable dots. Color graphics, a detachable keyboard with 30 user-defined keys, an Intel 8088 microprocessor, 192K bytes of RAM, and 640K-byte disk drives are a few of the features that provide versatility. The standard operating system is MS-DOS with T-BASIC16; the optional operating systems include CP/M-86 with CBASIC-86. Two models are available that house single- or double-disk drives, but both contain integrated Centronics and RS-232C serial-communications ports and seven expansion slots. For details, contact Toshiba America Inc., Information Systems Division, 2441 Michelle Dr., Tustin, CA 92680, (714) 730-5000.

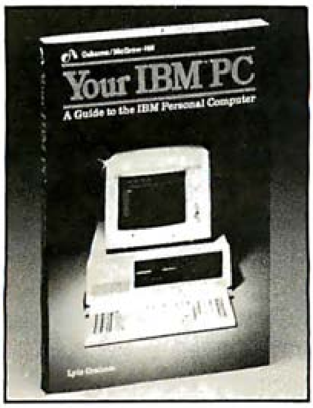
Circle 740 on inquiry card.

PUBLICATIONS

Books for the IBM PC

Several books designed for owners of the IBM PC have been published by John Wiley & Sons. Two

of the titles include **PC DOS: Using the IBM PC Operating System** and **CP/M for the IBM**. Both books are written by Ruth Ashley and Judi N. Fernandez and each one costs $14.95. Leroy Finkel and Jerald Brown's book **IBM PC: Data File Programming** sells for $14.95, and Richard Conklin's book **PC Graphics: Charts, Graphs, Games and Art** sells for $15.95. Contact John Wiley & Sons, 605 Third Ave., New York, NY 10158.
Circle 750 on inquiry card.



A Personal Guide

Osborne/McGraw-Hill announces a book by Lyle Graham called **Your IBM PC: A Guide to the IBM Personal Computer**. It is written for both beginning and experienced computer users. A functional overview of hardware and software, step-by-step operating instructions, and an introduction to IBM BASIC programming are a few of the main attractions for the novice. For more experienced users, Graham covers PC-DOS, CP/M-86, advanced IBM BASIC programming, color graphics, and sound. Chapters include troubleshooting, appendixes, and problem-definition procedures. The 400-page book costs $16.95. Contact Osborne/McGraw-Hill, 2600 Tenth St., Berkeley, CA 94710, (415) 548-2805.
Circle 751 on inquiry card.

Fundamentals of the IBM PC

Inside the IBM PC: Access to Advanced Features and Programming Techniques by Peter Norton covers the fundamentals behind the brains of the PC, how PC-DOS works, the service routines provided by ROM, a glossary, and an introduction to Pascal. The 288-page softcover book costs $19.95. The book/disk combination costs $79.95, and the disk alone is $65. All are available from Robert J. Brady Co., Bowie, MD 20715, (301) 262-6300.
Circle 752 on inquiry card.

Computer Literacy A Must

As a key issue to successful office-automation planning, **The Directory of Office Information Systems** stresses the benefits of training employees to develop computer awareness for personal as well as corporate goals.

The 300-page reference and buyer's guide also supplies the reader with information on practical reference tools needed for selecting the appropriate equipment, software, and services for specific office situations. Quick-glance comparison charts, personal-business computers, word-processing software, and typesetting/interface systems are discussed. A few of the chapters cover office systems, personal computers, software, system I/O, communications, and service bureaus, and an index organizes it all. The book costs $34.95 and quantity discounts are offered. Contact Information Clearing House Inc., Department OIS, 500 Fifth Ave., New York, NY 10110, (212) 354-2424.
Circle 753 on inquiry card.

TLC for Educators

TLC, or **Teaching, Learning, Computing**, is a magazine-style educator's guide to personal computing. It focuses on people whose contributions to computing have been integral to its success. Topics covered are special education, an administrator's planner, and essays as well as book reviews, a calendar, and answers to computer queries. Subscriptions are $24 a year. Contact TLC, Data Learning Tower, POB 9159, Brea, CA 92621.
Circle 754 on inquiry card.

Tesla's Inventions

An autobiography that reveals Nikola Tesla's struggle to harness power and perfect the electric motor using Niagara Falls has been rereleased. **My Inventions** is available in paperback with a new introduction by Ben Johnston, Tesla's biographer. Copies are $7.95. Contact Hart Brothers Publishing, Department N, POB 205, Williston, VT 05495, (802) 879-4670.
Circle 755 on inquiry card.

A First for Unix Users

A short course on Unix from Colorado State University covers more than 60 of the most frequently used Unix commands in 10 half-hour videotaped lectures. It teaches viewers how to build their own commands and provides a working knowledge of the versatility of the Unix operating system. For details, contact W. L. Somervell Jr., Engineering Renewal and Growth Program, Colorado State University, Fort Collins, CO 80523, (800) 525-4950.
Circle 757 on inquiry card.

Triannual Medical Software Directory

Medical Software Information Service (formerly Medisoft) produces a Medical Software Directory that contains programs written by physicians and information on publications and services related to computers in the practice of medicine. Some of the programs included are for practice management, intensive-care units, education in the hospital, pathology, psychiatry, ultrasound in obstetrics, and nuclear and emergency medicine. Subscriptions are $80 a year for three issues. Contact Medical Software Information Service, Route 3, Box 6744, Twin Falls, ID 83301.
Circle 756 on inquiry card.

Self-paced Tutor/Training Course

Computer Tutor Corporation offers a self-paced, self-teaching guide that combines a book with a disk for the IBM PC and the Apple II Plus and IIe computers. Courses include Multiplan, Wordstar, Visicalc, Supercalc, and two parts of Lotus's 1-2-3. Course data is loaded and saved on formatted disks. Each training course costs $39.95. Contact Computer Tutor Corp., 23 Central St., Wellesley, MA 02181.
Circle 768 on inquiry card.

The Latest Functions For New Buyers

Microprocessor-Microcomputer Technology is a book written by Frederick F. Driscoll that provides readers with a working knowledge of microcomputer functions by focusing on the 8080A, the 6800, and the 6502 microprocessors. For each processor, there is a ready-to-use instruction set, programs with explanations, and a description of basic operations and functions. The author shows how to use the microprocessors in conjunction with the 8255A peripheral interface and the 6821 peripheral-interface adapter. Other detailed instructions explain how to design, load, test, debug, and document programs, and how to use flowcharts, subroutines, and machine, assembly, and high-level languages. The book also discusses microprocessor architecture, BASIC instruction sets, addressing modes, and semiconductor memories. It costs $29.95. Contact Van Nostrand Reinhold, 135 West 50th St., New York, NY 10020, (212) 265-8700.
Circle 760 on inquiry card.

Visicalc for Students or Engineers

Visicalc for Science and Engineering describes how to use the "what-if" spreadsheet program for technical applications that include mechanics, optics, mathematics, statistics, electronics, civil engineering, systems control, and communications. Written by Stanley Trost and Charles Pomernacki, the book includes more than 50 ready-to-run scientific and engineering programs for Visicalc allowing a reader with only a slight familiarity with Visicalc to solve technical problems. The illustrated book costs $13.95. Contact Sybex Inc., 2344 Sixth St., Berkeley, CA 94710, (415) 848-8233.
Circle 761 on inquiry card.

Computers Serve Businesses

The Critic's Guide to Microcomputer Software by Phillip Good, editor of the CPA Micro Report, provides accountants with separate versions for the IBM PC, CP/M-based computers, or Apple computers. Reviews in all the volumes are based on the hands-on appraisals of the author and his staff and contain recommendations for spreadsheets, word processors, database managers, productivity analyzers, tax packages, and legal-billing software. Each book costs $12.95. Contact the Chilton Book Co., Radnor, PA 19089, (800) 345-1214.
Circle 763 on inquiry card.

How to Sell Your Software

A free booklet advises how to successfully sell the software you create on your personal computer. The eight-page booklet explains how to obtain national directory listings, how to price a new software product, locate an advertiser, write a user's manual, and operate a successful mail-order fulfillment service. Contact ATC Software, Route 2, Box 448, Estill Springs, TN 37330.
Circle 773 on inquiry card.

Learn by Using Fig FORTH on Atari

Forth on the Atari—Learning By Using is a book devoted to Fig-FORTH applications on Atari computers. It includes graphics and sound using the game ports for control applications and I/O programming in FORTH, and a mailing list in FORTH using virtual memory techniques. The 116-page book costs $7.95. Contact Elcomp Publishing Inc., 53 Redrock Lane, Pomona, CA 91766, (714) 623-8314.
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DETACHABLE INSERT

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Circle 520 on inquiry card.

DISK DRIVE For APPLE
Totally Apple compatible, 143,360 bytes per drive on DOS 3.3 full one year factory warranty, half-track capability, reads all Apple software, plugs right into Apple controller as second drive. DOS 3.3, 3.2.1 Pascal, & CP/M compatible

MSM-431010 *Standard Disk II size* — **$199.00**
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HALF-HEIGHT DRIVE For APPLE
Totally Apple compatible. Works with all Apple software and controllers. Faster and quieter than most other drives, yet only half the size!

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We bought out a major manufacturer's overstock, and we are passing the savings on to you! Single sided double density, package of ten

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CP/M 3.0 CARD For APPLE—ALS
The most powerful card available for your Apple!
6 MHz, Z-80B, additional 64K RAM, CP/M 3.0 plus, 100% CP/M 2.2 compatibility, C Basic, CP/M gr aphics, 300% faster than any other CP/M for Apple One year warranty

CPX-62810A *ALS CP/M card* — **$299.00**

Z CARD For APPLE—ALS
Two computers in one, Z-80 and 6502, more than doubles the power and potential of your Apple, includes Z-80 CPU card, CP/M 2.2 and complete manual set. Pascal compatible, utilities are menu-driven, one year warranty

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80 column x 24 line video card for Apple II addressable 25th status line, normal/inverse or high/low video. 128 ASCII characters, upper and lower case, 7 x 9 dot matrix with true descenders, CP/M, Pascal and Fortran compatible, 40/80 Hz, 40/60 column selection from keyboard. Best 80 column card!

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16K RAM CARD For APPLE II
Expand your Apple II 64K, use as language card, full one year warranty. Why spend $175.00?

MEX-16700A *Save over 115.00* — **$49.95**

PRINTER CARD & CABLE
For Apple. Standard centronics parallel interface for Epson, Okidata, C. Itoh, Gemini, NEC, Comrex, etc. Includes printer cable and supports graphics

IOP-2100A *Printer card & cable* — **$49.95**

FAN/POWER CENTER For APPLE
Cooling fan for your overheated Apple II, II+, or IIe; also includes power switch and two switched outlets with voltage protection circutry

SYA-1520A *Applefan* — **$59.95**

GRAPPLER PLUS—Orange Micro
The ultimate parallel printer graphics interface card with many new features, now at a new low price!

IOP-2300A *Grappler Plus* — **$119.95**

BUFFERED GRAPPLER PLUS
Combines the flexibility of the Grappler + with the convenience of the Bufferboard, all on a single board

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BUFFERBOARD—Orange Micro
Add up to 20 pages of text output buffering to your existing Grappler + board

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RS232 serial I/O board for Apple, works with printers or modems. 110 to 9600 baud. DOS, CP/M and Pascal compatible

IOI-2052A *ASIO* — **$119.95**

A488—SSM/TRANSEND
Allows Apple II, IIe, II+ to operate as an inexpensive IEEE 488/GPIB instrument controller. Comes with cable

IOX-7488A *A488* — **$339.95**

APPLE PROTOBOARD—VECTOR
Ideal for developing customized I/O circuits for your Apple—gold plated edge connector; power and ground planes

VCT-4609 *Apple Protoboard* — **$22.95**

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RS232 asynchronous interface for Apple, 75 to 9600 baud, full handshaking signals. CCS 7710-01

IOI-2020A *Limited Quantity* — **$119.95**

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Parallel printer or general purpose parallel interface board for Apple

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A To D CONVERTER—CCS
3¾ digit BCD Analog-to-digital converter for Apple. HURRY! limited quantity!

IOA-2010A *A to D converter* — **$94.50**

DUAL 8-inch DISK DRIVES
Up to 2 Megabytes for your Apple, two double density 8 inch slimline disk drives, cabinet, power supply, cable, controller, and software. Compatible with DOS, CP/M, Pascal, and IBM 3740 formats

1 MEGABYTE SUB SYSTEM — **$1195.00**
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COOL STACK For APPLE
System stand and organizer with cooling fan. Holds Apple II, two disk drives, monitor, and software. Constructed from heavy duty 16 guagesteel. Sentry II is anti-theft model with locks forentiresystem and all componets. A standard with most school districts!

SYA-1505A *Cool stack* — **$79.95**
SYA-1506A *Sentry II* — **$159.95**
SYA-1507A *Sentry II w/power guard* — **$229.95**

ULTRATERM—VIDEX
Revolutionary video support for the Apple—allows display of up to 4096 characters (128 x 32, 132 x 24, 160 x 24, or 80 x 48). Complete firmware support for BASIC, Pascal, and CP/M. For Apple II, II+, IIe and III

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Similar in concept to Z80 cards for Apple, but uses 8088, the same microprocessor used in IBM PC. Complete with MSDOS and MBASIC

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ARITHMETIC PROCESSOR—CCS
The CCS 7811C is a high speed arithmetic processor board designed to increase throughput of your Apple in computation-intensive programs. Uses AMD 9511 math processor chips

CPX-90811A *Limited Quantity* — **$269.95**

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Adds 128K to your Apple for Monster memory!

MEX-12801 **128K** — **$389.00**

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A touch sensitive pad that functions like a joystick or mouse, allowing you to move the cursor around the screen with the touch of a finger. Complete with software

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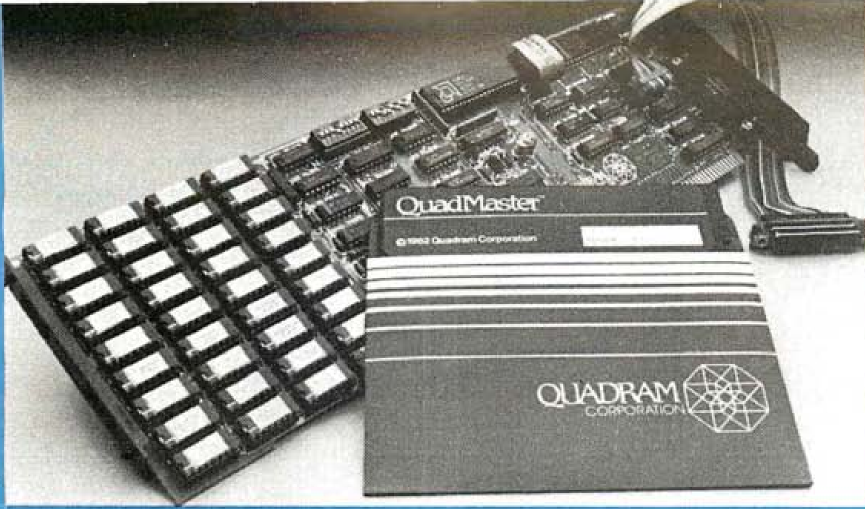

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Circle 521 on Inquiry card.

SIX PAK PLUS—AST

Up to 384K RAM, clock calendar with battery back up, serial port, parallel printer port, game port, superdrive and super spool software included FREE!

MEX-38064A *64K C,S,P* ________ $289.95
MEX-38256A *256K C,S,P* ________ $489.95
For Game Port Option Add ________ $39.95

MEGA PLUS—AST

Up to 512K RAM, clock calendar with battery back up, 2 serial ports, parallel printer port, game port, super drive and superspool software included FREE!

MEX-51064A *64K C, 1 serial* ________ $269.95
MEX-51000S *Second serial port option* ________ $39.95
MEX-51000P *Printer port option* ________ $39.95
MEX-51000G *Game port option* ________ $39.95
For Each Additional 64K RAM Add ________ $49.95

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Up to 256K of RAM, clock with battery back up, serial port, parallel printer port, superspool software included FREE!

MEX-25064A *64K C,S,P* ________ $269.95
MEX-25256A *256K C,S,P* ________ $419.95

I/O PLUS II—AST

Up to 2 serial ports, parallel printer port, game port, clock calendar with battery back up, super drive and superspool software included FREE!

IOI-7500A *Clock & 1 serial port* ________ $129.95
IOI-7500P *Printer port option* ________ $39.95
IOI-7500S *Second serial port option* ________ $39.95
IOI-7500G *Game port option* ________ $39.95

QUADBOARD I—QUADRAM

Up to 256K RAM, serial port, parallel printer port, clock calendar, RAM disk and printer spooler software

MEX-41064A *64K Quadboard* ________ $279.95
MEX-41256A *256K Quadboard* ________ $399.95

QUADLINK—QUADRAM

Allows IBM PC to run Apple software. Includes interface card and software to allow your IBM PC to run both Apple DOS and PC DOS

CPX-50500A *Quadlink* ________ $495.00

SYSTEM CARD—MICROSOFT

From the authors of MS-DOS—up to 256K RAM, serial port, parallel printer port, clock calendar, plus RAM drive disk emulation, print spooler, time utilities, and terminal emulation software. DOS 1.1 or 2.0 compatible

MEX-16064A *64K system card* ________ $279.95
MEX-16256A *256K system card* ________ $429.95

MONTE CARLO CARD—MBI

Up to 512K RAM, clock calendar, parallel printer port, serial port, GT model has dual port joystick adapter

MEX-55064Q *64K Monte Carlo Quatro* ________ $299.95
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Only the best Quadchrome or Princeton HX-12, 690 x 480 resolution, 16 brilliant colors, special .31mm dot-pitch tube, includes FREE! cable

VDC-241301 *Quadram Quadchrome* ________ $469.95
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NEC or AMDEK, popular RGB monitors for your IBM PC

VDC-652000 *NEC JC 1203 RGB* ________ $599.95
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Two pages of ultra-high resolution text and graphics 720 x 348, compatible with Lotus 123, Visicalc, dBase II, etc. Includes parallel printer port

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Up to 16 colors, 80 characters, biplanar technology, includes parallel printer port

IOV-6010A *Plantronics Color Plus* ________ $379.95

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Quadcolor I delivers standard IBM PC color and graphics, add Quadcolor II and hi-resolution (640 x 200) color graphics are possible

IOV-4010A *Quadcolor I basic board* ________ $234.95
IOV-4020A *Quadcolor II add on* ________ $229.95

64K RAM UPGRADE For IBM PC

High speed RAM upgrade kit with parity (error detection) and one year warranty

MEX-64100K *64K kit for IBM PC* ________ $49.95

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We have taken the top rated programs and reduced the price making them a super value

LOTUS 1 2 3 Best spreadsheet
SFP-24001020M *Lotus 123 (1A)* ________ $329.95
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SFP-11210100M *Ashton-Tate DBASE II* ________ $429.95
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SFP-13600100M *MicroPro Wordstar* ________ $299.95
PROPACK Wordstar/Mail/Spell/Starindex
SFP-13600900M *MicroPro's best* ________ $394.95
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SFP-14101080M *Visicorp Visifile* ________ $199.95
CROSSTALK Best communications package
SFP-53770100M *MicroStuff Crosstalk* ________ $129.95
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SFP-162010100 *Microsoft Multiplan* ________ $179.95
FLIGHT SIMULATOR Best Flight Simulator $39.95
SFP-332010100 *Microsoft Flight Simulator* ________ $39.95

NOW! BETTER THAN EPSON

Okidat's new plug-n-play ROMS for Oki 92 or Oki 93 printers are fully IBM PC compatible! 412 ASCII characters, full graphics, complete Epson emulation, and near letter quality printing not available with Epson

PRM-43092 *Okidata 92 160 cps* ________ $479.95
PRM-43093 *Okidata 93 160 cps* ________ $795.95
PRA-43086 *Plug-n-play for 92* ________ $49.95
PRA-43087 *Plug-n-play for 93* ________ $49.95
WCA-2536A *IBM PC to Oki or Epson cable* $32.95

NEC 3550 LETTER QUALITY

Only full IBM PC compatible letter quality printer available—why settle for less

PRD-35501 *NEC 3550 printer* ________ $1799.95

MORE PRINTERS ON PAGES 5 & 8

HAYES SMARTMODEMS

300 and/or 1200 baud direct connect, auto answer-auto dial, pulse or touch tone, auto baud rate selection 1200Bis a plug-in board for IBM PC only and includes Smartcom II FREE!

IOM-5550A *1200B with Smartcom II* ________ $399.95
IOM-5500A *Smartmodem 1200* ________ $475.00
IOM-5400A *Smartmodem 300* ________ $199.95
SFP-5500550M *Smartcom II* ________ $79.95

MICROSOFT MOUSE

Tandon TM-100-2 double-sided, double-density 320K disk drive. Original equipment drive on IBM PC

MSM-551002 *Full size Tandon* ________ $224.95
MSM-991004 *Half-height 320K drive* ________ $199.95

DISKETTES For IBM PC

High quality 320K double-sided, double-density diskettes, certified to be absolutely error free. Box of ten, warranteed for one year

MMD-5220104 *With FREE! plastic box* ________ $24.95
MMD-5220101 *Verbatium Datalife* ________ $34.95

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From Mouse Systems. Optical mouse with no moving parts—nothing to wear out, includes software and is compatible with all major software packages—a guaranteed best buy!

SYX-14100A *Mouse Systems mouse* ________ $249.95

MICROSOFT MOUSE

Mechanical mouse from the folks that wrote your PC's operating system. Includes software and cables

SYX-16100A *Microsoft mouse* ________ $149.95

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Better than USI, Better than Amdek!

BEST MONITORS AVAILABLE!

Ultra-high resolution, up to 22 MHz. 1000 lines per inch, amber or green phosphor, FREE! tilt and swivel base, US manufacturer

VDM-881220	*12" green 22 MHz*	**$149.95**
VDM-881210	*12" amber 22 MHz*	**$149.95**
VDM-880920	*9" green 18 MHz*	**$139.95**
VDM-880910	*9" amber 18 MHz*	**$139.95**

TAXAN MONITORS

18 MHz 800 lines per inch, ideal for 80 column operation

VDM-821210	*12" Amber*	**$139.00**
VDM-821220	*12" Green*	**$139.00**

TAXAN RGB VISION

Apple and IBM compatible RGB color. Both of these units feature an 18 MHz bandwidth linear video amplifier. The RGB-Vision I has 380 lines horizontal resolution; the super high-resolution RGB-Vision III has 630 line resolution

VDC-821210	*RGB-Vision I*	**$369.00**
VDC-821230	*RGB-Vision III*	**$649.00**
VDA-821210	*IBM PC cable*	**$19.00**
VDA-821220	*Apple III cable*	**$19.00**
VDA-821200	*Apple II card & cable*	**$129.00**
VDA-821230	*Apple IIe & 80 Column card*	**$179.00**

TAXAN COLOR MONITOR

Composite color monitor with audio, 13-inch/400 line screen

VDC-821205	*Color monitor*	**$399.00**

12-inch GREEN—ZENITH

15 MHz, 40 or 80 column

VDM-201201	*12" green*	**$94.95**

SMART TERMINAL—TTX

The new TTX 3000 is an intelligent, economical, full-feature terminal designed to be expanded into a full computer. It has more features and is priced lower than similar units from ADDS, LSI, Hazeltine, and Televideo. In addition to all the built-in features, there is also space inside the unit for a 6 x 12 inch single board computer, and provisions for mounting two half-height 5¼ inch disk drives (and sufficient power supply current to run the add-ins). The detached keyboard features 95 keys, with numeric keypad and 10 function keys. Screen is designed to tilt and swivel for comfortable viewing. Emulates TV 925

VDT-461201	*TTX-3000*	**$469.00**

SMARTMODEM—HAYES

Sophisticated direct-connect auto-answer/auto-dial modem, touch tone or pulse dialing. RS232C interface programmable

IOM-5500A	*Smartmodem 1200*	**$475.00**
IOM-5550A	*1200B for IBM PC*	**$399.95**
IOM-5550A	*Smartmodem 300*	**$199.00**
IOK-1500A	*Hayes Cronograph*	**$199.00**
IOM-1100A	*Micromodem 100*	**$349.00**
IOM-2010A	*Micromodem II*	**$259.00**

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

IOM-5241A	*300 Baud 103 Smart Cat*	**$229.95**
IOM-5251A	*1200 Baud 212/103 Smart Cat*	**$549.95**

J-CAT MODEM—NOVATION

1/5 the size of ordinary modems, Bell 103, manual or auto-answer, automatic answer/orginate, direct connect, built-in self-test, two LEDs and audio beeps provide status information

IOM-5261A	*Novation J-Cat*	**$119.00**

SMART BUY IN MODEMS SIGNALMAN

Direct connect, low cost, high quality, and state-of-the-art features. Includes FREE! subscription to the *Source*

MARK I Universal 300 baud, automatic originate/answer selection, RS232C

IOM-5600A	*300b RS-232*	**$79.95**

MARK II 300 Baud for Atari with 850 intf.

IOM-5660A	*300b for Atari*	**$79.95**

MARK III 300 Baud for TI 99/4A RS-232

IOM-5640A	*300b for TI 99/4A*	**$79.95**

MARK VI 300 Baud for IBM PC, auto-answer, auto-dial, plug-in modem board with full communications software included FREE!

IOM-5630A	*300 Baud IBM card*	**$159.95**

MARK VII Universal 300 baud, auto-answer, auto-dial RS-232 modem

IOM-5610A	*Deluxe RS-232 300b*	**$149.95**

NEW! MARK XII

NEW! MARK XII New Universal 1200 Baud auto-answer, auto-dial modem with all the popular features of the Hayes Smartmodem 1200

IOM-5620A	*1200B deluxe modem*	**$399.95**

NEW! 1200 Baud—US ROBOTICS

Auto-dial, auto-answer designed specifically for use with S-100 systems. 300 or 1200 baud. Full or half duplex, with auto mode and auto speed select; direct connect

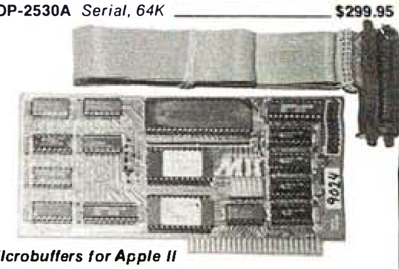
IOM-6000A	*1200 baud modem*	**$399.00**

MICROBUFFER PRACTICAL PERIPHERALS, INC

The stand-alone Microbuffer is installed in-line between virtually any computer and printer. Microbuffer II fits into any Apple expansion slot (except slot zero), the Microbuffer II for the Apple II has on-board firmware to do graphics dumps and control text formatting. Epson Microbuffer mounts easily in the existing auxiliary slot directly inside the Epson

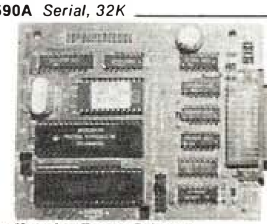
Stand-alone Microbuffers

IOP-2500A	*Parallel, 32K*	**$249.95**
IOP-2510A	*Parallel, 64K*	**$299.95**
IOP-2520A	*Serial, 32K*	**$249.95**
IOP-2530A	*Serial, 64K*	**$299.95**



Microbuffers for Apple II

IOP-2560A	*Parallel, 16K*	**$199.95**
IOP-2570A	*Parallel, 32K*	**$249.95**
IOP-2580A	*Serial, 16K*	**$199.95**
IOP-2590A	*Serial, 32K*	**$249.95**



Microbuffers for Epson Printers

IOP-2540A	*Parallel, 16K*	**$139.95**
IOP-2550A	*Serial, 8K*	**$139.95**

MICROFAZER—QUADRAM

The Microfazer stand-alone printer buffers are available in any configuration of serial or parallel input, with serial or parallel output. All are expandable up to 64K of memory (about 30 pages of 8½ x 11 text); the parallel-to-parallel version is expandable to 512K Copy and pause feature included

Parallel/Parallel

IOP-26008	*8K List 169.00*	**$139.95**
IOP-26032	*32K List 225.00*	**$164.95**
IOP-26128	*128K List 445.00*	**$269.95**

Serial/Parallel

IOP-27008	*8K List 199.00*	**$169.95**

Serial/Serial

IOP-28008	*8K List 199.00*	**$169.95**
IOP-28032	*32K List 220.00*	**$199.95**

Parallel/Serial

IOP-29008	*8K List 199.00*	**$169.95**

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Circle 522 on inquiry card.

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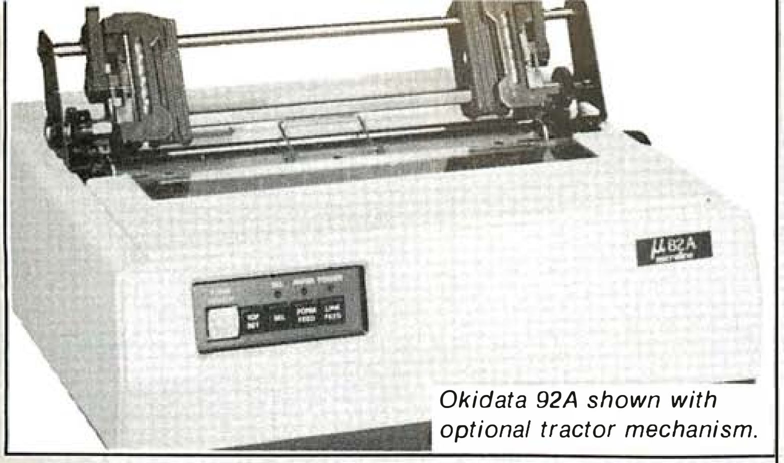

Okidata 92A shown with optional tractor mechanism.

JADE

PRINTERS ON SALE!

Circle 523 on inquiry card.

BEST PRINTER! BEST PRICE!

EPSON

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COMREX CR-II

Best buy in letter quality printers. NEW! from Comrex! full featured letter quality printer. FREE! 5K buffer, logic seeking bi-directional printing, boldface proportional spacing, double-strike, backspace, underline, true super script and sub script, drop in daisy wheel cartridge

PRD-11101	*CR-II parallel*	$495.00
PRD-11102	*CR-II serial*	$589.95
PRA-11100	*Tractor option*	$99.95
PRA-99700	*Cut sheet feeder*	$189.95
PRA-11115	*Keyboard option*	$179.95

PRINTER PALS—FMJ

Desk top printer stand and paper rack. Fits all printers

PRA-99080	*10" printer pal List 39.95*	$29.95
PRA-99100	*15" printer pal List 49.95*	$39.95
PRA-99700	*For letter quality List 69.95*	$49.95

PRINTER CABLES

Standard cables for Epson, Okidata, or any Centronics type printer

WCA-3636A	*Centronics to Centronics*	$24.00
WCA-2536A	*IBM to Centronics*	$32.00
WCA-3634A	*Cent to 34 pin socket*	$24.00
WCA-3635A	*Cent to 34 pin card edge*	$24.00
CNX-136	*Cent connector solder*	$8.95
CNX-236	*Cent conn IDC*	$9.50

UNIVERSAL PRINTER STAND

Free standing deluxe printer stand with chrome plated paper catch. Universal mounting for all 15-inch carriage dot matrix and letter qualtiy printers. List price $129.95 31 lbs

FRN-9000	*Deluxe printer stand*	$69.95

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Continuous form fan fold paper with clean-perf edges on all sides. Finish size 8½ x 11, box of 1000 sheets, 20 lb stock

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380Z By DTC

Based on the same quality mechanism as the Comrex printer, the 380Z contains electronic enhancements that allow it to print at speeds up to 32 CPS. Other features inlude a 48K buffer, proportional spacing, and Diablo 1640/1650/630 compatible protocol. Comes with printwheel, ribbon and users manual. Serial, parallel, and IEEE 488 interfaces standard. One year factory warranty

PRD-11300	*380Z printer*	$1095.00
PRA-11000	*Tractor option*	$159.00
PRA-11200	*Cut sheet feeder*	$699.95
Cable	*Please specify computer*	$43.95

STARWRITER F10

High speed letter quality printer, 40 CPS daisywheel, sleek low-profile design (6-inch high). Extensive built-in word processing functions, up to 15-inch paper width. Uses standard Diablo style printwheels, low noise for office environments. Centronics or serial interface versions available

PRD-22010	*F10/parallel*	$1125.00

SILVER REED EXP-550

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PRD-52002	*Serial, List 995.00*	$775.00
PRA-52000	*Tractor, List 159.95*	$129.00

REGULAR FAN-FOLD PAPER

PRA-91911	*9½ x 11, 1000 sheets*	$11.95
PRA-90511	*14 x 11, green bar 1000*	$14.95

OKIDATA—MICROLINE 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

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PRM-43093	*Oki 93 parallel List 1199.00*	$795.95
PRA-43181	*2K serial board*	$115.00
PRA-43086	*IBM PC ROMS for 92*	$49.95
PRA-43087	*IBM PC ROMS for 93*	$49.95
PRA-43080	*Extra ribbon (2)*	$9.95
PRA-43088	*Tractor for Oki 92*	$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

PRM-43082	*Oki 82 List Price 599.95*	$379.95
PRM-43083	*Oki 83 w/ FREE! tractor*	$625.95
PRM-43084	*Oki 84 parallel List $1399.00*	$925.00
PRM-43085	*Oki 84 serial List 1499.00*	$995.00
PRA-43081	*2K serial board*	$159.95
PRA-43080	*Extra ribbons 82/92, 83/93*	$9.95
PRA-43088	*Tractorfor Oki 82*	$54.95

GEMINI 10X & 15

Star Micronics—up to 120 CPS, full graphics, friction and tractor feed, Epson FX-80 compatible

PRM-66010	*Gemini 10X*	SAVE
PRM-66015	*Gemini 15*	SAVE
PRA-66200	*Serial board, G-10, G-15*	$85.00
PRA-66202	*Serial board, G-10X*	SAVE

NEW! DELTA 10

160 CPS, up to 16K buffer, serial and parallel interfaces, graphics friction and tractor, FX-80 compatible

PRM-66120	Save $150.00

Verbatim®

VERBATIM DATALIFE

Critical ANSI certification diskettes. Warranteed for 5 years, hub rings standard on minidiskettes. All tracks certified on 8-inch diskettes; full surface on 5¼ inch diskettes

5¼" (packaged w/plastic storage box & hub ring)

MMD-5120101	*SS DD soft sector*	$26.50
MMD-5220101	*DS DD soft sector*	$34.95
MMD-5140101	*SS QD soft sector*	$46.50
MMD-5240101	*DS QD soft sector*	$59.95

8" (soft box, no hub ring)

MMD-8110101	*SS SD soft sector*	$29.50
MMD-8120101	*SS DD soft sector*	$38.95
MMD-8220101	*DS DD soft sector*	$47.50

Available only in boxes of ten

VERBATIM VEREX

High quality, sensibly priced, 1 year warranty, exceeds all ANSI specifications. All tracks certified

5¼"

MMD-5110100	*SS, DD soft sector*	$24.95
MMD-5110110	*Apple compatible*	$24.95

8"

MMD-8110100	*SS SD soft sector*	$27.95
MMD-8220100	*DS DD soft sector*	$38.95

Available only in boxes of ten

VERBATIM OPTIMA

BETTER THAN DYSAN! Warranted for 17 years. Over 70 million revolutions average life. All Optima diskettes are full-service diskettes, extra heavy-duty jacket material provides superior protection and longer life

5¼" - Soft Sector

MMD-5120102	*SS DD*	$47.95
MMD-5220102	*DS DD*	$59.95

8" - Soft Sector

MMD-8120102	*SS DD*	$59.95
MMD-8220102	*DS DD*	$69.95

Available only in boxes of ten

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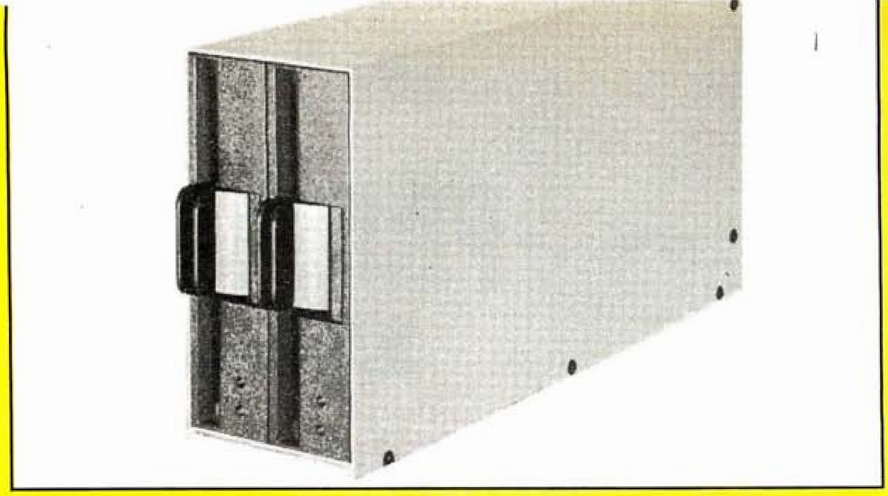

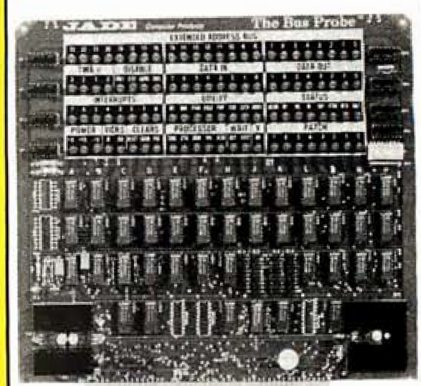

8 inch DISK DRIVES

SIEMENS FDD 100-8 Single sided, double density
MSF-201120 ______ **$179.00** ea 2 for **$175.00** ea

SHUGART SA 801R Single sided, double density
MSF-10801R ______ **$355.00 ea** 2 for **$349.00 ea**

SHUGART SA-851R Double sided, double density
MSF-10851R ______ **$459.00** ea 2 for **$455.00** ea

QUME DT-8 Double sided, double density
MSF-750080 ______ **$479.00 ea 2 for $459.00 ea**

TANDON TM 848-1 SS DD thin-line
MSF-558481 ______ **$369.00 ea** 2 for **$359.00 ea**

TANDON TM 848-2 DS DD thin-line
MSF-558482 ______ **$439.00 ea** 2 for **$435.00 ea**

NEC FD1165 DS DD thin-line
MSF-851165 ______ **$450.00 ea** 2 for **$440.00 ea**

NEC FD1164 SS DD thin-line
MSF-851164 ______ **$360.00 ea** 2 for **$350.00 ea**

5¼ inch DISK DRIVES

TANDON TM 100-1 SS DD 48 TPI
MSM-551001 ______ **$225.00 ea** 2 for **$195.00 ea**

SHUGART SA 400L SS DD 40 track
MSM-104000 ______ **$209.00 ea** 2 for **$199.95 ea**

TANDON TM 100-2 DS DD 48 TPI
MSM-551002 ______ **$229.00 ea** 2 for **$225.00 ea**

MPI B52 DS DD 48 TPI can be substituted for CDC
MSM-155200 ______ **$275.00 ea** 2 for **$270.00 ea**

MPI B51 SS DD 48 TPI
MSM-155100 ______ **$209.00 ea** 2 for **$199.00 ea**

MPI B91 Single sided, Quad Density 96 TPI
MSM-155300 ______ **$285.00 ea** 2 for **$275.00 ea**

MPI B92 Double sided Quad density 96 TPI
MSM-155400 ______ **$400.00 ea** 2 for **$390.00 ea**

5¼" CABINETS/POWER SUPPLY

END-000216 *Single cab w/power supply* ______ **$69.95**
END-000226 *Dual cab w/power supply* ______ **$85.00**

S-100 CPU SPECIAL!

SSM CB-2, 2/4MHz Z-80A CPU, 2 EPROM sockets, extended address lines, all lines buffered, use with or without front panel. HURRY! limited quantity.

CPU-30300K *Kit (List Price 299.95)* ______ **$159.95**
CPU-30300A *A & T (List Price)* ______ **$199.95**

DUAL SLIMLINE SUB-SYSTEMS

From JADE. Handsome vertical cabinet with scratch resistant baked enamel finish, proportionally balanced air flow system, quiet cooling fan, rugged dual drive power supply, power cables, power switch, line cord, fuse holder, cooling fan, all necessary hardware to mount two 8-inch slimline disk drives. Does not include signal cable

Dual 8-Inch Slimline Cabinet

END-000820 *Bare cabinet* ______ **$59.95**
END-000822 *A & T w/o drives* ______ **$164.95**

Dual 8-Inch Slimline Sub-systems

END-000843 *Kit w/2 SS DD drives* ______ **$869.00**
END-000844 *A & T w/2 SS DD drives* ______ **$879.00**
END-000845 *Kit w/2 DS DD drives* ______ **$1060.00**
END-000846 *A & T w/2 DS DD drives* ______ **$1099.00**

DISK SUB-SYSTEMS JADE

Handsome metal cabinet with proportionally balanced air flow system, rugged dual drive power cable kit, power switch, line cord, fuse holder, cooling fan, nevermar rubber feet, all necessary hardware to mount two 8-inch disk drives, power supply, and fan, does not include signal cable

Dual 8" Sub-Assembly Cabinet

END-000420 *Bare cabinet* ______ **$49.95**
END-000421 *Cabinet kit* ______ **$199.95**
END-000431 *A & T* ______ **$249.95**

8" Sub-Systems—Singal Sided, Double Density

END-000423 *Kit w/2 Siemens FD100-8Ds* ______ **$579.00**
END-000423 *A & T w/2 Siemens FD100-8Ds* **$595.00**
END-000433 *Kit w/2 Shugart SA-801Rs* ______ **$939.00**
END-000434 *A & T w/2 Shugart SA-801Rs* **$969.00**

8" Sub-Systems—Double Sided, Double Density

END-000426 *Kit w/2 Qume DT-8s* ______ **$1229.00**
END-000427 *A & T w/2 Qume DT-8s* ______ **$1249.00**
END-000436 *Kit w/2 Shugart SA-851 Rs* ______ **$1199.00**
END-000434 *A & T w/2 Shugart SA-851 Rs* **$1219.00**

DISK DRIVE POWER SUPPLY

Sufficient current to power up to three 8-inch disk drives

PSD-206A *List price $149.00* ______ **$89.95**

RAM BOARDS ON SALE!

64K EXPANDORAM II

Our all time best selling RAM board!

MEM-64633A *A & T List Price 799.95* ______ **$295.00**
ONLY $250.00 each For 4 or more

64K DYNAMIC RAM BARE BOARD

Design your own S-100 64K RAM board using inexpensive 4116 chips and TTL chips. Includes low-noise, four layer PC board and assembly manual with theory of operation. HURRY! limited quantity and at this price we can not support or guarantee these boards

MEM-99730B *Bare board* ______ **$24.95**
ONLY $15.00 each for 4 or more

THE BUS PROBE

Best selling inexpensive S-100 diagnostic analyzer

TSX-200B *Bare board* ______ **$59.95**
TSX-200K *Kit* ______ **$179.95**
TSX-200A *A & T* ______ **$199.95**

I/O-4 SSM MICROCOMPUTER

Two serial I/O ports plus two parallel I/O ports

IOI-1010A *A & T* ______ **$245.00**

I/O-5 SSM MICROCOMPUTER

Two serial and three parallel ports, 110-19.2K baud

IOI-1015A *A & T* ______ **$289.00**

INTERFACER 4 COMPUPRO

Three serial, one parallel, one centronics parallel

IOI-1840A *A & T* ______ **$389.95**
IOI-1830C *CSC* ______ **$495.00**

I/O-8 SD SYSTEMS

Full compliance with IEEE 696 standards, operates as a Bus Slave. Available with 8 Async parts of 4 Async and 4 Async ports, up to 1 Megabit/sec in synchronous mode. Real time clock with battery back-up. One year factory warranty

IOI-1510A *8 Async ports* ______ **$589.95**
IOI-1520A *4 Sync/4 Async* ______ **$669.95**

ULTRA-VIOLET EPROM ERASERS

Inexpensive erasers for industry or home

XME-3100 *Spectronics w/o timer* ______ **$69.50**
XME-3101 *Spectronics with timer* ______ **$94.95**
XME-3200 *Logical Devices* ______ **$49.95**

PB-1 SSM MICROCOMPUTER

2708, 2716 EPROM board with on-board programmer

MEM-99510A *A & T w/manual* ______ **$219.00**

PROM-100 SD SYSTEMS

2708, 2716, 2732 EPROM programmer with software

MEM-99520A *A & T with software* ______ **$219.95**

DISKETTE STORAGE BOXES

Clear plexiglass storage boxes for up to 75 diskettes

MMA-505 *Holds 75 5¼" diskettes* ______ **$19.95**
MMA-508 *Holds 50 8" diskettes* ______ **$29.95**

SINGLE BOARD COMPUTER

NEW! ADC SUPER SIX

First 6 MHz S-100 single board computer to support banked CP/M 3.0 featuring 128K RAM, 6 MHz Z-80B, DMA cont, DART, PIO, CTC, double-density disk controller, up to 4K of Eprom, IEEE 696 compatible, 6 MHz super slave boards also available for networks

CPC-30860A *64K super six* ______ **$749.95**
CPC-30862A *128K super six* ______ **$799.95**
SFC-52502000F *CP/M 3.0 for super six* ______ **$349.95**
SFC-55622000F *Turbo-DOS single user* ______ **$249.95**

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(800) 262-1710

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(213) 973-7707 Circle 524 on inquiry card.

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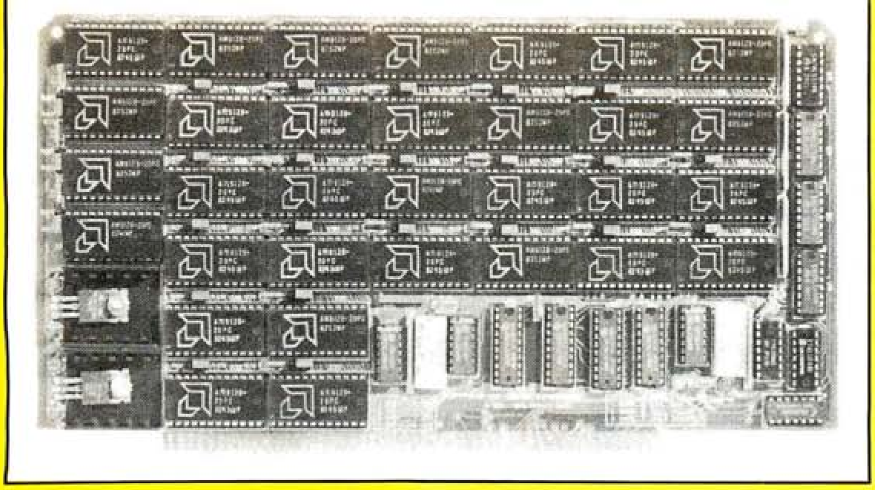

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S-100 BOARDS ON SALE!

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THE BIG Z—JADE

2 or 4 MHz switchable Z-80 CPU board with serial I/O accommodates 2708, 2716, or 2732 EPROM, baud rates from 75 to 9600

CPU-30200B	*Bare board w/manual*	$35.00
CPU-30201K	*Kit w/manual*	$179.95
CPU-30201A	*A & T*	$199.00

SBC-200 SD SYSTEMS

4 MHz Z-80A CPU with serial and parallel I/O, 1K RAM 8K ROM space, monitor PROM included

CPC-30200A	*A & T*	$298.95

SBC 300 SD SYSTEMS

Self-contained S-100 Z80 microcomputer, 4/6 MHz, 64K RAM with parity; 2 to 16K of PROM, 24 bit addressing, fully complies with IEEE 696 standards. It can function as a permanent Bus Master or as Slave. Two fully programmable serial channels with handshaking; full SASI port. One year factory warranty

CPC-30304A	*SBC 300, 4 MHz, A & T*	$619.95
CPC-30306A	*SBC 300, 6 MHz, A & T*	$689.95

CPU-Z COMPUPRO

2 or 4 MHz Z80A CPU, 24 bit addressing

CPU-30500A	*2/4 MHz A & T*	$279.95
CPU-30500C	*3/6 MHz CSC*	$374.95

8085/8088 COMPUPRO

Both 8 and 16 bit CPUs standard 8 bit S-100 bus, up to 8 MHz, accesses 16 MegaBytes of memory

CPU-20510A	*6 MHz A & T*	$389.95
CPU-20510C	*6/8 MHz CSC*	$497.95

ISO BUS—JADE COMPUTER

Silent, simple and on SALE! A better motherboard

19 MHz 6 Slot (5¼" x 8⅝")

MBS-061B	*Bare board*	$22.95
MBS-061K	*Kit*	$39.95
MBS-061A	*A & T*	$49.95

10 MHz 12 Slot (9¾" x 8⅝")

MBS-121B	*Bare board*	$34.95
MBS-121K	*Kit*	$69.95
MBS-121A	*A & T*	$89.95

6MHz 18 Slot (14½" x 8⅝")

MBS-181B	*Bare board*	$54.95
MBS-181K	*Kit*	$99.95
MBS-181A	*A & T*	$139.95

BEST S-100 MODEM BOARD!

Auto-dial, auto-answer designed specifically for use with S100 systems. 300 or 1200 baud. Full of half duplex, with auto mode and auto speed select; direct connect

IOM-6000A	*1200 baud modem*	$399.00

DOUBLE D—JADE COMPUTER

High reliability, double density disk controller with on-board Z-80A, auxilliary printer port. IEEE S-100 can function in multi-user interrupt driven bus

IOD-1200B	*Bare board & hdwr man*	$59.95
IOD-1200K	*Kit w/hdwr & sftwr man*	$299.95
IOD-1200A	*A & T w/hdwr & sftwr man*	$325.00
SFC-59002001F	*CP/M 2.2 with Double D*	$99.95

2422 DISK CONTROLLER—CCS

5¼" or 8" double density disk controller with on-board boot loader ROM, FREE! CP/M 2.2 and manual set

IOD-1300A	*A & T with CP/M 2.2*	$338.00

VERSAFLOPPY II—SD SYSTEMS

Double density disk controller for any combination of 5¼" and 8" single or double sided, analog phase-locked loop data seperator, vectored interrupts. CP/M 2.2 & Oasis compatible control/diagnostic software PROM included

IOD-1160A	*A & T with PROM*	$344.95
SFC-5509047F	*CP/M 3.0 with VF-II*	$80.00

VERSAFLOPPY II/696

Fully compatible with IEEE 696 standards, phase-locked loop data seperator, CRC error checking. Reads/writes IBM 3740 and system 34 formats, concurrent support of any combination of 4 5¼" or 8" drives. Single or double sided drives supported single or double density. One year factory warranty

IOD-1170A	*Versafloppy II/696 A & T*	$349.95
SFC-55009157F	*8" banked CP/M 3.0**	**$75.00
SFC-55009157M	*5¼" banked CP/M 3.0**	**$75.00
SFC-55009159F	*8" unbanked CP/M 3.0**	**$75.00
SFC-55009159M	*5¼" unbanked CP/M 3.0**	**$75.00

*configured for Versafloppy II/696 & SBC 300
**price $75.00 if ordered with Versafloppy II, price if ordered separtely is $199.95

VERSAFLOPPY III—SD SYSTEMS

Winchester and floppy controller in a single board! Full compliance with IEEE 696 standards, controls up to three floppy drives and three 5¼" Winchester drives. Data may be transfered under DMA or programmed I/O control. One year factory warranty

IOD-1180A	*Versafloppy III A & T*	$759.95
SFC-55009257F	*8" banked CP/M 3.0**	**$129.00
SFC-55009257M	*5¼" banked CP/M 3.0**	**$129.00
SFC-55009259F	*8" unbanked CP/M 3.0**	**$129.00
SFC-55009259M	*5¼" unbanked CP/M 3.0**	**$129.00

*configured for Versafloppy III & SBC 300
**price $129.00 if ordered with Versafloppy III, price if ordered separately $199.95

HIGH SPEED S-100 VIDEO SPECIAL!

Memory mapped S-100 video board with graphics, 64K x 16 high speed screen update, full upper/lower ASCII character set, selectable video attributes. HURRY! quantity limited

IOV-1051A	*List Price 299.95*	$99.95

THE ULTIMATE IN S-100 RAM BOARDS! JADE'S NEW 256K STATIC PERMA-RAM

NEW!

SEE PAGE 8 FOR DETAILS!

64 STATIC RAM JADE COMPUTER

Uses new 2K x 8 static RAMs, fully supports IEEE 696 24 bit extended addressing, 200ns RAMs, lower 32K or entire board phantomable, 2716 EPROMs may be subbed for RAMs, any 2K segment of upper 8K may be disabled, low power typically less than 500ma

MEM-99152B	*Bare board*	$49.95
MEM-99152K	*Kit less RAM*	$89.95
MEM-32152K	*32K kit*	$169.00
MEM-56152K	*56K kit*	$225.00
MEM-64152K	*64K kit*	$265.00
Assembled & Tested		add $30.00

EXPANDORAM III

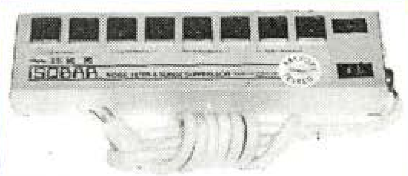
SD Sysyems ExpandoRAM III is a high density S-100 memory board utilizing the new 64K x 1 dynamic RAM chips. It allows memory sizes of 64K, 128K or 256K all on a single S-100 board

MEM-65064A	*64K*	$398.95
MEM-65128A	*128K*	$464.95
MEM-65192A	*192K*	$524.95
MEM-65256A	*256K*	$589.95

EXPANDORAM IV—SD SYSTEMS

State-of-the-art; full compliance with IEEE 696. 256K using 64K dynamic RAM chips. Up to 1024K using 256K dynamic RAM chips, parity check, error detection and correction optional. Supports both 8 and 16 bit data transfers. One year factory warranty

MEM-66256	*ExpandoRAM IV w/parity*	$975.95
MEM-67256	*ExpandoRAM IV w/EDC*	$1675.95



ISOBAR

The ISOBAR looks like a standard multi-outlet power strip, but contains surge suppression circuitry and built-in noise filters, plus a 15 amp circuit breaker

EME-115105	*4 receptacle*	$59.95
EME-115100	*8 recptacle*	$69.95

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ON THE WORLD'S BEST SELLING PRINTERS
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RX-80FT
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We accept cash, checks, credit cards, or purchase orders from qualified firms and institutions.
Minimum prepaid order $15.00 California residents add 6½% tax. Export customers outside the US or Canada please add 10% to all prices. **Prices and availibility subject to change without notice.** Shipping and handling charges via UPS Ground 50¢/lb. UPS Air $1.00/lb. **minimum charge $3.00**

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7400

7400	.19	74125	.39
7401	.22	74126	.44
7402	.22	74128	.59
7403	.22	74132	.69
7404	.22	74136	.75
7405	.23	74139	.95
7406	2.35	74141	.79
7407	2.35	74142	2.95
7408	.26	74143	2.95
7409	.23	74144	2.95
7410	.22	74145	.62
7411	.29	74147	1.95
7412	.29	74148	1.20
7413	.39	74150	1.09
7414	.59	74151	.67
746	.29	74152	.67
7417	.29	74153	.67
7420	.22	74154	1.19
7421	.35	74155	.78
7422	.29	74156	.78
7423	.29	74157	.69
7425	.29	74158	1.65
7426	.29	74159	2.49
7427	.25	74160	.88
7429	.45	74161	.88
7430	.23	74162	.89
7432	.29	74163	.87
7437	.25	74164	.87
7438	.29	74165	.87
7439	.29	74166	1.20
7440	.19	74167	1.95
7441	.79	74170	1.69
7442	.57	74172	4.75
7443	.95	74173	.79
7444	.95	74174	.89
7445	.79	74175	.85
7448	.79	74176	.75
7447	.65	74177	.75
7448	.79	74179	1.34
7450	.19	74180	.75
7451	.19	74181	1.75
7453	.19	74182	.75
7454	.19	74184	2.25
7459	.25	74185	2.25
7460	.23	74186	9.95
7470	.29	74188	3.90
7472	.29	74190	1.15
7473	.34	74191	1.15
7474	.34	74192	.85
7475	.38	74193	.85
7476	.34	74194	.85
7479	4.60	74195	.68
7480	.49	74196	.85
7482	.95	74197	.85
7483	.55	74198	1.39
7485	.65	74199	1.39
7486	.35	74221	1.19
7489	1.75	74251	.95
7490	.39	74273	1.05
7491	.57	74276	1.89
7492	.45	74279	.75
7493	.45	74823	1.40
7494	.69	74284	3.90
7495	.65	74285	3.90
7496	.69	74290	1.25
7497	2.90	74298	.95
74100	2.90	74365	.68
74107	.32	74366	.68
74109	.37	74367	.68
74116	1.95	74368	.68
74121	.29	74390	1.45
74122	.39	74393	1.90
74123	.59	74490	1.90

74LS00

74LS00	26	74LS162	1 05
74LS01	28	74LS163	1 05
74LS02	28	74LS164	1 19
74LS03	.28	74LS165	89
74LS04	35	74LS166	2 48
74LS05	28	74LS168	1 15
74LS08	28	74LS169	1 15
74LS09	35	74LS170	1 99
74LS10	28	74LS173	89
74LS11	39	74LS174	89
74LS12	33	74LS175	89
74LS13	47	74LS181	2 20
74LS14	95	74LS190	1 15
74LS15	33	74LS191	1 15
74LS20	26	74LS192	98
74LS21	33	74LS193	98
74LS22	33	74LS194	1 15
74LS26	33	74LS195	95
74LS27	33	74LS196	89
74LS28	.33	74LS197	89
74LS30	26	74LS221	1 15
74LS32	33	74LS240	1.69
74LS33	55	74LS242	1 69
74LS37	45	74LS243	1 69
74LS38	39	74LS244	1 49
74LS40	26	74LS245	2 20
74LS42	79	74LS247	1 10
74LS47	79	74LS248	1 10
74LS48	95	74LS249	1 19
74LS51	26	74LS251	1 40
74LS54	29	74LS253	1 40
74LS55	29	74LS257	85
74LS73	45	74LS258	98
74LS74	1.42	74LS259	2 95
74LS75	59	74LS260	65
74LS76	45	74LS261	2 49
74LS78	45	74LS266	59
74LS83A	79	74LS273	1 75
74LS85	1 19	74LS275	4 40
74LS86	45	74LS279	59
74LS90	57	74LS283	99
74LS92	75	74LS290	99
74LS93	75	74LS293	99
74LS95	88	74LS295	1 10
74LS96	98	74LS298	1 19
74LS107	45	74LS324	1 75
74LS109	45	74LS347	1 95
74LS113	43	74LS348	1 95
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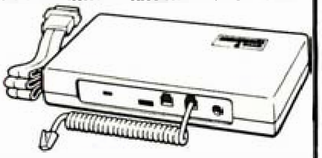

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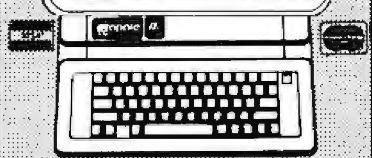

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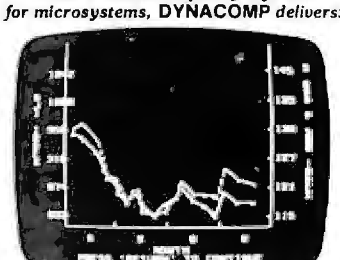

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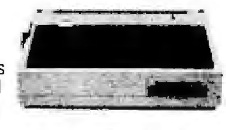

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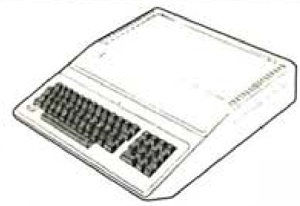

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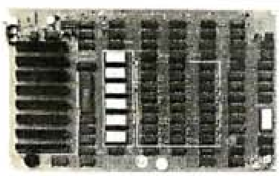

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74S09	14	.39	74S139	16	.89	74S260	14	1.19
74S10	14	.35	74S140	14	.55	74S280	14	1.95
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CD4009	16	.59	CD4046	16	1.19	CD4511	16	1.19
CD4010	16	.59	CD4047	14	1.29	CD4512	16	1.19
CD4011	14	.29	CD4048	16	.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
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CD4025	14	.23	CD4072	14	.29	CD4723	16	1.19
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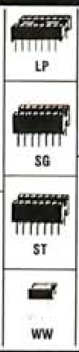

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7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	11.95
7224IPL	40	LCD 4½ Digit Up Counter DRI	10.95
7226AIJL	40	8 Digit Univ. Counter	2995
7226AEV/Kit*	40	5 Function Counter Chip, XTL	74.95

30009 1983 INTERSIL Data Book (1356 p.) $9.95

NEW PRODUCT! 74HC High Speed CMOS

74HC00	14	.59	74HC139	16	.99	74HC251	16	.89
74HC02	14	.59	74HC147	16	1.19	74HC253	16	.99
74HC03	14	.75	74HC151	16	.89	74HC257	16	.89
74HC04	14	.59	74HC153	16	.99	74HC259	16	1.49
74HCU04	14	.65	74HC154	24	2.49	74HC266	14	1.19
74HC08	14	.59	74HC157	16	.89	74HC273	20	2.89
74HC10	14	.59	74HC158	16	.89	74HC280	14	3.95
74HC11	14	.59	74HC160	16	1.29	74HC373	20	2.39
74HC14	14	.85	74HC161	16	1.29	74HC374	20	2.39
74HC20	14	.59	74HC162	16	1.29	74HC390	16	1.49
74HC27	14	.59	74HC163	16	1.29	74HC393	14	1.49
74HC32	14	.75	74HC164	14	1.29	74HC533	20	2.39
74HC42	16	.99	74HC165	16	2.79	74HC534	20	2.39
74HC51	14	.75	74HC173	16	1.69	74HC595	16	3.95
74HC58	14	.75	74HC174	16	.99	74HC688	20	3.19
74HC73	14	.79	74HC175	16	.99	74HC4002	14	.59
74HC74	14	.79	74HC192	16	1.39	74HC4017	16	2.19
74HC75	16	.89	74HC193	16	1.39	74HC4020	16	1.39
74HC76	16	.79	74HC194	16	1.09	74HC4024	14	1.59
74HC85	16	1.59	74HC195	16	1.09	74HC4040	16	1.39
74HC86	14	.69	74HC237	16	2.95	74HC4060	16	1.39
74HC107	14	.79	74HC240	20	1.95	74HC4075	14	.59
74HC109	16	.79	74HC241	20	1.95	74HC4078	14	.69
74HC112	16	.79	74HC242	14	1.95	74HC4511	16	2.69
74HC113	14	.79	74HC243	14	1.95	74HC4514	24	3.79
74HC132	14	.99	74HC244	20	1.95	74HC4538	16	2.39
74HC137	16	1.95	74HC245	20	2.49	74HC4543	16	3.49
74HC138	16	1.09						

74HCU04 is unbuffered. All others are buffered.

NEW Programmable Array Logic (PALS)

Part No.	**Pins	Function	Price
PAL10H8	20	Octal 10-Input AND-OR Gate Array (High Output)	$3.95
PAL12H6	20	Hex 12-Input AND-OR Gate Array (High Output)	3.95
PAL14H4	20	Quad 14-Input AND-OR Gate Array (High Output)	3.95
PAL10L8	20	Octal 10-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL12L6	20	Hex 12-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL14L4	20	Quad 14-Input AND-OR-Invert Gate Array (Low Output)	3.95
PAL16L8	20	Octal 16-Input AND-OR-Invert Gate Array	9.95
PAL16R8	20	Octal 16-Input Register AND-OR Gate Array	7.95
PAL16R6	20	Hex 16-Input Register AND-OR Gate Array	7.95
PAL16R4	20	Quad 16-Input Register AND-OR Gate Array	7.95

30012 1982 NATIONAL PAL Data Book (176 p.) .. $5.95

74C—C/MOS

74C00	14	.35	74C95	14	1.39	74C221	16	1.95
74C02	14	.35	74C107	14	.89	74C240	20	1.95
74C04	14	.29	74C151	16	2.49	74C244	20	1.95
74C08	14	.35	74C154	24	3.49	74C373	20	2.49
74C10	14	.35	74C157	16	2.25	74C374	20	2.49
74C14	14	.69	74C160	16	1.19	74C901	14	.59
74C20	14	.35	74C161	16	1.19	74C903	14	.59
74C30	14	.35	74C162	16	1.19	74C906	14	.59
74C32	14	.39	74C163	16	1.19	74C911	28	8.95
74C42	16	1.39	74C164	14	1.49	74C912	28	8.95
74C48	16	1.95	74C173	16	1.19	74C915	18	1.19
74C73	14	.79	74C174	16	1.19	74C917	28	8.95
74C74	14	.69	74C175	16	1.19	74C922	18	4.49
74C85	16	1.95	74C192	16	1.49	74C923	20	4.95
74C86	14	.39	74C193	16	1.69	74C925	16	5.95
74C89	16	5.95	74C195	16	1.39	74C926	18	5.95
74C90	14	1.19				80C95	16	.69
74C93	14	1.19				80C97	16	.69

LINEAR

TL071CP	8	.79	LM340T-5		.79	LM723N	14	.55
TL072CP	8	1.39	LM340T-12		.79	LM733N	14	1.00
TL074CN	14	1.95	LM340T-15		.79	LM739N	14	1.95
TL081CP	8	.59	LF347N	14	1.49	LM741CN	8	.35
TL082CP	8	1.19	LM348N	14	.99	LM747N	14	.69
TL084CN	14	1.95	LM350K		4.95	LM748N	8	.59
LM301CN	8	.35	LF355N	8	1.10	LM1310N	14	1.49
LM302H		1.95	LF356N	8	1.10	LM1458CN	8	.59
LM304H		1.95	LM370N	14	4.49	LM1488N	14	.89
LM305H		.99	LM373N	14	3.95	LM1489N	14	.89
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LM308CN	8	.69	LM380N	14	.89	LM1800N	16	2.49
LM309K		1.25	LM381N	14	1.79	LM1871N	18	2.95
LM310CN	8	1.75	LM382N	14	1.39	LM1872N	18	3.25
LM311CN	8	.69	LM384N	14	1.79	LM1877N-9	14	2.49
LM312H		2.49	LM386N-3	8	.89	LM1889N	18	2.25
LM317T		1.19	TL494CN	16	3.95	LM1896N	14	2.95
LM317K		3.95	TL496CP	8	1.19	LM2002T		1.95
LM318CN	8	1.95	NE531V	8	2.95	LM3189N	16	1.59
LM319N	14	1.95	NE544N	14	2.95	LM3900N	14	.59
LM320K-5		1.35	NE550A	14	1.95	LM3905CN	8	1.19
LM320K-12		1.35	NE555V	8	.35	LM3909N	8	.99
LM320K-15		1.35	LM556N	14	.69	LM3914N	18	2.95
LM320T-5		.89	NE564N	16	2.95	LM3915N	18	2.95
LM320T-12		.89	LM565N	14	1.19	LM3916N	18	2.95
LM320T-15		.89	LM566CN	8	1.49	RC4136N	14	1.25
LM323K		5.95	LM567V	8	.99	RC4151NB	8	1.95
LM324N	14	.59	NE570N	16	3.95	RC4194TK		4.49
LM337T		1.95	LM703CN	8	1.19	NE5532	8	2.49
LM338K		6.95	LM709N	14	.49	NE5534	8	1.69
LM339N	14	.69	LM710N	14	.69	ICL8038B	14	3.95
LM340K-5		1.35	LM711N	14	.79	LM13080N	8	1.19
LM340K-12		1.35				LM13600N	16	1.19
LM340K-15		1.35						

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30003 1982 Nat. Linear Data Book (1952 pgs.) . $11.95

Circle 244 on inquiry card.

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8214	3.80
8216	1.70
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8226	1.75
8228	3.45
8237	18.95
8237-5	20.95
8238	4.45
8243	4.40
8250	9.95
8251	4.45
8253	6.90
8253-5	7.90
8255	4.45
8255-5	5.20
8257	7.90
8257-5	8.90
8259	6.85
8259-5	7.45
8271	38.95
8272	38.95
8275	28.95
8279	8.90
8279-5	9.00
8272	6.45
8283	6.45
8284	5.45
8286	6.45
8287	6.45
8288	24.00
8289	48.95

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Z80-CPU	3.90
Z80-CTC	4.45
Z80-DART	9.95
Z80-DMA	13.95
Z80-PIO	4.45
Z80-SIO/0	15.95
Z80-SIO/1	15.95
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Z80A-CPU	4.90
Z80A-CTC	4.90
Z80A-DART	10.95
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6.0 Mhz

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Z80B-CTC	12.95
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ZILOG

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Z8671	38.95

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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
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UPD765	38.95
MB8876	28.95
MB8877	33.95
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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
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IM6403	8.90
INS8250	9.95

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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	7905K	1.44
7805K	1.34	7912K	1.44
7812K	1.34	7915K	1.44
7815K	1.34	7924K	1.44
7824K	1.34	79L05	.78
7PL05	.68	79L12	.78
78L12	.68	79L15	.78
78L15	.68	LM323K	4.90
78H05K	9.90	UA78S40	1.90
78H12K	9.90		

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 pinST	.12	.10
14 pinST	.14	.11
16 pinST	.16	.12
18 pin ST	.19	.17
20pinST	.28	.26
22pinST	.29	.26
24 pin ST	.29	.26
28 pin ST	.39	.31
40pinST	.48	.38
64pinST	4.20	call

ST = SOLDERTAIL

8 pin WW	.58	.48
14 pinWW	.68	.51
16 pin WW	.68	.57
18 pinWW	.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	6.70	call
24 pin ZIF	9.90	call
28 pin ZIF	9.95	call

ZIF = TEXTOOL (Zero Insertion Force)

CRYSTALS

32.768khz	1.90
1.0 mhz	4.90
1.8432	4.90
2.0	3.90
2.097152	3.90
2.4576	3.90
3.2768	3.90
3.579535	3.90
4.0	3.90
5.0	3.90
5.0688	3.90
5.185	3.90
5.7143	3.90
6.0	3.90
6.144	3.90
6.5536	3.90
8.0	3.90
10.0	3.90
10.738635	3.90
14.31818	3.90
15.0	3.90
16.0	3.90
17.430	3.90
18.0	3.90
18.432	3.90
20.0	3.90
22.1184	3.90
32.0	3.90

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50 PCS.	1.25
100 PCS.	2.00
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Power Supply	84.95
RF Mod	24.95
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Z80 Card	129.95
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Paddle Adapple	24.95
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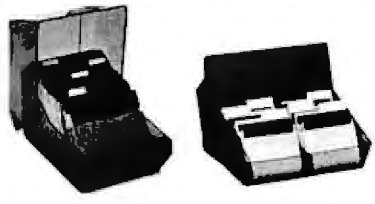

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20 M

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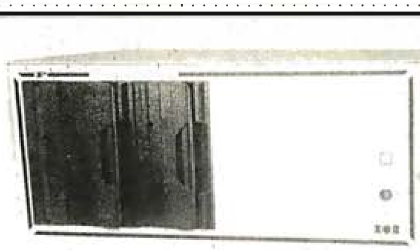

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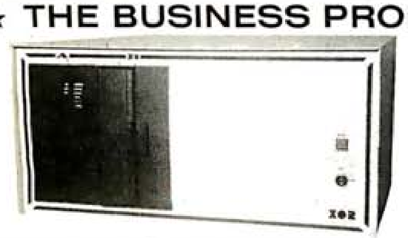

2 User Hard Disk System

A twenty meg hard disk (2 platter) with a DS/DD 1.2 Meg floppy disk makes this a perfect system for a small business. Two user allows dual access to the system files with each station up to 100 feet apart. Includes above software. Full one year parts and labor. #S-1000-6 $5495.00

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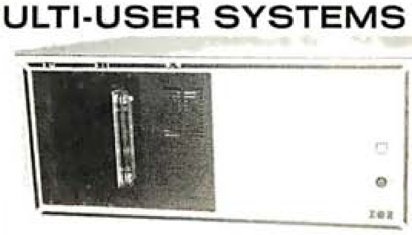

7 User 85 Meg w/17 Meg Backup

Now it's available, the automated business system to run even those large companies! 7 separate users tied into one professional host system. If 85 Meg isn't enough, we can put together as much as three hundred and forty megabytes! Full 17 Meg tape backup insures archival storage of valuable data #S-1000-00 $9595.00

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MEMOREX
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VERBATIM	525-01	525-10	NA	26.50
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DYSAN	3740/D	57.50

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SCOTCH	740-32	29.50

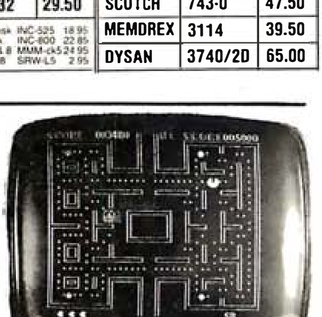
Double side Double Density		
SCOTCH	743-0	47.50
MEMOREX	3114	39.50
DYSAN	3740/2D	65.00

Flip & File 5¼" stores 50 disk	INC-525	18.95
Flip & File 8" stores 50 disk	INC-800	22.85
Scotch head clean kit 5¼ & 8	MMM-ck5	24.95
Plastic library cases 5¼ & 8	SRW-LS	2.95

23" COMPOSITE MONITOR

$159

Ideal monitor for classroom demonstrations.

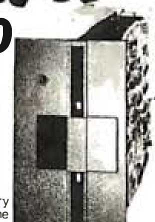


Ever try gathering a classroom of students around a 12" monitor? Here is your opportunity to purchase a 23" high resolution monitor at a reasonable price.
These units accept standard composit video signals generated by most personal computers including the Apple and IBM. Attach it your computer and in second you are shooting down Klingons in wide screen video.
MOT-BW23 35 Lbs. Monitors are open frame and for safety should be enclosed. Wood grained enclosure for above $35.00 additional CAL-ENC23 15 Lbs.

SPECIAL

Shugart 410

$129



These Shugart 410 5¼" disk drives are all factory fresh 1983 production, recently purchased from the Four Phase Division of the Motorola Corporation.
These disk drives are single sided 80 track (96 TPI) suitable for use with the Radio Shack Model 1 and Model 3. Or any other application that can support an 80 track second drive such as the IBM/PC. The 410 is full height and functionally the same as the Tandon TM 100-3. Complete with power connector and installation manual.
When these Shugart 410's are liquidated the price will revert to our regular price of $249. SHU-SA410

MEMORY

16K DYNAMIC	2732 EPROM
1.95	4.95
4116 150ns.	450ns.
64K DYNAMIC	**16K STATIC**
5.95	4.95
4164 150ns.	6116 200ns.

2764 EPROM SALE $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	5.75	5.55
41256 150ns 256K	ICM-41256150	Available Jan 84		

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 6	ICM-6116200	4.50	4.75	4.55
6116 P3 150ns 2K x 8	ICM-6116150	4.95	4.75	4.60
6167/2167 100ns 16K x 1 (20 pin)	ICM-6167100	7.95	7.50	7.90

EPROMS

2708 450ns 1K x 8	ICE-2708	4.95	4.75	4.55
2716 450ns 2K x 8	ICE-2716	4.95	4.75	4.55
2716TMS 450ns Tri-voltage	ICE-2716TMS	7.95	7.65	7.25
2732 450ns 4K x 8	ICE-2732	4.95	4.75	4.55
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	5.95	5.65	4.97
27128 350ns 16K x 8	ICE-27128	19.95	18.75	17.35

CONNECTORS

GOLD S-100 EDGE CARD CONNECTORS

	catalog	each	10-99	100+
Imsais/t 250	CNE-IMS	2.95	2.50	2.19
Sullins Hi/Rel	CNE-H100	4.19	3.85	3.17
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" CENTERED GECARD CONNECTORS

22/44 Eyelet	CNE-44E	2.50	2.15	1.95
43/72 Molo.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
57-30360 female	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	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	3.10	2.90
DA15S female	CND-15S	3.25	3.10	2.90
DA15 hood	CND-15H	1.60	1.35	1.30
DB25P male	CND-25P	2.50	1.95	1.65
DB25S female	CND-25S	3.35	2.75	1.95
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	.99	.69	.42

AMPHENOL / CENTRONICS TYPE

57-30360 36 P	CNC-36P	7.95	6.35	4.90
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 recpt	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 similiar 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. 60Hz. 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
SHUGART 810 Half Height	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
SHUGART 860 Half Height	495	485	475
QUME 842 "QUME TRACK 8"	459	459	449
TANDON 848E-2 Half Height	485	475	465
REMEX RFD-4000	219	219	209
MITSUBISHI M2894-63	379	375	369
MITSUBISHI M2896-63 Half Ht.	459	449	409

Five Inch Single Sided Drives

SHUGART SA400L	235	229	225
SHUGART SA410 96TPI/80 Trk.	129	119	call
SHUGART SA200 ⅔ Height	169	159	149
TANDON TM100-1	189	179	175
TANDDN TM50-1 Half Height	465	450	439
TEAC FD-55A Half Height	465	459	445

Five Inch Double Sided Drives

SHUGART SA450	319	309	299
SHUGART SA455 Half Height	259	249	239
SHUGART SA465 Half Ht. 96TPI	289	279	269
TANDDN TM50-2 Half Height	215	209	199
TANDDN TM55-4 half Ht. 96TPI	329	319	309
TANDDN 100-2	279	269	259
TANDDN 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
TEAC FD-55B Half Height	329	319	299

Five Inch Winchester Hard Disks 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
SEAGATE 506	6 M/Byte	555	495	475
TANDDN 503	12 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

VISA
master charge

Shipping: First five pounds $3.00, each additional pound $.50.
Foreign orders: 10% shipping, excess will be refunded.
California residents add 6½% sales tax. ● COD's discouraged.
Open accounts extended to state supported educational institutions and companies with a strong "Dun & Bradstreet" rating.
Retail location: 15608 Inglewood Avenue, Lawndale 90260.

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TECHNICAL & CALIFORNIA
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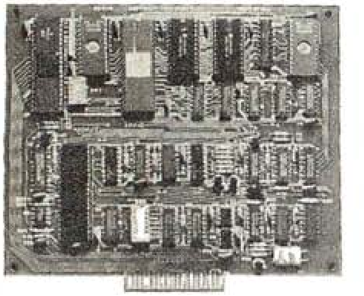
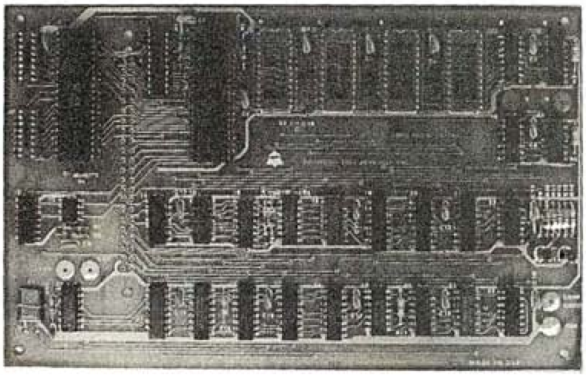
VIDEO DISPLAYS

look for low cost–high quality video displays



VIDEO TERMINAL BOARD. This is a complete stand alone Video Terminal board. All that is needed besides this board is a parallel ASCII keyboard, standard NTSC monitor, and a power supply. It displays 80 columns by 25 lines of UPPER and lower case characters. Data is transfered by RS232 at rates of 110 to 9600 baud —switch selectable. Complete source listing is included in the documentation. Both the CRT program and the character generator are in 2716 EPROMS to allow easy modification to your needs. This board uses a 6502 microprocessor and a 6845 crt controller. The serial input port is interrupt driven. Assembled and tested part number 82-018A **$199.95.** The bare board with the crystal and EPROMS, part number 82-018B **$89.95**



MINI VIDEO. This board can be used to add a video display to your aim or other computer. It can also, with the addition of a parallel keyboard, 5V power supply, and video monitor, run Tom Pittman's Tiny Basic. The display format is 40 columns by 24 lines. This board has two parallel ports (6522), a 6502 MPU 4K RAM, 2 or 4K EPROM. The assembled video board without EPROMS, part number 82-140A **$149.95.** The Tiny Basic EPROM **$39.95.** The character generator EPROM **$19.95.** The parallel input EPROM **$19.95.**

To order: Send check or money order. Add 6.5% tax in California. Add 5% shipping for orders less than $100 or 3% for orders over $100 or 10% outside U.S.A. Phone orders: We accept Visa or MC. Add $2.00 for C.O.D. Will Call Hours 9am to 4pm.

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PERIPHERALS FOR THE IBM PC

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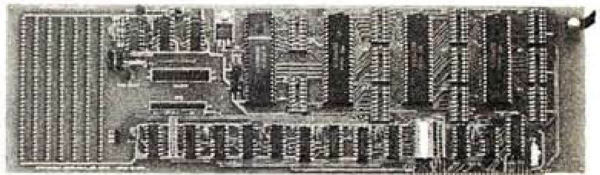
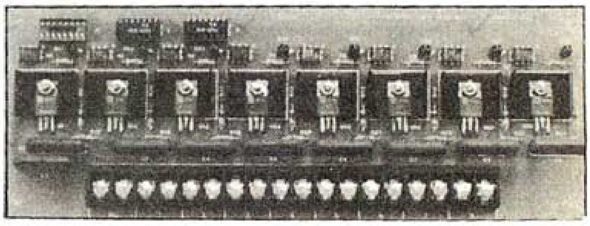
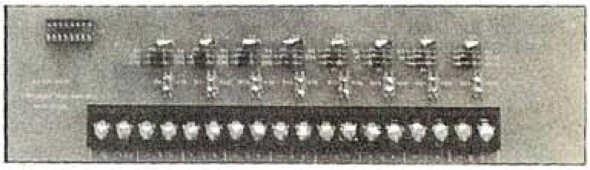


UNIVERSAL I/O. The Universal I/O board has 16 eight bit analog inputs with a voltage range of 0 to 5 volts. It also has 9 eight bit parallel I/O ports. It has interrupt circuitry, Timer clock 32768 Hz. to 512 sec., prototyping area, and LED for power. Part number 83-064A **$299.95**



120 VAC CONTROL. This board has eight optically isolated triac switches. Each switch can control 200 watts. It connects via a 16 pin ribbon cable to a parallel output port. Screw terminals are provided for 120 vac connection. Part number 82-332. **$119.95.**



INPUT PROTECTOR. This board protects the inputs of the ANALOG input or PARALLEL input ports. There are 4.7K pullups, diodes and caps for each line. It connects via a 16 pin ribbon cable. Screw terminals are provided for connection. Part number 82-334. **$89.95.**

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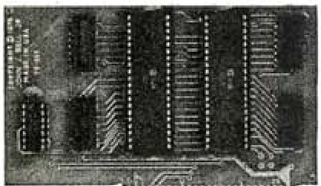
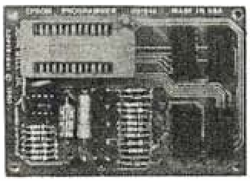
PERIPHERALS FOR THE APPLE II

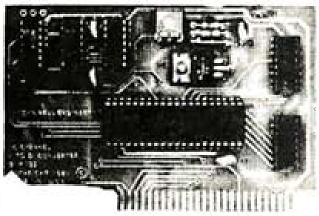
look for low cost– high quality inter–faces for the APPLE II



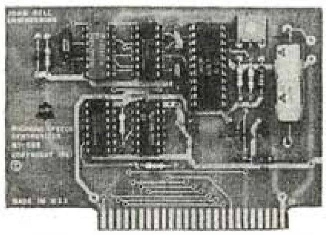
6522 APPLE II INTERFACE. This interface plugs directly into slot 1 through 7 in the APPLE II or the APPLE IIe. It provides four 8 bit bi-directional I/O ports, four 16 bit timer/counters, and handshaking. Four 16 pin dip sockets provide easy connections to peripheral devices. This board is also used to run the JBE EPROM Programmer. Order part # 79-295A assm. **$69.95** or # 79-295B bare board **$29.95**



EPROM PROGRAMMER. Programs 5 volt 2716's, 2516's, and 2532's. It interfaces to the 6522 interface with 4 ribbon cables. A Textool zero insertion force socket is used for the EPROM. Complete documentation for reading and writing. Cables available separately. Order part # 80-244A assm. **$49.95** or # 80-244B bare board **29.95** and set of 4 cables 2 ft. long **$17.00**



A-D CONVERTER. 16 Channel A-D plugs into your APPLE II or APPLE IIe. The 16 inputs are high impedance, 0 to 5 volt range, 8 bit resolution. Conversion time is less than 100 us per channel. Two 16 pin dip sockets are used for input. Order part # 81-132A assm. **$89.95** or # 81-132B bare board **$29.95**



SPEECH SYNTHESIZER. This board uses the VOTRAX SC-01 Phoneme Synthesizer chip. The on board audio amp connects directly to an 8 ohm speaker. A disk with a text to speech program is included. Order part #81-088 **$129.95**

To order: Send check or money order. Add 6.5% tax in California. Add 5% shipping for orders less than $100 or 3% for orders over $100 or 10% outside U.S.A. Phone orders: We accept Visa or MC. Add $2.00 for C.O.D. Will Call Hours 9am to 4pm.

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INDUSTRIAL CONTROL PRODUCTS

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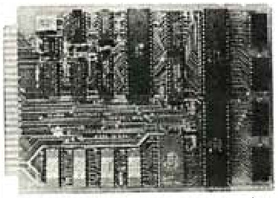
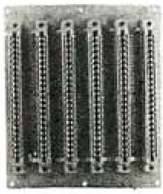
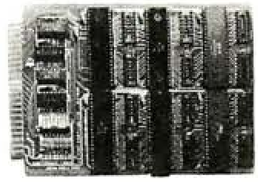


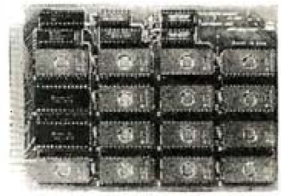
SLIM MICROCOMPUTER. This 6502 based 4.5" x 6.5" computer has the same 44 pin bus as the AIM computer. It has 2K RAM, 2K or 4K EPROM, and four 8 bit parallel I/O ports (two 6522's). The clock is 1 MHz crystal controlled and has power on reset. This board was designed for control and is ideal for personal and OEM use. This computer can be expanded with the peripherals listed below. Order part # 81-260A assm. **$199.95** or #81-260B bare board **$39.95**



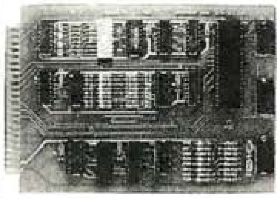
SIX SLOT MOTHER BOARD. This board has 6 44 pin edge connectors connected in parallel. The card spacing is .750". It will mount in VECTOR card cages. Order part # 81-320A assm. **$99.95** or # 81-320B bare board **$49.95.**



12 PORT PARALLEL I/O. This board has six 6522 VIA's. This is a total of 96 I/O lines. Each of the 12 8 bit ports also has 2 handshake lines. Order part # 82-036A assm. **$169.95** or # 82-036B bare board **$49.95**



RAM EPROM MEMORY (32K). This board has 16 24 pin sockets that will accept 2716 EPROM's or 6116 RAM's to total 32K bytes. The memory is mapped from 0 to 7FFF. The first 2K (0-7FF) can be disabled with a jumper to allow for the 2K of RAM on the SLIM computer. Order part # 81-330A assm. w/o memory **$99.95** or # 81-330B bare board **$49.95**



ANALOG I/O INTERFACE. This board has 16 analog inputs and 2 analog outputs. The inputs are 8 bit (256 steps), 0-5 volt, high impedance with a conversion time of 200us per channel. The outputs are R-2R ladders (R = 15K) driven between 0 and 5 volts and are 8 bit (256 steps) also. Order part # 81-292A assm. **$199.95** or #81-292B bare board **$49.95**

To order: Send check or money order. Add 6.5% tax in California. Add 5% shipping for orders less than $100 or 3% for orders over $100 or 10% outside U.S.A. Phone orders: We accept Visa or MC. Add $2.00 for C.O.D. Will Call Hours 9am to 4pm.

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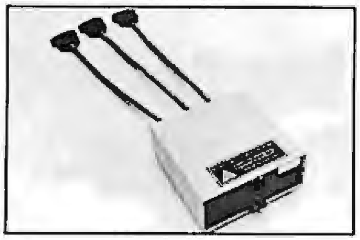
DATA SWITCH
FOR IBM PC PRINTER INTERFACE



Model 1220 Bi Directional Data Switch with 3-3ft. data cables gives an IBM PC user 2 Centronics Interfaces to connect a draft printer & letter quality printer to his Parallel Interface. A toggle switch on the front panel selects the desired printer. Runs at any speed. Built in data cables, save money. Supplied assembled and tested. $179.00. Available from your local computer dealer or

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Conductor	Price
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Specify: Male or female connectors, length of cable and pins to be connected. OEM & quantity discounts available to qualified customers. *On prepaid orders add $5.00 for shipping/handling.*

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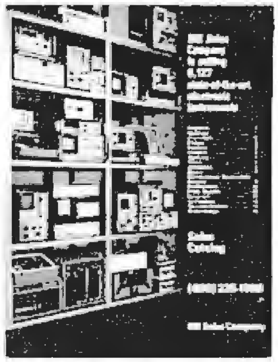

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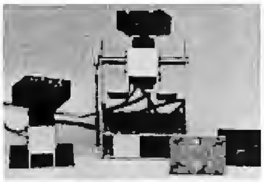

VISION SYSTEMS—VISION 1; 2D; CL, 0

Vision Kits let your computer see. They are simple but excellent for experiments with VIC-20 and Basic, or other computers. Vision 1 has a panoramic scan; 2D adds tilt for a TV image; CL close up lens; 0 fixed, or proximity sensor. Experiments with image processing, motion detection, pattern recognition and tracking. Usable with IR light. Interface kits available for several computers.

VISION I KIT..$100 VISION 0 KIT..$ 40
VISION I STEREO/TWIN..........$150
VISION 2D KIT....................$135

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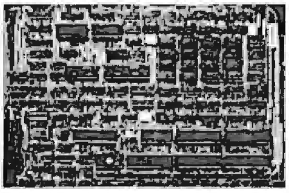

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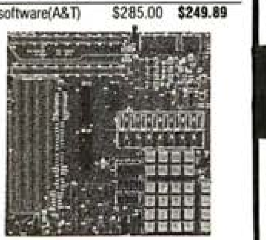

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STATIC RAM

RAM 16 - 32K x 16 BIT CMOS STATIC RAM

8 and/or 16 Bit 12MHz, RAM 16, 32K x 16 or 64K x 8 IEEE/696 16 Bit 2 Watt, 24 Bit Addressing, 12MHz

BWGBT180A	64K A&T 12MHz	$550.00	$510.00
BWGBT180C	64K CSC 12MHz	$650.00	$610.00

RAM 21 - 128K STATIC RAM

816 RAM 21 14MHz, 128K x 8 or 64K x 16 IEEE/696 8 or 16 Bit, 1.2 Amps, 24 Bit Addressing, 14MHz

BWGBT190A	128K A&T	$1095.00	$858.95
BWGBT190C	128K CSC	$1245.00	$1125.00

I/O BOARDS

SYSTEM SUPPORT 1 MULTIFUNCTION BOARD

Serial port (software prog. baud), 4K RAM included, 15 levels of interrupt, real time clock, optional math processor

Part No.	Description	List Price	Our Price
BWGBT162A	Assembled & Tested	$450.00	$308.95
BWGBT162C	CSC	$550.00	$495.00
BWGBT6231	Math Chip		$195.00
BWGBT8232	Math Chip		$195.00
BWGBT162AM1	A&T w/8231 Math Chip	$645.00	$538.95
BWGBT162CM1	CSC w/8231 Math Chip	$745.00	$670.00
BWGBT162AM2	A&T w/8232 Math Chip	$645.00	$538.95
BWGBT162CM2	CSC w/8232 Math Chip	$745.00	$670.89

INTERFACER 3

Eight-channel multi-user serial I/O board

BWGBT174BA	8 Port. Assembled & Tested	$699.00	$518.95
BWGBT1748C	CSC 200 hr. 8 port	$849.00	$748.89

INTERFACER 4

Three Serial, 1 Parallel, 1 Centronics Parallel

BWGBT187A	Assembled & Tested	$450.00	$314.87
BWGBT187C	CSC	$540.00	$414.87

MPX CHANNEL BOARDS

I/O Multiplexer, using 8085A-2 CPU on board w/16K RAM

BWGBT166A16	Assembled & Tested	$649.00	$584.89
BWGBT166C16	CSC	$749.00	$674.89

Industrial Computer Designs

S-100 TO "REAL WORLD" INTERFACE PRODUCTS

64 INPUT 8 BIT A/D D/A CONVERTERS

Part Number	Description	Price
BWICDAD64100	64 input 8 bit S-100 A/D board	$295.00
BWICDDA64100	64 output 8 bit S-100 D/A board	$395.00

REMOTE SENSORS, ALARMS, VALVES, AND CONTROLLERS FOR USE WITH ABOVE A/D D/A CONVERTER BOARDS

BWICDRTS1	remote temperature sensor (1 lb.)	$ 29.95
BWICDRLS1	remote light sensor (1 lb.)	$ 29.95
BWICDRMS1	remote moisture sensor (1 lb.)	$ 59.95
BWICDRSDA1	rewmote smoke detector alarm (2 lbs.)	$129.00
BWICDDNVAC1	in-line remote air-conditioner & heating controller (1 lb.)	$ 94.95
BWICDADV07	7" diameter valve (4 lbs.)	$ 74.95
BWICDADV08	8" diameter valve (4 lbs.)	$ 75.95
BWICDADV09	9" diameter valve (5 lbs.)	$ 76.95
BWICDADV10	10" diameter valve (5 lbs.)	$ 79.95
BWICDADV11	11" diameter valve (6 lbs.)	$ 81.95
BWICDADV12	12" diameter valve (6 lbs.)	$ 83.95
BWICDADV13	13" diameter valve (6 lbs.)	$ 84.95
BWICDADV14	14" diameter valve (6 lbs.)	$ 85.95

64 PIN CABLE ASSEMBLIES

BWICD464PCA	64 pin single ended 4' long (2 lbs.)	$ 59.25
BWICD1064PCA	64 pin single ended 10' long (3 lbs.)	$ 89.95
BWICD2064PCA	64 pin single ended 20' long (6 lbs.)	$145.00

"HOW TO" APPLICATION NOTES

If you would like to learn more about the ICD Designer Control Series of peripherals, ICD offers a complete collection of "How To" applications notes. See how your computer can control your home or office, or be used as part of an industrial control system.

BWICDAPN	Application notes (1 lb.)	$ 15.00

S-100 CLOCK/CALENDAR BOARDS

BWICDACA100	With alarm circuit	$228.00
BWICDCT100	With timer down to .01 second	$345.00
BWICDCTS	Software for ICDCT100 board on 8" CP/M format	$ 34.95

IO5

2 Serial, 3 Parallel S-100 Interface

Part No.	Description	List Price	Our Price
BWSSMI05A	Assembled & Tested	$329.00	$288.95

IO8

8 Port Serial I/O S-100 Board

BWSSMI08A	Assembled & Tested	$550.00	$450.00

IO4

2 Serial, 2 Parallel I/O S-100 Board

BWSSMI04A	Assembled & Tested	$290.00	$245.00

2708/2716 EPROM PROGRAMMER & EPROM BOARD

Programs 2708 and 2716 EPROMs. Holds 4 2708s (4K) or 4 2716s (8K)

BWSSMMB8A	Assembled & Tested	$265.00	$219.87

Vector

Manufactured by Vector Electronics under license from CompuPro

INTERFACER 1

Two Serial I/O

BWVCT8800GFB	Assembled & Tested	$295.00	$198.95
BWVCT8800GFCB	CSC	$370.00	$329.00

INTERFACER 2

Three parallel, one serial I/O board

BWVCT880DGF28	Assembled & Tested	$325.00	$249.00
BWVCT8800GF2CB	CSC	$399.00	$359.00

RAM 17 - 64K CMOS STATIC RAM

12 MHz, RAM 17, 2 Watt, DMA Compatible 24 Bit Addressing

BWVCT8800GR178	64K A&T 12MHz	$450.00	$399.00
BWVCT8800GR17CB	64K CSC 12MHz	$550.00	$510.00

CompuPro

STATIC RAM SALE!

12MHz 256K RAM 22

• Fully static • IEEE 696 • 24 bit extended addressing • 8 or 16 bit data • 5V only •

Assembled and Tested

BWGBT198A

$1595.00 each

$1500.00 EACH, WHEN YOU BUY TWO OR MORE!!

12MHz 128K RAM 21

• Fully Static • IEEE 696 • 24 bit extended addressing • 8 or 16 bit data • DMA compatible •

Assembled and Tested

BWGBTRAM21

$695.00 each

$650.00 EACH WHEN YOU BUY TWO OR MORE!!

List Price $1295.00

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PRIORITY ONE ELECTRONICS

SIEMENS FDD100-8

8" FLOPPY DISK DRIVE

SINGLE SIDED, DOUBLE DENSITY
SHUGART 801R COMPATIBLE

90 DAY WARRANTY!!

$175.00 each

$169.00 ea. 2 - 9

10+ CALL

OEM INQUIRIES INVITED

BWSIEFDD1008 (Include $7.00 per drive for shipping)

BUY DRIVE & CABINET TOGETHER AND $AVE!!

DUAL 8" SIEMENS FDD1008
DUAL 8" CABINET POWER SUPPLY AND INTERNAL POWER CABLES
(Include $30.00 for shipping)

- Positive Pressure Filter Cooling
- Power Supply: 4A@+5V, 3A@+24V 1A @ -5V
- Each output is individually fused
- Hinged to for easy access
- Heavy non-flex .090 aluminum base
- Modular power connectors

IF BOUGHT SEPARATELY: $890.00
SPECIAL SALE PRICE:

$625.00

BWPDBIIISIE (Include $30.00 for shipping)
BWIIIFDE002 CABINET ONLY (Sh. Wt. 38 lbs.) **$295.00**

OUR FINEST DUAL 8" DISK DRIVE CABINET!

International Instrumentation Incorporated

- Positive pressure forced air cooling for reliable disk drive operation
- AC input EMI filtered to six amps to help prevent disk crashes due to power spikes and line noise
- Integral power supply with 5V @ 6A/-5V @ 1A/24V @ 6A
- Each DC supply and AC separately fused

Part No.		List Price	SALE PRICE
BWIIIUDE004	(Sh. Wt. 40 lbs.)	$495.00	$349.00

With augmented power supply to handle Tandon Slimline, or Winchester disk drives. Includes the disk environment monitor.

BWIIIUDE004AUG	(Sh. Wt. 40 lbs.)	$733.00	$625.00
BWIIIUDE004EM	(Sh. Wt. 40 lbs.)	$584.95	$395.00

DUAL 5¼" HARD DISK ENCLOSURE

The **IIHD5002** enclosure provides all of the necessary power for two TANDON **TM500** series or equivalent hard disk drives, and Xebec Controller. Forced air cooling is provided by a 33 cfm fan, and is filtered to keep your equipment running at its best!

Part Number		List Price	SALE PRICE
BWIIIHD5002	Dual hard disk enclosure (Shipping Weight 20 lbs.)	$425.00	$375.00

DISK DRIVES

MICROPOLIS 5¼" HARD DISK

BWMCP1302	20.4/25.9 Mb Winchester	$1465.00
BWMCP1303	33.9/43.2 Mb Winchester	$1875.00
BWMCP1304	40.8/51.9 Mb Winchester	$2195.00

(Shipping Weight: 12 lbs. each)

TANDON 5¼" HARD DISK

BWTNDTM501	1 platter 6 Mbyte (Sh. Wt. 9 lbs.)	$749.00
BWTNDTM502	2 platter 12 Mbyte (Sh. Wt. 9 lbs.)	$895.00
BWTNDTM503	3 platter 19 Mbyte (Sh. Wt. 9 lbs.)	$1049.00

DUAL HARD DISK ENCLOSURE

BWIIIH05002	For above drives	$395.00

TANDON 5¼"

BWTNDTM1001	1 Sided 48 TPI	$225.00	2 FOR $195.00 each
BWTNDTM1002	2 Sided 48 TPI	$260.00	2 FOR $235.00 each
BWTNDTM1003	1 Sided 96 TPI	$275.00	2 FOR $250.00 each
BWTNDTM1004	2 Sided 96 TPI	$390.00	2 FOR $365.00 each

(Shipping Weights on above items: 5 lbs. each)

MPI 5¼" FULL HEIGHT

BWMPI51*	1 Sided 48 TPI	$200.00
BWMPI52*	2 Sided 48 TPI	$270.00
BWMPI91*	1 Sided 96 TPI	$275.00
BWMPI92*	2 Sided 96 TPI	$400.00

*Replace with an "M" for the MPI style bezel or with an "S" for Shugart style bezel (Shipping Weight 5 lbs.)

MPI 5¼" HALF HEIGHT

BWMPI501	1 Sided 48 TPI (Sh. Wt. 4 lbs.)	$260.00
BWMPI502	2 Sided 48 TPI (Sh. Wt. 4 lbs.)	$300.00
BWMPI901	1 Sided 96 TPI (Sh. Wt. 4 lbs.)	$300.00
BWMPI902	2 Sided 96 TPI (Sh. Wt. 4 lbs.)	$355.00

5¼" DRIVE CABINETS

BWJMR1C5	Single 5¼" Cabinet (5 lbs)	$69.00
BWJMR2C5	Dual 5¼" Cabinet (9 lbs)	$89.00
BWJMR2C5C	JMR2C5 w/internal data cable (9 lbs)	$99.00

SHUGART 8" FULL HEIGHT

BWSHU801R	1 sided (18 lbs)	$369.00

QUME 8" FULL HEIGHT

BWQMEDT8	2 sided (18 lbs)	$480.00
		2 FOR $460.00 each

MITSUBISHI 8" FULL HEIGHT

BWMITM289463B	2 sided (18 lbs.)	$380.00

MPI 8" FULL HEIGHT

BWMPI41S	1 sided (11 lbs.)	$380.00
BWMPI42S	2 sided (11 lbs.)	$460.00

MPI 8" DUAL HALF HEIGHT

(SAME SIZE AS ONE FULL HEIGHT)

BWMPI41D	1 sided (22 lbs.)	$760.00
BWMPI42D	2 sided (22 lbs.)	$870.00

TANDON 8" HALF HEIGHT

BWTNDTM8481	1 sided (9 lbs)	$395.00
		2 FOR $375.00 each
BWTNDTM8482	2 sided (9 lbs.)	$495.00
		2 FOR 475.00 each

MPI 8" HALF HEIGHT

BWMPI41M	1 sided (11 lbs)	$380.00
BWMPI42M	2 sided (11 lbs)	$460.00

DUAL 8" HALF HEIGHT FLOPPY CABINET

- 24V @ 4A, 5V @ 3A -5V @ 800ma
- Fan cooled
- Socketed power connections
- All supplies regulated

		List Price	Our Price
BWIIIDTL002	DualThin LineCabinet (12 lbs.)	$225.00	$165.00

BUY THE CABINET & DRIVES AND $AVE!

With 2 Tandon Thinlines

BWPDBIIITND1	Cabinet w/2 TNDTM8481 - 1 sided (30 lbs.)	$885.00
BWPDBIIITND2	Cabinet w/2 TNDTM8482 - 2 sided (30 lbs)	$1115.00

With 2 MPI Slimlines

BWPDBIIIMPI1	Cabinet w/2 MPI41M - 1 sided (30 lbs)	$920.00
BWPDBIIIMPI2	Cabinet w/2 MPI42M - 2 sided (30 lbs)	$1080.00

Options

BWIIIOTLMPIKIT	MPI drive adaptor mounting kit (2 lb.)	$24.95
BWIIIOCCSHU	Shugart / AC/DC power connector kit (2 lbs.) (For full size single SA801 or compatible drives)	$14.95

TERMINALS

VISUAL 330

NEW LOWER PRICES! Sorry TeleVideo!

(Sh. Wt. 41 lbs.)

SPECIFICATIONS	VISUAL 330	VISUAL 300	TeleVideo 950
ANSI X3.64 Specified	NO	STD	NO
Programmable Non-Volatile Function Keys	STD	STD	NO
Video Attributes Require No Display Space	STD	STD	NO
Smooth Scroll, Slow Scroll and Jump Scroll	STD	STD	NO
Non-Volatile Set-up Modes "Menu" style	STD	STD	NO
Programmable Non-Volatile Columnar Tabbing	STD	STD	NO
N-Key Rollover	STD	STD	NO
CR New Line Mode	STD	STD	NO
Tilt and Swivel	STD	STD	NO
User Programmable Non-Volatile Answerback, 32 Codes	STD	STD	NO
XON/XOFF Flow Control Split for Xmitter & Receiver	STD	STD	NO

Part No.	Description	List Price	SALE
BWVSL300GN	ANSI X3.64, 12" Green	$1095.00	$995.00
BWVSL330GN	Green 12" CRT (Sh. Wt. 41 lbs.)	$1200.00	$895.00
BWVSL33014GN	Green 14" CRT (Sh. WT. 41 lbs.)	$1250.00	$949.00

VISUAL 50

The **VISUAL 50** represents a new approach in low cost terminals. Although it costs drastically less, it offers the features you expect from the high priced units. For example, the **VISUAL 50** enclosure is ergonomically designed in light-weight plastic and can easily be swiveled and tilted for maximum operator comfort. A detached keyboard, smooth scroll, large 7 x 9 dot matrix characters and non-glare screen are a few of the many human engineering features normally offered only on much higher priced parameters.

Another distinctive feature of the **VISUAL 50** is its emulation capability. **VISUAL 50** is code-for-code compatible with the Hazeltine Esprit™, ADDS Viewpoint™, Lear Siegler ADM-3A™, and DEC VT-52. Menu driven set-up modes in non-volatile memory allow easy selection of terminal parameters.

BWVSL50BW	Black & White 12"	$695.00	$625.00
BWVSL50GN	Green Screen 12"	$770.00	$655.00

TELEVIDEO

BWPDBTLV9252P	w/2nd page memory kit FREE ($95.00 Value)	$729.00
BWPDBTLV9504P	w/2nd, 3rd, & 4th page memory kit FREE (A 285.00 Value) (above items: 37 lbs. each)	$929.00
BWTLV910	80 col. terminal (37 lbs.)	$558.95
BWTLV970	14" 80/132 col. terminal (40 lbs.)	$1019.00

LIBERTY ELECTRONICS

BWLIBF50	Freedom 50 (Sh. Wt. 30 lbs.)	$599.00	$474.00

ADDS

BWADDVWPR	Viewpoint 3A+ (30 lbs.)	$695.00	$575.00

QUME

BWQME102	80 Column Green (Sh. Wt. 30 lbs.)	$550.00
BWQME102AM	80 Column Amber (Sh. Wt. 30 lbs.)	$565.00
BWQME103	80/132 Column Green (Sh. Wt. 30 lbs.)	$765.00
BWQME108	22 function key, 80 col. Green (30 lbs.)	$749.00
BWQME108AM	22 function key, 80 col. Amber (30 lbs.)	$765.00

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Z80A - CP/M™ BASED COMPUTER SUB-SYSTEM WITH 30M BYTES OF DISK STORAGE!!

For Only:

$3995.00

BWPDBSDSMCP

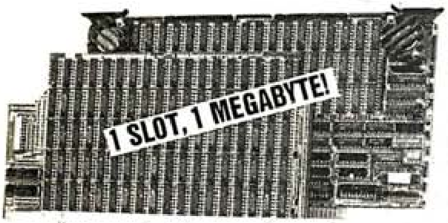
And Here Is What You Get:

Part	Description	List Price
BWSDCSBCCM	Z80A SBC w/64K RAM, 2 RS-232 Interface and Floppy Disk Controller	$ 895.00
BWSDCHD1	Micropolis 1200 series adaptor for use with above	$ 150.00
BWSDCCPM15	User-friendly CP/M™	$ 150.00
BWMCP12231	3 platter 35Mbyte hard disk 8" drive	$4495.00
BWSDCWNMCP	Enclosure and Power Supply for Drive	$ 550.00

WHAT YOU WOULD PAY IF YOU BOUGHT EVERYTHING SEPARATELY: $6240.00

YOU SAVE $2245.00

MACROTECH International Corp.



S-100 IEEE/696 DYNAMIC RAM
MACROTECH MAX
UP TO 1 MEGABYTE!!

See Page 134 For More Details

Features:

- S-100/IEEE-696 full compatibility
- Various configurations — field upgradeable. 256K - 384K - 512K - and 1 Megabyte!
- High speed — 6MHz in 8 bit environments and 8 MHz in 16 bit environments with no wait states
- Under CP/M 2.2*, CP/M 3.0* CP/M 86* or MP/M II*, all or part of the memory may be devided between system memory and virtual disk
- M3 Memory mapping option for 8-bit environments (Translated 16-bit logical address to 24-bit physical address). Gives Z-80, 8080, or 8085 16 MEG address space
- DMA fully supported in accordance with IEEE/696
- Low power consumption 4.0 Amps (1 MEG): 3.0 Amps (256K)
- 6 Layer HOST and 4 layer "piggy-back" card for noise-free operation
- Fully socketed — Augat HOLTITE™ zero profile sockets on all ICs

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. To order the M3 Memory Mapping Option, add **M3** to the end of the part number and add $90.00 to the price.

Part Number	Description	Our Price
BWMACMAX256	256K Dynamic RAM (A&T)	$1225.00
BWMACMAX384	384K Dynamic RAM (A&T)	$1467.00
BWMACMAX512	512K Dynamic RAM (A&T)	$1880.00
BWMACMAXM	1 MEG Dynamic RAM (A&T)	$2449.00
BWMACMAXTM	MAX Technical Manual	$ 15.00
BWMACMAXVDSK	MAX Virtual Disk Software supplied on 8" S/D Disk	$ 25.00

MACROTECH UPGRADE KITS

Each MAX board is upgradeable in 128K increments. Each upgrade includes the RAMs and the proprietary PALs (Programmable Array Logic) required to change the board addressing. Call or write for upgrade kits not listed.

BWMACMKT23	Upgrade from 256K to 384K	$ 265.00
BWMACMKT2M	Upgrade from 256K to 1 MEGABYTE	$1747.00
BWMACMKT3M	Upgrade from 384K to 1 MEGABYTE	$1500.00
BWMACMKT5M	Upgrade from 512K to 1 MEGABYTE	$1005.00

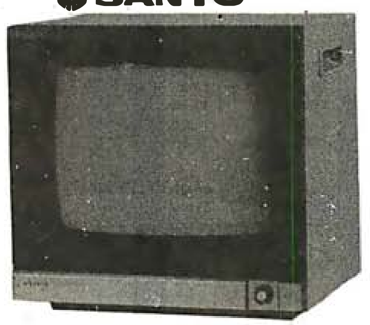
IBM-PC™ COMPATIBLE COMPUTER SYSTEM!

- MS DOS
- 16 bit 8088 CPU
- 128K RAM
- Color Graphics
- Centronics Printer Port
- Sanyo BASIC
- Word Processing
- Spread Sheet

SANYO MBC-555

Call For Special Package Price

SANYO



13" RGB MONITOR
IDEAL FOR IBM, SANYO, EAGLE, AND MANY OTHER COMPUTER SYSTEMS

Regular Price: $795.00

SALE PRICE $499

BWSYODM6113 (Sh. Wt. 35 lbs.)

BWSYOVMC6013 Composite (Wt. 35 lbs.) **$449.00**

12" GREEN SCREEN VIDEO MONITOR

64 Column Display Regular Price: $119.00

SALE PRICE $75.00

BWSYODM2112 (Sh. Wt. 16 lbs.)

80 Column Display Regular Price: $199.00

SALE PRICE: $159.00

BWSYODM8112CX (Sh. Wt. 24 lbs.)

TAXAN

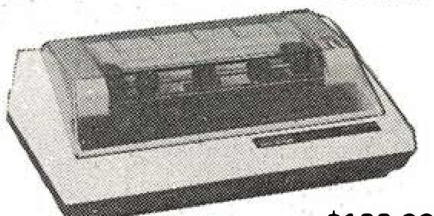
Part Number	Description	List Price	Our Price
BWTAXRGB1	Medium Resolution/310 lines	$399.00	$379.00
BWTAXRGB3	Super High Res./630 lines (Shipping Weight: 30 lbs each)	$699.00	$659.00

INTERFACE BOARDS AND CABLES

BWTAXAPPLE2RGB	RGB interface for Aple II	$149.00	$139.00
BWTAX410-80	RGB 80 col. int. for Apple IIe	$199.00	$185.00
BWTAXIBMRGB	RGB cable for IBM PC™		$ 19.00
BWTAXRGBAPL	RGB cable for Apple IIe and III (Shipping Weight: 1 lb on each)		$ 19.00

PRINTERS

AXIOM — AXIOM CORPORATION



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OUR LOWEST PRICED PRINTER!

BWAXMGP100A 30 cps; 80 col. dot matrix (11 lbs.) $199.00

Printers for Atari or Commodore
JUST PLUG AND RUN!
Complete With Built-In Interface Cables!

BWAXMAT100A	for ATARI	$229.00
BWAXMC0100A	for Commodore	$229.00

MORROW

LETTER QUALITY PRINTERS

Part Number	Description	List price	Our Price
BWMDSMP200	200 cps w/RS232 serial interface (Shipping weight: 35 lbs.)	$950.00	$795.00
BWMDSMPT50TK	MP200 tractor feed		$125.00
BWMDSMP100	12 cps friction/pin feed w/parallel interface	$595.00	$495.00

PRINT WHEEL

BWSRPCOURIER10	Courier 10 pica	$16.95
BWSRPCOURIER12	Courier 12, elite	$16.95
BWSRPMODERN	Proportional type	$16.95
BWSRPSCRIPT	Script elite	$16.95

COEX 80F/T
Friction and Pin Feed Standard

BWCOX80FT	Parallel Interface: 80 cps	$249.00
BWCOX80FTSER	Serial Interface: 80 cps	$249.00

GEMINI 10X & 15

BWGEM10X	120 cps Parallel Int. 80 col. (20 lbs.)	$319.00
BWGEM15	100 cps Parallel Int. 132 col. (26 lbs.)	$459.00
BWGEMSERINT	Serial interface card for GEM15 (1 lb.)	$85.00
BWGEMSERINTX	Serial interface for GEM10X (1 lb.)	$ 59.00
BWGEMSERINTX4K	Serial interface & 4K buffer for GEM10X	$119.00

OKIDATA

BWOKIDAT82AT	TRACTOR INCLUDED (25 lbs)	$449.00
BWOKIDAT83AT	TRACTOR INCLUDED (35 lbs)	$729.00
BWOKIDAT92AP	OKIDATA 92A Parallel (25 lbs.)	$480.00
BWOKIDAT92AS	OKIDATA92A Serial (25 lbs)	$599.00
BWOKIDAT92AT	OKIDATA92A Tractor (2 lbs.)	$ 79.95
BWOKIDAT93AP	OKIDATA93A parallel (35 lbs.)	$830.00
BWOKIDAT93AS	OKIDATA93A Serial (35 lbs.)	$995.00

MANNESMANN TALLY
LETTER QUALITY DOT MATRIX PRINTER

- 160 cps
- 40 cps (Letter quality)
- Serial & Parallel Interface
- Double wide characters
- Tractor and friction feed
- "Bullet-Proof" cast frame with metal cabinet

BWTALMT160L	160 cps 80 col (21 lbs.)	$569.00
BWTALMT180L	160 cps 132 col. (28 lbs.)	$784.00

QUME LETTER QUALITY

BWQMES945	45 cps Sprint 9 serial (49 lbs.)	$1789.00
BWQMES955	55 cps Sprint 9 serial (49 lbs.)	$2195.00
BWQMES1140	40 cps Sprint 11 (45 lbs.)	$1389.00
BWQMES11RS232	RS232 Module for Sprint 11 (3 lbs.)	$ 99.00
BWQMES11CENT	Centronics parallel for Sprint 11 (3 lbs.)	$ 99.00
BWQMES11IEEE488	IEEE488 Module for Sprint 11 (3 lbs)	$ 99.00
BWQMES11IBM	IBM module for Sprint 11 (3 lbs.)	$ 99.00
BWQMEBDT	Bi-Directional Tractor (9 lbs.)	$ 349.00
BWQMEWB	Wire basket (2 lbs.)	$ 85.00
BWQMECSF	Cut Sheet Feeder (20 lbs.)	$ 849.00

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RETAIL STORE PHONE NUMBERS: (Chatsworth:) (213) 709-5464 - (Irvine:) (714) 660-1411

Circle 370 on inquiry card.

4164 64K DYNAMIC 200 NS $5.95 — TMM2016 2KX8 STATIC 200 NS $4.15

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

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)	8/11.95
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

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)	9.95
2764-250	8192 x 8 (250ns) (5v)	14.95
2764-200	8192 x 8 (200ns) (5v)	24.95
TMS2564	8192 x 8 (450ns) (5v)	17.95
MC68764	8192 x 8 (450ns) (5v) (24 pin)	39.95
27128	16384x8 (300ns) (5v)	29.95

EPROM ERASERS

	Timer	Capacity Chip	Intensity (uW/Cm²)	
PE-14		9	8,000	83.00
PE-14T	X	9	8,000	119.00
PE-24T	X	12	9,600	175.00
PL-265T	X	30	9,600	255.00
PR-125T	X	25	17,000	349.00
PR-320T	X	42	17,000	595.00

Z-80

2.5 Mhz	
Z80-CPU	3.95
Z80-CTC	4.49
Z80-DART	10.95
Z80-DMA	14.95
Z80-PIO	4.49
Z80-SIO/0	16.95
Z80-SIO/1	16.95
Z80-SIO/2	16.95
Z80-SIO/9	16.95
4.0 Mhz	
Z80A-CPU	4.95
Z80A-CTC	4.95
Z80A-DART	11.95
Z80A-DMA	16.95
Z80A-PIO	4.95
Z80A-SIO/0	16.95
Z80A-SIO/1	16.95
Z80A-SIO/2	16.95
Z80A-SIO/9	16.95
6.0 Mhz	
Z80B-CPU	11.95
Z80B-CTC	13.95
Z80B-PIO	13.95
Z80B-DART	19.95
Z80B-SIO/2	39.95
ZILOG	
Z6132	34.95
Z8671	39.95

CRYSTALS

32.768 khz	1.95
1.0 mhz	4.95
1.8432	4.95
2.0	3.95
2.097152	3.95
2.4576	3.95
3.2768	3.95
3.579545	3.95
4.0	3.95
5.0	3.95
5.0688	3.95
5.185	3.95
5.7143	3.95
6.0	3.95
6.144	3.95
6.5536	3.95
8.0	3.95
10.0	3.95
10.738635	3.95
14.31818	3.95
15.0	3.95
16.0	3.95
17.430	3.95
18.0	3.95
18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

CRT CONTROLLERS

6845	22.50
68B45	19.95
HD46505SP	15.95
6847	11.95
MC1372	6.95
68047	24.95
8275	29.95
7220	99.95
CRT5027	39.95
CRT5037	49.95
TMS9918A	39.95
DP8350	49.95

KEYBOARD CHIPS

AY5-2376	11.95
AY5-3600	11.95
AY5-3600 PRO	11.95

8000

8035	5.95
8039	6.95
INS-8060	17.95
INS-8073	49.95
8080	3.95
8085	5.95
8085A-2	11.95
8086	29.95
8087	CALL
8088	39.95
8089	89.95
8155	6.95
8155-2	7.95
8156	6.95
8185	29.95
8185-2	39.95
8741	39.95
8748	24.95
8755	24.95

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

DISC CONTROLLERS

1771	16.95
1791	24.95
1793	26.95
1795	49.95
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

CONNECTORS

RS232 MALE	2.50
RS232 FEMALE	3.25
RS232 HOOD	1.25
S-100 ST	3.95

6800

68000	59.95
6800	3.95
6802	7.95
6803	19.95
6808	13.90
6809E	19.95
6809	11.95
6810	2.95
6820	4.35
6821	3.25
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	9.95
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	7.95
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	14.95

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

74LS00

74LS00	.24	74LS173	.69
74LS01	.25	74LS174	.55
74LS02	.25	74LS175	.55
74LS03	.25	74LS181	2.15
74LS04	.24	74LS189	8.95
74LS05	.25	74LS190	.89
74LS08	.28	74LS191	.89
74LS09	.29	74LS192	.79
74LS10	.25	74LS193	.79
74LS11	.35	74LS194	.69
74LS12	.35	74LS195	.69
74LS13	.45	74LS196	.79
74LS14	.59	74LS197	.79
74LS15	.35	74LS221	.89
74LS20	.25	74LS240	.95
74LS21	.29	74LS241	.99
74LS22	.25	74LS242	.99
74LS26	.29	74LS243	.99
74LS27	.29	74LS244	1.29
74LS28	.35	74LS245	1.49
74LS30	.25	74LS247	.75
74LS32	.29	74LS248	.99
74LS33	.55	74LS249	.99
74LS37	.35	74LS251	.59
74LS38	.35	74LS253	.59
74LS40	.25	74LS257	.59
74LS42	.49	74LS258	.59
74LS47	.75	74LS259	2.75
74LS48	.75	74LS260	.59
74LS49	.75	74LS266	.55
74LS51	.25	74LS273	1.49
74LS54	.29	74LS275	3.35
74LS55	.29	74LS279	.49
74LS63	1.25	74LS280	1.98
74LS73	.39	74LS283	.69
74LS74	.35	74LS290	.89
74LS75	.39	74LS293	.89
74LS76	.39	74LS295	.99
74LS78	.49	74LS298	.89
74LS83	.60	74LS299	1.75
74LS85	.69	74LS323	3.50
74LS86	.39	74LS324	1.75
74LS90	.55	74LS352	1.29
74LS91	.89	74LS353	1.29
74LS92	.55	74LS363	1.35
74LS93	.55	74LS364	1.95
74LS95	.75	74LS365	.49
74LS96	.89	74LS366	.49
74LS107	.39	74LS367	.45
74LS109	.39	74LS368	.45
74LS112	.39	74LS373	1.39
74LS113	.39	74LS374	1.39
74LS114	.39	74LS375	.95
74LS122	.45	74LS377	1.39
74LS123	.79	74LS378	1.18
74LS124	2.90	74LS379	1.35
74LS125	.49	74LS385	3.90
74LS126	.49	74LS386	.45
74LS132	.59	74LS390	1.19
74LS133	.59	74LS393	1.19
74LS136	.39	74LS395	1.19
74LS137	.99	74LS399	1.49
74LS138	.55	74LS424	2.95
74LS139	.55	74LS447	.95
74LS145	1.20	74LS490	1.95
74LS147	2.49	74LS624	3.99
74LS148	1.35	74LS640	2.20
74LS151	.55	74LS645	2.20
74LS153	.55	74LS668	1.69
74LS154	1.90	74LS669	1.89
74LS155	.69	74LS670	1.49
74LS156	.69	74LS674	14.95
74LS157	.65	74LS682	3.20
74LS158	.59	74LS683	3.20
74LS160	.69	74LS684	3.20
74LS161	.65	74LS685	3.20
74LS162	.69	74LS688	2.40
74LS163	.65	74LS689	3.20
74LS164	.69	81LS95	1.49
74LS165	.95	81LS96	1.49
74LS166	1.95	81LS97	1.49
74LS168	1.75	81LS98	1.49
74LS169	1.75	25LS2521	2.80
74LS170	1.49	25LS2569	4.25

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Circle 245 on inquiry card.

2114 450 NS 8/$9.95 — 2114 250 NS 8/$10.95

7400

7400	.19	74132	.45
7401	.19	74136	.50
7402	.19	74141	.65
7403	.19	74142	2.95
7404	.19	74143	2.95
7405	.25	74145	.60
7406	.29	74147	1.75
7407	.29	74148	1.20
7408	.24	74150	1.35
7409	.19	74151	.55
7410	.19	74152	.65
7411	.25	74153	.55
7412	.30	74154	1.25
7413	.35	74155	.75
7414	.49	74156	.65
7416	.25	74157	.55
7417	.25	74159	1.65
7420	.19	74160	.85
7421	.35	74161	.69
7422	.35	74162	.85
7423	.29	74163	.69
7425	.29	74164	.85
7426	.29	74165	.85
7427	.29	74166	1.00
7428	.45	74167	2.95
7430	.19	74170	1.65
7432	.29	74172	5.95
7433	.45	74173	.75
7437	.29	74174	.89
7438	.29	74175	.89
7440	.19	74176	.89
7442	.49	74177	.75
7443	.65	74178	1.15
7444	.69	74179	1.75
7445	.69	74180	.75
7446	.69	74181	2.25
7447	.69	74182	.75
7448	.69	74184	2.00
7450	.19	74185	2.00
7451	.23	74190	1.15
7453	.23	74191	1.15
7454	.23	74192	.79
7460	.23	74193	.79
7470	.35	74194	.85
7472	.29	74195	.85
7473	.34	74196	.79
7474	.33	74197	.75
7475	.45	74198	1.35
7476	.35	74199	1.35
7480	.59	74221	1.35
7481	1.10	74246	1.35
7482	.95	74247	1.25
7483	.50	74248	1.85
7485	.59	74249	1.95
7486	.35	74251	.75
7489	2.15	74259	2.25
7490	.35	74265	1.35
7491	.40	74273	1.95
7492	.50	74276	1.25
7493	.35	74279	.75
7494	.65	74283	2.00
7495	.55	74284	3.75
7496	.70	74285	3.75
7497	2.75	74290	.95
74100	1.75	74293	.75
74107	.30	74298	.85
74109	.45	74351	2.25
74110	.45	74365	.65
74111	.55	74366	.65
74116	1.55	74367	.65
74120	1.20	74368	.65
74121	.29	74376	2.20
74122	.45	74390	1.75
74123	.49	74393	1.35
74125	.45	74425	3.15
74126	.45	74426	.85
74128	.55	74490	2.55

LINEAR

LM301	.34	LM340 (see 7800)		LM566	1.49	LM1558H	3.10
LM301H	.79	LM348	.99	LM567	.89	LM1800	2.37
LM307	.45	LM350K	4.95	NE570	3.95	LM1812	8.25
LM308	.69	LM350T	4.60	NE571	2.95	LM1830	3.50
LM308H	1.15	LM358	.69	NE590	2.50	LM1871	5.49
LM309H	1.95	LM359	1.79	NE592	2.75	LM1872	5.49
LM309K	1.25	LM376	3.75	LM709	.59	LM1877	3.25
LM310	1.75	LM377	1.95	LM710	.75	LM1889	1.95
LM311	.64	LM378	2.50	LM711	.79	LM1896	1.75
LM311H	.89	LM380	.89	LM723	.49	ULN2003	2.49
LM312H	1.75	LM380N-8	1.10	LM723H	.55	LM2877	2.05
LM317K	3.95	LM381	1.60	LM733	.98	LM2878	2.25
LM317T	1.19	LM382	1.60	LM741	.35	LM2900	.85
LM318	1.49	LM383	1.95	LM741N-14	.35	LM2901	1.00
LM318H	1.59	LM384	1.95	LM741H	.40	LM3900	.59
LM319H	1.90	LM386	.89	LM747	.69	LM3905	1.25
LM319	1.25	LM387	1.40	LM748	.59	LM3909	.98
LM320 (see 7900)		LM389	1.35	LM1014	1.19	LM3911	2.25
LM322	1.65	LM390	1.95	LM1303	1.95	LM3914	3.95
LM323K	4.95	LM392	.69	LM1310	1.49	LM3915	3.95
LM324	.59	LM393	1.29	MC1330	1.69	LM3916	3.95
LM329	.65	LM394H	4.60	MC1349	1.89	MC4024	3.95
LM331	3.95	LM399H	5.00	MC1350	1.19	MC4044	4.50
LM334	1.19	NE531	2.95	MC1358	1.69	RC4136	1.25
LM335	1.40	NE555	.34	MC1372	6.95	RC4151	3.95
LM336	1.75	NE556	.65	LM1414	1.59	LM4250	1.75
LM337K	3.95	NE558	1.50	LM1458	.59	LM4500	3.25
LM337T	1.95	NE561	24.95	LM1488	.69	RC4558	.69
LM338K	6.95	NE564	2.95	LM1489	.69	LM13080	1.29
LM339	.99	LM565	.99	LM1496	.85	LM13600	1.49
						LM13700	1.49

H = TO-5 CAN T = TO-220 K = TO-3

RCA

CA 3023	2.75	CA 3082	1.65
CA 3039	1.29	CA 3083	1.55
CA 3046	1.25	CA 3086	.80
CA 3059	2.90	CA 3089	2.99
CA 3060	2.90	CA 3096	3.49
CA 3065	1.75	CA 3130	1.30
CA 3080	1.10	CA 3140	1.15
CA 3081	1.65	CA 3146	1.85
CA 3160	1.19		

TI

TL494	4.20	75365	1.95
TL496	1.65	75450	.59
TL497	3.25	75451	.39
75107	1.49	75452	.39
75110	1.95	75453	.39
75150	1.95	75454	.39
75154	1.95	75491	.79
75188	1.25	75492	.79
75189	1.25	75493	.89
75494	.89		

BI FET

TL071	.79	TL084	2.19
TL072	1.19	LF347	2.19
TL074	2.19	LF351	.60
TL081	.79	LF353	1.00
TL082	1.19	LF355	1.10
TL083	1.19	LF356	1.10
LF357	1.40		

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
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4514	1.25	74C915	1.19
4515	1.79	74C918	2.75
4516	1.55	74C920	17.95
4518	.89	74C921	15.95
4519	.39	74C922	4.49
4520	.79	74C923	4.95
4522	1.25	74C925	5.95
4526	1.25	74C926	7.95
4527	1.95	74C928	7.95
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74S00

74S00	.32	74S168	3.95
74S02	.35	74S169	3.95
74S03	.35	74S174	.95
74S04	.35	74S175	.95
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74S10	.35	74S189	6.95
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74S64	.40	74S253	.95
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74S133	.45	74S289	6.89
74S134	.50	74S301	6.95
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7812T	.75	7915T	.85
7815T	.75	7924T	.85
7824T	.75		
		7905K	1.49
7805K	1.39	7912K	1.49
7812K	1.39	7915K	1.49
7815K	1.39	7924K	1.49
7824K	1.39		
		79L05	.79
78L05	.69	79L12	.79
78L12	.69	79L15	.79
78L15	.69		
		LM323K	4.95
78H05K	9.95	UA78S40	1.95
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.22uf						.40	
.27						.40	
.33						.40	.45
.47				.35			.50
.68						.45	.50
1.0			.40	.40	.45	.45	
1.5				.45		.50	.60
1.8							.75
2.2		.35	.40	.45		.65	.85
2.7		.40	.45				.90
3.3		.45	.50	.55	.60	.65	.90
3.9		.45					
4.7	.45	.55		.60	.65	.85	.90
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						

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10pf	50V	.05	470	50V	[illegible]
22	50V	.05	560	50V	[illegible]
25	50V	.05	680	50V	[illegible]
27	50V	.05	820	50V	[illegible]
33	50V	.05	.001uf	50V	[illegible]
47	50V	.05	.0015	50V	.05
56	50V	.05	.0022	50V	[illegible]
68	50V	.05	.005	50V	[illegible]
82	50V	.05	.01	50V	[illegible]
100	50V	.05	.02	50V	[illegible]
220	50V	.05	.05	50V	[illegible]
330	50V	.05	.1	12V	[illegible]
			.1	50V	[illegible]

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.1uf-mono 50V .18 .47uf-mono 50V .25

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.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
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4N37	1.25	H11C5	1.25
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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		
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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		
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KBP04	400PIV 1.5amp bridge	.55
VM48	Dip-Bridge	.35

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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
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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

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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 MALE	SOLDER CUP FEMALE	RIGHT ANGLE PC SOLDER MALE	RIGHT ANGLE PC SOLDER FEMALE	IDC RIBBON CABLE MALE	IDC RIBBON CABLE FEMALE	HOODS BLACK	HOODS 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

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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 IDH**10**SR.

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FOR SALE: NEC APC includes 8086, dual 8-inch 1-megabyte floppy disks, 128K RAM, RS-232C, parallel, green display, detachable keyboard, CP/M-86, Computer Innovations C-86, and VEDIT. Almost a year old. Lists at $4650; asking $3900. Pete Gill, 17 Knowlton Rd., Nashua, NH 03063, (603) 882-1145.

WANTED: A CP/M 2.2-compatible program for finding averages, etc. that will work for several bowling leagues. Hopefully, a public-domain program is available. Otherwise one to work fairly quickly. Bev Elroy, 28850 Ol' Mine Rd., Hemet, CA 92343, (714) 926-1141.

FOR SALE: AIM 65, 4K RAM, BASIC, and Assembler. Set up as a portable unit in typewriter case with Gelcel battery pack. Asking $500. Chris Kosieracki, Bayview Estates, Devils Lake, ND 58301, (701) 766-4211 days or 662-3576 evenings.

FOR SALE: Ampzilla power amp. 200-watt-per-channel unit is partially constructed with about 70% of parts. Price reflects cost of parts only: $100. Also, function generator that produces variable frequency, sine, triangle, and square waves: $35. Mark Mitckes, 138 Lake Hills Dr., Oak Ridge, TN 37830, (615) 483-3113.

FOR TRADE: Apple II Plus programs: games, business, etc. Also, seeking VIC-20 software. Will trade Apple for VIC. Send listing with your name and address. Matt Taylor, 32 Casale Dr. S, Warren, NJ 07060.

FOR SALE: HP 9100A vintage programmable desk calculator. Needs repair. Operator's and programming manuals and 40 magnetic cards included. Price negotiable. E. G. Vogt, 4804 Randolph Dr., Annandale, VA 22003, (703) 750-2240.

FOR SALE: Netronics Explorer 85 with S-100 bus, 8085 microprocessor, 8K Microsoft BASIC in ROM, 4K RAM, steel cabinet with fan and power supply, and a 300 bit per second terminal that requires a video monitor. All for $300. William Davis, 2009 Evansdale Dr., Adelphi, MD 20783.

WANTED: Correspondence with 6809 users. Also, an editor/assembler that will run on a Percom SBC/9 and LFD42 under MPX/9. Any information concerning availability of such a product (or a viable alternative) will be greatly appreciated. Ken Fulton, 688 Powell Ave. #2, Morgantown, WV 26505, (304) 296-1628.

FOR SALE: VIC-20 with turtle graphics, 3K RAM, and road-race cartridges. Also, C2N datasette plus over 100 cassette programs. Joystick and paddles included. A $380 system for $350 or best offer. Stuart H. Brooks Jr., Rt. 2 Box 395, Stuarts Draft, VA 24477.

WANTED: BYTE vols. 1 to 7 plus other collections of computing journals and magazines. Send offers with shipping included. Erwin R. Carrasco, POB 567, Valdivia, Chile, South America.

FOR SALE: SS-50 (SwTPC) bus RAM boards. Two SwTPC MP/M 4K: $15 each. One Seals 68KSC 8K: $30. One DS&D 16K: $60. One Smoke Signal 16K: $75. William R. Hamblen, 946 Evans Rd., Nashville, TN 37204.

WANTED: Information from any surviving enthusiasts of Conway's game of Life. Have any new spaceships been discovered? Bring the Life story up to date. I am writing a book; credit given for contributions. Anthony Barcellos, 915 Capitol Mall, Room 435, Sacramento, CA 95814.

FOR TRADE: I would like to swap TRS-80 Color Computer games or utilities. Send a cassette containing some of your programs and I will send it back with the best of mine. Jim Ganninger, 2149 Pardoroyal, Des Peres, MO 63131.

FOR SALE: S-100 21L02 static RAM cards. Three 8K Godbout EconoRAM II boards: $40 each. One SK Processor Tech board: $40. One 4K Processor Tech board: $20. One 4K Altair dynamic board: $15. All were used in my working Altair. Ron Herman, RFD 2, Box 455K, Weare, NH 03281.

FOR SALE: S-100 memory boards. Two North Star 16K dynamic boards: $100 each. One Morrow 16K static board: $100. One Vector Graphic 8K static board: $50. Mark Sauerwald, 8085 Caminito Mallorca, La Jolla, CA 92037.

FOR SALE: Development Boards for 8051, 68000, 8048, 80C48, COSMAC, 6809. Also, Centronics 779 printer. Vic Wintriss, 254 Sunset Dr., Encinitas, CA 92024, (619) 566-3911.

FOR SALE: Three new Shugart SA400 SDSS disk drives, 35 tracks, used by Apple, Radio Shack, and others: $135 each. Joe Gunter, RR2 Box 823, Lot 125, Pompano Beach, FL 33067.

WANTED: S-100 64K static RAM board. For sale: Jade S-100 64K dynamic RAM board, fully populated. Kerry Crouse, 202 Alfred St., Bridgeport, CT 06605, (203) 852-7666.

WANTED: Laser printer to use with 8-bit (or will upgrade to 16-bit) S-100 computer. It may be new or used; I need super-quality print-out. It should also accept camera-digital input (pictures in—laser photos out). Rich Hartzog, POB 4143 XF, Rockford, IL 61110.

WANTED: Any information on an APL interpreter for the 8080 or Z80; or a copy of Nybbles' library publication, *An APL Interpreter in Pascal.* Also wanted: a source of Oume-compatible daisy wheels for generating bar code. R. Cooper, c/o J.E. Sirrine Co., 10000 Richmond, Houston, TX 77042.

WANTED: Anything related to Ohio Scientific Challenger II computer. Memory, any interfaces, cassette software, etc. Will pay top dollar for good equipment. Bill Chellberg, 448 Arlington Ave., Elmhurst, IL 60126, (312) 279-4494.

WANTED: Enhancements and expansion add-ons for IBM PC and technical-analysis programs for stockcharting for Apple II and IBM PC. Norman F. Wiss Jr., 12 Chestnut Place, Short Hills, NJ 07078.

FOR SALE: Teletype Model 33 RO Printer with TRS-232 interface and software driver on disk: $300. Shugart bare-drive Model 400 with 35 tracks on one side. $150. Jay Cox, 15 Lake Dr. E, Wayne, NJ 07470.

FOR TRADE: I would like to swap Superbrain QD utilities. Send a disk with some of your programs and I will return it with the best of mine. Normand Beaudoin, 3479-A St. Dominique, Montreal PO H2X-2X5, Canada.

FOR SALE: California Computer Systems parallel interfaces Models 7720B and 7728. Each comes with a cable and connectors. Includes documentation by CCS that explains how to interface printers and Apples. Mint condition: $80 will deliver either item plus manual; $145 will get you both. John Kundrat, 3316 4th St., Lewiston, ID 83501, (208) 746-3487.

FOR SALE: Three Base 2 16K static RAM boards for S-100 system, complete with manual. All three in good working condition for $150. I will pay shipping anywhere in the U.S. Send SASE for details. Richard Ray, 347 South Havenside Ave., Newbury Park, CA 91320, (805) 498-3878.

FOR SALE: North Star Horizon with 64K and two disk drives includes Televideo 950 terminal and Epson MX-80 printer; price negotiable. Ken Bonham, 106 Chesrown Rd., Mansfield, OH 44903, (419) 524-2142 evenings or 526-3800 days.

FOR SALE: North Star Horizon S-100 circuit boards at very low prices. Includes Z80 processor, 56K memory, and disk controller boards. Excellent condition; upgraded by 16-bits. Lots of software. Jim Haug, 1242 Sherman, Sturgis, SD 57785, (605) 347-4125 evenings.

FOR SALE: Zilog MCZ-1/70 Z80-based software-development system. Includes 64K RAM, two 8-inch drives, 10Mb Pertec, two systems disks, Beehive 100 and Infotron terminals, software, manuals, cabinet, spare power supply, and two spare drives. $18,000 new value; asking $3750 or $4500 with Okidata ML-84. Brent Regan, 2268 Redington Rd., Hillsborough, CA 94010, (415) 340-9409.

FOR SALE: HP-85 portable computer with 32K main memory, fast 32-character internal thermal printer that produces hard copy, 255 by 191 high-resolution display, and a tape drive. Both peripherals built in. Also includes Standard Pac, Games Pac, cartridges, software catalogue, application books, case, and more. Was $2400; asking $1900 or best offer. Alexander Witkowski, 6 East 97th St., New York, NY 10029, (212) 289-7578.

FOR SALE: Tektronix 4051 desktop graphics computer with RS-232C, GPIB, BASIC firmware with graphics commands, Tek hard-copy output. Includes 6-in-1 ROM pack and 22 tapes, pedestal, system-test fixture, manuals, and software: $1995. Bruce Ableidinger, 6520 Southwest Nehalem Lane, Beaverton, OR 97007, (503) 646-0670 evenings.

FOR SALE: IMSAI 8080, 22-slot motherboard, video ASCII/graphics keyboard and cassette interface, parallel and two serial RS-232C or TTL interfaces, three prototype boards, 8K protectable static RAM, keyboard, system monitor in ROM, BASIC, and documentation. First check over $700 or best offer. Jim Callahan, RR2 Box 444, Harvard, MA 01451.

FOR SALE: Two IBM Selectric typewriters with computer I/O interface ports. Full transmit/receive capability. Includes complete documentation, schematics, diagrams, etc. Packed to maintain good condition. Original cost new over $12,000 per unit; will sell for $525 each. Thad S. Shirley, POB 550, Palmdale, CA 93550, (805) 273-0105.

FOR SALE: 104-key keyboard by Control Data Corp. with typewriter-style layout, 8-bit parallel ASCII output, data, and numeric keypad. Brand new, good condition. $100 or will trade for S-100 I/O boards or 5¼-inch disk drive. Also, want video board: S-100 I/O mapped or stand-alone with RS-232C or parallel port. Russ Hersch, 8715 First Ave., 308D, Silver Spring, MD 20910, (301) 587-1799 evenings.

FOR SALE: TRS-80 Model III with two 5¼-inch disk drives, 48K RAM, and RS-232C serial interface. CTR-80 Cassette Recorder and Line Printer VIII. Includes all necessary cables and manuals with an assortment of software and accessories. Entire system, less than 2 years old for $1700, postage paid. Jim Parish, 4 Susan Lane Apt. F, Lexington Park, MD 20653, (301) 862-1217 before 3 p.m.

FOR SALE: Apple II Plus with Pascal language system, 64K, Videx Enhancer II, two disk drives, fan, and all manuals. Excellent condition: $1595 plus shipping. George J. Dawkins, (914) 382-1270.

FOR SALE: SwTPC CT-64 terminal (needs some work), CPU with 32K-bytes memory, dual disk drives (Wangco Model 82), AC-30 cassette interface, and a Centronics Model 730 80-column line printer with complete schematics and manuals. Best offer over $1000 takes all. Robert Ballard, 2731 Minot Lane, Waukesha, WI 53186, (414) 547-4073.

WANTED: Correspondence with Commodore-64 users to trade utilities, educational, home, and game programs. Also, to share experiences writing C-64 programs and using hardware and software. Roland Signett, POB 1351, Ferndale, WA 98248.

FOR SALE: Franklin Ace 1000 with 64K. Ace 10 drive with card. NEC green monitor, upper- and lowercase, auto-repeat keys, numeric pad, and a full library of software: $1800 for all. R. Rojas, 172-A, South Military Rd., Slidell, LA 70458, (504) 641-7176.

FOR SALE: Magazines from 1977 to present (with an occasional missing issue): BYTE, Personal Computing, Kilobaud Microcomputing, Interface Age, Creative Computing, ROM, and Softside. Also, several computing books for sale. Send SASE for list and prices. Henry Hoover, POB 479, Elk Grove, CA 95624.

WANTED: High school student needs used Apple IIe with disk drive, monitor, and software for $1000 or under. Also, want Timex/Sinclair with cassette recorder and software for $40 or under. Will trade software for the Commodore 64; send me your list and I'll send mine. Moritz Sell, 647 East 14th St., New York, NY 10009 (212) 533-8063.

FOR SALE: Sharp PC-1211 Pocket Computer (1.9K) with Sharp CE-122 printer/cassette interface; TI-58C with Master Library module (never used); Mini-Sensory Chess Challenger with Advanced Chess Module; and Fidelity Backgammon Challenger. All in excellent condition, in original cartons. Everything for $165 or trade for an HP-41 CV. Terry Ghetti, POB 698, Penetang, Ontario L0K 1P0, Canada.

FOR SALE: Heath H-8 with 56K (one 8K and three 16K static memory) with one spare 16K, H-19 terminal, H-17 (three drive), H-14 printer, Votrax Type n' Talk, UDS modem with Maple software; HDOS, BH BASIC, M-SOFT BASIC-80, M-SOFT FORTRAN-80, and UCSD Pascal. Includes Heath FORTRAN and Pascal courses. *Remark* magazine #9 to now, Hscoop all issues ($5000 value for $2300). Armand F. French, N675 Opal, Hayden Lake, ID 83835.

WANTED: Software and/or source (8080/Z80) for Heuristics Model S-50 Speech Analyzer and Computalker CT-1 Speech Synthesizer, any format (North Star DD CP/M or 8-inch CP/M, if possible). Also, BASIC programs to control DC Hayes MM-100. All reasonable offers considered. Send details and price. Sgt. Stanley K. London, FR554-19-1071, AFI (Air Forces Iceland), Box 205, FPO New York, 09571.

FOR SALE: Cromemco 16FDC floppy disk controller. Mixed 8-and 5¼-inch drives, 8- or 16-bit. Modified to work with Seattle Computer Products 8086 CPU (IEEE-696) and still usable with 8-bit S-100 systems. Includes 16FDC, full documentation (including modifications), and an SCP 8086 CPU boot EPROM: $199 plus shipping. G. Horgan, 981 Wild Plum Dr., Klamath Falls, OR 97601, (503) 884-6631.

FOR SALE: Back issues of BYTE, Kilobaud Microcomputing, Radio Electronics, Popular Electronics, Robotics Age, Creative Computing, and others. $1 each for BYTE, 75 cents each for all others. Also, many electronics books and college texts. Send SASE. Kevin Hansen, 903 G St., Box 157, Eagle, NE 68347.

FOR SALE: Microtek MT80P printer: $250. Microterm Act-I terminal: $100. SwTPC 6800 with 44K, two serial and one parallel interface computer: $425. SwTPC AC30 cassette interface: $50. Send for details. Jim Hall, 2063 108th Ave., Otsego, MI 49078, (616) 694-9760.

FOR SALE: Back issues of BYTE, 1/80 to present; missing 5/80 and 6/82. Wish to sell in large blocks. $3.50 per issue plus shipping. Dan Starr, 367 Franklin Ave., Princeton, NJ 08540, (609) 924-4583.

FOR SALE: Digital Group SD Disk Controller without drives: $100. Two DG 8K static RAM boards: $45 each. DG Z80card: $75. S-100 Morrow 32K static RAM: $225. Two 8-inch drive cabinets without drives, power supply, or cables: $10 each. Dennis Ellis, POB 25334, Colorado Springs, CO 80936, (303) 594-6199 after 5 p.m.

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The Top Five For the August BOMB

James Joyce takes first place in the August BOMB for his article entitled "A C Language Primer, Part 1: Constructs and Conventions." He wins the $100 bonus. Second-place winners are Stephen C. Johnson and Brian W. Kernighan, who wrote "The C Language and Models for Systems Programming." They will divvy up the $50 prize. Steve Ciarcia earns third place for "Build a Power-Line Carrier-Current Modem." The fourth-place winner is Jerry Pournelle for his User's Column about the "Epson QX-10, Zenith Z-29, CP/M-68K, and More," and David Fiedler takes fifth place with the first part of "The Unix Tutorial: An Introduction to Features and Facilities." Congratulations to these authors from their readers.

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